



SCHOOL OF
MATERIALS
SCIENCE AND
ENGINEERING

23-25 JULY 2026

Hanoi, Vietnam

ICPMAT - ICAMT 2026

The 20th International Conference on the Physical Properties and
Application of Advanced Materials

In conjunction with The 2nd International Conference on Advanced
Materials and Technologies

ABSTRACT BOOK

VENUE

TQT 2 Hotel - Nha Khach Tong Lien Doan
95 Tran Quoc Toan, Hoan Kiem District, Hanoi

ACADEMIC FOCUS

Advanced materials, physical properties,
technologies and sustainable materials
development

Functional Materials

Structural Materials

Metallurgical Engineering

Computational Materials Science

Material related technology

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ICPMAT - ICAMT 2026

**The 20th International Conference on The Physical Properties
and Application of Advanced Materials (ICPMAT 2026)
The 2nd International Conference on Advanced Materials and
Technologies (ICAMT 2026)**

Abstract Book

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DATE: 23-25th July, 2026

VENUE: TQT 2 Hotel, 95 Tran Quoc Toan, Hoan Kiem, Hanoi, Vietnam

Summary

Presentation type	Topic	Number of papers
Plenary Lecture	-	3
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ICPMAT-ICAMT 2026 Conference Statistics

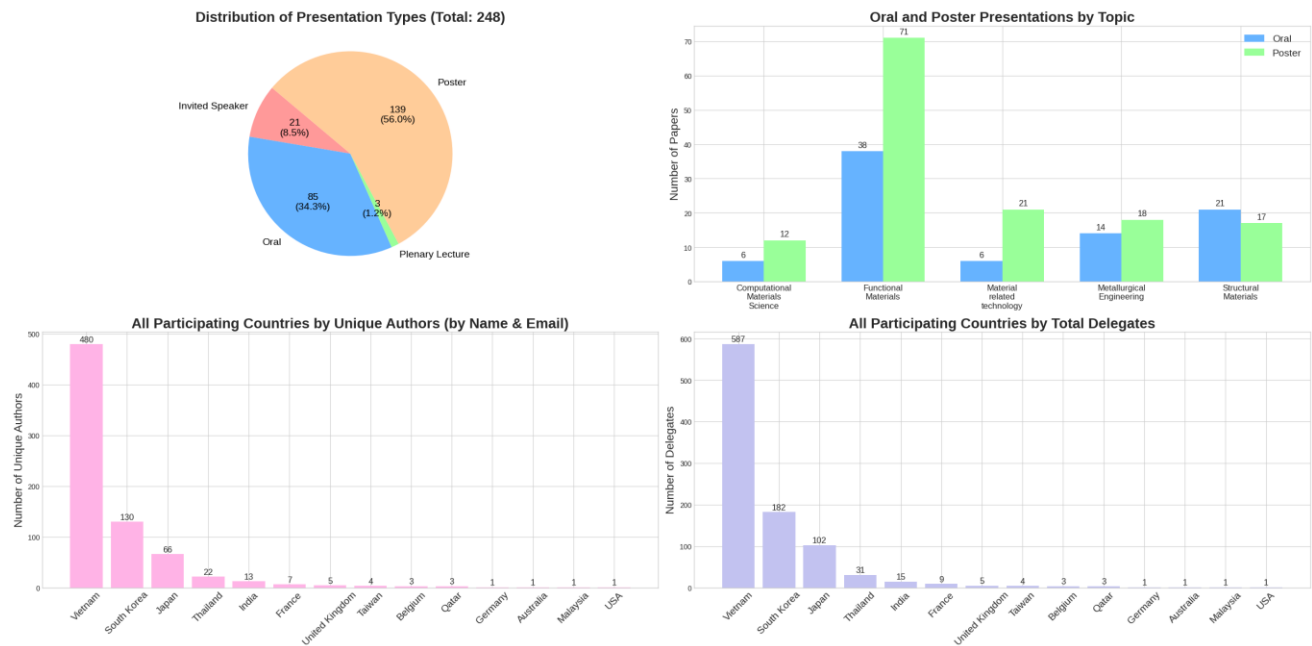


Figure 1. Summary statistics for ICPMAT-ICAMT 2026. The data highlights the conference's international scope and academic diversity, featuring 248 scientific contributions from 592 unique authors across 14 countries, spanning core areas of advanced materials science and engineering.

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1. Plenary Lecture

PL-01 [229]: Probing unique nano-scale microstructural features in LBPF processed alloys to explore their potential influence on mechanical behavior

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Abstract:

Additive manufacturing of metallic components, specifically Laser Bed Powder Fusion (LBPF) has been widely explored due to its unique ability to fabricate complex-shaped components directly compared to conventional powder metallurgy or casting processes. To date, the vast majority of LBPF research activities have primarily focused on mechanical engineering aspects, particularly on optimizing processing parameters to archive diredred or enhanced mechanical properties, as well as minizing inherent flaws of laser-based techniques (e.g., lack of fusion, porosity) and their effect on mechanical behavior.

In contrast, materials science perspectives – particularly in-depth understanding of microstructure down to nanoscale under localized, non-equilibrium conditions involving rapid melting and solidification - remains insufficiently explored.

This talk will focus on the materials science aspects of LBPF and will begin with several successful examples of microstructure control in grain scale, followed by our recent nanoscale investigations using a combination of scanning electron microscopy (SEM) and transmission electron microscopy (TEM). In particular TEM observations reveal various structural inhomogeneity, nanoscale precipitation, and defects – solute interactions that are not detectable by SEM. These investigations provide a foundation for establishing clear relationships among processing, microstructure, and performance in additively manufactured metallic components.

Keywords: Microstructure Characterization; Electron Microscopy; Laser Bed Powder Fusion; Mechanical Behavior

PL-02 [215]: Memristors for neuromorphic computing hardware

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Abstract:

In conventional von Neumann architecture computing, a major bottleneck exists between the processor and memory, leading to high power consumption. To overcome this limitation, neuromorphic computing, which mimics the human brain, has emerged as a promising solution. Just as synapses in the brain perform both memory and computation simultaneously, researchers are developing neuromorphic hardware that uses memristors as artificial synapses and neurons. These devices can store multiple resistance states at low power, which are then used for computation. Our research team is focusing on new materials to overcome the limitations of amorphous metal oxides, which are commonly used in existing memristors. Amorphous

metal oxides operate via a conductive filament mechanism, which results in asymmetric and non-linear synaptic weight modulation. This leads to low accuracy in parallel computing and poor energy efficiency.

To address this, our team has utilized halide perovskite materials, which have high ion mobility. While conventional organic-inorganic hybrid perovskites suffered from moisture instability and low reliability, the researchers developed a vertically aligned 2D halide perovskite. This device operates stably in the air for several months. By providing a uniform ion migration pathway, this new material enables highly linear and symmetric synaptic weight modulation.

This breakthrough significantly enhances the accuracy and energy efficiency of AI computations.

Keywords: neuromorphic computing; memristors; perovskite; synapse; linearity

PL-03 [95]: Molecularly Engineered Low-Dimensional Photocatalysts for Solar Fuel Production

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Abstract:

Efficient solar-fuel production requires photocatalysts that harvest not only ultraviolet and short-wavelength visible light, but also the red and near-infrared regions that dominate the solar spectrum. Single-walled carbon nanotubes (SWCNTs) and transition metal dichalcogenides (TMDs) are attractive light absorbers for this purpose; however, their strongly bound excitons must be converted into mobile charges before they can drive chemical reactions. We have addressed this problem by constructing molecularly engineered mixed-dimensional heterojunctions at nanomaterial interfaces.[1-8] Fullerodendron-modified SWCNTs form water-dispersible coaxial SWCNT/C₆₀ nanohybrids that promote exciton dissociation and photocatalytic H₂ evolution, including long-wavelength reactions driven by chirality-dependent SWCNT absorption.[1,2,5] These nanocarbon hydrogen-evolution photocatalysts were first incorporated into a particulate Z-scheme water-splitting system with BiVO₄ and [Co(bpy)₃]^{3+/2+}, giving solar H₂ and O₂ evolution with an STH efficiency of 0.09%.[2] In our latest work, the concept is advanced to a more robust SWCNT/WO₃ Z-scheme system mediated by I₃⁻/I⁻. Under AM 1.5G simulated sunlight and without sacrificial reagents or external bias, the optimized system produces H₂ and O₂ stoichiometrically at 15.2 and 7.6 μmol h⁻¹, respectively, corresponding to an STH efficiency of 0.08%.[9] This result establishes SWCNT/metal-oxide Z-scheme photocatalysis as a promising route toward full-solar-spectrum artificial photosynthesis.

The same interface-design principle also enables dye-encapsulated SWCNT photocatalysis. Photoinduced electron transfer from dyes inside SWCNTs to acceptors outside the nanotube affords efficient visible-light H₂ evolution,[1,4] and dye@CNT/C₆₀-dendron nanohybrids further achieve visible-light ammonia decomposition to N₂ and H₂ in a stoichiometric 1:3 ratio.[7] Beyond CNTs, the strategy can be extended to TMDs: MoS₂/anthracene hybrids show long-lived charge separation, [3] while MoSe₂/C₆₀-dendron nanohybrids use the A- and B-excitons of MoSe₂ for photocatalytic H₂ evolution.[8] Together, these studies demonstrate that molecular interface engineering is a general strategy for converting excitons in low-dimensional nanomaterials into solar-fuel chemistry.

Keywords: carbon nanotubes; transition metal dichalcogenides; artificial photosynthesis; water splitting; ammonia decomposition

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2. Invited Speaker

IS-03 [59]: Origin of Recrystallization in Low Pre-Strained Single-Crystal Ni-based Superalloys

Authors: Anh Hoang Pham^{1,3,4,*}, Mitsuaki Takemoto², Kei Kodera^{2,4}, Satoshi Utada⁴, Yuanbo Tony Tang⁵, Shigekazu Morito^{1,3}, Graham McCartney⁶, Catherine Rae⁷, Roger Reed^{3,6,8}

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Abstract:

Recrystallization (RX) triggered by low macroscopic strains remains a critical challenge for the processing and rejuvenation of single-crystal (SX) Ni-based superalloys. While post-mortem studies have proposed various RX mechanisms, the lack of direct experimental observation has prevented researchers from verifying these theories and determining the dominant mechanism needed to suppress RX in such circumstances. This study uncovers the origin of RX in SX alloys by tracking its transition from surface-initiated events to rare bulk nucleation using in-situ and correlative ex-situ microscopy.

Initially, utilizing in-situ high-temperature laser scanning confocal microscopy, we demonstrate that RX is normally a surface-driven phenomenon. When surface damage is removed, RX nucleation is significantly limited, proving that bulk nucleation requires highly localized driving forces.

To capture these rare bulk events, we developed a correlative interrupted heat treatment technique. By coupling in-situ microscopy with correlative ex-situ EBSD, we recorded the microstructural evolution of the same regions of interest across sequential thermal cycles, providing direct evidence of the RX nucleation process.

Our findings reveal that, for the experimental conditions employed, bulk RX nucleates exclusively at solidification pores, which act as localized strain regions. Direct tracking shows that sharp orientation gradients around these pores drive subgrain coalescence and rotation, aided by preferential γ' dissolution at the pore's free surface. Subsequently, the newly formed RX grain expands rapidly via a twin-dominated growth mechanism, consuming the locally strained matrix. By providing direct visualization of these microstructural evolution stages, this study conclusively links the origin of RX following low pre-strain to localized strain amplification at free surfaces and internal porosity.

Keywords: Recrystallization; Nucleation Mechanism; Low Pre-Strain; Solidification Pores; Single-Crystal Superalloy; In-situ Microscopy

IS-05 [54]: Alumina-based Refractories from Industrial Waste of Aluminum Molten Processes

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Abstract:

Recently, usage of aluminum alloys has been expanded in transportation industries such as automobiles and airplanes to decrease their weights to decrease CO₂ emission. As well, recycling aluminum alloys has been also required to reduce in CO₂ emission in life cycle of aluminum alloys.

During molten processes of aluminum alloys at high temperatures, aluminum dross is produced as an industrial waste. According to AL Circle [1], the world aluminum industry generated more than 4 million tons of aluminum dross in 2024. Aluminum dross includes mainly aluminum oxides and hydroxide, as well as metallic aluminum. As minor materials, magnesium and calcium oxides, aluminum nitride are included as well as halides from flux. We propose recycling of aluminum dross to alumina-based refractories such as heat-resistant bricks. As-received aluminum dross was water-treated to remove halides and stabilize aluminum nitride and metallic aluminum.

Conducting heat treatment and milling process, aluminum dross becomes starting materials for alumina-based refractories. We successfully obtained porous bricks, dense bricks and alumina-based porous filters. As well, alumina-based compounds such as aluminum-magnesium spinel can be produced from mixing between aluminum dross and magnesium oxide powder. Aluminum dross ceramics are comparable in thermal and mechanical properties with porous ceramics made of industry-graded alumina powder.

Keywords: Refractories; Alumina; Aluminum Dross; Sintering

IS-19 [263]: Electrocatalyst Design Strategy for Efficient Hydrogen Production

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Abstract:

Hydrogen is expected to play a pivotal role in building a carbon-neutral energy system, but its practical large-scale production still depends on making electrolysis both more energy-efficient and more durable. From this perspective, alkaline electrolysis is highly attractive because of its low cost and reliance on earth-abundant materials, yet its broader implementation is hindered by the slow oxygen evolution reaction (OER) and the limited stability of anodic catalysts. In this presentation, I will introduce our recent strategies to overcome these bottlenecks through the design of advanced electrocatalysts. For water oxidation, we developed LDH-based OER catalysts that improve reaction kinetics and operational durability by tuning the electronic structure, facilitating interfacial charge transfer, and strengthening structural integrity under alkaline conditions. These efforts are aimed not only at enhancing catalytic performance, but also at making alkaline hydrogen production more practical for long-term operation. Beyond conventional water electrolysis, I will also present an alternative route toward lower-energy hydrogen production through the

urea oxidation reaction (UOR). Unlike the LDH systems designed for OER, this approach employs a MOF-based catalyst in which conductivity engineering and dynamically generated active sites enable rapid formation of the NiOOH-derived active phase, efficient charge transport, and low-voltage urea-assisted electrolysis.

Keywords: OER; UOR; Electrocatalysts; Hydrogen

IS-01 [253]: Microstructural Characterization and Thermal Stability of CrAlN/SiCN Nanocomposite Coatings

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Abstract:

CrN/SiCN coatings have attracted attention as protective coatings for cutting tools because of their high hardness and excellent wear resistance. However, under high-temperature cutting conditions, crater wear caused by the diffusion of Fe from the work material into the coating remains a significant issue. In this study, Al was introduced into CrN/SiCN coatings to improve thermal stability and suppress Fe diffusion. CrAlN/SiCN nanocomposite coatings with different Al contents were synthesized using a reactive sputtering process in a facing-target-type magnetron sputtering system, and their microstructure, mechanical properties, thermal stability, and oxidation resistance were investigated.

The as-deposited (Cr_{0.69}Al_{0.31})N/SiCN coating exhibited excellent mechanical properties, with an indentation hardness of approximately 35 GPa and a Young's modulus of 340 GPa. After heat treatment at 1100 K for 1 h in vacuum, the hardness was further improved, while only a slight decrease was observed after heat treatment in air. SEM-EDS analysis and TEM/STEM observations revealed that Al addition effectively suppressed oxidation and Fe diffusion compared with conventional CrN/SiCN coatings. Furthermore, the formation of reaction products such as Fe–Si and Cr–C compounds was significantly reduced, and grain coarsening was minimized even after high-temperature exposure.

These findings demonstrate that the incorporation of Al is highly effective in improving the thermal stability and oxidation resistance of CrN/SiCN-based coatings. The (Cr_{0.69}Al_{0.31})N/SiCN nanocomposite coating exhibits a favorable combination of high hardness, resistance to Fe diffusion, and structural stability at elevated temperatures, making it a promising candidate for next-generation cutting tool protective coatings operating under severe machining conditions.

Keywords: Chromium aluminum nitride (CrAlN) coatings; Silicon carbon nitride (SiCN) coatings; Heat treatment; Scanning transmission electron microscopy (STEM); Nanoindentation

IS-04 [125]: Discontinuous Deformation in Metals at Ultra-cryogenic Temperature

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Abstract:

Low temperature discontinuous deformation (i.e., low temperature serrated deformation, LTSD) occurring at ultra-cryogenic temperatures is caused by plastic instability and localized-deformation band propagation, which can result in sudden failures or catastrophic accidents. Therefore, understanding LTSD is crucial for ensuring material stability and reliability in a cryogenic environment. However, despite its importance, our understanding of LTSD remains insufficient because it is challenging to prove experimentally. Here we report novel LTSD mechanisms, namely a thermally-induced dislocation-dynamics model. The origin of LTSD is considered to be the unique framework of dislocation behavior under severely limited thermal-vibration energy at 15 K, from which hierarchical dislocation networks and multiple lattice defects are established. In addition, the localized-heating generated from dislocation avalanches induces multiple types of LTSD and gives rise to transitions from heterogeneous to homogeneous deformation.

Our findings highlight the rate-dependent nature of LTSD and negative strain-rate sensitivity in the strength-elongation relation and include the first observation of changes in small stress fluctuations and their relationship to the changes in larger serrations.

Keywords: Cryogenic temperature; Serrated deformation; Negative strain-rate sensitivity

IS-06 [15]: Unusual behaviour of Martensite: From Hard Phase to Plasticity Carrier

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Abstract:

Martensite in steels exhibits complex mechanical responses that extend beyond conventional strengthening paradigms. This talk addresses three unconventional aspects spanning thermal and deformation-induced martensite. In thermally formed martensitic steels, solute segregation is shown to significantly influence yield strength under ultra-low strain rate conditions ($\sim 10^{-6} \text{ s}^{-1}$), highlighting rate-sensitive strengthening mechanisms. In addition, in-situ synchrotron X-ray diffraction shows that fully martensitic steels can sustain near steady-state plastic flow beyond necking, with signatures of room-temperature dynamic recovery. Extending this perspective, deformation-induced martensite in TRIP-assisted steels is not merely a hard phase but an active carrier of plasticity: at early stages, it accommodates significant deformation through transformation-assisted mechanisms, delaying localization. With increasing strain, subsequent hardening promotes strain redistribution toward ferrite. These results collectively highlight the intrinsic deformability of martensite and its evolving role in governing strength, ductility, and damage evolution in steels.

Keywords: Thermal martensite; Transformation-induced plasticity (TRIP); Deformation-induced martensite; In-situ synchrotron X-ray diffraction; Post-necking behavior

IS-07 [85]: Self-Powered Electronic Devices Enabled by Solar Steam-Induced Electricity

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Abstract:

Solar-driven steam generation has attracted significant attention as a sustainable approach for energy conversion and environmental remediation. This work presents recent advances in solar-to-steam-induced electricity generation based on evaporation-driven water flow integrated with nanogenerators. The system enables simultaneous energy harvesting and water purification without requiring external pressure or complex infrastructure. We highlight key material strategies and device designs to enhance photothermal conversion efficiency, salt rejection in desalination, and stable all-weather operation. In addition, the technology demonstrates promising applications in rapid clean-up of highly viscous crude oil spills in seawater. Overall, solar steam-induced systems offer a multifunctional and scalable platform for addressing critical challenges in energy, water, and environmental sustainability. Future work will focus on system scale-up and hybrid renewable energy integration.

Keywords: Solar to steam; Electricity; Carbon materials; Clean water.

IS-08 [105]: Programmable Patterning of Reconfigurable Surface Microdroplets

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Abstract:

Surface-bound liquid crystal (LC) microdroplets are promising optical platforms that can manipulate the characteristics of incident light via external stimuli, finding numerous optical applications. However, achieving organized arrays of LC microdroplets on a large scale remains a key challenge. Herein, we present a simple and versatile strategy to form LC microdroplets on surfaces with precisely defined sizes, densities, and lateral organization. We demonstrate that a heating and cooling cycle of a polymer matrix causes the diffusion and phase separation of LCs, leading to the nucleation and growth of LC microdroplets on surfaces. The size and number density of the microdroplets can be controlled via temperature parameters. In particular, the nucleation sites of LC microdroplets are found to be closely correlated with the LC-surface interfacial tension. Therefore, by utilizing photo-sensitive surfaces, we can instantly form a multitude of LC microdroplets of specific sizes at pre-programmed locations. Moreover, the size, location, and internal organization of the LC microdroplets are reconfigurable, providing new active elements for existing and novel applications of surface microdroplets.

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (RS-2023-00302586, RS-2023-00212739, and RS-2024-00411809)

Keywords: Microdroplet; Liquid Crystal; Surface Patterning; Microlens

IS-09 [201]: Severe plastic deformation of aluminum anodes for high-performance aluminum-air batteries

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Abstract:

The global transition toward renewable energy requires advanced energy storage systems with high energy densities and low production costs. Among various candidates, metal-air batteries have attracted significant attention due to their exceptionally high theoretical energy densities and environmental compatibility. In particular, aluminum-air (Al-air) batteries demonstrate strong potential for commercialization because aluminum is inexpensive, abundant, and environmentally benign. However, widespread commercialization remains challenging due to severe anodic corrosion, which reduces anode utilization efficiency and limits battery lifespan. To address these issues, severe plastic deformation (SPD) techniques were implemented to fabricate aluminum anodes with enhanced electrochemical performance. The SPD methods employed in this study include equal-channel angular pressing (ECAP), friction stir processing (FSP), severe cold rolling, and cold spray processing. The results revealed that SPD significantly refined the microstructure, reducing the average grain size from several hundred micrometers to below 10 μm , and in some cases to the ultrafine-grained regime of less than 1 μm . This grain refinement altered the corrosion behavior of the aluminum anodes from localized pitting in coarse-grained structures to more uniform intergranular corrosion in fine- and ultrafine-grained structures. Consequently, the aluminum anodes exhibited improved utilization efficiency, leading to enhanced energy density. The electrochemical performance of aluminum anodes fabricated using different SPD techniques, together with their scalability, is compared and discussed. The findings highlight the potential of SPD-based microstructural engineering for developing high-performance and commercially viable Al-air battery systems.

Keywords: Severe plastic deformation; Microstructure modification; Aluminum anode; Metal-air battery

IS-10 [252]: Synthesis and Application of Single-Atom-Doped Heterostructured Electrocatalysts for Green Hydrogen Production and Energy Conversion

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Abstract:

The rapid depletion of fossil fuels and the continuous increase in carbon dioxide (CO_2) emissions have accelerated the global transition toward sustainable and carbon-neutral energy technologies. Among various renewable energy carriers, green hydrogen produced via water electrolysis powered by renewable energy sources has emerged as a promising solution due to its high energy density, environmental compatibility, and integration potential with fuel-cell technologies. However, the widespread deployment of water electrolysis remains hindered by the sluggish kinetics of the hydrogen evolution reaction (HER) and oxygen

evolution reaction (OER), together with the high cost and limited availability of noble-metal-based electrocatalysts. To address these challenges, extensive efforts have been devoted to developing alternative catalytic materials, including alloys, high-entropy alloys, transition-metal phosphides, carbides, sulfides, and oxides. Nevertheless, many of these catalysts still suffer from insufficient intrinsic activity, limited long-term durability, and structural instability under harsh operating conditions. Therefore, the rational design of highly efficient and robust electrocatalysts remains a critical research priority for sustainable hydrogen production. In this work, we report the synthesis and application of advanced single-atom-doped heterostructured electrocatalysts through synergistic interface engineering, heteroatom incorporation, and electronic structure modulation. By integrating atomically dispersed active centers with multifunctional heterointerfaces, the resulting catalysts exhibit enhanced active-site utilization, accelerated charge-transfer kinetics, enlarged electrochemically active surface areas, and optimized adsorption/desorption energetics of reaction intermediates. Consequently, the developed catalysts demonstrate outstanding HER and OER activities in alkaline media, enabling overall water splitting at cell voltages below 1.55 V at practical current densities. Furthermore, when employed in alkaline water electrolyzer systems, the catalysts achieve industrially relevant performance with cell voltages below 1.90 V at 1 A cm⁻² and retain more than 90% of their initial activity after 1000 h of continuous operation. These results highlight the effectiveness of single-atom doping and heterostructure engineering in constructing next-generation electrocatalysts for efficient hydrogen production and renewable energy conversion. This work not only provides a scalable strategy for the development of high-performance electrocatalysts but also offers fundamental insights into the structure–activity relationships governing electrochemical energy-conversion processes.

Acknowledgements: This research was supported by the Regional Innovation System & Education (RISE) program through the Jeonbuk RISE Center, funded by the Ministry of Education (MOE) and the Jeonbuk State, Republic of Korea.

Keywords: Green hydrogen; Water electrolysis; Heterostructure catalysts; Interface engineering; Electronic structure modulation, Doping; Renewable energy

IS-11 [254]: Advanced and Innovative Materials Engineering for High-Efficiency, Low-Cost Energy Storage and Conversion Technologies

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Abstract:

The growing global demand for reliable, affordable, and clean energy continues to drive intensive research into large-scale energy storage and conversion technologies capable of accommodating the inherent variability of renewable energy sources. Despite significant progress, the high cost of many emerging technologies remains a major barrier to widespread deployment, particularly for communities and large-scale energy systems. Addressing this challenge requires innovative advances in materials science and engineering that simultaneously improve performance and reduce production costs.

Our research aims to develop advanced materials and engineering strategies to enhance the efficiency and cost-effectiveness of key energy storage and conversion technologies, with a particular focus on green hydrogen production through water electrolysis and vanadium redox flow batteries (VRFBs).

In the field of water electrolysis, we introduce an innovative electrode configuration designed to improve active surface area, gas release kinetics, intrinsic catalytic activity, and mechanical robustness under practical membrane – electrode assembly fabrication and operating conditions. This approach enables a reduction of approximately 20% in system costs and up to 30% in the overall cost of green hydrogen production.

In parallel, we also advance VRFB technology through the development of a self-thermostable electrolyte material. The electrolyte enables stable battery operation under extreme conditions, including elevated temperatures up to 55 °C and prolonged cycling exceeding 100 cycles, without the need for active cooling systems. Eliminating active thermal management significantly reduces system complexity and cost, leading to an estimated 15–25% reduction in the overall cost of VRFB systems.

Collectively, these innovations contribute to improving the economic viability and scalability of hydrogen and flow battery technologies, supporting their broader adoption in renewable energy storage and conversion markets

IS-12 [257]: Bio-Inspired Electronics Enabling AI Signal-Processing

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Abstract:

This presentation introduces an AI signal-processing hardware platform that emulates the stimulus–response function of the biological nervous system, based on charge transport engineering (ion migration and trap engineering). We first validate synaptic plasticity in InP-quantum-dot–embedded IGZO photonic synapses under optical stimuli and reveal a mid-gap trap-mediated recombination mechanism. We then present a method to precisely tune synaptic responses by leveraging ion penetration and release kinetics at electrolyte/semiconductor interfaces. In particular, we engineer MOF-based ion-regulating interlayers by tailoring pore diameter and ion affinity. The resulting devices exhibit enhanced short- and long-term plasticity and provide a strategy for on-device information processing. Finally, we demonstrate a signal-integration system incorporating an artificial-neuron circuit that exhibits parallel computation and signal summation properties. Taken together, the results indicate compatibility with BEOL-friendly processing, scalability across metal-oxide and porous-framework materials, and a feasible pathway toward nerve–machine interfaces and neuroprosthetic applications.

Keywords: artificial synapse; metal-oxide semiconductors; ion/trap behavior engineering; nerve–machine interface

IS-13 [48]: Chirality and Angular Momentum of Phonons Probed by Circularly Polarized Raman Spectroscopy

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Abstract:

Phonons with angular momentum have recently attracted significant attention due to their fundamental role in light-matter interaction and symmetry-dependent phenomena in solids. In this study, we investigate the relationship between chirality and phonon angular momentum using circularly polarized Raman spectroscopy in a range of material systems with distinct symmetry properties.

In the chiral crystal α -HgS, we observe phonon modes exhibiting well-defined pseudo-angular momentum, consistent with symmetry-imposed selection rules for circularly polarized light. The results demonstrate the realization of chiral phonons that break improper rotational symmetry and carry angular momentum [1].

In contrast, centrosymmetric NiTiO_3 provides a platform where phonon angular momentum exists without structural chirality. We detect Raman optical activity as a circular intensity difference between opposite helicities, indicating the presence of angular-momentum-carrying phonons in an achiral system. This highlights that phonon angular momentum does not necessarily imply chirality [2].

Furthermore, in pyrite FeS_2 , we extend this framework to systems hosting higher-order multipolar symmetry. We observe facet-dependent sign reversals in circularly polarized Raman signals, which are consistent with the presence of electric toroidal octupolar symmetry. These results reveal that phonon angular momentum can couple to hidden multipolar degrees of freedom beyond conventional dipolar or ferroaxial descriptions [3].

Together, these results establish a unified experimental framework for probing phonon angular momentum and its connection to chirality across different symmetry classes.

Circularly polarized Raman spectroscopy emerges as a powerful tool to distinguish between chiral and nonchiral phonons carrying angular momentum and to uncover symmetry-protected phononic responses in solids.

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Keywords: chiral phonons; phonon angular momentum; Raman optical activity; circular polarization

IS-14 [268]: Resistive Switching Characteristics of Halide Perovskite-Based Memory Devices

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Abstract:

Halide perovskites have recently attracted significant attention as promising materials for next-generation resistive random-access memory (ReRAM) devices owing to their excellent ionic conductivity, low-temperature processability, and tunable electrical properties. In particular, the migration of halide ions and the dynamic behavior of ionic vacancies within the perovskite lattice enable the formation and rupture of conductive filaments, leading to stable resistive switching characteristics. In this study, we investigate the

switching mechanism of halide perovskite-based resistive memory devices and explore the effects of electrode and interface engineering on memory performance. By employing an asymmetric electrode configuration, the electric field distribution and ion migration behavior are effectively controlled, resulting in improved switching uniformity and reduced operating voltage variation. The fabricated devices exhibit a high ON/OFF resistance ratio, reliable endurance, and stable retention characteristics. Electrical characterization further reveals that the resistive switching behavior is closely associated with ion migration-induced conductive pathway formation. These findings demonstrate the potential of halide perovskite-based ReRAM devices for future low-power, high-density non-volatile memory and neuromorphic computing applications

Keywords: Halide perovskite; Resistive random-access memory (ReRAM); Resistive switching; Ion migration; Conductive filament

IS-15 [270]: Electrically Conductive MOF-Based Gas Sensing under Light Activation

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Abstract:

Recently, electrically conductive metal–organic frameworks (cMOFs) have attracted increasing interest as gas-sensing platforms because of their large surface areas, high porosity, accessible catalytic sites, and intrinsic conductivity under room-temperature conditions. Their modular chemistry, including tunable metal nodes and organic linkers, also enables the development of diverse cMOF compositions, making them suitable for multi-compositional sensor array applications. cMOFs, however, sometimes show incomplete recovery toward strongly adsorbing gases such as NO₂, while their responses to weakly interacting gases, including many volatile organic compounds, are often limited.

Photoactivation has recently been explored as an effective approach to mitigate these issues. Most cMOFs consist of anisotropic two-dimensional frameworks, in which electrical transport is governed by in-plane d– π conjugation together with interlayer π – π interactions. These structural and electronic features create multiple energy levels that can participate in photoinduced charge generation. As a result, light irradiation can improve recovery behavior and enhance gas response, depending on the interaction between the target gas and the cMOF surface.

In this presentation, we discuss our recent advances in light-activated cMOF gas sensors designed to overcome the intrinsic limitations of room-temperature operation. We further introduce band-alignment strategies to enhance the efficiency of light activation. Finally, we demonstrate the integration of cMOF sensing layers with μ LED substrates for compact, low-power devices, together with pattern-recognition-based sensing, suggesting their potential for future electronic-nose systems.

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Keywords: Conductive metal-organic frameworks; Light-activations; Room-temperature gas sensors; Reversibility; Electronic-nose

IS-16 [272]: Development of high-performance p-type Transistors

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Abstract:

Developing high-mobility p-type oxide semiconductors that can be grown using silicon-compatible processes at low temperatures, has remained challenging in the electronics community to integrate complementary electronics with the well-developed n-type counterparts. This presentation will discuss our recent progress in developing high-performance p-type semiconductors as channel materials for thin film transistors. For the first part of my talk, I present an amorphous p-type oxide semiconductor composed of selenium-alloyed tellurium in a tellurium sub-oxide matrix, demonstrating its utility in high-performance, stable p-channel TFTs, and complementary circuits [1]. Theoretical analysis unveils a delocalized valence band from tellurium 5p bands with shallow acceptor states, enabling excess hole doping and transport. Selenium alloying suppresses hole concentrations and facilitates the p orbital connectivity, realizing high-performance p-channel TFTs with an average field-effect hole mobility of $\sim 15 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ and on/off current ratios of 10^6 – 10^7 , along with wafer-scale uniformity and long-term stabilities under bias stress and ambient aging.

Tin (Sn^{2+}) halide perovskites emerge as promising p-type candidates but suffer from low crystallisation controllability and high film defect density, which result in uncompetitive device performance. In the second part of my talk, I would like to introduce a general overview and recent progress of our group of p-type Sn-based metal halide perovskites for applying field-effect transistors (FETs). I will mainly address inorganic perovskite thin-film transistors with exceptional performance using high-crystallinity and uniform cesium-tin-triiodide-based semiconducting layers with moderate hole concentrations and superior Hall mobilities, which are enabled by the judicious engineering of film composition and crystallization. The optimized devices exhibit high field-effect hole mobilities of over $50 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$, large current modulation greater than 10^8 , and high operational stability and reproducibility [1,2]. Next, I will introduce A-site cation engineering method to achieve high-performance pure-Sn perovskite thin-film transistors (TFTs). We explore triple A-cations of caesium-formamidinium-phenethylammonium to create high-quality cascaded Sn perovskite channel films, especially with low-defect phase-pure perovskite/dielectric interface. As such, the optimized TFTs show record hole mobilities of over $70 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ and on/off current ratios of over 10^8 , comparable to the commercial low-temperature polysilicon technique level [3]. The p-channel perovskite TFTs also show high

processability and compatibility with the n-type metal oxides, enabling the integration of high-gain complementary inverters and rail-to-rail logic gates.

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Keywords: Oxide Semiconductor; Tellurium oxide; Halide perovskite; pMOS; thin film transistor; hole mobility

IS-17 [86]: Fluorinated Ether-Anchored Solid Polymer Electrolyte for Wide-Temperature Lithium Metal Batteries

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Abstract:

Solid polymer electrolytes (SPEs) have attracted considerable attention for next-generation lithium metal batteries owing to their inherent safety, flexibility, and compatibility with scalable fabrication processes. However, the practical implementation of SPEs is still hindered by sluggish ionic transport and unstable electrode/electrolyte interphases, particularly under low-temperature conditions.

Herein, we report a fluorinated ether-anchored polymer electrolyte (FAPE) based on a PEGDME semi-interpenetrating polymer network for wide-temperature solid-state lithium metal batteries. The fluorinated ether units interact with PEGDME chains through C–H···O interactions, suppressing polymer crystallization and weakening Li⁺–ether coordination. This molecular anchoring strategy promotes anion-enriched solvation structures and facilitates the formation of stable inorganic-rich interphases on both lithium metal anodes and high-voltage cathodes.

Consequently, the optimized FAPE electrolyte exhibits enhanced ionic conductivity, improved Li⁺ transference behavior, intrinsic nonflammability, and widened electrochemical stability. In particular, the electrolyte delivers stable ionic conduction even at sub-zero temperatures and enables highly reversible lithium plating/stripping with prolonged cycling stability.

Solid-state full cells employing LiFePO₄ and NMC₈₁₁ cathodes demonstrate superior rate capability and long-term cycling performance compared with conventional PEGDME-based electrolytes. Furthermore, pouch-type cells maintain stable operation under both ambient and low-temperature environments, highlighting the practical applicability of the proposed electrolyte system. These findings provide an effective molecular-level strategy for regulating solvation chemistry and interfacial stability in solid polymer electrolytes toward safe and durable high-energy lithium metal batteries.

Keywords: Solid polymer electrolyte; Lithium metal battery; Fluorinated ether; Low temperature operation

IS-18 [275]: Bilayer Oxide Semiconductors with Catalytic Overlayers: Toward Artificial Olfaction for Humanoid Robots

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Abstract:

Oxide-based chemiresistors have been widely investigated and applied to detect gases due to their advantages such as high response, simple structure, facile miniaturization, and fast response time. With rapid progress in sensor networks and computing technologies, the applications of gas sensors have expanded into various fields such as medical diagnoses, environmental monitoring, food quality assessment, and electronic nose.

Although considerable efforts have been devoted to enhancing gas-sensing performance through the loading or doping catalysts, the detectable analyte gases are still insufficient for use in new applications and high-performance electronic noses. Moreover, the resistance of catalyst-loaded or doped sensors often becomes excessively high to be measured with conventional electrical circuits due to oxygen spillover effects or charge transfer at hetero-interfaces. In addition, catalysts not only enhance the responses to target analyte gases, but can also increase the responses to interfering gases, thereby impeding selective gas detection. Therefore, to overcome the above catalyst-related limitations in gas sensing, a novel gas sensing strategy is required.

This work proposes a bilayer sensor architecture with a nanoscale catalytic overlayer. Unlike conventional single-layer sensors, the bilayer gas sensors can separate the gas-sensing and catalytic reactions into independent processes, which enables highly sensitive and selective gas detection. The advantages of bilayer sensors include the suppression of cross-responses from interfering gases by catalytic filtering and the improvement of responses to target gases through gas reforming. These advantages highlight the potential of bilayer gas sensors as high-performance gas-sensing platforms with excellent selectivity and sensitivity.

Keywords: Gas sensors; Bilayer; Overlayer; Selectivity; Artificial Olfaction

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IS-02 [273]: Stabilization of NCM622 Thin-Film Cathodes by Interface Engineering

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Abstract:

Thin-film Li-ion batteries (TF-LiBs) are promising for miniaturized electronics, but they often suffer from interfacial instability and cathode degradation. We fabricated Ni-rich Li_{1.0}Ni_{0.6}Co_{0.2}Mn_{0.2}O₂ (NCM622) thin-film cathodes by RF magnetron sputtering and improved them with two complementary steps: (i)

facing-target sputtered (FTS) Al_2O_3 as a conformal, defect-free interfacial coating, and (ii) O_2 -rich rapid thermal annealing (500–600 °C) to enhance crystallinity and suppress surface cracking and parasitic phases. The FTS Al_2O_3 layer stabilized the cathode/electrolyte interface, giving 91% capacity retention over 400 cycles. Optimized films annealed at 600 °C in O_2 delivered 646.8 mAh cm^{-3} at 0.1 C and 81% retention after 100 cycles. An all-solid-state TF-LiB using LiPON and a Li anode reached an energy density of 50.98 mWh cm^{-3} . Together, FTS- Al_2O_3 passivation and O_2 annealing provide a simple, scalable route to stabilize interfaces and microstructure, enabling high-performance TF-LiBs. In practical terms, the coating addresses interfacial chemistry while the O_2 anneal fixes bulk and surface structure. The combination is simple to add to a sputter flow, scalable, and directly improves cycle life, rate capability, and energy density for TF-LiBs.

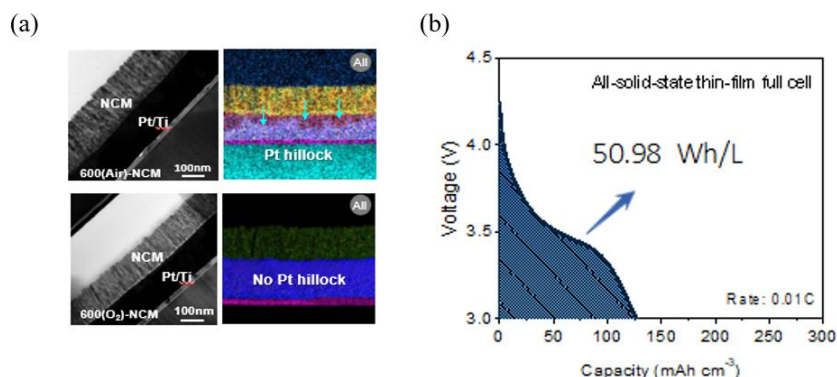


Figure 1. (a) TEM cross sectional analysis of the NCM622 thin films in air and oxygen annealing and (b) first discharge curve of the NCM500 ASSB.

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IS-20 [62]: Solid electrolyte-electrode interface engineering for anode-free lithium metal batteries

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Abstract:

Anode-free lithium metal batteries (AFLMBs) promise high energy density, but interfacial instability between the solid electrolyte and lithium-plated current collectors remains a critical barrier. We present a sequential interface engineering strategy to address this challenge.

First, stainless steel current collectors with varied surface roughness were evaluated in a model all-solid-state system. Moderately roughened surfaces enhanced interfacial contact with sulfide electrolytes, improving Coulombic efficiency and stability. Building on this, we introduced vertically aligned MoS₂ nanosheets via metal-organic chemical vapor deposition. These nanosheets formed a conformal interlayer of Mo and Li₂S during cycling, lowering nucleation overpotential and stabilizing the solid electrolyte interface. To suppress interfacial degradation from lithium volume fluctuations, a self-healing liquid metal (LM)–carbon composite was developed. LM enabled reversible liquid–solid–liquid transitions, but agglomeration limited stability. This was overcome by using an in situ polymerized LiFSI-based electrolyte, which encapsulated LM nanoparticles and prevented delamination.

These integrated strategies—surface texturing, functional interlayers, and phase-stabilized LM—demonstrate a scalable path toward durable AFLMBs through advanced solid electrolyte/electrode interface engineering.

Keywords: Anode-free; MoS₂; Liquid metal; Electrolyte/electrode interface; All-solid-state batteries

IS-21 [80]: Self-driven pressure and light sensor enabled by piezoelectric–photovoltaic synergy with broadband UV–vis–NIR photodetection using MAPbI₃–PVDF composite films

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Abstract:

Flexible, and self-powered multifunctional sensors are crucial for next-generation wearable electronics; however, most existing devices are limited to detecting only a single stimulus. Here, a structurally integrated, self-powered sensor that operates independently as a pressure sensor and as a photodetector, while also enabling simultaneous detection of pressure and light under zero external bias is developed. The device incorporates a methylammonium lead iodide–poly (vinylidene fluoride) (MAPbI₃–PVDF) composite active layer, with an interdigitated electrode configuration, enabling piezoelectric-photovoltaic synergy for pressure sensing and broadband photodetection with clear signal distinction across the UV–Vis–NIR region under zero external bias. The device exhibits a maximum responsivity of 1.66 mA/W at 365 nm and a minimum of 0.16 mA/W at 850 nm, with an on/off ratio on the order of 10⁴ under white-light illumination.

A maximum detectivity of 2.54×10^{12} Jones at 365 nm and 0.25×10^{12} Jones at 850 nm is achieved, indicating a rapid, wavelength-dependent response. Additionally, the device demonstrates high pressure sensitivity (0.46 ± 0.03 V/kPa) and a maximum piezoelectric power density of 0.23 mW/cm² under dark conditions. Real-world testing under varied environmental lighting conditions and mechanical vibrations further validates its practical applicability. This unique sensing capability, combined with high pressure sensitivity and broadband UV–Vis–NIR photodetection, highlights the potential of the proposed device for compact, multifunctional, and self-powered wearable and IoT-based systems.

Keywords: Self-driven photodetector (SPD); UV-Vis-NIR broadband photodetector; Pressure sensor

3. Oral Presentations

3.1. Metallurgical Engineering

1.01-O [51]: Study on Leaching Process for Recovering Valuable Metals from Lithium-Ion Battery Cathode Powder Using Inorganic Acids

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Abstract:

Spent lithium-ion batteries (LIBs) of portable electrical and electronic Equipment contain significant amounts of valuable metals, including Li, Co, and Ni, etc. As the number of spent LIBs continues to increase, recovering these metals has become an important strategy for conserving natural resources as well as environmental protection. This study investigates the leaching of Li and Co from LIBs cathode powder using different types of inorganic acids, including sulfuric acid (H₂SO₄), hydrochloric acid (HCl), and nitric acid (HNO₃). Effects of acid concentration (1-4 M), temperature (25-80 °C), reaction time (1-4hours), solid-to-liquid ratio and reducing agent H₂O₂ concentration (0-10%) on the leaching efficiency of cobalt and lithium from the cathode material of batteries were investigated. Among the three acids (H₂SO₄, HCl, and HNO₃) under the same condition, H₂SO₄ exhibits the highest efficiency. Using a leaching solution of 4 M sulfuric acid with 8 vol% H₂O₂ at 40 °C for 2 hours, the highest leaching efficiencies achieved for Li and Co were 98,15% and 96,5%, respectively. The experimental results show that recovery of Li and Co from spent LIBs using H₂SO₄ is a feasible approach to minimizing environmental impacts and moving toward a sustainable circular economy.

Keywords: Lithium-ion battery; Leaching; H₂SO₄; HCl; HNO₃

1.02-O [29]: Fabrication of tungsten powder by modern hydrometallurgical method from Vietnam tungsten minerals

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Abstract:

Tungsten is one of the most important refractory metals. It is used in the production of numerous end-use items such as incandescent lamps and hard materials. From its ore concentrates, tungsten is processed via a hydrometallurgical route. In the last 100 years there has been a significant change in its processing. Firstly, CaWO₄ were digested in sodium carbonate, and the sodium tungstate obtained after purification steps. Secondary, uniform WO₃ nanorods were prepared by hydrothermal process and the synthesis was accomplished by using NaCl as the capping agent and Na₂WO₄ as the inorganic precursor. Finally, WO₃

nanorods were used to fabricate tungsten nanopowders by hydrogen reduction method. The products were characterized by X-ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FE-SEM) and Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Obtained results indicated that the as-prepared nanorods had a diameter of 50 – 80 nm and lengths of several microns. Especially, the obtained W nanopowders had almost sizes below 100 nm in diameter and a purity of 99,5%.

Keywords: WO₃ nanorods; W nanopowders; Hydrogen reduction; Hydrothermal process

1.03-O [53]: Defect Chemistry and Phase Evolution of CrNbO₄ under Highly Reducing Environments at 1000 °C

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Abstract:

This study investigates the stability and defect mechanisms of CrNbO₄ under varying oxygen partial pressures (PO₂) at 1000 °C to elucidate its role in alloy oxidation. While CrNbO₄ remains stable down to PO₂≈10⁻¹⁷ atm, highly reducing conditions (10⁻²⁴ atm) trigger the partial reduction of Nb⁵⁺ to Nb⁴⁺, driving a transition into a rutile-type (Nb,Cr)O₂ solid solution accompanied by Cr₂O₃ precipitation. At the low-PO₂ interface of oxide scale/Ni-Cr-Nb alloys, this structural transition forces the dissolution of NbO₂ and the expulsion of chromium species. This kinetically favorable mechanism promoting the rapid formation of a continuous Cr₂O₃ scale that enhances overall oxidation resistance.

Keywords: CrNbO₄; solid solution; oxygen deficiency

1.06-O [75]: Effect of Temperature on the Formation Kinetics of Silver Nanoparticles in a Tannin–Ammonia–PVA System via Green Chemical Reduction

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Abstract:

This study investigates the effect of temperature on the formation kinetics of silver nanoparticles (AgNPs) synthesized in a tannic acid–ammonia–poly(vinyl alcohol) (TA–NH₃–PVA) system via a green chemical reduction method.

Tannic acid acted as both reducing and stabilizing agent, ammonia regulated the reduction and growth processes through silver–ammine complex formation, while PVA served as a steric stabilizer to prevent nanoparticle aggregation.

The evolution of AgNP formation was monitored by UV–Vis spectroscopy band at 420–425 nm. Temperature-dependent kinetic studies were carried out in the range of 30–70 °C, and the experimental data

were analyzed using the Finke–Watzky two-step nucleation–autocatalytic growth model to determine the nucleation (k_1) and growth (k_2) rate constants. The results revealed that increasing temperature significantly accelerated the reduction reaction, increased both kinetic constants, and shortened the induction period of the sigmoidal kinetic curves. TEM analysis confirmed the formation of predominantly spherical AgNPs with particle size strongly influenced by temperature and ammonia concentration. These findings provide important insight into the kinetic control of AgNP synthesis and offer a practical approach for scalable manufacture of size-controlled silver nanoparticles.

Keywords: Silver nanoparticles; temperature-dependent kinetics; Finke–Watzky model; tannic acid reduction

1.07-O [77]: Tailoring precipitation and mechanical properties of Al6061 alloy via pre-aging and deep cryogenic pre-straining

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Abstract:

The growing demand for thin-wall aluminum components in lightweight transportation systems has intensified the need for advanced strengthening strategies to simultaneously improve mechanical performance, reduce vehicle weight, and enhance energy efficiency. However, achieving a desirable balance between strength and ductility remains a major challenge in precipitation-hardenable Al-Mg-Si alloys. In this study, a synergistic processing route combining pre-aging (PA) and deep cryogenic pre-straining (DCP) was employed to tailor hierarchical microstructures in Al6061, followed by artificial aging at 170 °C. Compared to the conventional direct-aging route, the PA+DCP condition exhibited consistently higher hardness throughout aging and reached peak hardness significantly earlier (3 h vs. 8 h).

Tensile test at the peak-aged condition further demonstrated simultaneous improvements in yield strength, ultimate tensile strength, and elongation. TEM/STEM observations revealed that DCP introduced a uniform dislocation network that promoted heterogeneous precipitation during aging. Compared with the coarse and heterogeneously distributed β'' precipitates formed by direct aging, the PA+DCP condition produced a higher density of fine β'' precipitates and string-like precipitate structures along dislocations, thereby accelerating strengthening and improving the strength-ductility balance in Al6061.

Keywords: Al6061 alloys; Precipitates; Deep cryogenic pre-straining; STEM

1.08-O [116]: Aluminum Recovery from Sn-Al Alloys through Solid-Liquid Separation by Compression

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Abstract:

To achieve carbon neutrality, reducing CO₂ emissions is essential. CO₂ emissions from recycled Al are significantly lower, approximately 3% of those from primary Al. In Japan, however, only about 10% of wrought Al alloys are currently produced from recycled Al. To expand the use of recycled aluminum in producing wrought Al alloys, various impurities contained in scrap derived from cast Al alloys must be removed. To recycle scrap derived from high-impurity die-cast ADC12 alloy into wrought alloys 6061 and 6063, the removal of Si, Fe, and Cu is necessary. This study focused on the removal of Si, Fe, and Cu from ADC12 alloy, utilizing the differences in their solubility in a molten Sn bath (Sn(l)) compared to that of Al. In previous work, it has been shown that Si, Fe, Mn, Cr, and Ti can be removed from ADC12 alloy by dissolving it in a molten Sn bath. In this work, the recovery of solid Al from the Sn-Al alloy obtained after impurity removal was investigated using a compression method.

Keywords: Aluminum recycling; Sn-Al alloy; Compression; Solid-Liquid Separation

1.09-O [136]: Enhancing the Electrocatalytic Performance of Spinel NiFe₂O₄ via Optimized Lithiation

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Abstract:

Hydrogen energy has attracted significant attention as a promising alternative to fossil fuels due to its high energy density and zero-emission nature. However, conventional hydrogen production processes inevitably emit significant amounts of carbon dioxide (CO₂). Therefore, electrochemical water splitting has emerged as a pivotal technology for sustainable and eco-friendly hydrogen production. However, the sluggish kinetics of the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) hinder its widespread application, necessitating the development of efficient electrocatalysts. In this study, we employed a lithiation strategy to enhance the catalytic properties of spinel-structured NiFe₂O₄. Electrochemical evaluations revealed that the lithiation process dramatically improved the specific reaction kinetics and overall catalytic performance. For the HER, the lithiated samples demonstrated significantly accelerated reaction kinetics, exhibiting a substantially reduced Tafel slope compared to the pristine sample. Furthermore, the lithiated NiFe₂O₄ exhibited exceptional electrocatalytic performance for the OER. Notably, the optimally lithiated catalyst significantly lowered the required overpotential to drive the target current density, alongside a notable decrease in the OER Tafel slope. This study demonstrates that lithiation is a highly robust and effective approach for boosting specific catalytic kinetics and optimizing spinel oxides for advanced energy conversion systems.

Keywords: Water Splitting; Transition Metal Oxides; Lithiation

1.10-O [138]: Swelling kinetics of Banana fibers in Sodium - Iron–Tartaric Acid Complex (FeTNa)

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Abstract:

Banana fiber, extracted from the pseudostem of banana plants, is a promising natural cellulose-based material for sustainable textile and biomedical applications. However, the presence of a robust lignocellulosic matrix—comprising lignin, hemicellulose, and pectin—renders the raw fiber rigid and difficult to dissolve for advanced processing.

This study investigates the using of a "green" solvent system, Iron-Tartaric Acid (FeTNa), to treated banana fibers as an eco-friendly alternative to the toxic Viscose process. The experimental methodology involved: (1) synthesizing the FeTNa complex by coordinating Fe³⁺ ions with tartaric acid in an alkaline medium, and (2) evaluating the swelling kinetics of both raw and pre-treated banana fibers across varying concentrations of iron (0.1M–0.3M) and free NaOH (0.8M–2M). Fiber diameter changes and morphological alterations were recorded over a period of 90 minutes. Results demonstrated that pre-treatment is a prerequisite for successful dissolution, effectively removing approximately 25% of the fiber mass, which consists mainly of non-cellulosic impurities. In the FeTNa system, pre-treated fibers achieved a maximum swelling ratio of over 50% and reached a complete gelation state at fiber concentrations between 0.1% and 0.5% after 7 days. Microscopic analysis confirmed the successful disruption of cellulose hydrogen bonds, showing a transition from distinct fiber structures to a homogenous gel. These findings indicate that FeTNa is a powerful and environmentally compatible solvent for banana fiber for high-value green materials.

Keywords: Banana fiber; FeTNa complex; Green solvent; Swelling kinetics; Sustainable materials

1.11-O [141]: Integrated Three-Tier Blast Furnace Burden Optimisation System: Ore Screening, Sinter Optimisation, and Burden Optimisation via Linear Programming - Validation on Real Operational Data

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Abstract:

Burden material costs - encompassing iron ore, coke, pulverised coal injection (PCI), and fluxes - represent 60–70% of total ironmaking expenditure at integrated blast furnace (BF) steelworks, making raw material selection and blending one of the highest-leverage levers for cost reduction in ironmaking. Despite this, a fully integrated framework connecting ore screening, sinter optimisation, and BF burden optimisation within a single sequential pipeline has rarely been demonstrated on real plant operational data. This paper presents and validates such a framework - a three-tier BF burden optimisation pipeline - against operational data from an 8,000 t hot metal/day integrated steelworks in Vietnam (15 burden scenarios, PA0–PA14). The first tier

screens candidate ores by combining hard-limit tramp-element rejection with cosine similarity pattern matching on a 14-dimensional normalised chemical feature vector. The second tier minimises sinter blending cost via linear programming (LP) with burn-factor correction and a SiO₂ slack variable. The third tier couples a zero-dimensional (0D) mass-balance forward model with a BF LP formulation in which coke rate is treated as a linearised decision expression, and zinc load (≤ 0.40 kg/tHM) and alkali load (≤ 3.0 kg/tHM) stability constraints are explicitly enforced. On four calibration scenarios with measured sinter chemistry, the forward model achieved MAPE of 1.76% for slag volume and 0.98% for basicity R₂; across all 15 scenarios these values rose to 4.72% and 2.93%, respectively - both within the 5% industrial acceptance threshold. LP optimisation yielded mean cost savings of 111,060 VND/tHM (range: 0.3–1.8%), equivalent to 324.3 billion VND/year at full capacity. Statistical significance was confirmed by paired t-test [$t(14) = 12.10$, $p = 8.4 \times 10^{-9}$, 95% CI: 91,373–130,748 VND/tHM]. All furnace stability constraints were satisfied in every evaluated scenario, providing a transparent, auditable basis for procurement and blending decisions in integrated ironmaking operations

Keywords: blast furnace; burden optimisation; linear programming; sintering; cosine similarity; forward model; zinc load; alkali load; coke rate model

1.12-O [146]: Aluminum Recovery from Molten Al-alloys Using Immiscibility of Liquids

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Abstract:

Recycling aluminum (Al) scrap is important for reducing CO₂ emissions and promoting resource circulation. At present, Al scrap is mainly reused as a raw material for cast Al alloys; however, the amount of Al scrap will increase with the increasing adoption of electric vehicles, and exceeds the demand for cast Al alloy. Therefore, technologies for the advanced recycling of Al scrap into wrought Al alloys are required.

Cast Al alloys generally contain a large amount of silicon (Si), whereas the Si content in wrought Al alloys is strictly limited. In this study, a Si separation process based on the difference in solubility between Al and Si in Al-alloys was proposed.

To recover Al from the obtained Al alloy, Al separation using liquid–liquid immiscibility and unidirectional solidification was examined. The compositions of the two liquid phases formed at 973 K were investigated. In addition, the Al alloy after phase separation using liquid–liquid immiscibility was solidified under a temperature gradient, and the composition of recovered Al was investigated.

Keywords: Al recycling; Al scrap; Cast alloy; Wrought alloy; Liquid immiscibility

1.14-O [221]: Lower-carbon Steelmaking Using Steel Scraps and Hydrogen-based Direct Reduced Iron

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Abstract:

Hydrogen reduction processes for iron ores are being developed to achieve carbon neutrality. However, the high-grade iron ore pellets currently used in direct reduction processes are expected to be depleted in the future. On the other hand, steel scrap recovered from society is often contaminated with tramp elements, which are difficult to remove using existing steel refining processes. To produce high-quality steel from direct reduced iron (DRI) and steel scrap, the composition of molten steel during the melting process must be optimized, taking into account impurities originating from iron resources as well as process conditions such as temperature and oxygen potential. In this study, the equilibrium of slag–metal reactions in steelmaking processes using DRI and steel scrap was thermodynamically analyzed. The effects of scrap utilization on the composition of molten steel and slag, as well as the conditions required to produce low-phosphorus molten steel from high-phosphorus DRI and steel scrap, were discussed using an analytical model developed in our laboratory. Although increasing the partial pressure of oxygen at lower temperatures is effective for dephosphorization, this approach becomes less practical because carbon oxidation raises the liquidus temperature. On the other hand, the partition ratio of phosphorus can be increased to 523 at 1873 K and an oxygen partial pressure of $P_{O_2} = 10^{-10}$ atm. Under these conditions, carbon addition is scarcely required to produce low-phosphorus molten steel. Accordingly, the production of carbon-free steel is expected to be achievable by optimizing the melting process of DRI combined with the use of steel scrap.

Keywords: Hydrogen reduction; Steelmaking; Recycling; Thermodynamics

1.15-O [228]: Thermal Stability and Degradation Mechanisms of an ODS Nickel-Based Alloy Consolidated by Spark Plasma Sintering

Authors: Cong Dinh Van¹, Su-Gwan Lee¹, Hyun-Su Kim¹, Joon-Suh Park¹, Jin-Chun Kim¹

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Abstract:

Oxide dispersion-strengthened (ODS) nickel-based alloys are promising materials for high-temperature applications owing to their excellent mechanical strength, creep resistance, and oxidation resistance. The presence of finely dispersed oxide particles can effectively inhibit grain-boundary migration and enhance the thermal stability of ODS nickel-based alloy under severe service conditions. In this study, the thermal stability and degradation mechanisms of ODS nickel-based alloy, consolidated by spark plasma sintering (SPS), were investigated under short-term thermal exposure. Thermal exposure experiments were conducted at temperatures ranging from 400 to 1300 °C for 4 h. The thermal response of the alloy was evaluated using simultaneous thermogravimetric and differential scanning calorimetry (TGA–DSC) analyses. Surface evolution, oxidation behavior, microstructural changes, phase evolution, residual stress development, and mechanical performance were examined by using optical microscopy (OM), scanning electron microscopy coupled with energy-dispersive spectroscopy (SEM–EDS), electron backscatter diffraction (EBSD), transmission electron microscopy (TEM), X-ray diffraction (XRD), residual stress measurements, hardness

testing, and compression testing. This work is expected to provide a comprehensive understanding of the thermal stability and degradation processes of SPS-fabricated ODS Ni-based alloys for high-temperature engineering applications.

Keywords: ODS nickel-based alloy; Spark plasma sintering; Oxidation behavior; Microstructure evolution

Funding: This research was supported by the National Research Foundation of Korea (NRF, No. 2022M3H4A1A04076792) and the Ministry of Trade, Industry & Energy of Korea (MOTIE, KEIT, No. 20017647)

1.17-O [261]: Precipitation Behavior of Mg₂Si during Unidirectional Solidification of Al-5.8mass%Mg-2.0mass%Si Alloy

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Abstract:

Recycling aluminum is essential for achieving carbon neutrality. Silicon is usually added to cast Al alloy to improve the fluidity of molten aluminum whereas the silicon content of wrought aluminum alloy is controlled to be less than 1 mass%. Therefore, silicon removal is necessary to recycle cast aluminum scraps into wrought aluminum alloys. However, it is difficult to remove Si from molten Al by the current pyrometallurgical processes. The authors has proposed a new Si removal method through the precipitation of intermetallic compounds by adding Mg due to the thermodynamic affinity between Mg and Si. This study focused on the precipitation behavior of Mg₂Si during the solidification process, and unidirectional solidification experiments combined with thermodynamic analysis were carried out using Al–Mg–Si alloys to investigate the behavior of impurity elements and the conditions for their precipitation. The results indicate that impurity elements are enriched in the liquid phase during solidification due to solute redistribution, leading to the precipitation of Mg₂Si as an intermetallic compound. Subsequently, the remaining liquid undergoes eutectic solidification.

Keywords: Aluminum recycling; Precipitation behavior; Solidification; Mg₂Si; Intermetallic compound; Impurity control

1.18-O [187]: Synthesis of High-Entropy Oxides in the MgO-TiO₂-ZnO-CuO-Fe₂O₃ System with Spinel Structure by Mechanical Alloying and Subsequent Heat Treatment

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Abstract:

High-entropy oxides (HEOs) represent a promising class of multicomponent ceramics whose phase stability arises from configurational entropy stabilization. Synthesizing single-phase HEOs with spinel structure remains challenging due to large differences in cation radii and valence states among constituent oxides, which promote phase separation during conventional solid-state processing. Here we report the synthesis of a five-component HEO in the MgO-TiO₂-ZnO-CuO-Fe₂O₃ system with a single-phase spinel structure, achieved by combining high-energy mechanical alloying with controlled heat treatment at 800–1100 °C.

Mechanical alloying at equimolar composition produces a nanocrystalline, intimately mixed precursor that substantially lowers the activation barrier for cation interdiffusion, driving entropy-stabilized single-phase formation upon annealing. X-ray diffraction (XRD) confirms single spinel phase formation and provides crystallite size estimates via the Scherrer equation. Scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM/EDS) reveals homogeneous distribution of all five cations with no evidence of elemental segregation or secondary phases. Raman and FTIR spectroscopies corroborate spinel formation through characteristic metal–oxygen vibrational modes consistent with the Fd $\bar{3}$ m space group, while the absence of precursor oxide signatures confirms complete solid-solution reaction. These results demonstrate that mechanochemical activation is an effective route to single-phase spinel HEOs from thermodynamically immiscible oxide precursors.

Keywords: high-entropy oxide; spinel; mechanical alloying; solid-solution; entropy stabilization; multicomponent ceramics

3.2. Structural Materials

2.02-O [16]: Unusual High Hall–Petch Coefficients in Binary FCC Alloys via Misfit Engineering

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Abstract:

Single-phase FCC alloys are traditionally considered strength-limited unless compositional complexity is introduced. Here, we demonstrate that exceptional strengthening can be achieved in simple Ni-based binary alloys through misfit volume engineering. A series of single-phase FCC alloys (Ni–Mo, Ni–V, Ni–Cr, Ni–Co) with systematically varied atomic size mismatch was designed and processed to obtain grain sizes spanning ultrafine to coarse regimes. A clear Hall–Petch relationship is established at both room temperature (298 K) and cryogenic temperature (77 K), with the Hall–Petch coefficient strongly dependent on misfit volume. Alloys with higher misfit exhibit significantly elevated K_{HP} values, indicating enhanced grain boundary strengthening.

Simultaneously, friction stress increases at cryogenic temperature, leading to simultaneous improvement in strength and ductility. The results reveal that misfit volume acts as a dominant parameter controlling strengthening in binary FCC alloys, independent of elemental complexity. This study provides direct experimental evidence that grain boundary strengthening can be substantially amplified through atomic-scale misfit engineering, enabling simple alloy systems to achieve strength levels comparable to complex concentrated alloys without compromising ductility.

Keywords: Binary FCC Alloys; Hall-Petch Coefficients; Misfit Volume; Strength and Ductility

2.03-O [26]: Mechanistic insights into multimode deformation in a metastable Ti–base high-entropy alloys

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Abstract:

Titanium-based high-entropy alloys (HEAs) have emerged as promising structural materials owing to their high specific strength and excellent corrosion resistance. In this work, a metastable non-equiatomic BCC HEA, Ti₃₅Hf₂₅Zr₂₅Nb₅Ta₅Al₅, was designed using the bond order-mean d-orbital energy (Bo-Md) approach to achieve controlled phase stability. The alloy was fabricated via vacuum arc melting and thermo-mechanically processed to achieve different grain sizes. Microstructural and mechanical analysis revealed a complex interplay of dislocation glide, stress-induced $\beta \rightarrow \alpha''$ transformation, and deformation twinning during tensile loading. This synergy between TRIP and TWIP effects enabled superior strain-hardening and ductility without sacrificing strength. The results highlight how fine-tuning Bo-Md governs metastability, promoting multiple deformation pathways in BCC HEAs. Furthermore, lattice distortion intrinsic to HEAs is found to interact with phase stability, facilitating novel transformation mechanisms.

This study provides mechanistic insights into metastable refractory HEAs and establishes a robust design strategy for developing next-generation high-performance Ti-based alloys suitable for advanced structural and high-temperature applications.

Keywords: Refractory high-entropy alloy; Metastable BCC; Multimode deformation; TRIP; TWIP; Stress-induced martensitic transformation; Bo–Md approach; Phase stability; Lattice distortion; Ti-based HEA

2.04-O [28]: Age-hardening behavior of Al-Mg-Si alloys with high- and commercial-purity Al containing Fe and Mn impurities

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Abstract:

The growing demand for lightweight and sustainable materials has increased the use of recycled Al-Mg-Si (6xxx series) alloys in structural and automotive applications. However, recycling leads to the accumulation of impurity elements such as Fe and Mn, which promote the formation of secondary phases and can degrade precipitation strengthening. Understanding how these impurities influence age-hardening behavior is

therefore critical for the development of high-performance recycled aluminum alloys with improved mechanical properties and enhanced recycling tolerance.

In this study, four alloys (99.99-base, 99.7-base, 99.7Fe-added, and 99.7Mn-added) were systematically investigated to clarify the microstructural origins of reduced hardening in recycled compositions. Hardness results showed that all alloys follow typical β'' precipitation behavior; however, the Mn-added alloy exhibited a significantly lower age-hardening response ($\Delta H \approx 37$ HV) despite having a β'' precipitate density ($\sim 580 \mu\text{m}^{-2}$) comparable to the 99.7-base alloy.

Multi-scale characterization using TEM, HRTEM, HAADF-STEM, and STEM-EDS revealed that this behavior is governed by Si depletion across multiple length scales. The Mn-added alloy contains a high fraction of $\alpha\text{-Al(Fe,Mn)Si}$ intermetallic compounds and dispersoids, which act as sinks for Si. In addition, dispersoid-induced low precipitate zones (LPZs) were observed, where β'' precipitation is suppressed. The LPZ width increases with dispersoid size, leading to a reduction in effective strengthening.

These findings demonstrate that age-hardening in recycled Al-Mg-Si alloys is controlled not only by precipitate density but also by solute availability and its spatial distribution, providing useful guidance for the design of recycling-tolerant alloy systems.

Keywords: Al-Mg-Si alloy; age-hardening; β'' precipitate; $\alpha\text{-Al(Fe,Mn)Si}$ dispersoid; suppression factor; Si depletion; HAADF-STEM

Acknowledgement: This work was supported by JST Grant Number JPMJPF2216.

2.05-O [32]: Enhanced Precipitation and Strengthening in Al–Cu–Mg Alloys by Si Addition and Pre-Deformation

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Abstract:

The aim of the present work is to investigate a thermomechanical processing route that combines deformation and aging to achieve both high strength and good ductility in a age-hardenable Al-Cu-Mg-Si. The effect of deformation on precipitate and mechanical properties was examined through hardness measurement, tensile testing, and scanning transmission electron microscopy (STEM). The results demonstrated that deformation significantly accelerated age-hardening, enabling it to reach peak hardness more rapidly and maintain higher hardness compared to non-deformed conditions. Pre-aging at 70°C followed by 30% cold rolling and final aging at 160°C enhanced both strength and elongation due to precipitate formation and dislocation rearrangement. Non-deformed conditions mainly exhibited typical Guinier-Preston-Bagaryatsky (GPB) zones while deformed conditions developed a complex precipitate structures, including GPB/ β'' composite, precursor Q'/L phase, θ' phase, and precipitate-decorated

dislocation such as GP-like structure, S', Q', C phases. These results highlight the role of thermomechanical processing in tailoring the microstructure and achieving a desirable balance of strength and ductility. This study provides a foundation for improving thermomechanical processing routes of age-hardenable alloys.

Keywords: Al-Cu-Mg-Si alloys; thermomechanical processing; mechanical properties; precipitates; STEM

2.06-O [36]: Evolution of microstructure and properties of 16Cr–4Ni–Nb martensitic stainless steel during heat treatment

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Abstract:

This study investigated the effect of aging temperature on the microstructure, mechanical properties, and corrosion behavior of 16Cr–4Ni–Nb martensitic stainless steel. After solution treatment at 1050 °C and oil quenching, the specimens were aged at temperatures from 300 °C to 700 °C.

Microstructural characterization was conducted using X-ray diffraction (XRD), optical microscopy (OM), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), and electron backscatter diffraction (EBSD), while hardness, tensile, and electrochemical tests were performed to evaluate the structure–property relationship. The quenched and aged specimens mainly exhibited a martensitic matrix, with aging promoting precipitation and microstructural rearrangement. The mechanical properties were strongly dependent on aging temperature. Hardness and ultimate tensile strength increased from 418 HV and 1351 MPa at 300 °C to peak values of 442.33 HV and 1552 MPa at 500 °C, respectively. Electrochemical results showed that the 500 °C-aged specimen had the lowest corrosion current density of 1.08×10^{-9} A/cm², indicating superior corrosion resistance. The enhanced performance at 500 °C is attributed to optimized martensitic strengthening, fine precipitation, and reduced electrochemical activity. Overall, aging temperature critically controls the microstructure, mechanical performance, and corrosion resistance of 16Cr–4Ni–Nb martensitic stainless steel, with the specimen aged at 500 °C exhibiting the most balanced combination of strength and corrosion resistance, making this alloy a promising candidate for practical applications in turbine components, shafts, valves, marine equipment, and other structural parts requiring high strength and corrosion resistance.

Keywords: Martensitic stainless steel; Aging treatment; Microstructure; Properties; Corrosion resistance

2.07-O [37]: Microstructural control and mechanical enhancement of bicontinuous Mg–Ti composites through liquid metal dealloying in AZ31 alloy melt

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Abstract:

Liquid metal dealloying (LMD) is an effective method for producing bicontinuous metal–metal composites with interconnected three-dimensional structures. Mg–Ti bicontinuous composites are particularly attractive because the ductile Mg phase accommodates plastic deformation, while the Ti network serves as a mechanically robust load-bearing skeleton. However, LMD using pure Mg melt often leads to limited interfacial bonding between Mg and Ti, restricting effective load transfer. In this study, bicontinuous Mg–Ti composites were fabricated via LMD using commercial AZ31 Mg alloy melt and directly compared with those produced in pure Mg melt under identical conditions.

The AZ31 melt promoted the formation of TiAl intermetallic phases at the Mg/Ti interface, altering the phase distribution and ligament morphology. These microstructural changes markedly enhanced hardness and compressive strength, while maintaining relatively limited loss in compressive deformability. The improved mechanical properties are attributed to the increased load-bearing contribution of the Ti-based matrix, formation of TiAl intermetallic phases, enhanced interfacial load transfer, and improved structural stability of the Ti-based skeleton.

These findings demonstrate that alloyed Mg melts can effectively tailor the interfacial structure and mechanical properties of Mg–Ti bicontinuous composites fabricated by LMD.

Keywords: Mg–Ti composite; Liquid metal dealloying; AZ31 alloy melt; Microstructure; Hardness; Compression properties

2.08-O [38]: Enhanced microstructural homogeneity and mechanical properties of bimodal magnesium sheet via combined UNSM and EPT

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Abstract:

Rolled AZ31 Mg alloy sheets often exhibit a surface bimodal microstructure consisting of coarse and fine grains, which promotes strain localization and reduces mechanical properties. In this study, ultrasonic nanocrystal surface modification (UNSM) followed by electropulsing treatment (EPT) was applied to improve the microstructural homogeneity and tensile properties of a rolled Mg–3.0Al–0.8Zn–0.3Mn (AZ31, wt.%) alloy sheet. UNSM introduced severe plastic deformation into the surface region, forming a gradient microstructure with ultrafine grains, high dislocation density, and numerous deformation twins. Although these microstructural features increased the strength, it reduced elongation due to the highly strained surface layer. Subsequent EPT at 300 °C for 2 min induced static recrystallization and recovery, producing a fine and uniform surface microstructure with improved deformation stability. Consequently, the UNSM–EPT-treated alloy exhibited superior strength and ductility compared with the as-rolled alloy, with a tensile yield strength of 158 MPa, ultimate tensile strength of 252 MPa, and elongation of 21.9%. Digital image

correlation analysis confirmed that the UNSM–EPT-treated sheet showed more uniform strain distribution during tensile deformation.

These results demonstrate that the UNSM–EPT process effectively improves microstructural homogeneity and mechanical properties of rolled AZ31 Mg alloys with a surface bimodal microstructure.

Keywords: Magnesium alloy sheet; Ultrasonic nanocrystal surface modification (UNSM); Electropulsing treatment (EPT); Microstructural homogeneity; Tensile properties

2.09-O [39]: Effect of Bi content on microstructure and mechanical properties of high-speed-extruded Mg–Bi–2Al alloys

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Abstract:

Mg–Bi–Al alloys have attracted considerable attention as promising candidates for high-speed extrusion because of their excellent extrudability and potential for high-productivity manufacturing. In these alloys, Bi addition promotes the formation of thermally stable Mg₃Bi₂ particles, which suppress hot cracking under severe extrusion conditions and assist the fabrication of defect-free extrudates. The Mg₃Bi₂ phase also restricts grain growth during extrusion and contributes to strengthening, thereby providing an effective means of controlling the microstructure and mechanical properties of extruded Mg alloys. For industrial application, optimization of Bi content is essential because the amount, distribution, and strengthening contribution of Mg₃Bi₂ particles are expected to vary strongly with alloy composition. In this study, Mg–xBi–2Al alloys (BAx2; x = 3, 5, and 7 wt.%) were fabricated by casting and homogenization, followed by direct high-speed extrusion with a die-exit speed of 42 m/min. Both naturally air-cooled and water-quenched extrudates were examined to clarify the microstructural evolution that occurred immediately after the material exited the extrusion die, with particular focus on grain structure and crystallographic texture. Microstructural characterization and tension–compression testing were conducted to systematically evaluate the effects of Bi content on grain refinement, texture evolution, Mg₃Bi₂ phase distribution, and mechanical properties. The results clarify the role of Bi in controlling the microstructure–property relationship of high-speed-extruded Mg–Bi–Al alloys and provide useful guidelines for compositional design for high-speed extrusion applications.

Keywords: Mg–Bi–Al alloy; Bi content; High-speed extrusion microstructure; Mechanical properties

2.10-O [40]: Phase specific deformation responses during plastic instabilities in a Medium Manganese Steel

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Abstract:

Medium manganese steels (MMnS) have emerged as promising candidates among the third-generation Advanced high strength steels (AHSS). These steels offer an excellent combination of strength and ductility through the synergistic activation of TRIP and TWIP deformation mechanisms. However, their commercialization remains challenging due to plastic instabilities such as Lüder deformation and dynamic strain aging. In the present study, a Fe-4.28Mn-0.15C-0.49Si-0.02Al-0.06Nb (wt.%) steel with a ferrite (α) and retained austenite (γ) microstructure was fabricated through hot rolling followed by Inter-critical annealing, resulting in an ultrafine grained structure with an average mean grain size of $\sim 0.6 \mu\text{m}$. Tensile testing was carried out at room temperature with initial strain $8.3 \times 10^{-4} \text{ s}^{-1}$, combined with simultaneous Digital image correlation (DIC) to evaluate local strain. The results revealed the formation and propagation of Lüders bands at low strains, followed by the emergence of Portevin–Le Chatelier (PLC) bands at higher strains, each associated with repeated cycles of band formation, propagation, and annihilation. To further understand this behavior, in-situ synchrotron X-ray diffraction (XRD) was performed during tensile deformation to investigate phase-specific responses. The evolution of retained austenite fraction, phase-specific lattice strains in austenite (γ) and ferrite (α), and dislocation density were systematically tracked as a function of applied strain. Strain partitioning between the α and γ phases was quantitatively evaluated in relation to the propagation of Lüders and PLC bands. These results establish a clear relationship between localized deformation events, interphase stress redistribution, and deformation-induced martensitic transformation.

Keywords: Medium Manganese steel; PLC effect; Luders band; Digital image correlation; In-situ synchrotron XRD; Deformation induced martensite

2.11-O [63]: Deep cryogenic treatment for enhancing strength-fatigue synergy in Ti6Al4V alloy

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Abstract:

Simultaneously improving deformation stability and fatigue reliability remains a critical challenge for Ti6Al4V (Ti64) alloy used in load-bearing structural components. To address this challenge, deep cryogenic treatment (DCT) was employed as a liquid-nitrogen-temperature post-processing route for engineering the microstructure. The effects of DCT on the microstructure, tensile properties and high-cycle fatigue behavior were systematically examined.

DCT increased dislocation density, promoted grain refinement and induced extension twins, thereby generating effective microstructural barriers against dislocation motion and crack propagation. Consequently, the DCT-treated alloy showed an approximately 19% improvement in tensile performance (UTS $\times$ UE) and a 1.2-fold greater fatigue endurance limit than the as-received alloy. These findings demonstrate the potential of DCT as a manufacturing-relevant processing strategy for enhancing strength-fatigue synergy in Ti64.

Keywords: Ti6Al4V; deep cryogenic treatment; high-cycle fatigue; strength-fatigue synergy

2.12-O [66]: Recycling of Gypsum Mold Wastes for Plaster Production Using Calcination Method

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Abstract:

This research investigated the recycling of gypsum mold wastes from ceramic industry to reduce waste disposal and promote efficient resource utilization. The gypsum mold wastes ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) were calcined to produce calcium sulfate hemihydrate or beta plaster ($\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$) at temperatures of 120, 150 and 180 °C. The quality of the recycled beta plaster was evaluated based on their specific surface areas, microstructures, setting times, and mechanical properties. The optimal condition was a plaster calcined at 150 °C due to the complete dehydration. The study also investigated the calcined plaster at 150 °C with the additions of 0.02, 0.05, and 0.07 wt% to retard the hydration for workability control. Increasing the amounts of citric acid resulted in an increase in the setting times to 17, 25, and 27 min, respectively. Without citric acid, the setting time was too short (6 min) to cast. The compressive strengths were 12.2, 7.6, and 6.3 MPa, respectively. With 0.02 wt% of citric acid, the compressive strength exceeded that of commercial beta plaster that contained 10.1 MPa at the same water to plaster ratio.

However, the setting time of the recycled plaster was faster (17 min and 33 min for the recycled and commercial plasters, respectively). The disadvantage of the faster setting time would be considered for flowability improvement in the next experiment. Additionally, the microstructures of the plaster with citric acid at different ratios were studied.

Keywords: Recycling of gypsum mold wastes; Calcium sulfate hemihydrate; Citric acid; Hydration

2.13-O [107]: Intermetallic-driven matrix depletion and its impact on precipitation kinetics in scrap-recast 6063 alloys

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Abstract:

Aluminum recycling is important for sustainable materials, but the microstructure of scrap-based alloys strongly affects their mechanical performance. In this study, I compare two conditions made from the same aluminum scrap, (i) base scrap (ii) 6063 Base, cast alloy produced by remelting and casting the same scrap. The aim is to understand how recasting changes microstructure, precipitation behavior, and mechanical properties. Both samples were heat treated under the same conditions. Hardness and tensile tests were used

to evaluate mechanical properties, while XRD, SEM, TEM, and STEM were used to study intermetallic phases, matrix composition, and precipitate structures.

The base scrap shows a higher amount of coarse Fe- and Si-rich intermetallic, which consume Mg and Si from the matrix. Because of this, the precipitate density is lower, leading to reduced hardness and strength. In contrast, the recast alloy shows improved solute redistribution after remelting. TEM results confirm a higher density of fine β'' precipitates, and STEM analysis shows more solute available in the matrix.

As a result, the 6063 alloy has better hardness and tensile properties. This study shows that recasting improves microstructure and is a better approach for recycling 6063 aluminum scrap.

Keywords: Artificial aged.; Intermetallic.; SEM.

Acknowledgement: This work was supported by JST Grant Number JPMJPF2216.

2.14-O [108]: Investigating of Ag effect on mechanical properties and precipitates behavior in Al-Zn-Mg alloys after isothermal aging process

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Abstract:

Al-Zn-Mg alloys are age-hardenable materials whose mechanical properties are significantly enhanced through solution heat treatment followed by aging. Owing to their high strength-to-weight ratio, these alloys are widely used in structural and aerospace applications. In recent years, Ag has also attracted increasing attention as an alloying element. Despite its high cost, Ag addition has been reported to markedly enhance mechanical strength; in some cases, it also improves corrosion resistance in Al-Zn-Mg alloys. In this study, the effects of 0.1 at% Ag additions on the mechanical properties and precipitation behavior of an Al-4Zn-2Mg (at%) alloy during aging treatment were systematically investigated. The results show that grain size decreased and hardness increased of the alloy content Ag and reached peak-aging earlier than free Ag alloy. The ultimate tensile strength (UTS) and elongation of Ag added alloy is higher than free Ag alloy when aging at same condition (200 °C). TEM observation of peak-aged alloys at 200°C, SAED patterns showed precipitates of two alloys are η'/η and T phase. TEM bright field (BF) observation exhibits the change in number density increasing and precipitate free zone (PFZ) decreasing tendency in Ag-added alloy. STEM observation show the precipitate behavior of these alloys change significantly inside grain and at grain boundary precipitate in Ag-added sample. It also shows the distribution of Ag atoms in precipitate phase at peak-aged condition. From these good characteristics and advantages, Ag addition in Al-Zn-Mg alloy is very potential to replace traditional alloys to be used in automobile field and aerospace fields.

Keywords: TEM; STEM; Precipitates; Segregation; Hardness; Al-Zn-Mg-Ag.

2.15-O [114]: Improvement of Strength and Corrosion Resistance in Ti-6Al-4V Alloys by Ta Addition

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Abstract:

Introduction: Ti-6Al-4V is a representative titanium alloy known for its excellent properties, combining high strength with high corrosion resistance. However, this alloy faces the challenge of significantly reduced corrosion resistance in harsh acidic environments, such as those containing hydrochloric acid. In this study, we propose the addition of Ta to the Ti-6Al-4V alloy, as Ta is a highly corrosion-resistant element that is also expected to provide solid solution strengthening. Unlike Ti, Ta is known to form a thermodynamically stable passive film even in acidic environments. The objective of this study is to improve corrosion resistance and increase strength in acidic solutions by adding Ta to Ti-6Al-4V.

Materials and Methods: Ingots of Ti-6Al-4V ELI and an alloy containing 10 wt.% Ta were produced by vacuum arc melting. The produced alloys underwent a 24-hour homogenization heat treatment (ST) at 1323 K. In addition, the Ta-added alloys were subjected to aging heat treatment at 753 K for 2 h or 24 h. Tensile testing was performed to evaluate the mechanical properties. Corrosion resistance was evaluated by anodic polarization test and immersion test. The test solutions were 5 wt.% NaCl aqueous solution at 298 K (neutral environment) and 5 wt.% HCl aqueous solution at 298 K (acidic environment). To clarify the differences in corrosion behavior due to composition and microstructure, surface observations and corrosion morphology analyses were performed using FE-SEM, and the composition and chemical bonding state of the passive film were analyzed using XPS.

Results and Discussion: In tensile test, the yield stress of the Ta-added alloy was higher than that of Ti-6Al-4V, and aging treatment increased its strength further. In anodic polarization test in NaCl aqueous solution (neutral environment), the Ta-added alloy exhibited higher corrosion resistance than Ti-6Al-4V. In polarization test in HCl aqueous solution (acidic environment), the ST materials of both Ti-6Al-4V and the Ta-added alloy exhibited an active region near the corrosion potential before transitioning to a passive region. In contrast, the 2-h and 24-h aged specimens of the Ta-added alloy did not exhibit an active region; instead, they reached the passive region from near the corrosion potential and maintained a stable passive region up to 2.5 V. This is thought to be due to the increased Ta concentration in the passive film formed by the addition of Ta and the aging treatment, which improved the passivation ability in an acidic environment.

This work was supported by JSPS-KAKENHI (JP24K01194, JP24K17529, 26K17673).

Keywords: α + β titanium alloy; Tantalum; corrosion resistance; passive film

2.16-O [115]: Suppression of Localized Corrosion in Metallic Materials by Laser Thermal Processing

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Abstract:

Introduction: Martensitic stainless steels are widely used in medical devices and industrial equipment because they can be hardened by quenching and exhibit high mechanical strength. Stainless steels generally show high corrosion resistance due to the formation of a passive film on their surfaces. However, among stainless steels, martensitic stainless steels exhibit relatively low corrosion resistance. Carbon, which is an essential element for hardening martensitic stainless steels, deteriorates corrosion resistance. Consequently, achieving both high hardness and high corrosion resistance is theoretically difficult. In stainless steels, MnS inclusions are known to act as corrosion initiation sites. In this study, laser thermal processing was applied to improve the corrosion resistance of martensitic stainless steel. The cooling rate after laser irradiation is estimated to be as high as 105 K s^{-1} , which is significantly faster than that of conventional thermal processing. During laser irradiation, only the surface layer of the specimens was slightly melted. It is expected that MnS inclusions near the surface melt during rapid heating and that their reformation is suppressed by rapid cooling. The effects of laser thermal processing on the corrosion resistance, microstructure, and hardness of both the surface and substrate regions were investigated.

Materials and Methods: The specimens used in this study were commercially available Type 420J₂ stainless steel plates.

Each specimen was irradiated with a laser beam of 10 mm in diameter at a scanning rate of 100 cm min^{-1} . The surface and cross-sectional microstructures, as well as inclusions in the laser-irradiated specimens, were characterized using OM, SEM/EDS, and EBSD. Corrosion resistance was also evaluated by anodic polarization tests. A mixed aqueous solution of 0.1 M Na₂SO₄ and 0.585 M NaCl at $297 \pm 3\text{ K}$ was used as the electrolyte.

Results and Discussion: Vickers hardness in Phase A significantly increased compared with that of the unprocessed specimen. EBSD analysis revealed that martensite and austenite phases were formed in the laser-remelted region, whereas ferrite and retained austenite phases were observed in the substrate region. The formation of martensitic phases induced by rapid cooling during laser irradiation contributed to the increase in hardness. In addition, the laser-remelted region exhibited higher corrosion resistance than the unprocessed specimen.

No MnS inclusions were observed in the remelted region. In contrast, the substrate region showed hardness and corrosion resistance similar to those of the unprocessed specimen. These results indicate that laser thermal processing suppressed the formation of corrosion-inducing inclusions in the surface layer while simultaneously transforming the surface microstructure into a martensitic structure. Therefore, laser thermal processing can effectively modify the surface of martensitic stainless steel to achieve both high hardness and high corrosion resistance.

Keywords: Corrosion; Laser; Inclusion; Stainless steels; Polarization

2.17-O [121]: The Effect of Organic Additive on The Microstructure and Properties of Nickel Electrodeposition in Nickel Sulfamate Bath

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Abstract:

Ni-coated steel is important in the construction and performance of lithium ion batterie case due to their specific characteristics and benefit. The addition of additive results in enhancements to the properties of the Ni-coated layer, including hardness, corrosion resistance, internal stress and microstructure. This study systematically investigates the effect of organic additive (2-Formylbenzenesulfonic acid sodium salt) concentration on the surface quality, crystallographic texture, and properties of nickel electrodeposition. The XRD patterns reveals the preferred orientation shift from (022) to (020) and (111) with the increase of additive concentration. The surface morphology becomes denser and smoother upon additive addition, as the result, the improvement in glossiness of coated layer. The internal stress is transitioned from tensile to compressive stress. However, the stress reverts to tensile stress while the additive concentration beyond 2 g/L, attributes to the hydrogen evolution. The Vicker hardness values of nickel layer increase as the additive increase, respectively. The corrosion experiments indicates the passive regions are observed, attributes to NiO and Ni(OH)₂ film formation.

These results underscore the critical role of additive concentration in optimizing nickel deposit properties for advanced forming and corrosion resistance applications

Keywords: Nickel electrodeposition; Nickel plated steel; Organic additive; Corrosion resistance; Internal stress

2.19-O [128]: Effect of gas nitriding on surface properties of Ti6Al4V alloy

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Abstract:

To enhance the tribological performance of dual-phase Ti6Al4V alloy, this study systematically investigated the effects of gas nitriding on its surface characteristics. The alloy was nitrided at temperatures ranging from 850 to 950 °C for 4 h and at 900 °C for durations from 2 to 6 h. The growth kinetics of the nitrided layer, phase evolution, hardness distribution, and wear resistance were evaluated. XRD and optical microscopy analyses confirmed the formation of a continuous compound layer consisting mainly of TiN and Ti₂N phases, accompanied by a reduction in the β-Ti phase near the surface. The nitriding treatment significantly increased the surface hardness from approximately 318 HV_{0.1} to a maximum of 1314 HV_{0.05} at 950 °C. The hardness depth profile revealed the development of a distinct hardened diffusion zone beneath the compound layer. In addition, the friction coefficient and mass loss decreased substantially after nitriding, indicating remarkable improvement in wear resistance. The results demonstrate that both nitriding temperature and duration play critical roles in controlling the nitrided layer growth and tribological performance of Ti6Al4V alloy.

Keywords: Gas nitriding; Ti6Al4V; Surface hardness; Wear resistance; Nitrided layer

2.20-O [130]: Supplementary Cementitious Materials from Combustion By-products for Partial Portland Cement Replacement

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Abstract:

Abstract. This research aimed to prepare high-calcium supplementary cementitious materials (SCMs) derived from lignite fly ash (FA) from Mae Moh Power Plant for use as partial replacements for Portland cement (PC) to approach zero-waste management and promote effective waste circulation. High calcium SCMs are required in the system of high PC replacement due to the tendency to form binding phases according to pozzolanic reaction. In this study, FA was mixed with limestone to produce the high CaO-SCMs using different chemical compositions. The compositions were designed to obtain glassy contents in the range of 35–40% in order to promote pozzolanic reactions. The prepared SCMs exhibited amorphous contents of 39% ($\text{CaO}/\text{SiO}_2 = 2.2$, $\text{SiO}_2/\text{Al}_2\text{O}_3 = 3.8$ and $(\text{Na}_2\text{O}+\text{K}_2\text{O})/\text{SiO}_2 = 1.5$), 37% ($\text{CaO}/\text{SiO}_2 = 2.1$, $\text{SiO}_2/\text{Al}_2\text{O}_3 = 4.0$ and $(\text{Na}_2\text{O}+\text{K}_2\text{O})/\text{SiO}_2 = 1.5$), 36% ($\text{CaO}/\text{SiO}_2 = 2.2$, $\text{SiO}_2/\text{Al}_2\text{O}_3 = 3.8$ and $(\text{Na}_2\text{O}+\text{K}_2\text{O})/\text{SiO}_2 = 1.6$), and 35% ($\text{CaO}/\text{SiO}_2 = 1.7$, $\text{SiO}_2/\text{Al}_2\text{O}_3 = 5$ and $(\text{Na}_2\text{O}+\text{K}_2\text{O})/\text{SiO}_2 = 1.5$). The synthesized SCMs were used to replace PC at replacement levels of 10 wt%, 30 wt%, and 50 wt% with a water-to-binder ratio (w/b) of 0.35 and cured for 7 days. The results showed that compressive strength did not directly correlate with the amorphous contents. The best condition was obtained at CaO/SiO_2 of 2.1 and $\text{SiO}_2/\text{Al}_2\text{O}_3$ of 4.0 exhibiting the highest compressive strength at 7 days of 43.1 MPa, 21.1 MPa and 20.8 MPa at 10 wt%, 30 wt% and 50 wt% replacements, respectively. This result indicated an appropriate balance between CaO and SiO_2 for hydration and pozzolanic reactions of the synthesized SCM. While PC without SCM addition contained 67.6 MPa. The great reduction in the strength was due to the cement dilution effect and coarser SCM particle sizes than PC. Furthermore, the phase evolution after hydration at curing ages of 7 days, together with the microstructural characteristics of the synthesized SCMs, were investigated.

Keywords: Supplementary cementitious materials; Fly ash; Compressive strength; Hydration; Pozzolanic reactions

2.21-O [158]: Microstructural evolution and accelerated $\gamma \rightarrow \epsilon$ phase transformation in SLM-fabricated biomedical CoCrMo alloy during heat treatment

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Abstract:

Selective Laser Melting (SLM) has emerged as a promising additive manufacturing technique for fabricating biomedical CoCrMo alloys with complex geometries and refined microstructures. However, the rapid solidification inherent to the SLM process produces metastable microstructures, residual stresses, and process-induced defects that strongly influence the alloy's mechanical performance and phase stability. In this study, the microstructural evolution and phase transformation behavior of low-carbon CoCrMo alloy fabricated by SLM were systematically investigated before and after post-processing heat treatment.

The as-built specimens exhibited characteristic hierarchical microstructures consisting of melt pools, scanning tracks, cellular substructures, and directional columnar grains aligned with the thermal gradient. X-ray diffraction analysis revealed that the as-built alloy was dominated by the metastable γ -FCC phase with approximately 16–18% ϵ -HCP phase. Fine cellular structures enriched with Mo at the cell boundaries were observed through SEM-EDS analysis, indicating microsegregation induced by rapid solidification during SLM processing.

Following solution treatment at 1150 °C and subsequent aging at 750–900 °C for 4 h, the inherited SLM microstructures were dissolved and recrystallized into equiaxed grains with bimodal grain size distributions. Simultaneously, a pronounced $\gamma \rightarrow \epsilon$ phase transformation occurred, resulting in a progressive increase in ϵ -HCP phase fraction with increasing aging temperature. The sample aged at 900 °C/4 h exhibited more than 90% ϵ -HCP phase together with minor Cr-rich σ -phase precipitation along grain boundaries. These microstructural changes contributed to a significant hardness improvement from approximately 300 HV in the as-built condition to 400 HV after heat treatment.

The accelerated $\gamma \rightarrow \epsilon$ transformation kinetics observed in the SLM-fabricated alloy were attributed to the high density of stacking faults and residual strain generated during rapid solidification. The results demonstrate that post-processing heat treatment is highly effective in homogenizing SLM-induced anisotropic microstructures and enhancing the mechanical performance of biomedical CoCrMo alloys.

Keywords: Selective Laser Melting; CoCrMo Alloy; Phase Transformation; Heat Treatment; Microstructure Evolution

2.23-O [168]: Influence of Microstructure on the Wear Resistance of Ni-Cr-Cr₃C₂ Composite Coatings on 20Cr Steel

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Abstract:

In industrial sectors, wear and corrosion are the primary causes of damage and reduced service life of machine components. This study evaluates the influence of the thermal spray process on a Ni-Cr-Cr₃C₂ composite coating system used for restoring components operating under severe wear conditions. The experimental process utilized Ni-Cr-Cr₃C₂ spray powder, which was dried at 120–150 °C and sieved to

control the particle size below 100 μm , before being thermally sprayed onto the surface of a 20Cr steel substrate that had undergone mechanical grit-blasting for surface roughening. The microstructure of the coating layer was analyzed using optical microscopy and field emission scanning electron microscopy (FESEM Jeol 7600); the mechanical properties were determined via Vickers microhardness measurements, adhesion strength testing using a specialized DLR system, and wear intensity testing. The results indicate that the thermal spray technology successfully produced a coating with a uniform thickness of approximately 180 μm , featuring a typical lamellar structure characterized by high density and low porosity.

The particles of the chromium carbide (Cr_3C_2) hard phase retained their angular morphology and were alternately and uniformly distributed within the tough Ni-Cr binder matrix, creating a continuous interface with the steel substrate through a robust mechanical "interlocking" effect. The Vickers microhardness of the material exhibited a distinct step-like variation along its depth: reaching its highest value at the coating layer (~ 700 HV, approximately 5.2 times higher than the steel substrate), decreasing to ~ 518.7 HV in the transition zone, and returning to ~ 135 HV at the base steel substrate, thereby enabling the component to optimize both surface hardness and internal core toughness. Although the presence of the hard carbide phase increased brittleness, causing the overall adhesion strength of the system to decrease to 15.80 MPa compared to the single Ni-Cr bond coat (25.21 MPa), this value still fully satisfies the technical requirements for surface protection. The complete coating system achieved a very low average wear intensity of approximately 4.85×10^{-9} kg/N.m due to the effective collaborative mechanism between the load-bearing Cr_3C_2 hard particles and the Ni-Cr alloy matrix, which acts as a binder that absorbs impact energy and mitigates delamination. Overall, the successfully fabricated Ni-Cr- Cr_3C_2 composite coating demonstrates superior microstructural and mechanical properties, confirming its high feasibility for practical applications in restoring and enhancing the performance and lifespan of industrial mechanical components.

Keywords: Thermal spray; 20Cr steel; Lamellar structure; Vickers microhardness; Adhesion strength; Wear intensity

2.24-0 [210]: Relationship between microstructure and hardness of soldering alloys of Sn-xZn/C1990HP

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Abstract:

This study investigated the relationship between interfacial microstructural evolution and hardness of lead-free Sn-xZn/C1990HP solder joints (with $x = 1, 3, 5, 7, 9$ wt.%) under solid-state aging at 0.5 h and 2 h. The morphology, elemental partitioning, and phase transitions at the joint interfaces were characterized via SEM-BSE and EDS, while the localized mechanical responses were quantified using low-load (10 gf) Vickers microhardness testing within the critical transition regime (1, 3, 5 wt.% Zn). The experimental results reveal a profound correlation where the mechanical fingerprint strictly mirrors the underlying structural defects and phase constitutions.

Within the low-Zn regime (1–3 wt.%), the kinetic competition of Cu-Sn/Cu-Zn phases and the stress accumulation at the Ti-solute barrier trigger severe massive spalling of the intermetallic compound (IMC)

layer after 2 h. This microstructural degradation directly governs the mechanical collapse of the interface, as evidenced by a drastically drop in the average microhardness of the Sn-1Zn IMC from 247.5 HV(0.5 h) to 134.3 HV (2 h), alongside an expanded data scattering caused by localized microvoiding. Conversely, as the Zn content reaches 5 wt.%, the microstructure transitions into a continuous, planarized, and compact γ -Cu₅Zn₈ barrier layer that entirely suppresses spalling. This structural stabilization radically alters the mechanical behavior of the Sn-5Zn IMC, shifting it from a highly scattered state at 0.5 h (averaging 193.2 Hv due to the thin-film piercing/substrate effect) to a highly stable state of 226.3 HV at 2 h with a narrowed standard deviation as the compact layer thickens. Meanwhile, the bulk solder matrix exhibits a relatively stable hardness (11–14 HV), experiencing only a minor softening over time induced by the coarsening of Zn-rich precipitates within the soft primary β -Sn matrix. Ultimately, this work clarifies the quantitative mapping between interfacial phase morphology and localized mechanical properties, identifying 5 wt.% Zn as the optimum threshold for microelectronic interconnect optimization.

Keywords: Lead-free solder; Interfacial structure; Sn-xZn/C1990HP system; Microhardness

3.3. Functional Materials

3.01-O [17]: Spin-Canting-Driven Circularly Polarized Photoluminescence in Few-Layer AgCrP₂S₆

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Abstract:

AgCrP₂S₆ is an emerging two-dimensional layered semiconductor that offers a rare combination of antiferromagnetic order and direct-gap optical activity, making it a promising platform for spin-dependent optoelectronics. Here, we investigate the magnetic, optical, and electronic properties of AgCrP₂S₆ single crystals using magnetometry, photoluminescence spectroscopy, and first-principles calculations.

Temperature-dependent magnetization measurements reveal zigzag-chain antiferromagnetic ordering with a Néel temperature of ~21 K. Strong magnetic anisotropy and a field-induced spin-flop transition are observed when the magnetic field is applied parallel to the crystallographic c-axis. Photoluminescence measurements show a strong emission peak near 950 nm, corresponding to a direct bandgap of ~1.30 eV, in good agreement with density functional theory calculations predicting a direct gap of ~1.31 eV. Under externally applied magnetic fields, AgCrP₂S₆ exhibits helicity-controlled circularly polarized photoluminescence, where the dominant emission switches between right- and left-circular polarization depending on the field direction. The circular polarization increases linearly beyond a critical field, indicating spin canting and Zeeman-type splitting of band-edge states mediated by p–d exchange coupling between localized Cr³⁺ spins and itinerant carriers. These results establish AgCrP₂S₆ as a unique antiferromagnetic semiconductor with magnetically controllable light helicity, providing new opportunities for spintronic, valleytronic, and magneto-optical device applications.

Keywords: 2D materials; AgCrP₂S₆; Antiferromagnetism; Circularly polarized photoluminescence; Spintronics; Magneto-optics

3.02-O [42]: Silver Nanoparticle-Decorated CuO Nanoneedles for Non-Enzymatic Glucose Sensing toward Non-Invasive Monitoring

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Abstract:

CuO nanoneedles (CuONN) decorated with silver nanoparticles (AgNP) have been deployed as the active sensing material in the development of an efficient and sensitive non-enzymatic electrochemical glucose sensor. CuO nanoneedles were grown directly on copper substrates and subsequently decorated with Ag nanoparticles using a low-temperature chemical process. This enhances highly conductive catalytic sites while maintaining the one-dimensional nanostructure. The structural and electrochemical characteristics of the modified electrode were thoroughly investigated, and its glucose sensing performance was evaluated via cyclic voltammetry in an alkaline solution. Effective electrocatalytic glucose oxidation on the Ag nanoparticles decorated CuONN surface is confirmed by the cyclic voltammetry data, which show a significant and concentration-dependent rise in anodic current with increasing glucose concentration. The fabricated AgNP/CuONN electrode showed enhanced electrocatalytic performance for glucose sensing, delivering a sensitivity of $2446 \mu\text{A mM}^{-1} \text{cm}^{-2}$. The enhanced sensing performance is attributed to a synergistic combination of Ag nanoparticles, which enable quick electron transfer, and the $\text{Cu}^{2+}/\text{Cu}^{3+}$ redox-active CuO nanoneedles, which offer plenty of active sites for glucose oxidation. These findings validate the effectiveness of Ag nanoparticle decoration in boosting the electrochemical performance of CuO nanostructures and indicate the potential of the proposed platform for future non-enzymatic glucose sensing and non-invasive monitoring applications.

Keywords: CuO nanoneedles; Silver nanoparticles; Non-enzymatic glucose sensor; Cyclic voltammetry

3.03-O [46]: Fabrication of Eco-Friendly Adsorbents from Waste Silk Fibroin and Sugarcane Bagasse Nanocellulose for Industrial Dye Removal from Textile Wastewater

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Abstract:

Color removal from textile dyeing wastewater remains an urgent environmental challenge, requiring the development of efficient and biodegradable adsorbent materials. In this study, pelletized adsorbents were fabricated from regenerated silk fibroin derived from waste silkworm cocoons and nanocellulose extracted from sugarcane bagasse.

Waste silk cocoons were first degummed to remove sericin and subsequently dissolved in a $\text{CaCl}_2\text{-H}_2\text{O-EtOH}$ (CWE) solvent system with a molar ratio of 1:8:2. The resulting solution was centrifuged to remove insoluble impurities, and the clear supernatant was subjected to dialysis for salt removal. The regenerated silk fibroin after desalination (FibCa) was blended with sugarcane bagasse nanocellulose (NCSB) at weight ratios of 3:7, 5:5, and 7:3.

The mixtures were further processed under different temperature and treatment-time conditions to obtain pelletized adsorbent materials (FN). The structural and morphological characteristics of the FN pellets were investigated using optical microscopy (OM), scanning electron microscopy (SEM), and Fourier-transform infrared spectroscopy (FT-IR). Using Lanaset Red G (LR) acid dye as simulated pollutants, the adsorption performance and isotherm models of the FN pellets were investigated. The results revealed that the fabricated FN materials exhibited effective adsorption performance toward LR dye, with adsorption equilibrium best described by the Langmuir isotherm model and a maximum adsorption capacity of approximately 1.691 mg/g. These findings demonstrate the potential of waste-derived silk fibroin/nanocellulose composite pellets as sustainable and environmentally friendly adsorbents for textile dyeing wastewater treatment.

Acknowledgment:

The authors would like to thank Hanoi University of Science and Technology for financially supporting this research under Grant No. T2025-PC-120. We thank Department of Textile Material and Chemical Processing for providing excellent research facilities.

Keywords: silk fibroin; sugarcane bagasse nanocellulose; eco-friendly adsorbent; textile dyeing wastewater

3.06-O [64]: Suppresses Mn Dissolution Enables High-Rate and Ultra-Stable Mn-Rich $\text{LiMn}_{0.7}\text{Fe}_{0.3}\text{PO}_4$

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Abstract:

Manganese-rich lithium manganese iron phosphate ($\text{LiMn}_x\text{Fe}_{1-x}\text{PO}_4$, $x \geq 0.5$) is a promising cobalt-free olivine cathode for next-generation lithium-ion batteries due to its high operating voltage and sustainable chemistry.

Despite these thermodynamic advantages, Mn dissolution during cycling remains a critical challenge that limits the long-term stability of Mn-rich olivine cathodes. Here, we report a surface cation engineering strategy to stabilize Mn-rich $\text{LiMn}_{0.7}\text{Fe}_{0.3}\text{PO}_4$ while preserving its favorable high-rate kinetics. Incorporating high-valence-state cations such as Ti and Zr, and low-valence-state Zn and Mg, at the particle surface effectively suppresses surface reconstruction and significantly mitigates Mn dissolution.

Soft X-ray adsorption reveals that Zr^{4+} , as an optimized dopant, induces the changing of the electronic structure of Fe and Oxygen near the surface of the particle, while preserving the Mn oxidation state, thereby enhancing the stability of the active surface material. The resulting surface-engineered $LiMn_{0.7}Fe_{0.3}PO_4$ with Zr 1 at.% cathodes exhibit improved interfacial stability while maintaining the intrinsic high-rate performance of the optimized bulk composition. This work demonstrates that coupling bulk kinetic optimization with surface stabilization provides an effective pathway to overcome the long-standing stability challenges of Mn-rich olivine cathodes, advancing cobalt-free high-energy cathode materials for durable lithium-ion batteries.

Keywords: Surface engineering; doping; Mn-rich olivine-based cathode; high-power; long-term cycling

3.07-O [67]: Z scheme photocatalyst of ternary heterostructure $Au@WO_3/WS_2$ graphene nanoplatelets for highly-efficient photocatalytic hydrogen evolution

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Abstract:

The development of an innovative composite photocatalyst is imperative for achieving efficient decomposition of aquatic hydrogen through photocatalysis. In this study, we synthesized $Au@WO_3/WS_2$ graphene nanoplatelets structures using a two-step hydrothermal technique. The distinctive charge transfer mechanisms exhibited by mixed heterojunctions, namely Z-scheme heterojunctions and Type-I heterojunctions, significantly enhance charge transfer and separation. As a result, exceptional performance in terms of photocatalytic hydrogen evolution is observed for the $Au@WO_3/WS_2$ graphene nanoplatelets structures composite. The hydrogen evolution rate for $Au@WO_3/WS_2$ graphene nanoplatelets structures is $\sim 90,000 \mu\text{mol g}^{-1}\text{h}^{-1}$. Moreover, the quantum efficiency reaches $\sim 20\%$. Additionally, the performance of $Au@WO_3/WS_2$ graphene nanoplatelets structures surpasses most of the other reported WS_2 based photocatalysts. The adsorption-desorption potential barrier is considerably decreased, indicating that the $Au@WO_3/WS_2$ graphene nanoplatelets structures photocatalytic system is highly favorable for H^* adsorption. This outstanding performance can be attributed to the unique transfer mechanism resulting from mixed heterojunctions. Thus, this study introduces a novel concept for photocatalytic hydrogen production and offers a valuable reference for future research in the field of photocatalytic hydrogen production technology.

Keywords: Photocatalyst; heterostructure; hydrogen; evolution

3.08-O [72]: Deep Eutectic Solvent-Assisted Synthesis of High-Entropy Spinel Oxide Catalysts for Efficient Alkaline Water Splitting

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Abstract:

Developing low-cost, highly durable, and efficient electrocatalysts for oxygen evolution reaction and hydrogen evolution reaction remains a critical bottleneck for commercial alkaline water splitting. High-entropy spinel oxides (HESOs) offer a promising solution due to their unique cocktail effects and structural stability; however, traditional high-temperature synthesis routes often lead to severe particle agglomeration and limited active surface areas. Herein, we report a novel, environmentally friendly deep eutectic solvent (DES)-assisted synthesis strategy to prepare high-uniformity HESO catalysts. The DES network acts as both a green solvent and a structural template, effectively regulating the nucleation rate and preventing element segregation during phase formation. Microstructural and electrochemical characterizations reveal that the DES-mediated HESOs exhibit a uniform morphology, abundant oxygen vacancies, and suitable electronic configurations.

Consequently, the optimized HESO catalyst delivers exceptional electrocatalytic activity for alkaline water splitting, which requires a remarkably low overpotential to achieve a current density of 10 mA cm^{-2} along with the outstanding long-term stability exceeding 50 hours. This work demonstrates a facile and scalable green chemistry pathway for engineering high-entropy transition metal oxides toward advanced energy conversion technologies.

Keywords: Deep Eutectic Solvents; High-Entropy Spinel Oxides; Green Synthesis; Alkaline Water Splitting; Electrocatalysis

3.09-O [73]: Dual Strategy for High-Performance Blue Perovskite LEDs via Strontium Ion Substitution and Molecular Additives

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Abstract:

Metal-halide perovskites are an emerging class of semiconductors with outstanding optoelectronic properties, facile solution processability, and tunable bandgaps, making them highly attractive for solar cells, lasers, photodetectors, and light-emitting diodes (LEDs). Among these, perovskite LEDs (PeLEDs) are highly promising candidates for next-generation displays and solid-state lighting due to their high color purity. However, while green and red PeLEDs have achieved remarkable progress in efficiency and stability, blue PeLEDs remain a critical challenge. Current devices suffer from poor operational lifetimes, electroluminescence instability under bias, and efficiency losses associated with unbalanced charge injection and non-radiative recombination pathways.

Previous studies have reported that the trap density in blue 3D perovskites can be significantly reduced by introducing a B-site alloy (Pb/Sr), resulting in improved color stability and enhanced efficiency of LEDs. In this study, we propose a dual strategy to address the limitations. First, substituting Pb^{2+} with strontium ions in quasi-2D perovskites aims to reduce trap density in blue perovskite LEDs. Moreover, introducing small amounts of Sr^{2+} has a minimal impact on the crystal structure due to its similar ionic radius to Pb^{2+} , while promoting the formation of continuous and denser perovskite films with fewer defects. This leads to an enhanced photoluminescence quantum yield, longer photoluminescence lifetimes and improved spectral stability of blue perovskite films.

Second, we incorporate (2-(3,6-dibromo-9H-carbazol-9-yl)ethyl)phosphonic acid, a carbazole-based molecule with a deep HOMO level, into the precursor solution. This additive facilitates balanced hole injection and passivates trap states, thereby suppressing non-radiative recombination and offering a viable strategy for enhancing the performance of blue perovskite LEDs. The combination of Sr^{2+} substitution and carbazole-based additive engineering yields blue perovskite LEDs with improved efficiency, stability, and emission quality. These findings provide valuable insights into material design and device engineering strategies, advancing the development of reliable blue PeLEDs for future display and lighting technologies.

Keywords: Metal-halide perovskites; Blue emission; Sr^{2+} doping; Carbazole-based additive; PeLEDs

3.12-O [91]: Electrochemical Performance and Structural Stability of a Co/Ni-Free Mn-Rich Polyanion-Incorporated Spinel Cathode for High-Voltage Lithium-Ion Batteries

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Abstract:

The demand for high-energy-density lithium-ion batteries based on earth-abundant elements has motivated extensive investigation of Mn-based cathode materials as sustainable alternatives to Ni- and Co-rich layered oxides. Among these, spinel-type frameworks are attractive due to their inherent three-dimensional Li^+ diffusion pathways; however, their practical application at high voltages remains hindered by oxygen-related instability and structural degradation. Herein, we report a Co- and Ni-free cathode in the Li-Mn-P-O system, in which $(\text{PO}_4)^{3-}$ polyanion group is incorporated within a spinel-type lattice, forming an integrated polyanion–spinel architecture. The covalent P–O bonds are proposed to anchor the oxygen sublattice and suppress oxygen release at high voltage, while the spinel framework enables facile Li^+ diffusion pathways. The material is synthesized via a single-step, room-temperature mechanochemical ball-milling route. The substantial size mismatch (~12–15 %) between the PO_4 tetrahedral unit and the MnO_6 octahedral building block of the spinel lattice exceeds the conventional solid-solubility limit, driving phase separation under thermodynamic equilibrium at elevated temperatures. The room-temperature mechanochemical route circumvents this limitation by kinetically trapping the polyanion-incorporated spinel as a single metastable phase, thereby avoiding the high-temperature calcination required by conventional polyanion chemistry. Galvanostatic cycling between 1.5–4.8 V vs. Li/Li^+ delivers an initial capacity of ~190 mAh g^{-1} at 20 mA g^{-1} and ~70 % retention after 100 cycles at 50 mA g^{-1} . This work establishes the potential of polyanion-incorporated spinel architecture as a sustainable design strategy toward high-energy, Co/Ni-free lithium-ion cathodes with enhanced high-voltage durability.

Keywords: Mn-rich spinel cathode; polyanion incorporation; PO_4^{3-} ; mechanochemical synthesis; Co/Ni-free cathode; high-voltage stability

3.13-O [96]: Toward Full-Solar-Spectrum Water Splitting: A Robust SWCNT/ WO_3 Z-Scheme Photocatalyst Pair Mediated by Iodide

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Abstract:

Solar-driven overall water splitting (OWS) is an attractive route to carbon-neutral hydrogen production by converting abundant solar energy and water into a storable chemical fuel. We previously showed that physical decoration of single-walled carbon nanotubes (SWCNTs) with an amphiphilic C₆₀-dendron forms SWCNT/C₆₀ van-der-Waals (vdW) nanohybrids that act as efficient hydrogen-evolution photocatalysts (HEPs), delivering an external quantum yield (EQY) of 13 % at 1000 nm, where conventional particulate photocatalysts are essentially inactive [1,2]. Here we report a particulate Z-scheme OWS system comprising the SWCNT/fullerodendron/Ru-derived hydrogen-evolution photocatalyst, commercially available WO₃ as the oxygen-evolution photocatalyst, and an I₃⁻/I⁻ redox mediator. The SWCNT component exploits chirality-dependent red-to-near-infrared excitonic absorption, while WO₃ serves as a chemically robust water-oxidation partner under mildly acidic conditions. The I₃⁻/I⁻ mediator effectively couples the two photocatalysts, enabling stoichiometric H₂ and O₂ evolution with an H₂/O₂ ratio of 2:1. Under simulated sunlight (AM 1.5G, 1000 W m⁻²), the optimized system evolved H₂ and O₂ at rates of 15.2 and 7.6 μmol h⁻¹, respectively, corresponding to a solar-to-hydrogen conversion efficiency of 0.08% without sacrificial reagents or external bias. This work highlights SWCNT/metal-oxide Z-scheme photocatalysis as a platform for long-wavelength-driven artificial photosynthesis, integrating excitonic nanocarbon light harvesters with durable inorganic water-oxidation photocatalysts.

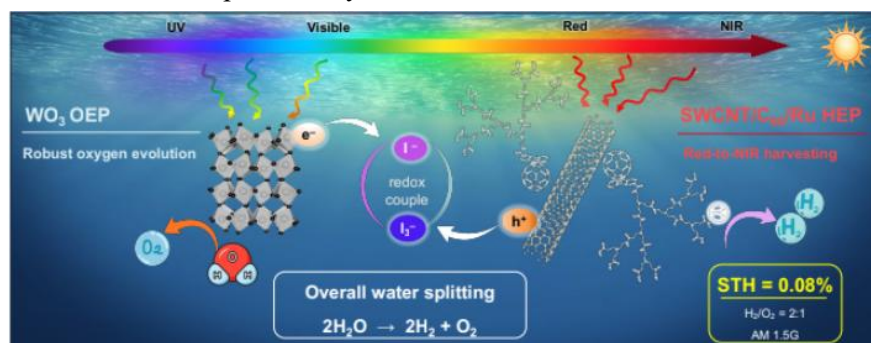


Figure 1: Schematic illustration of the SWCNT/WO₃ Z-scheme OWS system mediated by I₃⁻/I⁻.

[1] Y. Takaguchi et al. Chem. Lett., 48, 410 (2019).

[2] Y. Takaguchi et al. Catalysts, 14, 715 (2024).

Keywords: SWCNTs red-light harvesting; tungsten oxide; iodide mediator; artificial photosynthesis Z-scheme overall water splitting

3.14-O [98]: Enhancement of Bonding Reliability and Thermoelectric Performance of Bi₂Te₃ Modules via Ni-P/Ag Interfacial Coating

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Abstract:

Bi₂Te₃-based thermoelectric modules frequently suffer from high interfacial resistance, weak solder bonding, and harmful interfacial reactions with SAC₃₀₅ solder, all of which can reduce bonding reliability and module performance. To address these issues, this study introduces a Ni–P/Ag interfacial structure for Bi₂Te₃ modules. A 1 μm-thick electroless Ni–P layer was applied as a diffusion barrier to suppress direct reactions between SAC₃₀₅ solder and Bi–Te materials, while an electrodeposited Ag layer was introduced to enhance solder wettability and electrical contact. The Ni–P/Ag coating led to clear improvements in both mechanical reliability and thermoelectric performance.

The bonding strength increased from 4.40 to 16.1 MPa for n-type legs and from 6.26 to 13.9 MPa for p-type legs, corresponding to approximately 3.7-fold and 2.2-fold improvements, respectively. The Ag coating also greatly reduced the solder contact angle from 136.3° to 33.9°, confirming enhanced solder spreading on the coated surface.

After Ni–P/Ag coating, the module resistance decreased, and the output power nearly doubled due to improved interfacial contact. In addition, the cooling/heating performance was enhanced, suggesting more effective heat and charge transfer across the bonding interface. SEM/EDS analysis of the fracture surface after shear testing revealed a more uniform Sn distribution, indicating stronger solder attachment and improved interfacial bonding. Overall, the Ni–P/Ag coating is an effective strategy for simultaneously enhancing the bonding reliability and thermoelectric performance of Bi₂Te₃-based modules.

Keywords: Diffusion barrier; Thermoelectric module; Bi–Te; Ag plating; Bonding strength

3.15-O [100]: Weakly Solvating Electrolytes: A Promising Solution for Next Generation Alkali Batteries

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Abstract:

Lithium metal batteries (LMBs) are considered one of the most promising next-generation energy storage systems because of their ultrahigh theoretical capacity and low electrochemical potential. However, the practical application of LMBs is still hindered by lithium dendrite growth, unstable electrode/electrolyte interfaces, and poor cycling stability. Recently, electrolyte solvation structure engineering has emerged as an effective strategy to address these challenges. In this work, the concept of weakly solvating electrolytes (WSEs) is introduced and discussed for alkali batteries including lithium and sodium batteries. Compared with conventional strongly solvating electrolytes, WSEs exhibit weaker Li⁺-solvent interactions, leading to anion-rich solvation structures and modified interfacial chemistry. Such unique solvation environments can suppress undesirable side reactions, improve the stability of solid electrolyte interphases, enhance low-temperature performance, and mitigate graphite exfoliation in ether-based electrolytes. Several representative electrolyte systems based on ethers with different solvating abilities are presented to demonstrate the relationship between solvation structure and electrochemical performance. The results suggest that balancing Li⁺ interactions with solvents and anions is crucial for the development of practical high-performance alkali metal batteries.

Keywords: solvation structure; lithium batteries; weakly interaction; dendrite-free; co-intercalation free

3.16-O [101]: Fabrication of Superhydrophobic ZnO/PDMS-Coated Melamine Sponge for Oil Spill Recovery

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Abstract:

Oil spills and oily wastewater from industrial zones have caused serious impacts on the environment, ecosystems, and human health. In this study, commercial melamine sponge was modified to fabricate a superhydrophobic and oleophilic oil-absorbing material. ZnO particles were first modified with stearic acid and then coated onto the surface of the melamine sponge. The effect of ZnO particle loading on the wettability of the sponge was evaluated. In addition, a PDMS coating was applied to improve the hydrophobicity, oil absorption capacity, and reusability of the material. The modified sponge exhibited superhydrophobic properties, with a water contact angle of up to $151 \pm 1^\circ$. The material also showed relatively good oil absorption performance for the tested oils, including diesel oil, gasoline, lubricant oil, and condensate, with absorption capacity ranging from 54% to 72% of its original weight, depending on the oil type.

After repeated absorption–squeezing cycles, the sponge retained its oil absorption ability and maintained its structure. Specifically, the material could be reused up to 9 times for diesel oil, 8 times for gasoline and condensate, and 5 times for lubricant oil. Although several organic solvents were used during the fabrication process, the obtained material shows potential as a low-cost, reusable, and selective absorbent for oil spill recovery and oily wastewater treatment.

Keywords: Superhydrophobic melamine sponge; ZnO particleless; oil/water separation

3.17-O [109]: Study effects of Cu doping for Sn sites on thermoelectric properties of Cu_4SnS_4

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Abstract:

This study investigated the effects of partial substitution Cu for Sn sites in Cu_4SnS_4 compound on their thermoelectric (TE) properties. The $\text{Cu}^{4+}\text{xSn}_{1-\text{x}}\text{S}_4$ samples ($\text{x} = 0$ and 0.05) were synthesized using a high energy ball mill method with high-purity Cu, Sn and S (99.5%) powders.

The as-milled powders were subsequently heat-treated at 600°C for 1 h with a heating rate of $10^\circ\text{C}\cdot\text{min}^{-1}$ to evaluate phase stability. The milled powders were consolidated by spark plasma sintering (SPS) at 600°C under a pressure of 50 MPa for 30 min prior to characterization TE properties.

The particle size of the milled powders was observed by scanning electron microscopy (SEM) and analyzed using ImageJ software, which revealed particle size ranging from 0.6 to 0.7 μm . X-ray diffraction (XRD) results indicated that Cu_3SnS_4 was formed after 16 h of milling. Following heat-treatment at 600 $^\circ\text{C}$ for 1 h, Cu_3SnS_4 was completely transformed into Cu_4SnS_4 . After Cu doping, the diffraction peaks exhibited a slight shift toward to higher angles, which indicated to the substitution of Cu atoms at Sn sites. Thermoelectric measurements revealed a great improvement in electrical conductivity, whereas the Seebeck coefficient significantly reduced, resulting in reduced power factor of doped $x = 0.05$ sample. Finally, the maximum figure of merits (ZT) of $x = 0$ and 0.05 samples at 723 K were of 0.022 and 0.054, respectively.

Keywords: Cu_4SnS_4 thermoelectric properties; synthesis; Cu doping for Sn sites

3.18-O [113]: Functional 2D materials: From fundamental chemistry to advanced applications

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Abstract:

Two-dimensional (2D) materials have attracted significant attention owing to their unique structural, electronic, and physicochemical properties, which make them promising candidates for a wide range of advanced technologies. In this presentation, recent progress in the synthesis, crystal growth, and functionalization of layered 2D materials will be discussed, with a particular focus on transition metal dichalcogenides (TMDCs) and MXenes.

A molten salt-mediated synthesis (MSM) approach has been developed to produce high-quality layered materials, including MoS_2 , TiS_2 , and TiSe_2 , through controlled reaction pathways and crystal growth processes. The fundamental chemistry underlying phase formation, diffusion behavior, defect control, and morphology evolution in molten salt environments will be presented. The advantages of MSM for scalable and cost-effective production of layered materials will also be highlighted.

Furthermore, the structure–property relationships of these materials will be discussed through representative examples involving electrochemical energy storage and other emerging functional applications. Particular attention will be given to how synthetic design and crystal engineering can influence the performance of 2D materials and facilitate their integration into future advanced technologies.

This presentation aims to provide insights into the connection between fundamental materials chemistry and the practical development of functional 2D materials, demonstrating the opportunities and challenges associated with translating laboratory discoveries into real-world applications.

Keywords: 2D materials; MSM (Molten Salt Method); TMDC; MAX and MXene

3.19-O [124]: Enhancing Bonding Strength and Performance of Bi_2Te_3 -Based Thermoelectric Modules via Electroless Ni-P and Electroplated Cu

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Abstract:

Bismuth telluride (Bi_2Te_3)-based materials are widely recognized as the most efficient thermoelectric (TE) candidates for low-temperature ($\leq 200^\circ\text{C}$) applications.

However, severe structural degradation at the joint often limits their device performance. In this study, an electroless Ni-P (ENP) and electroplated Cu (ENPEC) multilayer coating was developed for Bi_2Te_3 elements to enhance bonding strength and increase output power. The ENPEC-plated samples exhibited an outstanding initial bonding strength. This superior bonding strength was primarily attributed to the significantly improved wettability of Sn solder on the ENPEC surface compared to the ENP-plated and unplated surfaces. Importantly, fracture surface analysis after the shear test showed a transition from brittle interfacial failure within the Sn-Te layer for the unplated sample to cohesive failure inside the Bi_2Te_3 matrix for the ENPEC sample, confirming that the joint strength exceeded the intrinsic limit of the Bi_2Te_3 thermoelectric element. Cross-sectional analysis via SEM-EDS and FE-EPMA revealed that the Ni-P layer functioned as a diffusion barrier, successfully inhibiting brittle Sn-Te intermetallic compound (IMC) formation. Thermal aging tests at 150°C for 100 h demonstrated the exceptional reliability of the ENPEC coating. The unplated sample severely degraded in bonding strength due to rapid IMC growth. In contrast, the ENPEC sample maintained a remarkably stable bonding strength with negligible variation. Additionally, the ENPEC coating reduced the module internal resistance by over 50% and 40% compared to the unplated and ENP-plated modules, respectively, leading to 3 and 1.8 times higher output powers alongside an enhanced cooling capacity. These findings demonstrate the potential of the developed ENPEC multilayer coating for improving the interfacial properties, thermal stability, and overall performance of Bi_2Te_3 -based thermoelectric modules.

Keywords: Thermoelectric modules; Bi_2Te_3 ; Electroless Ni-P; Electroplated Cu; Output power

3.20-O [131]: Electrodeposition time governs hierarchical surface architecture and cytocompatibility of hydroxyapatite/ TiO_2 nanotube coatings on titanium

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Abstract:

Surface architecture plays a critical role in regulating implant–cell interactions on titanium-based biomaterials.

In this study, hydroxyapatite (HA)/ TiO_2 nanotube (TNT) coatings were synthesized on titanium substrates by anodization followed by electrochemical deposition, with deposition time varied from 5 to 20 min. XRD analysis showed that HA crystallinity and Ca/P ratio increased with deposition time, while FE-SEM revealed a distinct morphological evolution from sparse dendritic crystals to densely packed flower-like hierarchical structures and subsequently to aggregated plate-like morphologies at prolonged deposition times. All coatings exhibited superhydrophilic behavior with near-zero contact angles. In vitro cytocompatibility evaluation using BHK-21 cells demonstrated that the 10 min coating, characterized by a homogeneous flower-like hierarchical architecture, significantly enhanced ($*p < 0.001$) cell adhesion, spreading, and

proliferation at both 48 and 72 h compared with other HA/TNT coatings as well as bare Ti and TNT control surfaces. These findings suggest that, in addition to crystallinity and chemical composition, the uniformity of the hierarchical surface morphology plays an important role in modulating cytocompatibility. The study highlights electrodeposition time as a key parameter for tailoring HA/TNT coating architecture for biomedical implant applications.

Keywords: Electrodeposition; Hydroxyapatite; TiO₂ nanotube; Flower-like; Cytocompatibility

3.21-O [135]: A Photo-Hydrogen-Evolving Molecular Device (PHEMD) Based on a C₆₀-Terpyridine-Pt(II) Complex

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Abstract:

Artificial photosynthesis has attracted considerable attention as a key technology for addressing climate change and realizing sustainable solar fuel production. In particular, light-driven hydrogen evolution via water-derived proton reduction is a central reaction in solar-to-chemical energy conversion. Molecular catalytic systems based on transition-metal complexes are promising because their structures can be precisely designed and modified. However, conventional molecular systems often require separate components, such as a photosensitizer, an electron-transfer mediator, and a hydrogen-evolution catalyst, which complicates mechanistic understanding and molecular design. Recently, Sakai and co-workers developed photo-hydrogen-evolving molecular devices (PHEMDs) based on terpyridine-Pt(II) complexes, in which the complex itself absorbs light and promotes proton reduction in the presence of a sacrificial electron donor such as EDTA.[1] Although this concept offers an important strategy for integrated molecular photocatalysts, further improvement of the hydrogen-evolution activity remains necessary. Sakai also reported that introducing viologen moieties as electron-accepting units enhanced the catalytic activity.[2] Inspired by this strategy, we focused on C₆₀ as an alternative electron acceptor because fullerene has excellent electron-accepting ability and can stabilize multi-electron-reduced states. We therefore designed a C₆₀-terpyridine-Pt(II) complex as a new fullerene-based PHEMD.

The target C₆₀-terpyridine-Pt(II) complex was synthesized via the corresponding anthracene-terpyridine-Pt(II) complex. We have previously reported the synthesis of various fullerene derivatives through the Diels-Alder reaction between C₆₀ and anthracene derivatives.[3] In the present study, an anthracene-terpyridine ligand was first synthesized by the reaction of 2-aminoanthracene with 2,2':6',2''-terpyridine-4'-carboxylic acid, followed by coordination to Pt(II). The resulting anthracene-terpyridine-Pt(II) complex was then reacted with C₆₀ through a Diels-Alder reaction to afford the desired C₆₀-terpyridine-Pt(II) complex. The molecular structure of the obtained complex is shown. Photocatalytic hydrogen evolution was investigated in aqueous solution in the presence of BNAH as a sacrificial electron donor. The C₆₀-terpyridine-Pt(II) complex exhibited higher hydrogen-evolution activity than the corresponding anthracene-terpyridine-Pt(II) complex without C₆₀. This enhancement is attributed to the ability of C₆₀ to stabilize charge-separated states through its strong electron-accepting character, as well as its possible contribution as a light-absorbing unit. These results demonstrate that the newly synthesized C₆₀-terpyridine-Pt(II) complex represents a new class of fullerene-based PHEMDs for molecular photocatalytic hydrogen evolution.

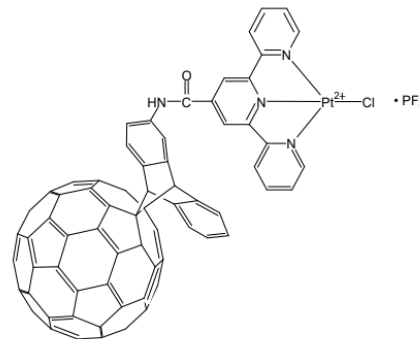


Figure 1. Molecular structure of C₆₀-terpyridine-Pt(II) complex acting as PHEMD.

[1] K. Sakai et al. Dalton Trans. 2009, 6127-6133.

[2] K. Sakai et al. Dalton Trans. 2016, 45, 10643-10654.

[3] Y. Takaguchi et al. Tetrahedron Lett. 2003, 44, 5777-5780.

Keywords: fullerene; PHEMD; photocatalyst; hydrogen evolution; Pt(II) complex

3.22-O [137]: Phase-controlled of FePO₄·2H₂O (FP) precursor for LiFePO₄ (LFP) cathode material.

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Abstract:

Lithium iron phosphate (LiFePO₄, LFP) is one of the most practical cathode materials for lithium-ion batteries because of its excellent thermal stability, intrinsic safety, long cycle life, low cost, and use of earth-abundant elements. Despite these advantages, the electrochemical performance of LFP is limited by its low electronic conductivity and relatively slow Li⁺ diffusion, making structural and morphological control essential. In particular, the phase and crystallinity of the FePO₄·2H₂O precursor can strongly affect the formation of olivine LFP and the resulting Li⁺ transport behavior. In this study, FePO₄·2H₂O precursors were synthesized by pH-controlled precipitation to regulate the saturation index and selectively obtain monoclinic, mixed-phase, and orthorhombic precursor phases. These precursors were subsequently converted to carbon-coated LFP through lithiation and calcination under reducing atmosphere. The precursor phase produced distinct particle morphologies and led to different electrochemical properties in the final LFP/C cathodes. The monoclinic precursor formed rod-like primary particles assembled into

spherical secondary particles, while the orthorhombic precursor produced denser agglomerated particles. For the electrochemical, the orthorhombic-derived LFP/C exhibited superior high-rate performance and cycling stability, delivering 95 mAh/g at 5 C and 97.10 % capacity retention after 200 cycles at 1 C.

This improvement is attributed to the crystallographic compatibility between orthorhombic $\text{FePO}_4 \cdot 2\text{H}_2\text{O}$ and olivine LFP, which promotes stable phase evolution, suggesting precursor phase engineering as an effective strategy for developing high-performance and durable LFP/C cathodes.

Keywords: $\text{FePO}_4 \cdot 2\text{H}_2\text{O}$; Orthorhombic precursor; pH control; LiFePO_4/C ; Lithium-ion battery; Precipitation

3.23-O [151]: Microstructural Characterization and Electrochemical Performance of Fine-Grained Aluminum Anodes Processed by Friction Stir for Aluminum-Air Batteries

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Abstract:

This research explores the application of aluminum-zinc alloy anodes in aluminum-air batteries, with a focus on optimizing their microstructure and electrochemical performance through solid-state processing and post-heat treatment. Aluminum alloys were produced using a modified Friction Stir Process, offering an alternative route for microstructural refinement. The processed samples were extensively characterized using ex-situ Electron Backscatter Diffraction and Transmission Electron Microscopy. Post-heat treatment was employed to examine changes in crystal orientation, revealing that preferred orientation can be altered to improve electrochemical properties.

Electrochemical performance was evaluated by measuring discharge behavior under a constant current density in a cell assembly. The results highlight how microstructural refinement and heat treatments enhance anode performance.

Post-heat treatment performed at a relatively low temperature promoted recovery without significant grain growth, with orientation contrast attributed to changes in dislocation density. These findings demonstrate that fine-grained aluminum-zinc alloys produced via Friction Stir Processing show strong potential as high-performance anodes for aluminum-air batteries, with refined grain structures leading to significantly improved electrochemical behavior.

Keywords: Microstructure Characterization; Electrochemical Behavior; Aluminum Anodes; Aluminum-Air Batteries

3.24-O [156]: Lithium Storage Properties of Nucleation-Dominated Manganese Carbonate Nanoparticles

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Abstract:

Transition metal carbonates are promising lithium storage materials for next generation lithium batteries owing to their high theoretical storage capacities compared with commercial graphite materials. However, their applications can be limited by poor electrical conductivity and severe volume variation during the cycling process. In this study, the nucleation-dominated synthesis of MnCO_3 ($\text{MnCO}_3\text{-ND}$) was performed using a simple aqueous precipitation route by employing a higher precursor concentration and faster precipitant rate. Compared with the growth-dominated synthesis of MnCO_3 ($\text{MnCO}_3\text{-GD}$)—prepared under mild conditions—the $\text{MnCO}_3\text{-ND}$ exhibited an approximately 18-fold higher surface area and 6-fold larger pore volume. This architecture enabled superior lithium storage properties through both improved bulk Li-storage capacity and considerably enhanced interfacial storage capacity, thereby markedly improving the overall energy-storage efficiency.

Consequently, the $\text{MnCO}_3\text{-ND}$ delivered a reversible capacity of 1340 mAh g^{-1} after 400 cycles at 0.2 A g^{-1} and maintained a capacity of 517 mAh g^{-1} after 400 cycles at a high current density of 1.0 A g^{-1} . Moreover, when combined with a LiFePO_4 (LFP) cathode, the $\text{MnCO}_3\text{-ND}$ exhibited a capacity of 147 mAh g^{-1} after 200 cycles at 0.5 C . This study provides a simple and effective strategy for designing high lithium storage performance of carbonated-based materials for next generation lithium batteries.

Keywords: Lithium-ion batteries; Manganese carbonate nanoparticles; Lithium storage mechanisms

3.25-O [165]: Leaching of Cathode Materials from Spent Lithium-Ion Batteries using Acetic and Citric Acid

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Abstract:

The recovery of valuable metals from spent lithium-ion batteries (LIBs) has become increasingly important due to growing demand and environmental concerns. This study investigated the leach-ing behavior of Li, Ni, and Co from spent LIBs using acetic and citric acids. The effects of leach-ing temperature, acid concentration, solid-to-liquid ratio, reaction time, and H_2O_2 addition on Li, Ni, and Co leaching were systematically evaluated. The results indicated that both acetic and cit-ric acid could be used as the leaching solution as the leaching efficiencies have remained high. Li, Ni, and Co leaching efficiency were 98.4%, 93.5%, and 86% for acetic acid and 80.8%, 96%, and 69.3% for citric acid, respectively. Leaching Co metal was the most difficult task as those high efficiencies were only archive when H_2O_2 was added into the leaching solution

Keywords: leaching; organic acid; cathode material; spent LIB

3.26-O [167]: Synergistic Effects of Carbonization Temperature and KOH Activation in Amine-Functionalized Low-Molecular-Weight Lignin Carbons for High-Rate Supercapacitors

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Abstract:

Sustainable and high-performance energy storage materials are essential for next-generation supercapacitors. Lignin, an abundant biomass-derived by-product, has emerged as a promising carbon precursor; however, achieving a precisely tailored pore network remains a critical challenge. In this study, low-molecular-weight lignin derivatives containing amine functionalities were synthesized and systematically optimized through a dual-parameter matrix involving carbonization temperatures (600 – 800 °C) and KOH activation ratios (1:1 to 1:3).

Electrochemical investigations revealed an intriguing “sweet-spot shifting” phenomenon governed by the synergistic interplay between thermal kinetics and activator concentration. At the relatively low carbonization temperature of 600 °C, mild activation at a 1:1 KOH ratio produced the highest specific capacitance of 222 F g⁻¹, whereas excessive KOH loading resulted in pore blockage and structural deterioration. In contrast, at 700 °C, the optimal activation condition shifted to a 1:2 ratio, yielding the highest specific capacitance of 256 F g⁻¹ at 0.5 A g⁻¹. This enhancement was attributed to the balanced formation of cheese-like porous architectures and electrochemically active nitrogen functionalities. Notably, at the elevated temperature of 800 °C, electrochemical performance became strongly dependent on intensive activation conditions. A high KOH ratio of 1:3 effectively mitigated framework collapse while promoting K-vapor intercalation, thereby minimizing internal resistance and generating highly accessible ion-transport channels for rapid electrolyte diffusion.

Furthermore, kinetic analysis based on the power-law relationship ($i = av^b$) and electrochemical impedance spectroscopy (EIS) elucidated the transition from predominantly surface-controlled pseudocapacitive behavior at low scan rates to electric double-layer capacitance (EDLC)-dominated behavior at higher scan rates. These findings demonstrate that, rather than relying on a single fixed parameter, fine-tuning the interdependent relationship between carbonization temperature and activation ratio is crucial for maximizing the capacitive performance of biomass-derived carbon electrodes.

Keywords: Low molecular weight lignin; nitrogen doped; Supercapacitor

3.27-O [177]: Role of Gold Electrodeposition in Tailoring the Bonding Strength and Performance of Bismuth Telluride Thermoelectric Modules

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Abstract:

This study evaluated how gold electrodeposition influences the bonding strength and performance of bismuth telluride (Bi_2Te_3) thermoelectric modules. An electroless nickel–phosphorus (NiP) layer was first deposited as a barrier to prevent harmful diffusion during module fabrication. Subsequently, gold layers with different thicknesses were electrodeposited to improve the electrical and thermal properties of the thermoelectric legs. The electrodeposited gold significantly enhanced the wettability between the thermoelectric legs and the solder, thereby increasing the effective contact area at the interface. Consequently, stronger interfacial bonding was achieved, leading to improved bonding strength of the solder joints. Furthermore, the electrodeposited gold diffused into the solder layer during the fabrication process and promoted a more homogeneous interfacial structure. This diffusion reduced the formation of interfacial voids and defects, which contributed to lower contact resistance and improved electrical transport across the joints. Among the studied samples, the module with a 10 μm -thick electrodeposited gold layer exhibited the best performance, showing approximately 22.5% higher power output than the original module without gold electrodeposition. These results demonstrated that gold electrodeposition is an effective strategy for enhancing interfacial bonding, reducing electrical resistance, and improving the durability and energy conversion efficiency of Bi_2Te_3 thermoelectric modules.

Keywords: thermoelectric; Bi_2Te_3 ; power performance; bonding strength; electrodeposition; diffusion barrier

3.29-O [192]: Biophysical study of carbon dots for kidney cell imaging applications

Authors: Vuong-Hung Pham¹, Nguyen Van Nam², Vu Hoang Minh², Trinh Thi Vi Khanh², Le Huyen Phuong², Vu Thi Ngoc Cham², Sai Duc Loc², Nguyen Truong Giang², Le Tuan², Truong Quoc Phong²

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Abstract:

The surface chemistry and optical properties of carbon dots (CDs) play a pivotal role in dictating their performance for biomedical imaging applications. In this study, CDs were synthesized via a facile hydrothermal method using lemon juice as the precursor. The hydrothermal temperature was systematically varied at 150 °C, 200 °C, 240 °C, and 280 °C to evaluate its impact on the physiochemical characteristics of the nanoparticles. The colloidal stability in physiological media varied distinctly as a function of the synthesis temperature. Furthermore, optical analyses revealed that the synthesized CDs exhibited bright green luminescence. Confocal laser microscope confirmed that the CDs synthesized at 240 °C and 280 °C provided the bright visualization of kidney cells with low background noise and negligible photobleaching. This study affirms the potential of hydrothermally synthesized CDs as a safe, cost-effective, and optimizable fluorescent probe for renal cell imaging and related biomedical applications.

Keywords: Carbon; Dots; Hydrothermal; Lemon; Imaging; Kidney

3.30-O [199]: Synthesis of ferromagnetic LTP-MnBi by mechanical alloying method

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Abstract:

MnBi alloys were synthesized using a mechanical alloying method. Elemental Mn and Bi powders were mixed at various compositions and milled at 300 rpm for 10 h under an argon atmosphere. The milled powders were subsequently annealed at 300 °C for 24 h to promote phase formation. The crystal structure, morphology, and magnetic properties of the samples at different synthesis stages were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), and a vibrating sample magnetometer (VSM), respectively. The results revealed the formation of a highly pure low-temperature phase MnBi (LTP-MnBi), with a phase fraction of up to 90 wt.% as determined by Rietveld refinement of the XRD patterns. Magnetic measurements showed that the saturation magnetization (M_s) and coercivity (H_c) reached approximately 45 emu.g⁻¹ and 0.5 T, respectively, under an applied magnetic field of 3 T.

Keywords: LTP MnBi; ferromagnetic materials; mechanical alloying; rare earth free magnet

3.31-O [200]: High-Performance Solar-Regenerable MOF/GO/Alginate Composite Beads for Atmospheric Water Harvesting in Arid and Semi-Arid Environments

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Abstract:

Freshwater scarcity in arid and semi-arid regions demands decentralized, energy-efficient water harvesting solutions operable across diverse climatic conditions. This work reports UiO-66-NH₂/graphene oxide/sodium alginate (UiO-66-NH₂/GO/AG) composite beads engineered for atmospheric water harvesting (AWH) with low-energy solar regeneration. No prior study has reported MOF/graphene oxide/alginate composite beads designed specifically for AWH, representing a critical gap this work addresses.

Fabricated via ionotropic gelation and characterized by FTIR, SEM/EDS, and TGA, the beads achieve water uptake of 0.9 g g⁻¹ at 80% RH and 25 °C across both arid and humid conditions. Solar desorption is confirmed at 65 °C under low-intensity irradiation, and cycling tests confirm stable performance with no measurable degradation. This work establishes UiO-66-NH₂/GO/AG beads as a scalable, solar-powered AWH platform with direct relevance to water security in arid and semi-arid regions, offering a promising pathway toward sustainable decentralized freshwater production

Keywords: Functional composite materials; Atmospheric water harvesting; Solar-driven nanomaterials

3.32-O [202]: Research and Development of Piezoresistors for Strain Sensor Applications

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Abstract:

This paper presents the research and development of a zigzag-patterned piezoresistive sensor structure utilizing a Copper-Nickel (Cu-Ni) alloy thin film fabricated via electroplating. The application of electrodeposition technique enables effective control of film thickness while simultaneously optimizing the electrical properties and mechanical durability of the alloy layer, establishing a critical foundation for the strain-sensing capability of the device. The fabrication process is built upon the close integration of electrochemical plating and photolithography to pattern the sensing element with microscale precision.

Specifically, the zigzag piezoresistive structure is designed with a conductor linewidth of 30 μm and a film thickness of 0.5 μm , yielding a simulated resistance of approximately 117.8 Ω . To evaluate the design, a multiphysics simulation model was implemented to analyze the electromechanical response under mechanical loading.

Simulation results demonstrate excellent linearity and a stable gauge factor. The proposed structure shows strong potential for application in the fabrication of compact, low-cost, and reliably stable force sensors. The findings contribute meaningfully to the refinement of microelectromechanical device fabrication processes and broaden the applicability of precision measurement sensor systems in both scientific research and industrial contexts.

Keywords: Piezoresistive sensor; Zigzag resistor; Cu-Ni Electrodeposition; Numerical simulation; Photolithography; MEMS

3.33-O [204]: Method for Fabricating Localized Plasmon Resonance Nanostructures Based on Size-Controlled Silica Nanoparticles

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Abstract:

Silica nanoparticles with well-defined size and spherical morphology are essential building blocks for the fabrication of localized surface plasmon resonance (LSPR) nanostructures. In this work, we present a sol-gel approach for synthesizing size-controlled silica nanoparticles via the hydrolysis and condensation of tetraethyl orthosilicate (TEOS) in an ethanol–water medium, with ammonium hydroxide serving as a base catalyst. Three target particle diameters of approximately 100 nm, 200 nm, and 300 nm are pursued by systematically varying the synthesis conditions. Particle size is governed by a set of interdependent parameters — namely TEOS concentration, ammonium hydroxide content, water-to-TEOS ratio, reaction temperature, and stirring conditions — which collectively determine the nucleation and growth kinetics of silica particles. Careful tuning of these variables yields spherical nanoparticles with controlled dimensions and adequate colloidal stability, enabling reliable preparation of distinct size populations for downstream nanostructure assembly. The proposed route relies on commercially available reagents, straightforward wet-

chemical processing, and low-cost equipment, making it well-suited for laboratory-scale implementation and scalable toward large-area plasmonic substrate fabrication.

Keywords: Silica nanoparticles; Size-controlled synthesis; Sol-gel process; Stöber method; Localized plasmon resonance

3.34-O [206]: Rational engineering of a 3D porous NiFe Hydroxide Nanosheet Arrays for Oxygen Evolution Electrocatalysis

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Abstract:

Abstract: Developing cost-effective and highly efficient non-noble metal electrocatalysts for the oxygen evolution reaction (OER) is crucial for large-scale green hydrogen production. This study presents a practical, single step galvanostatic electrodeposition approach to fabricate a 3D porous NiFe layered double hydroxide (LDH) nanosheet array directly on a conductive nickel foam substrate. By optimizing the Ni:Fe precursor ratio to 5:5, the resulting catalyst exhibits a roughened, hierarchical nanosheet architecture that maximizes exposed active sites and facilitates mass transport. The binder-free NiFe LDH electrode demonstrates extraordinary OER activity, requiring a remarkably low overpotential of approximately 268 mV to achieve a current density of 10 mA·cm⁻².

Furthermore, it maintains robust long-term electrochemical stability, retaining 89% of its initial current after 50 hours at a high-stress current density of 50 mA·cm⁻². This work offers a scalable, high-throughput fabrication strategy for texturing non-noble-metal surfaces, providing a clear roadmap for high-performance industrial water-splitting electrodes.

ACKNOWLEDGEMENT This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 103.02-2025.47.

Keywords: Oxygen evolution reaction; NiFe layered double hydroxides; 3D porous nanosheets; Electrodeposition

3.35-O [207]: Fluctuation-Driven Nonlinear Dynamics in Low-Dimensional Superconductors under Multiple External Fields

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Abstract:

The transport behavior of low-dimensional superconductors near the transition temperature is strongly influenced by thermal fluctuations and external driving fields. In this work, we develop a self-consistent theoretical description of two-dimensional superconducting films exposed to simultaneous electric and magnetic fields within the framework of the stochastic time-dependent Ginzburg–Landau equation. By incorporating fluctuation interactions through a Hartree-type renormalization scheme, we obtain closed-form relations for fluctuation-induced charge transport, resistive response, and transverse thermoelectric effects.

The analysis reveals that nonequilibrium fluctuation dynamics can substantially modify the current–voltage characteristics, leading to nonlinear transport regimes and the emergence of S-type electrical instability. The model further identifies critical conditions under which multivalued transport states cease to exist. Beyond electrical transport, superconducting fluctuations are shown to contribute significantly to transverse thermoelectric signals, providing a consistent interpretation of the Nernst–Ettingshausen response observed near the superconducting transition. Theoretical predictions are compared with representative experimental observations reported for thin superconducting systems, showing satisfactory agreement over a broad parameter range. These results demonstrate that fluctuation-mediated processes play a central role in determining both electrical and thermoelectric properties of two-dimensional superconductors driven far from equilibrium and provide a unified framework for analyzing nonlinear phenomena in confined superconducting structures.

Keywords: two-dimensional superconducting films; superconducting fluctuation dynamics; stochastic time-dependent Ginzburg–Landau theory; S-type current–voltage characteristics; thermoelectric transport phenomena

3.36-O [208]: Study and Fabrication of Silicon Nanowires based on SOI technology

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Abstract:

We report the fabrication and investigation of the electromechanical properties of silicon nanowires (SiNWs) for potential applications in nanoelectromechanical systems and sensor devices. The silicon nanowires were fabricated on Silicon-On-Insulator (SOI) wafers by combining conventional photolithography and wet etching techniques.

Initial micro-scale patterns were transferred onto the photoresist layer using standard UV photolithography. The patterned structures were subsequently transferred into the SiO₂ masking layer by buffered hydrofluoric acid (BHF) etching. The dimensions of the SiO₂ mask were further reduced through lateral wet etching to obtain nanoscale features. Anisotropic wet etching in KOH solution was then employed to form silicon nanowires with triangular-shaped cross-sections and smooth surfaces. The fabricated SiNWs were characterized by scanning electron microscopy (SEM) to evaluate their morphology and structural dimensions. In addition, the electromechanical properties of the silicon nanowires were investigated through the relationship between mechanical deformation and electrical response.

Experimental results demonstrate that the fabricated SiNWs exhibit stable structural characteristics and promising electromechanical behavior, indicating their potential for applications in nanoscale sensing and MEMS/NEMS devices.

Keywords: silicon nanowire; electromechanical properties; wet etching; photolithography; SOI wafer

3.37-O [212]: Fabrication, characterization, and RCS simulation of BiFeO₃-CoFe₂O₄/MoS₂ composites

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Abstract:

Radar systems serve as critical active sensing technologies, driving continuous research into strategies that minimize electromagnetic signatures. This work investigates the fabrication, electromagnetic characterization, and radar absorption performance of a BiFeO₃-CoFe₂O₄/MoS₂ (BC-M) composite coating applied to a metallic ground plane. The scattering parameters of the fabricated composite were measured to determine its complex permittivity and permeability via the Nicolson-Ross-Weir (NRW) method. To evaluate the radar cross-section (RCS) reduction performance, three-dimensional monostatic and bistatic RCS simulations of both a bare Perfect Electric Conductor (PEC) plate and a PEC plate coated with a 1.75 mm-thick BC-M composite layer were conducted using CST Microwave Studio. Simulation results at 11.2 GHz demonstrate that the proposed 1.75 mm composite coating achieves a minimum boresight RCS of -21.2 dBm₂ at a 0° aspect angle. The synergy between the dielectric and magnetic losses of the BC-M composite ensures efficient energy dissipation, resulting in significant RCS suppression compared to the bare PEC surface. These findings underscore the potential of the BC-M composite coating for advanced radar attenuation and microwave absorption applications.

Keywords: multiferroic; MoS₂; radar absorption; metamaterial absorber; radar cross section

3.38-O [224]: Factors Influencing the Demand for Smart Health-Monitoring Garments among the Elderly in Vietnam: A First- and Second-Order Structural Equation Modeling Approach

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Abstract:

With Vietnam's fast-growing aging population (forecasted to reach more than 21 million people aged 60 years and over by 2038), there is a growing need for continuous and non-invasive monitoring. The use of smart garments that have built-in sensors can address the issue; yet, how they will be accepted by elderly users in a multigenerational and emerging market context is not clear. In an attempt to answer the research questions, we formulate a model based on a combination of Technology Acceptance Model, UTAUT2, and Health Belief Model, which includes six need components and eleven hypotheses, where we differentiate between a first-order model (each need $\rightarrow$ purchase intention) and a second-order hierarchical model involving a higher-order generalized need concept. Data were gathered from 500 elderly people aged 60 years and above in five northern Vietnamese provinces and analyzed in R (lavaan/semTools) through exploratory factor analysis, confirmatory factor analysis, and first- and second-order SEMs. All need concepts received high mean values (≥ 4.0) with support services being evaluated most highly ($M = 4.41$).

Keywords: Smart Clothing; Healthy Ageing; Functional Fashion; Elderly Consumers; Structural Equation Modeling

3.39-O [230]: From Magnetic Tunnel Junctions to Hardware Randomness: Unbiased Random Number Generation with Spintronic Nano-Oscillators

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Abstract:

True random number generation (TRNG) is essential for cryptography, hardware security, and stochastic computing, where the predictability of pseudorandom sequences is a liability. Spintronic devices can produce truly random bits at very low energy cost by harnessing nanoscale thermal magnetization fluctuations, but most implementations suffer from bias — an unequal proportion of 0s and 1s — that requires additional debiasing circuitry. Here we present an approach based on spin-torque nano-oscillators (STNOs), nanoscale magnetic tunnel junctions (CoFeB/MgO) that convert a DC current into microwave auto-oscillations. When an STNO is injection-locked at twice its natural frequency, its phase settles into one of two symmetric, energetically equivalent states; thermal noise then drives random switching between them. The intrinsic symmetry of this $2f_0$ injection-locking guarantees an unbiased bitstream — a measured duty cycle of 0.5 — without any correction circuitry. Using a dedicated electrical phase-readout circuit, we generate bitstreams that pass all 188 tests of the NIST statistical test suite, and we show that the bit-flip rate can be tuned over three orders of magnitude (from the kHz to the MHz range) through the drive-frequency detuning. These results establish injection-locked STNOs as compact, CMOS-compatible, and naturally unbiased building blocks for hardware random number generation [Phan et al., Phys. Rev. Applied 21, 034063 (2024)].

Keywords: Spintronic; Magnetic Tunnel Junction; Spin-Torque Nano-Oscillators; True Random Number Generation; Injection Locking; Phase Dynamics; Stochastic Computing; Hardware Security

3.40-O [262]: Beyond Single Sites: Unveiling the Synergy Between Single Atoms and Nanoparticles in Electrocatalysis

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Abstract:

Single atom catalysts (SACs) provide exceptional atom utilization and well-defined active sites, whereas nanoparticles (NPs) and clusters offer structural robustness and high catalytic throughput. Integrating these distinct catalytic motifs into single atom-nanoparticle (SA-NP) hybrid architecture creates opportunities to overcome the limitations of individual components through cooperative interactions and complementary reaction functions.

This talk explores how different SA-NP structural configurations give rise to synergistic effects, including electronic communication, metal-support interactions, tandem reaction pathways, and interface mediated adsorption and activation. Particular attention is given to nitrogen doped carbon frameworks, which serve as versatile platforms for simultaneously stabilizing single atoms and nanoparticles while tailoring the local electronic environment and local reaction environment.

Representative examples illustrating the benefits of SA-NP synergy in electrocatalytic reactions are highlighted, together with the fundamental challenges that remain. These include the lack of systematic understanding of structure-synergy relationships, limited durability under practical operating conditions, and the absence of universal descriptors for correlating catalyst structure with performance. Finally, perspectives and design principles are presented to guide the rational development of next generation hybrid electrocatalysts that fully exploit the cooperative interplay between single atoms and nanoparticles.

Keywords: single atoms; nanomaterials; energy conversion; electrocatalyst; carbon materials

3.41-O [264]: Nonlinear Transport in a One-Dimensional Superconducting Wire within the Time-Dependent Ginzburg–Landau Framework

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Abstract:

We investigate the nonequilibrium transport properties of a one-dimensional superconducting wire subjected to a uniform electric field within the framework of the time-dependent Ginzburg–Landau (TDGL) theory. The model incorporates thermal fluctuations through a stochastic noise term satisfying the fluctuation–dissipation relation and is solved numerically using a nonlinear Crank–Nicolson finite-difference scheme combined with Picard iteration. The developed solver is employed to calculate the superconducting order parameter, current density, and electrical conductivity as functions of temperature and applied electric field. The numerical results show that both the superconducting order parameter and conductivity decrease with increasing temperature and field strength, consistent with theoretical expectations near the superconducting transition. In addition, the current–electric-field characteristics exhibit a pronounced nonlinear S-shaped behavior. Comparison between stochastic and deterministic simulations reveals that thermal fluctuations influence the quantitative features of the current response but are not the primary origin of the observed nonlinearity, which persists even in the absence of noise. These findings demonstrate that the proposed numerical framework provides a stable and efficient approach for studying nonlinear transport and fluctuation effects in low-dimensional superconducting systems.

Keywords: Time-dependent Ginzburg–Landau theory; nonlinear transport; superconducting wire; thermal fluctuations; Crank–Nicolson method;

3.42-O [111]: Tuning Light at the Nanoscale: Two Examples for Smart Windows and Sensitive Sensors

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Abstract:

Tiny nanostructures can control how light interacts with them, just by changing their size or spacing. This work shows two examples of that idea. First, vanadium dioxide (VO₂) nanoparticles were made in different sizes, from about 90 to 180 nanometers. Smaller particles shifted their light response toward shorter wavelengths and made the material far better at blocking unwanted solar heat, a useful property for energy-saving smart windows. Second, gold nanowires were fabricated with extremely small, precisely controlled gaps between them, down to just 5 nanometers. Narrowing the gap let the light response be tuned to match a specific laser, producing very strong Raman signals that can detect tiny amounts of chemicals. Together, these two examples show a simple and practical idea: by controlling size and spacing at the nanoscale, we can direct exactly how light is captured and used, whether for saving energy in buildings or for sensitive chemical detection.

Keywords: Localized surface plasmon resonance (LSPR); VO₂ nanoparticles; thermochromic smart windows; gold nanowire arrays; surface-enhanced Raman scattering (SERS)

Acknowledgement:

This work was supported by the VLIR-UOS IUC-QNU Program (grant VN2022IUC044A101) and the Nafosted (grant 103.02.2023.152).

References:

- 1/ Thi Hang Hoang, et al., Size-Selected VO₂ Nanoparticles Enabling Tunable Plasmonic and Thermochromic Behavior for Smart Glazing, ACS Appl. Nano Mater. 2026, 9, 16, 7019–7027.
- 2/ L. Le Thi Ngoc, et al., Large Area Metal Nanowire Arrays with Tunable Sub-20 nm Nanogaps, ACS Nano 2013, 7(6), 5223–5234.
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3.43-O [7]: Research on the Influence of the N₂/Ar Ratio on the Properties and Color of TiN Coating Fabricated by Plasma Cathodic Arc Technology

Authors: Trung Van Trinh¹, Anh Lan Thi Luu², Khanh Gia Nguyen¹, Long Hoang Ly¹, Thao Thi Nguyen³, Emilien Grasset⁴, Khanh Van Vu⁵

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Abstract:

TiN coating has high hardness and good biocompatibility, so it is often used to create a protective coating on the surface of biomedical implant devices. In implant devices (such as teeth, joints, screws, braces, etc.), there are many devices that are different in size, thread type, or position of use. Manufacturers often create different colors for them to be easily and quickly identified in the operating room, reducing confusion during implantation, increasing professionalism, and controlling the assembly process correctly. Although TiN is known for its characteristic yellow color, it can also have other colors depending on the manufacturing technology parameters and its microstructure. The main focus of this study is to investigate the influence of gas composition (N₂/Ar ratio) on the change of microstructure, properties, and color of TiN coating fabricated by plasma cathodic arc technology on the Ti-Cp substrate. The results showed that the coating contains many macro particles. The main component of the coating film is TiN phase. When increasing the N₂/Ar ratio from 5/40 to 40/40, the contact angle of the coating tends to decrease but is still higher than the contact angle of the sample surface coated with only Ti and much higher than that of the uncoated sample. The hardness reaches a maximum value of approximately 374.5 HV_{0.05} at a N₂/Ar ratio of 20/40, and the adhesion of the coatings is poor due to the high hardness difference between the coating and the Ti-Cp substrate. The TiN coating is silver-white when coated with a N₂/Ar flow rate of 5/40, changes to yellow with a N₂/Ar flow rate of 20/40, and dark brown with a N₂/Ar flow rate of 40/40.

Keywords: Plasma cathodic arc; TiN coating; Color

3.4. Computational Materials Science

4.01-O [81]: Strain-Induced Modulation of Electronic and Optical Properties in 1T'-OsTe₂ Monolayer: A First-Principles Study

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Abstract:

Two-dimensional (2D) transition metal dichalcogenide (TMD) materials have attracted considerable research interest due to their unique mechanical, physical, and chemical properties. In this work, based on first-principles calculations, we investigate the mechanical, electronic, and optical properties of the 1T'-OsTe₂ monolayer. Our results reveal that the 1T'-OsTe₂ monolayer exhibits pronounced mechanical anisotropy, with Young's moduli of 79.9 N/m and 86.2 N/m along the x- and y-directions, respectively. The corresponding ideal strengths are calculated to be 7.79 N/m and 12.54 N/m along the x- and y-directions, respectively. At equilibrium ($\epsilon = 0.0$), the 1T'-OsTe₂ monolayer is identified as an indirect semiconductor with a band gap of 0.69 eV. The band gap of the 1T'-OsTe₂ monolayer can be effectively tuned as a function of mechanical strain. In addition, the strain-dependent optical properties of the 1T'-OsTe₂ monolayer are also systematically investigated. The present results provide valuable insights into the physical properties of the 1T'-OsTe₂ monolayer and demonstrate that strain engineering is an effective approach for modulating its electronic and optical properties.

Keywords: first-principles calculations; ideal strength; strain engineering; optical properties

4.02-O [82]: Study on the influence of mechanical strain on the electronic and magnetic properties of 2D magnetic topological MnBi₂SSe₃

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Abstract:

Magnetic two-dimensional (2D) topological materials have attracted significant interest due to their intrinsic magnetism and rich, tunable topological phases, which hold great potential for applications in quantum computing and spintronic devices. In this study, based on first-principles calculations, we propose a two-dimensional (2D) Janus MnBi₂SSe₃ monolayer. Our calculated results reveal that the 2D Janus MnBi₂SSe₃ exhibits anisotropic mechanical properties, with the Young's moduli along the x- and y-directions being 101.1 and 90.8 N/m, respectively. At equilibrium ($\epsilon = 0$), MnBi₂SSe₃ is an indirect semiconductor with a band gap of 0.8 eV and exhibits magnetic behavior with a magnetic anisotropy energy (MAE) of -1.27 meV/atom. Furthermore, the effects of mechanical strain on the electronic band structure and MAE of the 2D Janus MnBi₂SSe₃ are systematically investigated. These findings provide valuable insights into the physical properties of MnBi₂SSe₃, establishing a foundation for the application of strain engineering to tune the properties of magnetic 2D topological materials.

Keywords: Janus MnBi₂SSe₃; 2D magnetic materials; magnetic anisotropy energy; strain engineering; topological properties.

4.03-O [112]: Preparation, characterization, and quantum chemical study of PETN/BTATz energetic co-crystals

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Abstract:

Energetic co-crystallization has emerged as an effective strategy for tuning the physicochemical properties of energetic materials through intermolecular interactions. In this study, PETN/BTATz energetic co-crystals were prepared via a slow evaporation method and characterized using Fourier transform infrared spectroscopy (FT-IR) and powder X-ray diffraction (PXRD). Shifts in characteristic absorption bands and changes in diffraction patterns compared with those of the pristine components indicated the formation of new supramolecular assemblies. To elucidate the formation mechanism and intermolecular stabilization of the PETN/BTATz system at the molecular level, quantum chemical calculations based on density functional theory (DFT) were performed. Following xTB pre-screening of 500 configurations generated by Gemmer/Molclus, the four most favorable structures were selected for in-depth investigation at the B₃LYP-D₃BJ/def2-TZVP level. Intermolecular interaction strengths were further evaluated using basis set superposition error (BSSE)-corrected interaction energies, while atoms in molecules (AIM), reduced density gradient (RDG), non-covalent interaction (NCI), electrostatic potential (ESP), and frontier molecular orbital analyses were employed to reveal the nature of intermolecular interactions governing system stability. The findings provide useful insights into the rational design of advanced energetic co-crystal materials.

Keywords: quantum chemical; DFT; PETN; BTATz; co-crystal

4.04-O [163]: Numerical Simulation of Temperature Field and Residual Stress in Dissimilar Steel-Copper TIG Welding: Effects of Heat Source Power

Authors: Thi Hong Nhung Nguyen^{1,2}, Viet Quyen Vu², Thi Ngoc Mai Bui², Nam Duong Nguyen²

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Abstract:

This study utilizes Abaqus numerical simulation to evaluate the effects of heat source power (2.8, 3.0, and 3.2 kW) on the temperature field and von Mises residual stress in dissimilar Steel-Copper TIG welded joints. The results indicate that the joint's characteristics are heavily governed by thermal accumulation and the physical property mismatch between the base metals.

Regarding the thermal field, the superior thermal conductivity of Copper (400 W/m·K) rapidly dissipates heat flux, flattening the thermal gradient. Conversely, the poor heat retention of Steel generates a severe temperature gradient at the weld pool boundary. As power increases from 2.8 to 3.2 kW, the maximum peak temperature progressively rises from 2,281 °C to 2,500 °C. While higher heat input expands the weld pool and penetration depth, it induces localized overheating in the terminal segments due to thermal accumulation. Post-cooling von Mises residual stresses exhibit a pronounced asymmetry across the weld centerline. On the copper side, residual stress remains low (77–115 MPa) as its high ductility allows internal force relief via plastic deformation. In contrast, the steel side suffers an expanded stress-affected zone with elevated values (197–288 MPa), because the high yield strength of steel severely restricts weld pool

contraction. A clear correlation between heat input and peak stress was elucidated. At 2.8 and 3.0 kW, the stress distributes smoothly with peaks within a safe threshold (< 500 MPa).

However, at 3.2 kW, the extreme thermal gradient triggers an anomalous stress concentration skyrocketing to 1,137 MPa at the boundary edge, increasing technological cracking risks. Consequently, the 2.8–3.0 kW range constitutes the optimal technological window, ensuring stable weld pool fusion while safely controlling residual stresses.

Keywords: Steel-Copper joint; Abaqus numerical simulation; von Mises residual stress; Heat source power

4.05-O [172]: Overcoming Scaling Limits via Catalytic Outlier Engineering

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Abstract:

Recent studies in electrochemical reaction simulations have revealed the construction of Volcano plots and 2D contour plots based on a strong linear scaling relation between the adsorption energies of intermediate species. This linear scaling relation provides researchers with a straightforward descriptor to predict catalyst performance and enables the visualization of large datasets of catalyst performance on simple contour plots. However, to maximize catalyst performance, it is crucial to identify outliers that do not follow the linear scaling relation.

Particularly in the oxygen reduction reaction (ORR), a strong linear scaling relation between OH and OOH adsorption energies sets clear limits on catalyst activity.

Overcoming these limits requires understanding how outliers arise and how researchers can control them. In this presentation, we will explore the fundamental assumptions and theories of electrochemical catalyst simulations and examine how Volcano plots and 2D contour plots are formed based on the linear scaling relation. Additionally, we will investigate the impact of ensemble, electronic, and strain effects on adsorption energies and explore various possibilities for generating outliers that deviate from the linear scaling relation.

Keywords: Density functional theory; ORR; nanoparticle; catalyst; OER

4.06-O [223]: A Vision-Language Model-Based Digital Wardrobe System for Personalised Garment Management

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Abstract:

Personal wardrobe management remains largely a manual process, lacking systematic digital tools for garment organisation, retrieval, and decision-making. In this study, we suggest developing a digital wardrobe recommendation system tailored to female office workers based on a Vision-Language Model (VLM)-driven approach to deep learning and classification of five different garments along with their visual

attributes, including color, pattern, and texture. Item Encoder creates a high-dimensional feature vector for every garment item, which captures both its semantic and visual aspects. The performance was evaluated using a hybrid set of images sourced from both fashion pictures available online and photos taken by real-life users in situ. For our experiments, the following metrics were reported: Top-1 classification accuracy (91.3%), macro-F1 (0.90), color classification accuracy (93.7%), and Top-3 retrieval accuracy (94.2%) using cosine similarity on 256 dimensions.

Apart from classifying the items, our system is able to assess the wardrobe composition, detect category imbalance, and provide tailored suggestions in order to prevent overbuying and make informed decisions regarding wardrobe management.

Keywords: digital wardrobe; garment classification; CLIP; OpenFashionCLIP; vision-language model; image similarity; fashion informatics; cosine similarity; outfit recommendation; zero-shot inference

3.5. Material related technology

5.01-O [22]: Method for Determining Detonation Wavefront Parameters of RDX-Based Polymer-Bonded Explosives

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Abstract:

This report presents a computational method for predicting the detonation properties of RDX-based Polymer-Bonded Explosives (PBXs). The proposed approach is developed based on information regarding the composition, density, shock adiabatic compression equations of the components, and the detonation characteristics of RDX. The scientific foundation of this method is the assumption that, at the front of the detonation wave in PBXs, the additives do not immediately participate in the detonation reaction.

Instead, they are only compressed and accelerated together with the detonation products generated by the base explosive. By evaluating the energy loss associated with the compression and acceleration of the inert components moving together with the detonation products, the method predicts the parameters at the detonation front. The results calculated using the proposed method for five different PBXs demonstrate good agreement with experimental data, with deviations in detonation velocity remaining below 3% on average. Furthermore, the predicted detonation pressure, polytropic index, and detonation-product velocity showed negligible deviations (below 4%) compared to values obtained using the specialized DETO software.

Keywords: explosives; detonation; PBX; polymer

5.02-O [68]: Experimental Investigation into the Compatibility Limits of Nitrocellulose/N-nitrodiethanolamine dinitrate Energetic Blends

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Abstract:

Compatibility between energetic polymers and plasticizers is a critical parameter in designing stable energetic formulations. In this study, nitrocellulose with ~12 % nitrogen content (NC) was blended with N-nitrodiethanolamine dinitrate (DINA) at mass ratios NC:DINA = 10:1, 10:2, 10:3, 10:4, and 10:5 to assess their mutual compatibility. Blends were characterized by Fourier-transform infrared spectroscopy (FTIR), optical microscopy, thermomechanical analysis (TMA) and solvent extraction in dichloroethane. It was found that as the DINA proportion increases, the mixtures become less homogeneous under microscopic inspection, the TMA curves show earlier onset of mechanical deformation, and the extractable fraction rises significantly compared to pure NC. This combined evidence points to limited compatibility above a certain DINA loading, and suggests constraints on the maximum safe incorporation of DINA into NC matrices. This work provides a preliminary screening protocol and formulation guidance for future advanced energetic systems.

Keywords: Nitrocellulose (NC); N-nitrodiethanolamine dinitrate (DINA); Compatibility; Fourier-transform infrared spectroscopy (FTIR); Thermomechanical analysis (TMA); Solvent extraction

5.03-O [88]: Comparing Physical and Simulated Drape of Jersey and Rib Knits for Optimizing Bending and Shear Parameters in CLO 3D

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Abstract:

In 3D apparel simulation, achieving high fidelity in fabric drape is critical. Although CLO 3D offers an automated tool to predict physical parameters, its accuracy heavily relies on the expensive CLO Fabric Kit, limiting independent designers and academic institutions from achieving precise digital twins. This study aims to establish a cost-effective, mathematical calibration methodology for virtual materials by optimizing bending and shear parameters based strictly on accessible metadata (fabric type, fiber composition, weight, and thickness). A matrix of 37 commercial Jersey and Rib fabric specimens was selected for the experimental setup. Virtual fabric profiles were initialized in CLO 3D using their basic physical attributes, followed by empirical and virtual drape tests. To quantify drape morphology, high-resolution silhouettes of both physical and simulated fabrics were digitized and measured via Adobe Illustrator to extract precise geometric indices, including drape angles, projected node areas, flute counts, and fold depths.

Multiple linear regression analysis established mathematical correlation equations between input basic attributes and output drape behaviors. The results revealed that CLO 3D demonstrated an artificial structural rigidity in highly fluid specimens and generated a rigid baseline of 8 flute nodes for Jersey fabrics, whereas Rib fabrics exhibited substantially lower simulation errors. Finally, a predictive regression equation successfully derived and compensated for the bending and shear properties of newly introduced knits. This research delivers a practical blueprint that eliminates premium hardware dependencies while maintaining high physical-to-virtual drape fidelity.

Keywords: CLO 3D; fabric drape; drape morphology; 3D apparel simulation; bending and shear parameters; digital twins

5.04-O [180]: Thermo-Mechanical Recycling of Waste Shoe Soles and Properties of Recycled Styrene-Butadiene Rubber

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Abstract:

This study investigates thermo-mechanical devulcanization as a method to reactivate waste shoe sole rubber powder.

Two processing methods: a two-roll mill and an internal mixer, were compared. Devulcanization efficiency was assessed by sol fraction, and the resulting devulcanized waste rubber powder (dWRP) was blended with virgin styrene-butadiene rubber (SBR) at various contents to evaluate vulcanization behavior and mechanical properties.

The internal mixer was more effective than the two-roll mill, achieving a sol fraction of 22% under optimal conditions (60 rpm, 160 °C, 30 min). dWRP exhibited lower minimum torque (ML) and faster curing than untreated WRP, indicating successful crosslink breakage. When incorporated into SBR at 20 phr, dWRP improved tensile strength and hardness due to better interfacial bonding. At a dWRP content of 40 phr, the mechanical properties were reduced, suggesting an optimum filler content. Thermo-mechanical devulcanization offers a facile and scalable method to recycle shoe sole waste into reusable rubber materials.

Keywords: Thermo-mechanical devulcanization; waste rubber powder; waste shoe sole; recycled rubber

5.05-O [182]: Morphology-Controlled Thermomechanical Reinforcement of PTFE-Modified Double-Base Propellant Composites

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Abstract:

Energetic polymer composites relevant to propulsion and gas-generating applications require a carefully balanced combination of mechanical integrity, energy-dissipation capability, and low-temperature thermomechanical reliability. In this study, the influence of polytetrafluoroethylene (PTFE) content on the structure and mechanical performance of a nitrocellulose/nitroglycerin (NC/NG)-based double-base propellant matrix was investigated. Five formulations containing 0, 0.5, 1.5, 2.5, and 3.5 wt% PTFE were characterized using scanning electron microscopy with elemental mapping, X-ray diffraction, dynamic

mechanical analysis, and tensile testing. The results showed that PTFE formed fibrillar features within the NC/NG matrix, with the most refined morphology observed at 1.5 wt% PTFE, whereas higher PTFE loadings promoted coarser fibrillar or ribbon-like structures. The apparent crystallinity of the PTFE-associated phase remained lower than that of pristine PTFE, suggesting partial disruption of crystalline order during PTFE fibrillation. The formulation containing 1.5 wt% PTFE maintained a glass-transition temperature close to that of the unmodified matrix while exhibiting the highest storage modulus at 25 °C, tensile strength, and elongation.

At higher PTFE loadings of 2.5 and 3.5 wt%, high-temperature damping increased, whereas low-temperature stiffness and tensile performance decreased. These findings indicate that a refined PTFE fibrillar morphology at 1.5 wt% provides an effective route for thermomechanical reinforcement of double-base propellant composites.

Keywords: Double-base propellant; Polytetrafluoroethylene; Energetic polymer composite; Fibrillar morphology; Thermomechanical properties; Glass transition temperature

5.06-O [197]: Effects of Dyestuff Concentration on the Color Strength (K/S), Thermal Behavior and Crystal Structure of Biodegradable Polylactic Acid (PLA)

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Abstract:

This study investigates the effect of disperse dye concentration on the color strength (K/S), thermal behavior and crystal structure of biodegradable polylactic acid (PLA) films. PLA films with a thickness of about 50 µm were prepared by the solution casting method. The specimens with dimension of 10 × 1 cm were dyed at 100 °C for 15 min with a liquor-to-goods ratio of 30:1 by using a disperse dye at concentrations ranging from 0.5–1.5% owf. The effects of dye concentration were evaluated by CIE L a b* color coordinates, color strength (K/S), Differential Scanning Calorimetry (DSC) and X-ray diffraction (XRD) analysis. The results showed that the samples dyed with 0.5% disperse dye at 100 °C for 15 min (pH 5–6, liquor ratio 30:1) exhibited the highest color strength. XRD analysis indicated characteristic peaks of (010), (200/110), (203), and (210) of the PLA at diffraction angle (2θ) of 14.96°, 16.93°, 19.3°, and 22.6°, respectively. A close relationship was found between degree of crystallinity, lattice constant and color strength (K/S) as the disperse dye concentration was changed.

Keywords: Biodegradable polymer; polylactic acid; color strength; crystal structure

4. Poster Presentations

4.1. Metallurgical Engineering

1.17-P [1]: Friction stir sintering assisted powder metallurgy of pure Mg

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Abstract:

Conventional sintering of magnesium (Mg) powder poses significant fabrication challenges due to its high flammability and stringent processing requirements. To address these limitations, the present study introduces a novel friction stir sintering (FSS) technique for fabricating Mg components by integrating uniaxial pressing with frictional heating. Initially, commercially pure Mg powder is cold- compacted to form a green compact (GC), followed by sintering through the FSS process. The relative density of the FSSed sample increases progressively through each stage, reaching approximately 99.43% of the theoretical density after FSS. Optical microscopy observation reveals a stepwise reduction in porosity and enhanced microstructural consolidation through the FSS.

Correspondingly, microhardness measurements show a significant increase and ultimately a uniform distribution across the FSS cross-section. These results confirm the feasibility and effectiveness of the FSS approach for the powder metallurgy of pure Mg.

Keywords: Mg pure; Friction stir sintering; Porosity; Density; Microhardness

1.18-P [50]: Effect of Pre-alloying Elements on the Mechanical Properties of Iron-based Materials by Powder Metallurgy

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Abstract:

In this study, Cu and Ni were added to Fe metal to form a pre-alloying phase based on Fe using the powder metallurgy method. Fe, Cu, and Ni powders were milled using a high-energy ball mill at a rotational speed of 350 rpm, with a ball-to-powder ratio of 10:1 and milling times ranging from 4 to 10 h. The mixed powders were compacted at 430 MPa and sintered at temperatures ranging from 1000 to 1120 °C to produce FeCu30 and FeNi15Cu5 materials. The sintering temperature of pure Fe powder compacts is approximately 1100–1300 °C, while the addition of Cu and Ni to form pre-alloyed phases helps reduce the sintering temperature

and enhance mechanical properties. The crystal structure and microstructure were analyzed by X-ray diffraction and optical microscopy. The mechanical properties were evaluated through hardness and wear tests.

The FeNi15Cu5 sample achieved the highest hardness of 90 HRB when milled for 6 h and sintered at 1120 °C, while that of pure Fe metal is 40 HRB. This material has great potential for applications such as high-strength bearings, bulletproof armor, and wires. It is also a potential precursor for manufacturing metal matrix composites for high-performance cutting tools.

Keywords: Fe-based; Cu; Ni; pre-alloy; powder metallurgy

1.19-P [127]: Research on Optimization of Electroless Ni Plating Process and Improvement of Exothermic Characteristics According to Al Powder Particle Size

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Abstract:

Aluminum powder used as solid fuel in space launch vehicle solid propellants suffers from ignition delay and reduced combustion efficiency due to a robust passivation layer that naturally forms on its surface. To overcome this, the study aimed to induce a SHS reaction between the two metals by completely removing the oxide film using hydrofluoric acid (3.3%) and forming intermetallic compounds by coating Ni on top. In this study, to enhance the energy density of the propellant, the electroless plating process was optimized and combustion characteristics were analyzed for powders with various particle sizes of 5, 10, 42, and 74 μm. FE-SEM was used to observe coating uniformity by particle size for the analysis of the powder surface morphology. Additionally, the aluminum oxidation initiation temperature and exothermic characteristics were analyzed via TGA/DSC, and the oxidation weight gain rate after final combustion was measured. Furthermore, the formation pattern of Al-Ni intermetallic compounds was confirmed through XRD analysis.

Keywords: Al powder; passivation layer; heat generation performance; weight gain

1.20-P [140]: Microwave-Assisted Carbothermic Self-Reduction of Magnetite Composite Pellets: Parameter Optimization and Microstructural Evolution

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Abstract:

Carbothermic self-reduction of magnetite-carbon composite pellets provides a highly promising route for low-carbon steelmaking and energy conservation. However, microwave-assisted reduction of these pellets often experiences technical challenges like localized sintering, thermal runaway, and fayalite (Fe₂SiO₄) formation that encapsulate iron oxides and inhibit deeper reduction. This study systematically investigates the microwave reduction behavior of magnetite composite pellets mixed with anthracite coal (11-14 wt%)

and bentonite binder (1.0 wt%) under different microwave power levels (P7:560W, P8:640W, P9: 720W) and heating times (10-40 min). Mechanical drop strength tests confirm that all green pellets possess drop numbers ≥ 5 , fully satisfying handling requirements.

Microwave reduction experiments demonstrate that the reduction degree (RD) is strongly dependent on both power and coal ratio, following the order of $14\% > 13\% > 12\% > 11\%$. The optimal technological window is identified at P₈ power and 14 wt% anthracite coal for 40 min, achieving the highest RD of over 60%. Excessive microwave power (P₉) leads to localized overheating, structural cracking, and a high concentration of fayalite formed by the reaction between intermediate FeO and SiO₂ impurities. SEM and EDX analyses confirm the formation of high-purity metallic sponge iron (up to 99.4 wt% Fe) in the localized porous zones under optimized conditions, establishing a scientific basis for energy-efficient green ironmaking.

Keywords: Microwave carbothermic reduction; Carbothermic self-reduction pellets; Anthracite coal; Phase evolution; Microstructural analysis; Fayalite formation

1.21-P [144]: Carbon-Free Production of Molten Steel from Low-Grade Iron Ore: Thermodynamic Limits of Phosphorus Removal

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Abstract:

To achieve carbon neutrality, reducing CO₂ emissions is essential. In 2022, approximately 13% of CO₂ emissions originated from the steel industry in Japan, highlighting the importance of emission reduction in this sector.

Currently, the steel industry mainly relies on the blast furnace (BF) process, which is cost-effective and suitable for mass production. However, because the BF process uses coke as a reducing agent, it emits approximately 2 tons of CO₂ per ton of steel produced. As a result, research is being conducted on alternative technologies such as hydrogen-based direct reduction (H-DR), which can potentially eliminate CO₂ emissions during ironmaking.

While this process is promising, it requires high-grade iron ore. With increasing steel demand produced using H-DR, a shortage of high-grade iron ore is expected, making it necessary to develop processes that can utilize low-grade iron ore. Low-grade iron ore contains a high proportion of gangue minerals, making direct processing more challenging.

Typically, such ores are first smelted to produce molten iron, followed by refining in a converter. However, the converter process requires the addition of carbon, which leads to CO₂ emissions. Therefore, eliminating CO₂ emissions during this stage is crucial for achieving carbon neutrality. In this study, we propose a process to produce molten steel with low impurity levels without the use of carbon. Specifically, we focus on the removal of phosphorus (P), which has a high refining load. The objective is to determine the limit of phosphorus removal without using carbon by controlling temperature and oxygen partial pressure. Experimental conditions were determined through thermodynamic simulations, taking into account 16

chemical species: CaO, SiO₂, Al₂O₃, MgO, FeO, MnO, S, P₂O₅, Fe, C, O, Si, Mn, S, P, and CO. Based on these simulation results, experiments were conducted to investigate the P distribution ratio between slag and metal under the selected conditions.

Keywords: Thermodynamics; P removal; Carbon free; Steelmaking; H-DR

1.22-P [148]: Measurement of Interaction Coefficient of Nd on Cu in Molten Iron at 1873 K

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Abstract:

Sulfur and phosphorus adversely affect the steel properties; therefore, they are typically removed during the refining process. However, it is difficult to remove them completely, and the residual sulfur and phosphorus segregate during solidification, causing cracking and fatigue fracture. This study focused on the rare earth metals (REM) to suppress the segregation of sulfur and phosphorus. When REM are enriched in molten steel during the solidification process, they readily form compounds such as sulfides and phosphides due to the high reactivity of REM, thereby suppressing the segregation of sulfur and phosphorus. On the other hand, the demand for steel production using ferrous scrap has been increasing, and the tramp elements such as Cu can be enriched in steel products. Therefore, it is essential to understand the effect of the tramp elements on the activity of REM to suppress the segregation of sulfur and phosphorus. However, the thermodynamics data of the interaction coefficient of REM on tramp elements, such as Cu and Sn, is limited. This study focused on Nd as a rare earth metal, and the interaction coefficient of Nd on Cu in molten iron was measured at 1873 K using a chemical equilibration technique based on the liquid immiscibility between molten iron and silver phases. The Nd and Cu contents of molten Fe and Ag phases were analyzed by inductively coupled plasma atomic emission spectrometry (ICP-AES). It is found that the Nd content of the Ag phase decreases with the increase of the Cu content of iron phase and an attractive force works between Nd and Cu in molten iron.

Keywords: Rare earth metal; Nd; Tramp Elements; Cu; Interaction parameter; Segregation

1.23-P [154]: Fabrication of Hybrid Graphene–Nanoceramic Reinforced Mg–Ti Alloy Matrix Composites by Spark Plasma Sintering

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Abstract:

The demand for orthopedic implants for bone repair and regeneration has been increasing rapidly in recent years.

Research and development of implant materials play a crucial role in the field of orthopedic surgery.

Magnesium-based composites are considered promising candidates for biomedical implants due to their elastic modulus, which is close to that of natural bone, and their excellent biocompatibility. However, their relatively low mechanical strength and, more importantly, their excessively rapid biodegradation rate result in poor retention of mechanical integrity during service. These limitations remain significant barriers to the broader application of magnesium-based materials in biomedical engineering. Therefore, the present study aims to fabricate advanced Mg–Ti alloy matrix composites reinforced with graphene–nanoceramic hybrid materials for potential orthopedic implant applications. The graphene–nanoceramic hybrid material, serving as the reinforcing phase, was synthesized using a hydrothermal method. The morphology and structural characteristics of the hybrid material were investigated by scanning electron microscopy (SEM), transmission electron microscopy (TEM), Raman spectroscopy, and X-ray diffraction (XRD). The results revealed that nanoceramic particles were uniformly anchored onto the surface of graphene sheets. The Ti–Mg powder mixture and graphene–nanoceramic hybrid material were subsequently blended using high-energy ball milling to achieve homogeneous dispersion of the constituent phases. Spark plasma sintering (SPS) was employed to consolidate the graphene–nanoceramic hybrid reinforced Mg–Ti alloy matrix composites. The effects of fabrication parameters on the morphology and microstructure of the resulting composites were systematically investigated and are discussed in detail in this study.

Keywords: Ti–Mg composites; Graphene–nanoceramic hybrid material; Spark plasma sintering (SPS); Hybrid reinforcement; Microstructure; Mechanical properties

1.24-P [161]: Characterization of Red Mud Generated from Alumina Production in Vietnam

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Abstract:

Red mud, a solid waste generated from the Bayer process in alumina production, is considered a significant risk of environmental pollution during long-term storage due to its high alkalinity and fine particle size. In this study, the main characteristics of red mud originated from a Vietnamese alumina plant were studied using chemical composition analysis (ICP-OES), phase composition (XRD), morphological observation (SEM), and particle size distribution (LA-950). The results showed that the red mud had a complex composition, being rich in iron (45.47 wt.% Fe₂O₃), alumina (17.77 wt.% Al₂O₃), and notable amounts of SiO₂, TiO₂, and Na₂O. The mineral composition included major phases such as hematite (Fe₂O₃), magnetite (Fe₃O₄), quartz (SiO₂), and aluminosilicate phases, with a fine particle size distribution in the micrometer range ($D_{50} \approx 5.47 \mu\text{m}$). SEM observations revealed that the particles exhibit irregular shapes, developed surface textures, and a strong tendency toward agglomeration. The findings of this research provided an initial database for environmental impact assessment and served as a basis for future studies on the efficient recycling of red mud. It can be concluded that the present red mud is a valuable secondary raw material for other industrial processes.

Keywords: red mud; mineral composition; particle size; recycling

1.25-P [170]: Study on the Reusability of Blast Furnace Dust for Pig Iron Production Using Soda Ash

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Abstract:

Blast furnace dust is a by-product generated during the blast furnace ironmaking process. Due to its relatively high iron and carbon contents, blast furnace dust has significant potential for reuse as a secondary raw material in ironmaking. In this study, blast furnace dust was mixed with fine iron ore concentrate and soda ash (Na_2CO_3) to produce composite briquettes. Different soda ash additions of 1, 2, and 3 wt.% relative to the total weight of ore and dust were investigated. The raw materials were thoroughly blended using a mixer and then compacted into briquettes.

The briquettes were subsequently dried and subjected to reduction roasting at temperatures of 900, 1000, and 1100 °C for reduction times of 30, 60, and 90 minutes. The results demonstrated the significant influence of soda ash addition on the reduction behavior of the briquettes. X-ray diffraction (XRD) and scanning electron microscopy (SEM) analyses were employed to evaluate the reduction characteristics and phase transformation of the blast furnace dust-containing briquettes. In addition, the reduction kinetics of the briquettes were investigated to better understand the reduction mechanism during thermal treatment. The study also assessed the practical feasibility of reusing blast furnace dust in pig iron and direct reduced iron (DRI) production processes.

Keywords: Blast furnace dust; soda; recycling

1.26-P [171]: Influence of Bentonite on the Reduction Behavior of Coke-Containing Iron Ore Briquettes

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Abstract:

Iron ore and coke were mixed with excess coke contents of 10%, 20%, and 30% above the theoretical amount required for reduction. The study aimed to evaluate the influence of bentonite addition on the reducibility and reduction behavior of iron ore briquettes containing different coke contents. For this purpose, samples were prepared with 2 wt.% bentonite and without bentonite addition. The mixtures of iron ore powder, coke, and bentonite were blended according to the designed proportions and then compacted into briquettes. The briquettes were subsequently dried and reduced at temperatures of 900, 1000, and 1100 °C for 15, 45, and 90 minutes. The reduction behavior of the samples was evaluated through the calculation of the reduction degree, porosity measurement, X-ray diffraction (XRD) analysis, and scanning electron microscopy (SEM) observation. In addition, the kinetic mechanism of the reduction process was discussed. The results showed

that bentonite significantly affected the reduction behavior, microstructural evolution, and overall reducibility of the iron ore briquettes.

Keywords: Iron ore; Bentonite; Reduction

1.27-P [183]: Solid-State Carbothermic Reduction of Manganese Dioxide using Anthracite Coal: Influence of C/MnO₂ Ratio, Recovered Fe/Cr, and Heating Methods

Authors: Hai Tran Xuan¹, Duong Phan Hai¹, Huy Ngo Quang¹, Thanh Luong Xuan¹, Hieu Le Trung¹, Tu Dinh Quang¹, Viet Nguyen Hoang¹

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Abstract:

The carbothermic solid-state reduction of manganese oxides is an energy-intensive process with significant CO₂ emissions. To improve energy efficiency and control product phase evolution, this study systematically investigates the solid-state carbothermic reduction of manganese dioxide (MnO₂) composite compacts using anthracite coal under high-frequency induction and microwave heating. The effects of the C/MnO₂ mass ratio (M1 = 20% coal, M2 = 30% coal, M3 = 45% coal) and the addition of recovered iron (Fe) or chromium (Cr) metals (M4 = 30% coal + 15% Fe, M5 = 30% coal + 15% Cr) are investigated. High-frequency induction heating (I₉ power, 15-60 min) and microwave heating (P9 power, 30-60 min) are compared. The phase transformation sequence is characterized by X-ray diffraction (XRD) and scanning electron microscopy with energy-dispersive spectroscopy (SEM/EDS). The results reveal that increasing the C/MnO₂ ratio shifts the system from a MnO-dominated phase to complex manganese carbides (Mn₇C₃ and Mn₃C₂). The addition of Fe promotes the formation of (Mn,Fe)_xC_y and Fe-Mn alloys, significantly accelerating the reduction kinetics by dissolving carbon and wetting MnO grains. The addition of Cr leads to stable complex (Mn,Cr)_xC_y carbides and Mn-Cr alloy regions. Microwave volumetric heating provides a highly uniform temperature distribution but requires careful power control, as excessive power causes localized slag encapsulation. This study provides crucial experimental bases for direct reduction and phase control in green manganese production.

Keywords: Manganese dioxide; Carbothermic reduction; Anthracite coal; Iron catalysis; Chromium carbide; Phase evolution; High-frequency induction; Volumetric microwave heating

1.28-P [186]: Impact of Microwave and Conventional Resistance Pretreatment on the Subsequent Microwave-Assisted Carbothermic Reduction of Magnetite Composite Compacts

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Abstract:

Carbothermic self-reduction of magnetite-carbon composite compacts provides a highly promising route for low-carbon steelmaking. However, the pre-drying step of green compacts dictates their dry mechanical strength and subsequent high-temperature microwave reduction. This study systematically investigates the comparative influence of microwave pre-drying (MW, P1 power, 90 min) and conventional electrical resistance oven drying (RF, 200 °C, 90 min) on the mechanical properties, moisture diffusion kinetics, and subsequent high-temperature microwave carbothermic reduction of composite compacts prepared with Minh Son magnetite ore, anthracite coal (11-14 wt%), and bentonite binder (0.5-1.5 wt%). The experimental results demonstrate that microwave pre-drying increases the drop strength of dry compacts by approximately 33-56% (averaging 1.45 times) compared to conventional oven. This mechanical enhancement is attributed to the volumetric heating mechanism of microwave energy, which prevents outer crust formation and uniform moisture release without inducing internal thermal stresses or macro-cracks. When subjected to subsequent high-temperature microwave reduction (P8 power), the MW-pre-dried compacts exhibit significantly faster kinetics, achieving a reduction degree (RD) of over 60% within 50 min. In contrast, the RF-dried compacts exhibit lower reduction efficiency and a high concentration of intermediate wüstite and fayalite (Fe_2SiO_4) slag phases due to pre-existing structural cracks. SEM and EDX spot analyses confirm the growth of highly sintered, porous metallic sponge iron (up to 92.65 wt% Fe) in the optimized MW-dried compacts, establishing a robust scientific basis for clean ironmaking.

Keywords: Microwave carbothermic reduction; Magnetite compacts; Microwave drying; Resistance drying; Moisture diffusion; Phase evolution; Fayalite

1.30-P [225]: Influence of Oxygen Content in Starting Aluminum Powder on the Phase Evolution and Mechanical Performance of MA-SPS Ti-48Al Alloys

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Abstract:

Gamma titanium aluminide (γ -TiAl) intermetallic alloys are promising materials for high-temperature applications and weight-sensitive components owing to their low density, high specific strength, and good oxidation resistance at elevated temperatures. However, the quality of TiAl alloys fabricated by the combination of Mechanical Alloying (MA) and Spark Plasma Sintering (SPS) is strongly influenced by impurity contamination, particularly oxygen originating from the starting powders. In this study, the effect of oxygen content in aluminum powder on the microstructural evolution and mechanical properties of Ti-48Al alloy was investigated using two Al powders with different oxygen levels while maintaining the same nominal composition and processing route. The fabricated alloys were characterized by X-ray diffraction (XRD), scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDS), Rockwell hardness testing, and wear testing. The results show that a higher oxygen content reduces microstructural homogeneity, promotes the formation of oxide-rich regions, and hinders diffusion between Ti and Al during the sintering process. In contrast, the alloy produced from low-oxygen aluminum powder exhibited higher hardness and superior wear resistance compared with that fabricated from high-oxygen aluminum powder. These findings demonstrate that controlling the oxygen content in the starting materials is essential for improving the microstructural quality and mechanical performance of TiAl alloys produced by the MA-SPS route.

Keywords: Ti-48Al alloy; Mechanical Alloying; Spark Plasma Sintering; oxygen; contamination; microstructure; hardness

1.31-P [226]: Estimating collision energy and optimizing milling parameters for mechanical alloying using Python simulation

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Abstract:

High-entropy alloys (HEAs) have attracted considerable attention due to their outstanding mechanical properties, with mechanical alloying being an effective synthesis method. However, selecting milling parameters to control phase transformation remains challenging due to the lack of tools for estimating and comparing impact energy. In this study, a Python-based program was developed based on a collision kinematic model to calculate the milling energy of the $\text{Al}_{30}(\text{CuCrFeMn})_{70}$ HEA system. The simulation investigated three milling regimes varying in planetary disk speeds (400 and 500 rpm) and tungsten carbide ball masses (125 g and 200 g) for 10 g of powder. The calculated outputs, including energy per collision, total power, and cumulative energy, were compared with X-ray diffraction (XRD) analyses. The simulation indicated that the 500 rpm / 200 g configuration generated the highest power and cumulative energy (~19 W). This trend is consistent with the XRD experimental results, where the high-speed regimes (500 rpm) exhibited the dissolution of elemental peaks and the formation of a BCC+FCC solid solution earlier (~2 hours) than the 400 rpm regime (~3 hours). Furthermore, the analysis showed that due to the large vial geometry, ball-to-ball hindrance was minimized, resulting in nearly identical collision energy per impact for both 500 rpm regimes; thus, the difference in alloying rates was primarily governed by the total power. These findings demonstrate that Python-based energy simulation is a useful supporting tool for predicting trends and comparing the efficiency of different milling parameters in HEA synthesis.

Keywords: Mechanical alloying; Python simulation; Impact energy; High-entropy alloy; X-ray diffraction.

1.108-P [166]: Research on casting methods of Al-Zn-Mg-Cu alloy added La, Ce to improve the formability of grain-refinement intermetallic phases

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Abstract:

The development of aluminum alloy sheets with enhanced formability is of great importance to the automotive industry, owing to their low density, high strength-to-weight ratio, and superior surface appearance.

The formability of aluminum alloys is primarily determined by the grain size and morphology of the microstructure. In this study, an approach was proposed to improve the formability of Al alloys by refining the grain structure during the smelting and casting processes. The refinement mechanism involves the addition of small amounts of rare-earth (RE) elements, specifically lanthanum (La) and cerium (Ce), to promote heterogeneous nucleation and restrict grain growth. An aluminum alloy with a chemical composition similar to AA7475 was selected as the base material. During casting, La and Ce were added either directly in amounts up to 0.4 wt.% or in the form of an intermediate alloy containing 10.96 wt.% La, 6.87 wt.% Ce, and 82.17 wt.% Al. The use of the intermediate alloy was found to be more effective in refining the microstructure.

During smelting, $\text{Al}_{11}\text{Ce}_3$ and Al_3La intermetallic phases formed, which played distinct roles in the solidification process. The $\text{Al}_{11}\text{Ce}_3$ phase, with a crystal structure similar to that of $\alpha\text{-Al}$, acted as a heterogeneous nucleation site, while the Al_3La phase inhibited the growth of $\alpha\text{-Al}$ grains. Consequently, the modified Al–Zn–Mg–Cu alloy exhibited a uniform and refined grain structure with an average grain size of approximately 40–50 μm , significantly smaller than that of the unmodified alloy.

These findings demonstrate that controlled addition of La and Ce is an effective strategy to enhance grain refinement and improve the formability of aluminum alloys for advanced engineering applications.

Keywords: intermetallic phases; heterogeneous nucleation; grain-refinement

1.109-P [265]: Porous Pelletized CuO-Modified Fe_2O_3 –Rice Husk Biochar–Bentonite Composite for Selective H_2S Removal

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Abstract:

Pelletized biochar–metal oxide composites have emerged as promising adsorbent materials for hydrogen sulfide (H_2S) removal from industrial waste streams and biogas due to their porous structures and abundant metal-active sites. This study systematically optimized CuO-modified Fe_2O_3 –rice husk biochar–bentonite porous pellets by investigating the effects of Cu^{2+} precursor concentration and calcination temperature on H_2S adsorption performance. The adsorption capacities for H_2S , CO_2 , and CH_4 were evaluated using a dynamic adsorption system. Comprehensive physicochemical characterization was conducted to elucidate the structural and textural properties of the synthesized composites. The optimal pelletized composite was obtained with a 0.25 M Cu^{2+} precursor solution and calcination at 300 °C. The optimized mesoporous pellets exhibited an H_2S adsorption capacity of $11.5 \pm 0.5 \text{ mg g}^{-1}$ at a breakthrough concentration corresponding to 10% of the inlet H_2S concentration, representing an 80% increase relative to the unmodified pelletized composite. The enhanced H_2S adsorption performance was attributed to the synergistic effects of the porous structure and the active metal oxide phases within the CuO-modified Fe_2O_3 –rice husk biochar–bentonite

matrix. These results demonstrate that the developed pelletized composite is an effective adsorbent for H₂S removal and has considerable potential for practical biogas purification applications.

Keywords: Biogas filter; biochar; composite; copper oxide; hydrogen sulfide removal; iron oxide

Acknowledgements: This research is conducted within the framework of IUC-QNU Program phase 1 under the project code VN2022IUC044A101.

1.113-P [271]: Investigation into the influence of solvent and phenolic resin content on the bonding strength between friction material and steel backing

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Abstract:

Research focuses on evaluating the interfacial bonding performance of an adhesive system based on phenolic (PF) novolac thermosetting resin modified with acetone solvent on low-carbon CT3 steel substrates subjected to mechanical roughening. Through experimental analysis, the influence of key processing parameters—including solvent content (3, 3.5, 4, 4.5, 5 ml/g) and unit resin mass (0.5, 0.75, 1, 1.25, 1.5 g) was thoroughly investigated to optimize the interfacial bond strength. Experimental results indicate that the evaporation kinetics of the acetone solvent follow a rate of 12 hours/ml for a surface area of 0.0028 m². The findings demonstrate that the bond strength reaches a maximum peak at a critical shear stress of 4.75 MPa when utilizing an adhesive system with a 3 ml/g dilution ratio and a resin mass of 0.5 g. The degradation in bonding performance at higher dilution ratios is attributed to residual solvent trapped within the resin matrix, while an increase in adhesive layer thickness leads to the formation of stress concentration zones within the brittle intermediate layer, thereby reducing the joint's load-bearing capacity. These results emphasize the critical necessity of pre-treating the adhesive layer before bonding the friction material to the steel backing plate

Keywords: Friction materials; phenolic resin; acetone solvent; CT3 steel

1.115-P [276]: Electrodeposition of Pd(II)-Cu(I) Alloys from PdCl₂ and CuCl Precursors

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Abstract:

The electrochemical synthesis of Pd-Cu alloys has attracted considerable interest owing to their promising catalytic performance in fuel cell applications. In this study, the mechanism of one-step electrodeposition of Pd-Cu alloys was systematically investigated to provide fundamental insights for the controlled fabrication of Pd-Cu electrocatalysts. A deep eutectic solvent (DES) composed of choline chloride and ethylene glycol (1:2 molar ratio), containing PdCl₂ and CuCl precursors, was employed as the electrolyte for alloy deposition

on a glassy carbon electrode. Cyclic voltammetry revealed well-defined cathodic and anodic peaks associated with the co-deposition and dissolution of Pd and Cu species in the DES electrolyte. The nucleation and growth behavior was further examined by chronoamperometry. The experimental current transients were successfully fitted using a kinetic model comprising two contributions: an adsorption-controlled process (j_{ads}) and three-dimensional diffusion-controlled nucleation and growth ($j_{3\text{D}}$). The fitting results enabled the determination of the nucleation frequency (A), nuclei density (N_0), and diffusion coefficient (D), providing quantitative insight into the early-stage formation of the Pd-Cu alloy. The morphology, chemical composition, and crystal structure of the deposits were characterized by scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and X-ray diffraction (XRD), confirming the formation of crystalline Pd-Cu alloy deposits consistent with the electrochemical nucleation mechanism.

Keywords: Pd-Cu; alloys; electrodeposition; nucleation and growth kinetics

4.2. Structural Materials

2.24-P [2]: Precision Hardness Measurement in Engineering Materials Using Instrumented Indentation Techniques

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Abstract:

Instrumented indentation hardness testing offers a rapid and nearly non-destructive technique for characterizing the mechanical properties of a wide range of materials. Micro- and nanoindentation enable the precise determination of hardness and elastic modulus even in very small material volumes. Although this technique has been established for several decades, its relevance has grown significantly due to expanding applications across powders, bulk materials, thin films, and additively manufactured components. With small applied loads ranging from a few hundred millinewtons to several micronewtons and indentation depths in the micro and sub micrometer regime, micro and nanoindentation techniques make it possible to evaluate small components, thin coatings, and complex microstructures. In this study, a Picodentor HM500 from Helmut Fischer GmbH (Sindelfingen, Germany) was used to demonstrate the capabilities of instrumented indentation testing. A variety of materials – including glass, ceramics, metals, and 3D printed samples – were examined, representing a broad spectrum of mechanical properties.

The measured hardness values and elastic moduli highlight the distinct mechanical responses of the different material classes and confirm the versatility of instrumented indentation hardness as a powerful tool for material research and development. Overall, the results demonstrate that instrumented indentation is an effective and precise method for the mechanical characterization of modern engineering materials.

Keywords: Instrumented hardness testing; Microindentation; Nanoindentation; Elastic modulus

2.25-P [3]: Effect of Current Density and pH on Hydrogen Evolution and Internal Stress in Pd-Co Alloy Electrodeposition

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Abstract:

Pd-Co alloy electrodeposits are widely utilized as core contact materials in electronic components owing to their exceptional hardness and wear resistance. However, the internal stress inevitably accumulated during the electrodeposition process has long been pointed out as a persistent issue that triggers cracking and delamination of the plating layer, thereby degrading material reliability.

The manifestation of this stress is inextricably linked to the hydrogen evolution reaction (HER), which is highly governed by the applied current density and electrolyte pH.

Accordingly, moving beyond the mere observation of stress phenomena, this study aimed to systematically investigate the impacts of varying pH (7.5, 8.0, 9.0) and current density on hydrogen evolution behavior and internal stress from the perspective of fundamental electrochemical mechanisms. To this end, electrodeposition was conducted in a 1 L electrolytic bath, and the strip deflection method was introduced to quantitatively track the trajectory of internal stress generation. Furthermore, the activation behavior of HER and the contribution of side reactions were meticulously evaluated via polarization curves and current efficiency analyses, while changes in microstructure and alloy composition were observed in parallel using SEM and XRF.

Keywords: Pd-Co alloy electrodeposition; Internal stress; Hydrogen evolution reaction; Current density

2.26-P [27]: Influence of tempering time on microstructure, hardness and corrosion behavior of 13 wt.%Cr high chromium cast iron

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Abstract:

In this research, the influences of tempering time on microstructure, hardness and corrosion behavior of 13wt.%Cr high chromium cast iron were studied. The microstructure, hardness and corrosion behavior of high chromium cast iron were investigated after tempering at different times in the range from 2 to 7 hours at 400 °C. The results show that after tempering at different times, the primary carbides were rounded and shortened, the microstructure of high chromium cast iron was distribution of carbides on tempered martensite. During the tempering process, the fine particles of alloy carbides precipitated in the martensitic matrix. The precipitation of the alloy carbides in the microstructure of different specimens is the cause leading to the increase in hardness and corrosion resistance. The corrosion results showed that the differences between the corrosion resistance of as-cast and tempered samples are only due to microstructural transformation. With increasing tempering time, the hardness increases and reaches a maximum value of 62.6 HRC at 3 hours of tempering. However, the hardness begins to decrease with further tempering time, while the best corrosion resistance is achieved after 2 hours of tempering.

Keywords: high chromium cast iron; corrosion behavior; tempering time

2.27-P [34]: Effects of UNSM Scanning Path on Microstructure, Texture, and Bendability of Rolled AZ31 Magnesium Alloy

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Abstract:

Ultrasonic nanocrystal surface modification (UNSM) is an effective surface treatment technique for tailoring the microstructure and properties of metallic materials through severe plastic deformation in the near-surface region. This process introduces high stored strain energy, which provides a driving force for static recrystallization during subsequent annealing. Owing to its scanning-based nature, UNSM also produces direction-dependent surface topography associated with the scanning path. In this study, the effects of UNSM scanning direction, i.e., rolling direction (RD) and transverse direction (TD), on the surface microstructure, surface topography, and bendability of rolled AZ31 Mg alloy sheets were systematically investigated. UNSM was applied to both surfaces of the sheets, followed by annealing at 300 °C for 5 min. After annealing, the surface layer exhibited a modified basal texture that was broadened along the scanning direction and tilted toward the interval direction. In addition, UNSM induced periodic ridge–valley surface waviness, in which the surface undulation varied along the interval direction while the ridges and valleys were elongated along the scanning direction. These scan-dependent evolutions in surface texture and topography resulted in distinctly different bending properties depending on the UNSM scanning direction. Consequently, the results demonstrate that UNSM combined with short-time annealing is an effective strategy for tailoring surface characteristics and enhancing the bendability of rolled Mg alloy sheets.

Keywords: Magnesium alloy; Ultrasonic nanocrystal surface modification (UNSM); Annealing; Scanning path; Bendability

2.28-P [35]: Controlling Abnormal Grain Growth in polycrystalline Ni-based superalloy

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Abstract:

Abnormal grain growth (AGG) during the solution heat treatment (SHT) remains a critical challenge in polycrystalline Ni-based superalloys such as RR1073, as it can generate heterogeneous and excessively coarse grains that degrade mechanical performance. Although stored energy heterogeneity, prior deformation conditions, and microstructural pinning factors have been proposed as contributing factors, direct evidence for the mechanisms responsible for AGG initiation and development remains limited. This study therefore

investigates the microstructural evolution associated with AGG during SHT and aims to propose effective approaches for its occurrence.

A powder-processed RR1073 alloy was examined after isothermal forging, with specimens extracted from low-strain regions. Thermal analysis and heat-treatment trials indicated that complete γ' dissolution occurred at approximately 1160–1165 °C. Microstructural evolution during sub-solvus and super-solvus heat treatment was investigated using in-situ high-temperature confocal scanning laser microscopy, supported by quasi-in-situ EBSD and EPMA analyses on the same regions of interest after intermittent thermal exposure. This iterative approach enabled the temporal evolution of grain structure, local stored energy, and relevant microstructural features to be tracked systematically.

The results suggest that AGG develops through a stage-dependent mechanism during SHT. Localized microstructural differences appear to promote early grain boundary migration, while the subsequent development of abnormal grains is controlled by the evolving balance between growth advantage, matrix grain coarsening, and boundary pinning effects. This dynamic interaction between selected growing grains and the surrounding microstructure strongly influences the overall grain growth behavior.

Further details on these mechanisms, together with potential strategies for suppressing AGG in RR1073, will be discussed at the conference.

Keywords: Powder Nickel-based superalloy; Abnormal Grain Growth; Quasi-in situ EBSD

2.29-P [43]: Electrochemical Formation of Colored Oxide Films on Commercially Pure Titanium in an Environmentally Friendly Electrolyte

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Abstract:

Dense TiO₂ oxide films were successfully formed on commercially pure Ti Grade 2 by electrochemical anodization in citric acid, an environmentally friendly organic electrolyte. The oxide films were produced at applied voltages ranging from 10 to 60 V to control the film thickness and corresponding color. The resulting colors included bronze orange, dark blue, light blue, light yellow, light pink–orange, and purple, with the film thickness increasing from approximately 80 nm to 400 nm.

Raman spectroscopy revealed that the oxide layers possessed a predominantly amorphous structure. Potentiodynamic polarization measurements conducted in 1 M H₂SO₄ solution revealed a significant improvement in corrosion resistance, with the corrosion potential shifting from –0.1431 V for the untreated sample to –0.0235 V for the sample anodized at 60 V. The corrosion current density decreased from 5.2×10^{-6} A/cm² to 8.8×10^{-7} A/cm², while the corrosion rate was reduced from 0.091 mm/year to 0.015 mm/year. These results demonstrate that the anodized TiO₂ films provide both decorative coloration and enhanced corrosion protection for Ti Grade 2, highlighting their potential for surface engineering applications.

Keywords: Colored TiO₂ film; Ti Grade 2; Electrochemical anodization; Corrosion resistance

2.30-P [45]: Shortened Peak-Aging Time and Enhanced Corrosion Resistance of a Low-Cu Al–Zn–Mg–Cu Alloy via Non-Isothermal Aging

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Abstract:

The effects of non-isothermal aging treatments (120 °C/160 °C) with various aging times on the mechanical properties, exfoliation corrosion behavior, and corrosion rate of a low-Cu Al–Zn–Mg–Cu alloy (7S₁₀) were investigated and compared with those of the conventional T₆ aging condition (130 °C for 48 h). The results show that the non-isothermal aging treatment reduces the corrosion rate by approximately 20%, improves exfoliation corrosion resistance, and shortens the peak-aging time by nearly 70%, while the tensile strength decreases by less than 3%. These improvements are mainly attributed to microstructural evolution during aging, particularly the coarsening and increased spacing of grain-boundary precipitates, whereas the size and density of intragranular precipitates remain nearly unchanged, as revealed by scanning electron microscopy (SEM). The significant reduction in peak-aging time also demonstrates the potential economic benefits of this aging treatment for industrial applications of the 7S₁₀ alloy.

Keywords: 7S₁₀; Aluminium alloy; Non-isothermal aging; Exfoliation corrosion

2.31-P [52]: Influence of particle size of aluminum dross as raw materials on microstructural and mechanical properties of fabricated ceramic foam filters

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Abstract:

In recent years, recycling of secondary aluminum dross (SAD) has been receiving much attention. SAD need to undergo proper recycling treatment due to the presence of nitrides and chlorides, which can generate hazardous environmental impacts during landfill disposal. However, with a high Al₂O₃ content (more than 40%), this is a prerequisite for recovering SAD as raw materials to create porous ceramics by using the foam replication method, which has significant potential for industrial ceramic foam filters applications. In this research concerns the effect of different particle sizes of aluminum dross by considering different ball milling times during the synthesizing procedure. Detailedly, the aluminum dross was under water treatment for 3 d for stabilization and then under heat treatment at 1000 °C for 2 h in air for obtaining a dry powder. A batch of slurry was experimented by ball-milling which consisted of treated aluminum dross powder, polyvinyl alcohol solution (PVA) as an organic binder and distilled water. The samples were drying and then sintering at 400 °C for 1 h for burning polyurethane sponge and holding 1500 °C for 3 h in air for phase transformation. The evaluation of the microstructure was carried out to show the difference in the variation of the distribution of particle size and how morphological features are transformed before and after sintering. In addition, density was also measured to obtain the weight of powder coating on the sponge, and X-ray was also used to quantitatively analyze the phase composition. Besides, the mechanical property of different particle size-synthesized samples can be explained by measuring compressive strength.

The study presents results that the initial average particle size plays a crucial role during the sintering process of ceramics. As the milling time increased, aluminum dross particle size reduced as well. Thus, it is possible to prepare ceramic foam filters from aluminum dross by observing the multiple sizes of particle size with various ball milling time.

Keywords: Aluminum dross; open porous; ceramic foam filters; particle size

2.32-P [69]: Critical insights into localized corrosion and passivation in super stainless steel in coastal environments

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Abstract:

This work systematically investigates chloride-induced pitting corrosion in super duplex stainless steel (SDSS) and super austenitic stainless steel (SASS), with particular emphasis on the roles of microstructural heterogeneity, inclusion chemistry, and chloride concentration in aggressive aqueous environments. Cyclic and potentiodynamic polarization tests were employed to evaluate pit initiation, propagation, and repassivation behavior, while also clarifying a long-standing debate regarding the origin of the transpassive current rise in chloride solutions. The results show that at high anodic potentials, the measured current is dominated by localized metal dissolution associated with passive-film breakdown, whereas the contributions from oxygen evolution and chlorine evolution reactions remain negligible. In SDSS, pit initiation preferentially occurs at oxide-rich inclusions near phase boundaries, leading to a high density of shallow, wide, and laterally extended pits that often repassivate. By contrast, SASS tends to form fewer pits, but these pits are deeper and have a higher aspect ratio, making the material more susceptible to severe localized attack and pit-to-crack transition. Overall, these findings indicate that pit morphology and repassivation behavior, rather than pit initiation frequency alone, govern the damage tolerance of super stainless steels in chloride-containing environments, thereby providing useful mechanistic guidance for material selection in coastal and other aggressive service conditions.

Keywords: Pitting corrosion; Super austenite stainless steel; Super duplex stainless steel; Oxide inclusions; Chloride environment

2.33-P [78]: The effect of annealing on the precipitation of BCC phase in FeCoNiAl_{0.25}Mn_{0.75}Ti_{0.25} high-entropy alloy

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Abstract:

This study investigates the influence of annealing temperature and holding time on the precipitation behavior of the BCC phase in the FeCoNiAl_{0.25}Mn_{0.75}Ti_{0.25} high-entropy alloy. The as-cast alloy was annealed at 700, 800, and 1000 °C for 4, 8, and 16 h. At 700 °C, needle-like AlNiTi-rich BCC precipitates embedded in the FCC matrix were first observed after 16 h of annealing, exhibiting an average length of approximately 1–3 μm. In contrast, similar precipitates formed after only 4 h at 800 °C, indicating accelerated precipitation kinetics at higher temperature. In both conditions, the volume fraction of the precipitated phase increased progressively with annealing time, resulting in significant strengthening of the alloy.

The optimum mechanical properties were achieved after annealing at 800 °C, with a hardness of approximately 371 HV₃, yield strength of 630 MPa, ultimate tensile strength of 930.5 MPa, and elongation of 7.5%, compared with 224 HV₃, 427.5 MPa, 820 MPa, and 19.6%, respectively, for the as-cast alloy. However, annealing at 1000 °C led to microstructural coarsening and a reduction in the precipitated phase fraction with prolonged holding time.

The results demonstrate that annealing at 800 °C provides the most effective condition for promoting fine BCC precipitation and enhancing the mechanical performance of the alloy.

Keywords: high entropy alloy; FeCoNiAl_{0.25}Mn_{0.75}Ti_{0.25} alloy; annealing; precipitation; mechanical properties

2.34-P [139]: Influence of Chromia Addition and Pressure on the Pressureless Sintering of Porous Al₂O₃-based Ceramics for Exhaust Gas Filtration

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Abstract:

Porous Al₂O₃-based ceramics have attracted considerable attention as candidate materials for primary filters in industrial exhaust gas treatment systems because of their excellent thermal stability, chemical resistance, and high gas permeability at elevated temperatures. However, achieving an optimal balance between pore structure and mechanical strength for practical filtration applications remains a significant challenge in the fabrication of porous ceramic. This study systematically investigates the combined effects of Cr₂O₃ addition (0 - 1 wt.%) and compaction pressure (30 - 60 MPa) on the microstructure, porosity, pore size distribution, and compressive strength of porous Al₂O₃-based ceramics prepared by pressureless sintering with NH₄HCO₃ as a pore-forming agent and sintered at 1450 °C. As the Cr₂O₃ content increased from 0 to 1 wt.% and the compaction pressure increased from 30 to 60 MPa, the total porosity decreased from 80.04% to 67.35%, while the mean pore size decreased from 162.74 to 66.52 μm.

Correspondingly, the compressive strength improved from 1.39-1.68 MPa to 2.76-3.96 MPa. Cr₂O₃ addition showed more effective than compaction pressure in refining pore structure and enhancing mechanical strength. The resulting ceramics exhibited a well-interconnected open microporous network with tunable porosity, indicating potential application for exhaust gas filters with high permeability and low pressure drop.

Keywords: Porous Al₂O₃; Pressureless sintering; Chromia addition; Compaction pressure; Pore structure

2.35-P [150]: Rapid-cooling-induced transition in twinning-mediated deformation and improved strength-ductility balance in refined α'' martensite structures

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Abstract:

Introduction The α'' martensite phase, one of the metastable phases in titanium alloys, exhibits a relatively low Young's modulus and possesses attractive characteristics for biomedical applications, such as excellent work-hardening capability and high ductility, both arising not only from slip deformation but also from crystallographic reorientation and deformation twinning (TWIP effect). However, it also suffers from a drawback in that the introduction of crystal reorientation and deformation twins readily induces yielding at relatively low stress levels. To overcome this limitation, the present study aimed to realize a high-strength and high-ductility biomedical titanium alloy through the refinement of the α'' phase and its internal twins by rapid quenching in liquid nitrogen.

Methods Ti-V-Cu-Al alloy ingots were fabricated by arc melting.

After homogenization treatment, specimens were subjected to liquid-nitrogen quenching (LNQ), while water-quenched (WQ) specimens were prepared as reference materials. Tensile test was conducted to evaluate the mechanical properties, including strength and ductility. Strain gauges were attached to the tensile specimens to determine Young's modulus. Phase identification was carried out using X-ray diffraction (XRD). Microstructural observations and crystallographic analyses were performed using an optical microscope, a scanning electron microscope, and a transmission electron microscope.

Result Both the LNQ and WQ specimens exhibited a single α'' martensitic phase, with lath-like martensite structures and internal twins observed throughout the specimens. The LNQ specimen showed a pronounced refinement of the α'' martensite lath and a higher density of finer internal twins. Moreover, a higher dislocation density was estimated from broadened XRD peaks. The LNQ specimen exhibited significant increases in yield stress (critical stress) from approximately 470 MPa to 600 MPa, and in ultimate tensile strength from 710 MPa to 850 MPa, compared with the WQ specimen, while maintaining large elongation and low Young's modulus. Microstructural analysis after plastic deformation revealed that the twin width increased in the WQ specimen, whereas the twin number density increased in the LNQ specimen instead of twin thickening. These results suggest that the high density of dislocations introduced by the higher cooling rate in the LNQ specimen impeded twin-boundary migration, thereby changing the twin development behavior from boundary migration-dominated growth to nucleation-dominated formation. This transition in the deformation mechanism is suggested to be responsible for the strengthening observed in the LNQ specimen. In general, strength and ductility exhibit a trade-off relationship; however, in the present case, ductility was not reduced because both deformation modes could provide a comparable amount of transformation strain.

This work was supported by JSPS-KAKENHI (JP24K01194, JP21H05197) and Research funding from the Light Metal Educational Foundation.

Keywords: TWIP; alpha" martensite; Deformation twinning; Deformation mechanism; Titanium

2.36-P [152]: Investigation of the effect of silicon carbide on hardness and coefficient of friction of FGH-95 nickel-based superalloy

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Abstract:

Nickel-based superalloys have been investigated due to serving as an important role in engine components which are operated under extreme conditions. In this work, FGH-95 nickel-based superalloy matrix composites were successfully fabricated by spark plasma sintering (SPS) with a different volume fraction silicon carbide (SiC) content. With the changing of SiC content in mixed powder, the microstructure, hardness, phase transition, coefficient of friction and bulk density were systematically evaluated by using numerous techniques. The results demonstrate that SiC powder significantly enhances the mechanical properties of FGH-95 by strengthening mechanisms. X-ray diffractions (XRD) confirmed the existence of SiC in composites and revealed the primary phase and the new phase. The bulk density of samples was measured, demonstrated a homogenous dispersion of SiC particles within FGH-95 matrix.

Mechanical testing indicated a significant enhancement in Vickers hardness with presence of SiC, which attributed to strength of samples. Furthermore, coefficient of friction and wear rate in SiC-reinforced composites were both decreased slightly. In summary, this work demonstrates that adding SiC reinforcements into FGH-95 is efficacy for enhancing mechanical properties and promised for various application.

Keywords: FGH-95; Silicon carbide (SiC); Sintering; Tempering; Phase; Hardness; Coefficient of friction

2.37-P [164]: Effect of heat treatment on the microstructure and distribution of Al and V elements in Ti6Al4V alloy

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Abstract:

Ti6Al4V alloy (ASTM - Grade 5) is a widely used titanium alloy with many applications in the fields of aviation, medicine, transportation, chemistry. Through heat treatment, mechanical properties of the alloy

such as yield strength, tensile strength, hardness, ductility will be changed. This article focuses on studying the microstructural morphology of Ti6Al4V alloy quenched at temperatures above and below the α - β transformation temperature T_β (820 °C, 900 °C and 1000 °C). The microstructure and distribution of Al and V elements in the α and β phases are also evaluated after heat quenching at 900 °C – 2 h and aging at different temperatures and times including 400 °C – 4 h, 525 °C – 1 h, 4 h, 7 h, 650 °C – 4 h, thereby the microstructural changes that lead to changes in the mechanical properties of Ti6Al4V alloy during heat treatment will be determined.

Keywords: Ti6Al4V - Grade 5 alloy; heat treatment; β phase transformation temp

2.38-P [176]: Effect of Austempering Temperature on the Microstructure and Hardness of a Low-Carbon Carbide-Free Bainitic Steel for high-speed Railway Crossing Applications

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Abstract:

The crossing nose is one of the most critical components in high-speed railway turnout systems, where it is subjected to severe impact loading and wear during wheel transition.

Traditionally, pearlitic and pearlite–ferrite steels have been widely employed for this application; however, the performance of pearlitic microstructures has approached the practical limits required for modern high-speed railway service. Consequently, bainitic steels have attracted increasing attention as alternative materials because of their superior combination of strength, toughness, fatigue resistance, and weldability. In particular, silicon-alloyed carbide-free bainitic steels have emerged as promising candidates owing to their ability to suppress carbide precipitation and promote the formation of a refined bainitic ferrite and retained austenite microstructure. In this study, the effect of austempering temperature on the microstructure and hardness of a low-carbon carbide-free bainitic steel was investigated. The experimental steel with the given composition was produced by vacuum induction melting and subsequently forged to a total deformation of 80%. The forged specimens were austenitized at 900 °C for 30 min and then austempered in a molten salt bath at 200, 300 and 400 °C, respectively. The results showed that the as-forged steel exhibited a ferrite–pearlite microstructure. After heat treatment, bainitic transformation was successfully achieved at all austempering temperatures. Significant differences in bainite morphology were observed as a function of austempering temperature. Lower austempering temperatures promoted the formation of finer bainitic ferrite, whereas coarser bainitic structures were obtained at higher temperatures. Correspondingly, the hardness decreased with increasing austempering temperature, reflecting the coarsening of the bainitic microstructure. These findings demonstrate that austempering temperature plays a crucial role in controlling bainitic morphology and hardness in low-carbon carbide-free bainitic steel, providing a scientific basis for optimizing high-performance railway crossing materials.

Keywords: carbide-free bainite steel; austempering temperature; railway crossing nose; microstructure; hardness

2.39-P [209]: Comparative Corrosion Study of Single- and Double-Layer Ni-Based Coatings Produced by Arc Spraying and HVOF

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Abstract:

This study investigates the corrosion behavior of single-layer and double-layer thermally sprayed nickel-based alloy coatings, comprising bond and top coating systems. Ni-5 wt.% Al, PMET 866, and Ni-20 wt.% Cr were selected as bond coatings, while highly alloyed Ni-based materials, including Hastelloy C₂₇₆ and Inconel 625, were used as top coatings. The coatings were deposited on 304 stainless steel substrates using arc spraying and high-velocity oxy-fuel (HVOF) spraying techniques.

Corrosion performance was evaluated through potentiodynamic polarization and immersion tests in a 20 vol.% H₂SO₄ solution at ambient temperature. The microstructure and chemical composition of the coatings were characterized using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS). The arc-sprayed coatings exhibited a lamellar microstructure with low porosity, unmelted particles, and a relatively high oxide content at the intersplat regions. In contrast, the HVOF-sprayed coatings showed a more uniform and compact microstructure with minimal oxide formation and porosity. For the single-layer coatings, Inconel 625 demonstrated superior corrosion resistance compared with Hastelloy C₂₇₆, which was attributed to the formation of a protective Cr-rich oxide passive film. For the double-layer coatings, the HVOF-sprayed Ni-20 wt.% Cr bond coating provided the highest corrosion resistance owing to its dense microstructure and low oxide and porosity contents.

Among the arc-sprayed coatings, the PMET 866 bond coating exhibited the best corrosion resistance, followed by Ni-20 wt.% Cr and Ni-5 wt.% Al, respectively. Although the PMET 866 bond coating showed a high open-circuit potential and favorable corrosion resistance, its arc-sprayed structure contained higher oxide and porosity levels than the HVOF-sprayed coating, facilitating electrolyte penetration toward the substrate. These findings provide useful guidance for selecting thermally sprayed Ni-based coating systems for future maintenance applications.

Keywords: Thermal spray coating; Nickel alloy; Corrosion behavior; Arc spraying; High velocity oxy-fuel (HVOF)

2.116-P [162]: Consolidation of Nanostructured WC–10Ni Hard Alloys by Spark Plasma Sintering under Different Sintering Conditions

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Abstract:

Nanostructured WC-Ni hard alloys are of significant interest due to their combination of high hardness and excellent wear resistance. However, the influence of processing parameters on their densification behavior,

microstructural development and mechanical properties during spark plasma sintering (SPS) has not yet been fully clarified. In the present work, nanostructured WC–10 wt.% Ni hard alloys fabricated by SPS at different sintering parameters was investigated. The starting powder mixture consisted of 300 nm WC and Ni powders mixed at a mass ratio of 9:1 and consolidated at sintering temperature ranging from 1200 to 1250 °C for 5 min under a uniaxial pressure of 50 MPa in vacuum, using various heating rates of 100 - 200 °C/min. The sintered samples were characterized in terms of relative density, phase identification, microstructure, and hardness by the Archimedes method, X-ray diffraction, scanning electron microscopy, and Vickers indentation, respectively. The results revealed that the heating rate and sintering temperature significantly affected both the densification behavior and the mechanical properties of the nanostructured WC–10Ni hard alloys. Appropriate sintering conditions promoted enhanced densification and a more homogeneous microstructure, leading to improved mechanical performance. These results indicate that careful control of SPS parameters is essential for optimizing the consolidation and properties of nanostructured WC–Ni hard alloys

Keywords: Nanostructured WC-Ni; SPS; Heating rate; Hardness

4.3. Functional Materials

3.40-P [12]: Interfacial Electronic Reconstruction and Charge-Transfer Kinetics In Colloidally Assembled S-scheme MoSe₂/Porphyrin Heterostructures for Solar Water Splitting

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Abstract:

The growing global energy demand and environmental concerns necessitate the development of sustainable energy conversion technologies. Photoelectrochemical (PEC) water splitting represents a promising route for green hydrogen production; however, its efficiency is largely constrained by limited light absorption and rapid charge recombination in semiconductor materials. In this work, an inorganic–organic S-scheme MoSe₂/porphyrin hybrid heterostructure was successfully constructed via a scalable, non-covalent self-assembly strategy. The integration of porphyrin molecules with MoSe₂ significantly enhances light harvesting and promotes interfacial charge separation. Comprehensive electrochemical and spectroscopic characterizations, including cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), linear sweep voltammetry (LSV), and X-ray photoelectron spectroscopy (XPS), confirm improved charge transfer kinetics and favorable band alignment. The optimized hybrid exhibits a ~3-fold increase in specific surface area, delivering a high photocurrent density of 0.613 mA cm⁻² and a low Tafel slope of 75 mV dec⁻¹, indicating accelerated reaction kinetics. The enhanced PEC performance is attributed to the efficient S-scheme charge transfer mechanism, which preserves strong redox ability while suppressing carrier

recombination. This study provides an effective strategy for designing high-performance hybrid photocatalysts for solar-driven hydrogen generation.

Keywords: MoSe₂/porphyrin; S-scheme photocatalysis; water splitting

3.41-P [13]: Rational design of SnO₂/SnS₂ heterostructures for high-performance ammonia sensing toward low-temperature operation

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Abstract:

Ammonia (NH₃) gas is an important industrial pollutant, yet its reliable detection at low temperature remains a significant challenge due to limited sensitivity and sluggish surface kinetics in conventional metal oxide sensors. Herein, we report a rationally designed SnO₂/SnS₂ heterostructure nanocomposite for enhanced NH₃ sensing performance. The formation of a well-defined n–n heterojunction between layered SnS₂ and SnO₂ facilitates efficient charge transfer and modulates surface adsorption–desorption dynamics, thereby significantly improving gas sensing characteristics. The fabricated sensor exhibits a significant enhancement in response toward NH₃ compared to pristine SnO₂, with a 2.47-fold improvement in sensitivity, along with rapid response (68 s) at an operating temperature of 100 °C. The improved performance is attributed to the synergistic effects of heterointerface engineering and increased active surface sites. These results demonstrate a promising strategy for developing high-performance gas sensors with potential for room-temperature operation, providing a foundation for practical deployment in portable and wearable sensing platforms.

Keywords: NH₃ gas sensing; SnO₂/SnS₂ composite; heterojunction engineering; low-temperature operation

3.42-P [20]: Formation of an Electroless Ni–W–P Diffusion Barrier Layer on Ag–Sb-Based Thermoelectric Materials

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Abstract:

Ag–Sb-based thermoelectric materials are promising candidates for thermoelectric power generation devices operating in the low- to medium-temperature range, owing to their favorable electrical properties and low thermal conductivity. However, during device fabrication, interdiffusion and interfacial reactions may occur between the thermoelectric material and the bonding layer when metal electrodes and Sn-based solder are used. Such interfacial reactions can lead to the formation of brittle intermetallic compounds, increased

contact resistance, and reduced bonding reliability. Therefore, a diffusion barrier layer is required to control elemental diffusion between the thermoelectric material and the electrode.

In this study, an electroless Ni–P–W plating layer was formed on the surface of Ag–Sb-based thermoelectric materials and applied as a diffusion barrier layer. The Ni–P–W layer was deposited through an electroless plating process without an external power source. The Ni-based coating was expected to suppress interdiffusion between the thermoelectric material and the electrode bonding layer owing to its solder wettability, electrical conductivity, and thermal stability. In particular, the incorporation of W and P into the Ni–P–W layer may improve the stability of the diffusion barrier under elevated-temperature conditions through amorphous structure formation and delayed crystallization.

The morphology, composition, and interfacial characteristics of the formed Ni–P–W diffusion barrier layer were investigated using surface and interfacial characterization methods. In addition, the elemental diffusion behavior and possible formation of reaction layers before and after heat treatment were comparatively examined. Based on these analyses, the role of the Ni–P–W plating layer as a diffusion barrier between the Ag–Sb-based thermoelectric material and the electrode or solder bonding layer was evaluated, and its potential contribution to interfacial stability was discussed.

Keywords: Ag–Sb-based thermoelectric material; electroless Ni–P–W plating; diffusion barrier layer; interfacial reaction; elemental diffusion; thermoelectric device

3.43-P [23]: Synergistic Effects of Citric Acid and Aerogel Silica on the Electrochemical and Mechanical Properties of Eco-Friendly Bio-Polymer Composite Films for Electrolytic Films in Zinc-Air Battery

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Abstract:

Bio-based polymer composite films were developed as solid polymer electrolytes (SPEs) for zinc-air battery applications. A chitosan and mung bean starch blend (2:1 volume ratio) was optimized to balance mechanical flexibility and electrochemical stability. Glycerol (1 wt%) was incorporated as a plasticizer to disrupt polymer crystallinity, while citric acid served as a cross-linking agent to reinforce structural integrity against alkaline degradation. Aerogel silica synthesized from sugarcane leaf ash was incorporated as a compatibilizer and reinforcement filler at concentrations ranging from 0.5 to 3.0 wt%. Films were fabricated via solvent evaporation and characterized for mechanical properties, chemical structure, and surface morphology. Composite films containing 0.5–1.0 wt% aerogel silica exhibited superior tensile strength and secant modulus compared to aerogel silica-free films while maintaining flexibility and alkaline resistance. FT-IR analysis confirmed crosslinking interactions between hydroxyl and carboxyl functional groups

induced by citric acid, alongside interfacial interactions between aerogel silica and the polymeric matrix. Digital image correlation analysis revealed that films with 1.0–3.0 wt% aerogel silica displayed smoother and more homogeneous surfaces.

Electrochemical impedance spectroscopy showed Nyquist plots with steep linear profiles, confirming dominant ionic migration with minimal grain boundary resistance. Although ionic conductivity slightly decreased compared to pristine chitosan films, stable functional performance was maintained. Initial charge-discharge cycling in a demonstrative metal-air test cell confirmed the material's viability as a functional SPE. These findings highlight that eco-friendly bio-polymer composite films represent a promising biodegradable pathway for next-generation energy storage systems.

Keywords: Aerogel silica; Bio-polymer film; Citric acid; Solid electrolyte; Zinc-air battery

3.44-P [24]: Sustainable Synthesis of MnO₂ Nano-electrocatalysts via *Clerodendrum infortunatum* L. Phytochemical Extract: A Comparative Hydrothermal and Low-Temperature Approach for Zinc-Air Battery Electrocatalysts

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Abstract:

Metal-air batteries have attracted considerable attention as promising energy storage devices owing to their high theoretical energy density and environmental compatibility.

However, the oxygen reduction reaction (ORR) at the air cathode remains a critical challenge limiting overall battery performance. In this study, manganese dioxide nanoparticles were synthesized using Hill glory bower (*Clerodendrum infortunatum* L.) flower extract as a natural reducing and surface-capping agent via two approaches: low temperature and hydrothermal condition. Under mild condition, 5 mL of flower extract was mixed with 50 mL of 0.10 M KMnO₄ solution and stirred at 120 rpm for 1 hour.

Under hydrothermal condition, 5 mL of phytochemical extract was mixed with 50 mL of 0.10 M or 0.05 M KMnO₄ solution and reacted at 120 °C for 4 hours. Synthesized particles were filtered, washed, and dried in a hot-air oven. X-ray diffraction (XRD) and scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDS) confirmed the formation of α -MnO₂ nanoparticles within a carbon-based composite structure, in which the carbon matrix was derived from the phytochemical extract. Electrochemical performance was assessed as air cathode electrocatalysts in a solid-state zinc-air battery. The mild condition synthesized MnO₂ maintained 100% coulombic efficiency for the first 18 cycles and retained more than 89% up to the 30th cycle. By contrast, hydrothermal condition synthesized MnO₂ from 0.10 M KMnO₄ retained only 3% coulombic efficiency by the 30th cycle, while that from 0.05 M KMnO₄ retained more than 64%. The mild condition synthesized MnO₂ also demonstrated significantly superior long-term stability compared to hydrothermal synthesized MnO₂. These results confirm the successful formation of α -MnO₂/carbon-based nano-electrocatalysts and highlight that the green synthesis approach

enhances electrochemical performance while providing a sustainable pathway for clean energy storage in solid-state zinc-air battery systems.

Keywords: Electrocatalyst; Green synthesis; Manganese dioxide; Phytochemical extract; Zinc-air battery

3.45-P [25]: Dendrite-Suppressing and Safety-Enhanced Lithium Metal Batteries Enabled by MOF-Coated PP Separators under Lean Electrolyte

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Abstract:

Lithium metal batteries (LMBs) are regarded as next-generation energy storage systems; however, their practical deployment is constrained by safety risks, dendrite formation, and the reliance on large amounts of flammable liquid electrolytes. Herein, we report ZIF-8-functionalized polypropylene (PP) separators to construct pore-confined electrolytes for lean-electrolyte LMBs ($E/C < \sim 3$ g/Ah). ZIF-8 was uniformly coated onto commercial PP separators via a doctor-blade method, enabling effective electrolyte confinement within the intrinsic microporous framework after electrochemical activation, thereby significantly reducing electrolyte consumption. The activated single-sided ZIF-8 coated separator (Z/PP) exhibits enhanced thermal stability and flame resistance, along with an expanded electrochemical stability window (~ 4.9 V) and an increased Li^+ transference number (~ 0.79). Notably, LFP//Li cells employing activated Z/PP separators deliver reversible capacities above 140 mAh g^{-1} at 0.1 C after 100 cycles, with high capacity retention (up to 97.9 %) under lean electrolyte conditions. In contrast, commercial PP and Boehmite-coated PP (B/PP) separators fail to operate even at a low current density of 0.1 C at room temperature under identical lean-electrolyte conditions. The activated Z/PP separator also enables stable cycling at elevated temperature (60 °C), delivering an improved discharge capacity of 146.2 mAh g^{-1} after 150 cycles at 1 C with a high capacity retention of 89.6 %.

These results demonstrate that ZIF-8 coatings effectively enhance electrolyte retention, suppress dendrite growth, and significantly improve the safety and electrochemical performance of LMBs under lean electrolyte conditions.

Keywords: Lean-electrolyte; metal–organic frameworks; superior dendrite suppression; lithium metal batteries; pore-confined electrolytes; thermal stability

3.46-P [30]: Multifunctional Cellulose Nanofibrous Membranes with Antibacterial and UV-Blocking Properties via ZnO Immobilization and Ag Sputtering

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Abstract:

The goal of this research is to develop a multifunctional nanofibrous membrane with improved ultraviolet (UV) resistance and antibacterial properties for protective textiles and environmental filtration. To achieve this, cellulose nanofibrous membranes are first fabricated using the electrospinning method. Zinc oxide (ZnO) nanoparticles are then synthesized and physically immobilized onto the electrospun fibers through dip-coating method, followed by the application of a thin silver (Ag) layer using magnetron sputtering. The structural, morphological, and chemical properties of the synthesized nanocomposites are systematically characterized using X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), and Fourier-transform infrared spectroscopy (FTIR). The functional performance of the membranes is evaluated through UV transmittance measurements and disk diffusion tests against Gram-negative (*Escherichia coli*) and Gram-positive (*Staphylococcus aureus*) bacteria. The results demonstrate that the subsequent Ag sputtering process synergistically enhances both UV-blocking and antibacterial characteristics. Consequently, this study provides a novel architectural strategy to optimize the durability and functional efficacy of multimetallic cellulose nanocomposites for advanced real-world applications.

Keywords: cellulose nanofibers; zinc oxide; silver sputtering; antibacterial properties; UV resistance

3.47-P [33]: Short- and Long-Term Synaptic Plasticity Modulation via Metal–Organic Framework for Information-Filterable Perception System

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Abstract:

Neuroprosthetic systems integrated with artificial synapses hold considerable promise for resolving complex medical challenges, including human sensory disorders. A fundamental requirement for such systems, however, is the capacity to discriminate between significant and insignificant input signals. Here, we present an information-filterable perception system that couples artificial synapses with a signal-integration device to realize attention-based signal perception and processing.

The modulation of synaptic plasticity — spanning both short-term and long-term regimes — is achieved through the incorporation of metal–organic framework (MOF) layers, whose pore diameter and chemical functionality serve as the primary determinants of synaptic behavior. Four isorecticular Zr-based MOFs sharing the $\text{Zr}_6\text{O}_4(\text{OH})_4$ secondary building unit were systematically examined. MOFs with smaller pore diameters were found to favor short-term plasticity, while those with larger pores and enhanced ion affinity supported long-term retention. A 6×6 pixel perception array was further constructed by integrating short- and long-term artificial synapses with a signal-integration device, wherein signal summation enables attention-driven information filtering. The proposed system successfully emulates human perceptual mechanisms, offering a promising framework for future applications in neuroprosthetics and bio-inspired artificial intelligence.

Keywords: Artificial synapse; Metal-organic framework; Synaptic plasticity; Attention-driven information filtering.

3.48-P [41]: Effect of Al_2O_3 doping on the phase transition and electrical properties of BaTiO_3 -based piezoelectric ceramics

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Abstract:

Lead-free piezoelectric ceramic materials of $(1-x)[(\text{Ba}_{0.85}\text{Ca}_{0.15})(\text{Ti}_{0.9}\text{Zr}_{0.1})]\text{O}_3 + x\text{Al}_2\text{O}_3$ (abbreviated as BCZT-A), with $x = 0.0, 0.01, 0.02, 0.03$ and 0.04 were synthesized using the solid-state reaction method. The starting materials BaCO_3 , CaO , TiO_2 , ZrO_2 and Al_2O_3 for BCZT-A ceramic were ball-milled in alcohol for 24 hours. The mixed powders were then calcined at 1000°C for 2 hours. After calcination, the BCZT-A powders were shaped and sintered at 1300°C for 2 hours. The BCZT-A ceramic materials were characterized by X-ray diffraction analysis, which showed a crystal structure that coexisted in the tetragonal and orthorhombic phases at $x = 0$ and then transformed into the cubic and tetragonal phases when the Al_2O_3 doping concentration ranged from 0.01 to 0.03. The highest dielectric constant, piezoelectric coefficient and dynamic piezoelectric coefficient are 3328, $d_{33}=155$ " " pC/N and $d_{33}^*=200$ " " pm/V , respectively. The BCZT-A ceramic material exhibited the highest energy storage density 0.123 J/cm^3 , corresponding to an efficiency reached 86% at $x = 0.04$.

Keywords: Lead-free; piezoelectric; ceramic; BaTiO_3 ; Al_2O_3

3.49-P [44]: Hybrid Metamaterial Absorber based on $\text{MoS}_2\text{-Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4\text{-C}$ composite for Broadband RCS Reduction

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Abstract:

Metamaterial absorbers have emerged as a critical research frontier for radar cross-section (RCS) reduction and electromagnetic interference shielding. However, achieving broadband performance while maintaining angular stability remains a persistent challenge. This study proposes a high-performance three-layer hybrid metamaterial absorber (HMA) comprising a periodic concentric split-ring metasurface, an intermediate $\text{MoS}_2\text{-Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4\text{-C}$ absorbing layer, and a metallic ground plane. The $\text{MoS}_2\text{-Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4\text{-C}$ composite material, characterized via scanning electron microscopy and energy-dispersive X-ray spectroscopy, exhibits a hierarchical microstructure that promotes multiple scattering and significant interfacial polarization (the Maxwell-Wagner effect).

Electromagnetic analysis reveals that the synergy between the geometric resonance of the metasurface and the dielectric-magnetic loss of the composite ensures efficient energy dissipation across the 2-18 GHz range. Simulation results demonstrate that the HMA achieves a boresight RCS reduction of nearly 19 dB compared to the bare $\text{MoS}_2\text{-Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4\text{-C}$ coating. At 10 GHz, the three-dimensional monostatic RCS is suppressed to -13.6 dBm_2 , representing an impressive 38.3 dB reduction compared to a conventional perfect electric conductor surface.

Furthermore, the structure maintains exceptional scattering control under wide-angle and grazing incidence by redistributing incident energy in a diffuse manner. These findings underscore the potential of the proposed $\text{MoS}_2\text{-Cu}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4\text{-C}$ -based hybrid metamaterial absorber for advanced stealth technologies and electromagnetic wavefront engineering.

Keywords: Hybrid metamaterial absorber; MoS_2 ; Cu-Ni ferrite; Broadband microwave absorption; RCS reduction

3.50-P [47]: Interplay of composition and microstructure in the magnetic properties of Ca–Zn co-doped YIG powders synthesized by sol–gel

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Abstract:

Ca–Zn co-doped yttrium iron garnet (YIG) powders were synthesized by a sol–gel method to investigate composition-dependent magnetic properties. X-ray diffraction confirms the formation of a single-phase garnet structure. Magnetic hysteresis measurements in the temperature range of 5–300 K show that the saturation magnetization ($M_s \approx 37\text{--}38\text{ emu g}^{-1}$) exhibits a non-monotonic dependence on doping concentration, reflecting magnetic dilution by Zn^{2+} ions and modifications of $\text{Fe}^{3+}\text{--O}^{2-}\text{Fe}^{3+}$ superexchange interactions. In contrast, the coercive field ($H_c \approx 20\text{--}100\text{ Oe}$) shows a pronounced dependence on composition and temperature, with an enhancement at intermediate doping levels associated with domain-wall pinning and microstructural effects. The results indicate stable ferrimagnetic behavior and demonstrate that Ca–Zn co-doping via sol–gel synthesis is an effective approach to tailor the magnetic softness of YIG.

Keywords: Ca–Zn co-doped YIG; Sol–gel; Saturation magnetization; Coercivity; Domain-wall pinning

3.51-P [57]: Engineering Rare-Earth Iron Garnet Heterostructures for High Spin Seebeck Efficiency

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Abstract:

Rare earth iron garnets are widely studied magnetic insulators for spintronic and spin caloritronic applications, where they enable efficient spin transport and thermally driven spin current generation. A major challenge is the intrinsically low thermoelectric efficiency and power output of Spin Seebeck devices. In this work, we report an enhanced Spin Seebeck response achieved by rare earth garnet heterostructure engineering.

We fabricate rare earth garnet heterostructures using metal organic decomposition, a simple and low-cost method that allows rapid growth. In our heterostructure design, gadolinium doped or thulium doped YIG layers are first deposited, followed by a YIG layer and a Pt layer for electrical detection of the Spin Seebeck signal. Among all samples, the pure thulium iron garnet configuration exhibits the largest enhancement, showing an high increase in the Spin Seebeck signal compared to the YIG double layer

Keywords: Rare earth iron garnet; Spin Seebeck effect; garnet heterostructures; metal organic decomposition

3.52-P [58]: Altermagnetism in Oriented RuO₂ Thin Films

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Abstract:

Altermagnetism represents a newly recognized magnetic phase that combines essential features of both ferromagnetic and antiferromagnetic systems. Although the net magnetization is fully compensated, similar to conventional antiferromagnets, the crystal symmetry induces a momentum-dependent spin splitting in the electronic band structure. This effect resembles the spin polarization observed in ferromagnets and enables the efficient generation and manipulation of spin currents without producing stray magnetic fields. As a representative altermagnetic material, RuO₂ exhibits distinctive spintronic functionalities, particularly in generating transverse spin currents. In this work, we focus on the growth and optimization of RuO₂ thin films on sapphire C-plane substrates, with special emphasis on how substrate surface treatment affects epitaxial growth. RuO₂ films on Al₂O₃ C-plane substrates show Néel vectors oriented along multiple directions corresponding to three equivalent crystal domains. Enhancing the crystallinity of RuO₂ is therefore crucial to achieving well-defined Néel vector alignment, which is essential for investigating altermagnetic phenomena, especially the spin-splitting effect associated with altermagnetism.

Keywords: Altermagnetism; RuO₂; Yttrium Iron Garnet; Spin Seebeck Effect

3.53-P [60]: Optically tunable spin Seebeck effect in Au-nanoparticle embedded Pt/YIG Bilayers

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Abstract:

Generating spin currents through thermal gradients, known as the spin Seebeck effect (SSE), presents a viable route for next-generation spin-caloritronic applications. In this work, we demonstrate a remarkable boost in SSE efficiency within a Pt/Y₃Fe₅O₁₂ (YIG) system by incorporating localized gold nanoparticles (Au NPs). This improvement is driven by the surface plasmon resonance induced plasmonic spin currents and the thermal fin effect (TFE), which significantly strengthens magnon-phonon coupling. Under resonant light illumination, we achieve a substantial SSE signal enhancement of over 190%, with plasmonic spin currents contributing 137.2% and the TFE accounting for 56.1%. Furthermore, we reveal a distinct nonlinear power dependence of the resonant SSE signal. Above a threshold laser intensity, the output degrades due to excessive plasmonic heating. This study highlights the dual role of plasmonic excitation in tailoring spin currents and establishes a pathway for designing highly controllable, light-driven spin-thermoelectric devices.

Keywords: Spin Seebeck Effect; Spin Pumping; Magnon temperature; Thermal Fin; Yttrium Iron Garnet

3.54-P [61]: The YIG film deposition via MOD with high temperature annealing by using microwave oven and magnetic properties investigation

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Abstract:

In this study, we report the deposition of Yttrium Iron Garnet (YIG, Y₃Fe₅O₁₂) thin films by using a microwave oven for annealing process. The thickness of the films was controlled by spin coating for 35 seconds at different speeds (RPM). The crystallization of YIG needs a high-temperature annealing, and we experimentally determined that the temperature was reached after 30 minutes of microwave heating. According to this result, the annealing time for the samples were set to 30, 35, and 40 minutes.

Grazing Incidence X-ray Diffraction (GIXRD) measurements showed that the YIG thin films has high crystallinity with no secondary phases. Scanning Electron Microscopy (SEM) image showed that the films were highly closed, but some pores were observed, which are attributed to the decomposition of organic residues (PVP and DMF) caused by fast temperature increase.

Measurements of the magnetic hysteresis loops showed a significant increase in the magnetic moment for the sample annealed for 40 minutes compared to annealed other samples.

This tendency appears due to the fact that although the temperature inside the kiln has reached the crystallization temperature of YIG, the kiln characteristic of the temperature dropping after heat treatment means that there is not enough time for the YIG film to crystallize.

These findings demonstrate that microwave oven annealing is a reasonable and scalable approach for producing high-quality YIG films on Si substrates. This positions the technique as a promising alternative to conventional methods for applications in spintronics devices.

Keywords: YIG; MOD; SSE; Microwave oven annealing; Si substrate; rapid annealing

3.55-P [70]: Introducing NiOx layer for stacked photodetector

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Abstract:

Modern silicon-based color image sensors suffer from substantial optical losses originating from color filter arrays, which typically dissipate nearly two-thirds of the incident light and thereby limit the attainable sensitivity and image fidelity. Filter-free silicon Foveon-type architectures have been developed to address this issue;

however, the fixed bandgap of silicon intrinsically restricts wavelength selectivity and requires complex post-processing algorithms for color reconstruction, ultimately limiting their imaging performance. Recently, vertically stacked RGB image sensors based on halide perovskites have attracted considerable attention owing to their composition-tunable bandgaps, high optical absorption coefficients, and solution-process compatibility, which enable direct spectral selectivity without external color filters.

For practical implementation of vertically stacked perovskite photodetectors, low-temperature atomic layer deposition (ALD) is required to form dense and conformal interlayers while minimizing thermal damage to the underlying functional layers. However, low-temperature ALD processes render the surface highly hydrophobic, with water contact angles exceeding 80°, which severely hinders subsequent solution-based perovskite deposition and thus imposes a critical fabrication barrier for multilayer stacked devices. To overcome this challenge, we introduce a NiOx interlayer strategy that restores surface wettability and enables robust solution processing on ALD-modified surfaces while fully preserving the integrity of the underlying device layers. The NiOx surface exhibits a hydrophilic character with a contact angle below 20°, facilitating uniform film coverage and minimizing interfacial defects in the stacked architecture. This approach provides a viable and scalable process platform for vertically integrated perovskite photodetectors and represents an important step toward the realization of filter-free, 6-terminal RGB photodetector architectures with enhanced light utilization and superior color-selective detection.

Keywords: NiOx layer; Photodetector; Perovskite

3.56-P [71]: Enhanced green perovskite photodetector performance via Rbl additive engineering

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Abstract:

Perovskite photodetectors have attracted considerable attention due to their excellent optoelectronic properties, tunable bandgap, and low cost solution processing. However, devices fabricated using pristine perovskite solution often suffer from limited film quality, reduced photosensitivity, and high signal noise. In this work, the effects of various inorganic and organic additives on the performance of green perovskite photodetectors were systematically investigated.

Inorganic additives including CsI, RbI, and PbSCN, together with organic additives such as thiourea, NH₄SCN, GuaSCN, and MASCN, were introduced into the perovskite precursor solution to improve film morphology and device characteristics. Optical microscopy and SEM analyses revealed that additive engineering strongly influenced wrinkle formation, grain growth, and surface uniformity.

Among the investigated additives, RbI significantly reduced surface wrinkles and promoted larger grain formation, while thiourea produced clearer and larger grains compared with the pristine film. Device characterization demonstrated that the RbI-based device exhibited the best performance, achieving an external quantum efficiency (EQE) exceeding 80% in the green spectral range of 500 - 600 nm. These results indicate that additive engineering is an effective strategy for improving perovskite film quality and enhancing the performance of green photodetectors.

Keywords: Perovskite thin film; Green photodetector; External quantum efficiency

3.57-P [79]: Applications in Transfer-Free Graphene Grown at 100 °C via Plasma-Assisted Thermal CVD

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Abstract:

Transfer-free graphene growth at low temperature has attracted increasing attention due to its compatibility with temperature-sensitive substrates and its potential for scalable device fabrication. Among various approaches, plasma-assisted thermal chemical vapor deposition (PATCVD) on Ti-buffered substrates has emerged as a promising method for enabling graphene synthesis under reduced thermal conditions. This technique allows for direct growth on target substrates, eliminating the need for transfer processes and improving integration with device architectures. Recent studies have demonstrated continuous improvements in process control and material quality, contributing to the development of more reliable graphene films. Through the optimized process, transfer-free graphene can be applied for various electronic devices. In this study, for flexible and stretchable electronic devices, high-flexible and good stretchable properties were demonstrated. For the lowest sheet resistance of the transfer-free graphene, we tried to integrate the multi-layers in situ PATCVD. The four layers integration were performed like as follows: Gr/TiO_{2-x}/Gr/TiO_{2-x}/Gr/TiO_{2-x}/Gr/TiO_{2-x}/SiO₂/Si substrates at 100 °C. Four-layers integrated graphene revealed the lowest sheet resistance such as ~ 6 W/square, that was replaced for ITO flexible electrodes. Furthermore, we can achieve the reliable n-type and p-type semiconducting properties using FET devices for digital logic devices.

Keywords: Transfer-free graphene; PATCVD; low-temperature growth; various applications

3.58-P [89]: Enhanced Flame Retardancy of Nitrile Butadiene Rubber Using DOPO-Modified Expandable Graphite in Synergy with APP and MH/ATH

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Abstract:

This study investigates the flame-retardant properties of nitrile butadiene rubber (NBR) containing DOPO-modified expandable graphite (D-EG) and its synergistic effects with ammonium polyphosphate (APP) and a magnesium hydroxide/aluminum trihydroxide mixture (MH/ATH). The successful modification of EG was confirmed by FTIR, FE-SEM, EDX, and TGA analyses. D-EG exhibited superior flame-retardant performance compared with unmodified EG while maintaining acceptable mechanical properties.

Specifically, the composite containing 30 phr D-EG achieved an LOI value of 27.2% and a UL-94 V-2 classification.

Combining D-EG with MH/ATH significantly improved flame retardancy, resulting in an LOI of 32.0% and a UL-94 V-0 rating. Meanwhile, the optimum D-EG/APP ratio of 2:1 achieved the highest LOI of 28.1% and a UL-94 V-1 classification. Morphological and thermal analyses revealed that DOPO promoted the formation of an intumescent char layer, thereby enhancing thermal stability and flame retardancy through a condensed-phase barrier effect. When combined with APP or MH/ATH, the resulting char layer became denser and more continuous compared with those of the individual systems.

Keywords: Nitrile butadiene; modified expandable graphite; DOPO; flame retardancy; APP; MH/ATH

3.59-P [92]: InSb-Assisted Broadband Switchable Terahertz Metasurfaces for Anomalous Reflection and Focusing

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Abstract:

Metasurfaces offer versatile capabilities for electromagnetic wave manipulation; however, achieving dynamically switchable wavefront control over a broadband terahertz regime remains a significant challenge. In this work, we propose a thermally switchable metasurface based on InSb split-ring (SR) resonator for dynamic control of reflected circularly polarized (CP) waves, as illustrated in Fig. 1(a). By

using the Pancharatnam–Berry (PB) phase principle, a full 2π phase modulation is obtained by simply rotating the SR resonator. Due to the temperature-dependent conductivity of InSb, the metasurface can be reversibly switched between the “OFF” state at 200 K and the “ON” state at 320 K, allowing polarization conversion in the 0.21–0.41 THz frequency range. Based on this concept, two metasurface designs are demonstrated a broadband anomalous reflector with a reflection angle changing from 51° to 21° across 0.21–0.41 THz (Fig. 1(b)) and a reflective metalens with switchable focusing functions, including on-axis (Fig. 1(c)), off-axis, and dual-focus beam generation. The proposed metasurface offers a promising platform for thermally reconfigurable terahertz devices and may support the development of future reconfigurable terahertz photonic systems.

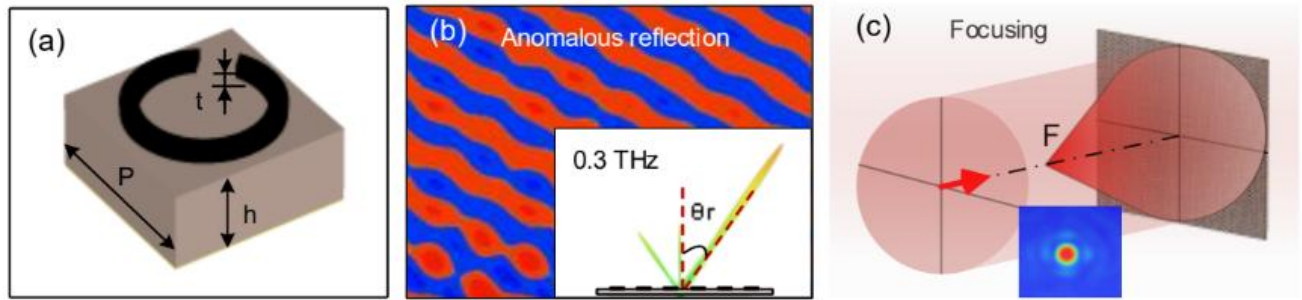


Fig. 1. (a) Proposed reflective InSb metasurface unit cell, (b) reflected electric-field distribution with the 3D far-field pattern (inset), (c) electric-field distribution of the reflected orthogonal CP wave for the single-focus metalens at 0.3 THz.

Keywords: Metasurfaces; Pancharatnam-Berry; Metalens; Anomalous reflector; InSb

Acknowledgments: This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 103.02-2025.115.

3.114-P [274]: Sputtered Nickel oxide-coated porous carbon nanofibers as binder-free anodes for high-performance lithium-ion batteries

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Abstract:

Free-standing and binder-free anode for high-performance lithium-ion batteries (LIBs) consisting of NiO uniformly coated on porous carbon nanofibers (FCNF) was successfully fabricated. The NiO was formed on the FCNF surface through a two-step process involving radio frequency magnetron sputtering of Ni followed by thermal oxidation. The obtained NiO/FCNF composite electrode eliminates the need for binders and conductive additives, simplifying electrode preparation and increasing the active material loading. The electrode has been characterized by using scanning electron microscopy (SEM), surface area analysis, X-ray diffraction (XRD), transmission electron microscopy (TEM), thermogravimetric analysis (TGA), and Raman spectra (Raman). The NiO/FCNF anode provided a high initial discharge capacity of 1619 mAh g⁻¹

and a charge capacity of 1046 mAh g⁻¹ after 100 cycles at a current density of 100 mA g⁻¹. Furthermore, the composite electrode displayed good rate performance, remaining a specific capacity of 456 mAh g⁻¹ even at a high current density of 3 A g⁻¹. The enhanced performance is attributed to the synergistic effects of the components: the FCNF network provides excellent electrical conductivity and a robust scaffold that accommodates the volume changes of NiO during cycling, while the uniformly coated NiO offers high theoretical capacity. This work highlights a promising approach for developing high-performance, free-standing anodes for next-generation LIBs

Keywords: Anodes; binder-free; electrospinning; free-standing; lithium-ion batteries; nickel oxide; sputtering

3.60-P [93]: Design of a Broadband and High-Efficiency Metasurface for Anomalous Reflection in the Terahertz Regime

Authors: Duc Manh Nguyen¹, Huynh Phuong Mai Tran², Thi Kim Thu Nguyen², Thi Minh Tam Nguyen², Tien Hung Luu², Hong Quang Nguyen², Thi Quynh Hoa Nguyen²

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Abstract:

Terahertz metasurfaces have attracted significant attention for compact wavefront manipulation devices. However, simultaneously achieving broadband operation and high efficiency remains challenging because of the difficulty in maintaining complete phase coverage and high reflection amplitude over a wide frequency range. In this work, a broadband reflective metasurface for efficient manipulation of circularly polarized (CP) terahertz waves is proposed based on the Pancharatnam - Berry (PB) phase principle. The metasurface consists of a dielectric substrate integrated with a double-side axes resonator backed by a metallic ground plane. By rotating the anisotropic resonator, full 2π phase modulation is achieved while preserving high reflected orthogonal CP amplitudes above 0.9 across the 0.78 - 1.82 THz frequency range. Based on this approach, broadband anomalous reflection is numerically demonstrated for reflected CP waves. Stable anomalous reflection is achieved from 1.0 to 1.8 THz with efficiencies up to 94.5%, while tunable reflection angles ranging from approximately 15° to 71° are realized through engineered phase gradients from 45° to 90°. These results demonstrate the potential of the proposed metasurface for broadband and high-efficiency terahertz wavefront manipulation and provide a promising platform for future terahertz imaging, sensing, and wireless communication systems.

Keywords: Metasurfaces; Pancharatnam-Berry; Anomalous reflection; THz

Acknowledgments: This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 103.02-2025.115.

3.61-P [94]: Design of a 1-Bit Reconfigurable Intelligent Surface Operating in the Sub-6 GHz Band for 5G Systems

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Abstract:

Reconfigurable intelligent surfaces (RISs) have recently emerged as a promising technology for next generation wireless communication systems due to their capability to dynamically manipulate electromagnetic wave propagation.

Through programmable control of the reflection phase, RISs can realize various functionalities such as beam steering, beamforming, and multi beam generation, thereby improving spectrum efficiency, signal coverage, and communication reliability for 5G and beyond networks. In Vietnam, the commercial deployment of 5G networks is mainly focused on the sub 6 GHz frequency spectrum, particularly within the 6.425–7.125 GHz band. Nevertheless, the development of RISs operating at GHz frequencies still encounters significant challenges because efficient tuning mechanisms capable of achieving precise phase modulation while preserving high reflection efficiency remain limited.

In this work, a programmable 1 bit RIS for 5G applications is proposed. The metasurface is composed of low cost and easily fabricated metamaterial unit cells integrated with PIN diodes for dynamic phase modulation. By switching the diode states, the proposed unit cell achieves an approximately 180° reflection phase difference across the 6.425–7.125 GHz frequency range while maintaining a reflection amplitude higher than 80%. To reduce the complexity of the biasing and interconnection network, a 10×10 RIS array based on 2×2 grouped unit-cell is designed. Full wave simulation and experimental results demonstrate that the proposed RIS achieves beam steering from -40° to $+40^\circ$. In addition, flexible beamforming functionalities, including multi beam radiation patterns, are realized through programmable phase distributions. The obtained results verify that the proposed RIS provides an efficient, low complexity, and scalable platform for future wireless communication and microwave imaging systems.

Keywords: Metasurfaces; Reconfigurable intelligent surfaces; 5G

Acknowledgments: This research is funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 103.02-2025.115.

3.62-P [97]: Fabrication of porous biphasic calcium phosphate scaffolds by solid state sintering and the replica method

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Abstract:

Biphasic calcium phosphates of hydroxyapatite ($(\text{Ca}_{10}\text{PO}_4)_6(\text{OH})_2$, HAp) and β -tricalcium phosphate ($\text{Ca}_3(\text{PO}_4)_2$, β -TCP) have been attracted considerable attention as bone substitute material due to its excellent bioactivity, osteoconductivity, and chemical similarity to that of the bone mineral. In this study, the porous HAp/TCP scaffolds were fabricated using a replica method based on the solid-state sintering principle. The polyurethane foam (PU) was used as a template to generate interconnected porous structure. After coating PU foam with a mixture of $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$, CaCO_3 , and 10 vol% polyvinyl alcohol, the templates was removed by thermal decomposition, and the scaffolds was sintered at various temperatures of 1000, 1100

and 1200 °C for 5 hours. The porous HAp/TCP scaffolds exhibited interconnected porous structure that closely resembled cancellous bone, with the pore sizes ranging from 150 to 250 µm. X-ray diffraction analysis revealed that all samples composed of biphasic calcium phosphate, including HAp and β-tricalcium phosphate (β-TCP). The amount of β-TCP decreased with increasing sintering temperature. In addition, the FTIR results confirmed the presence of characteristic functional groups of PO₄ and OH corresponding to the biphasic calcium phosphate phases. In addition, the intensity of OH⁻ groups increased with increasing sintering temperature, attributing to the increased HAp content. At 1200 °C, the scaffold exhibited a compressive strength of 10 ±3 MPa which is within the suitable range for cancellous bone application.

Keywords: Hydroxyapatite; replica; solid state sintering; bone repair

3.63-P [99]: Synthesis of mesoporous carbonate apatite nanocrystals as bone substitute and drug delivery

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Abstract:

Mesoporous carbonate hydroxyapatite (CHAp), with a chemical composition of bone mineral and a mesoporous structure, was successfully synthesized using a hydrothermal method.

Calcium nitrate tetrahydrate (Ca(NO₃)₂•4H₂O), disodium hydrogen phosphate (Na₂HPO₄), and sodium hydrogen carbonate (NaHCO₃) were employed as the calcium, phosphate, and carbonate precursors, respectively. Tartaric acid was used as an organic pore-forming agent. Initially, CHAp precipitates were prepared by the dropwise addition of phosphate-carbonate solutions into the calcium solution under continuous stirring. The obtained precipitates were subsequently hydrothermally treated at 150 °C for 5 h. The results showed that the synthesized CHAp compose of nanocrystals. Nitrogen adsorption-desorption analysis revealed a type IV isotherm with a hysteresis loop, confirming the characteristic mesoporous nature of the material. The average pore diameter was approximately 23-25 nm. Furthermore, the mesoporous CHAp demonstrated a good drug-loading capability, achieving approximately 14.22 wt% loading of ciprofloxacin (CIP) after 24 h of immersion.

These results suggest that mesoporous CHAp is a promising biomaterial for bone regeneration and drug delivery applications.

Keywords: Mesoporous calcium phosphate; bone regeneration; hydrothermal treatment; drug delivery

3.64-P [102]: Single-Phase Bi₂Ti₂O₇ Microspheres for Highly Efficient Sonocatalytic Degradation of Rhodamine B

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Abstract:

In this study, single-phase $\text{Bi}_2\text{Ti}_2\text{O}_7$ photocatalyst was successfully synthesized via a facile solvothermal method using glycerol and ethanol as mixed solvents. The precursor solution was treated at 120 °C for 10 h, followed by calcination at 600 °C for 3 h to obtain the crystalline pyrochlore $\text{Bi}_2\text{Ti}_2\text{O}_7$ phase. The structural, morphological, and optical properties of the synthesized material were systematically investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM), UV–Vis diffuse reflectance spectroscopy, and Raman spectroscopy. XRD and Raman analyses confirmed the formation of highly crystalline single-phase $\text{Bi}_2\text{Ti}_2\text{O}_7$ without detectable impurity phases. SEM images revealed that the obtained particles possessed a uniform spherical morphology with an average diameter of approximately 4.3 μm . UV–Vis analysis indicated that the material exhibited visible-light absorption characteristics suitable for catalytic applications. The sonocatalytic activity of $\text{Bi}_2\text{Ti}_2\text{O}_7$ was evaluated through the degradation of Rhodamine B (RhB) aqueous solution under ultrasonic irradiation. The experimental results demonstrated that the synthesized $\text{Bi}_2\text{Ti}_2\text{O}_7$ exhibited remarkable sonocatalytic performance, achieving complete degradation of RhB within 30 min. The enhanced degradation efficiency could be attributed to the synergistic effects between ultrasonic cavitation and the catalytic properties of the $\text{Bi}_2\text{Ti}_2\text{O}_7$ microspheres, which promoted the generation of reactive oxidative species during the sonocatalytic process. These findings indicate that solvothermally synthesized $\text{Bi}_2\text{Ti}_2\text{O}_7$ is a promising sonocatalyst for the efficient removal of organic dye pollutants from wastewater and has significant potential for environmental remediation applications.

Keywords: $\text{Bi}_2\text{Ti}_2\text{O}_7$; Pyrochlore; Sonocatalysis; Rhodamine B; Solvothermal

3.65-P [103]: Synthesis brick-like nanostructure of WO_3 by Sol-Gel method

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Abstract:

WO_3 is a n-type semiconductor with band gap around 2.8-3.0 eV which is operated in the visible light region. It is widely known for its excellent electronic and morphological properties and good stability. To narrow the band gap, WO_3 is mainly synthesized by hydrothermal method at quite high reaction temperatures (around 180-200 °C) and need to doping metals. So, with this study, we try to narrow the band gap by sol-gel method with reducing the reaction temperature to 70 °C without doping metals. The result shows that WO_3 with a brick-like nanostructure reduces the band gap to 2.62 eV at 500 °C annealing. The XRD, SEM, Raman, FTIR, UV-Vis and PL spectra were investigated. The results showed brick-like nanostructure of WO_3 is suitable for further measuring in the fields of gas sensor or photocatalysis.

Keywords: WO_3 ; Sol-gel method; Gas sensors; Photocatalysis

3.66-P [104]: Zwitterionic Coordination-Driven Crystallization Engineering of Sn-Pb Perovskites for High-Efficiency Tandem Solar Cells

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Abstract:

Sn-Pb mixed perovskites have attracted considerable attention as bottom-cell materials for all-perovskite tandem solar cells owing to their tunable bandgap and excellent near-infrared absorption properties. However, the rapid crystallization behavior of Sn species and the oxidation of Sn^{2+} induce high defect density and poor device stability, which are major factors limiting the photovoltaic performance of Sn-Pb perovskite solar cells.

In this study, a zwitterionic additive was introduced to regulate the crystallization behavior and interfacial properties of Sn-Pb perovskite films. Through strong coordination interactions with Sn ions, the additive effectively regulated the rapid crystallization of Sn species and thereby controlled the crystallization dynamics of the perovskite films. As a result, high-quality Sn-Pb perovskite films with larger grain sizes and improved crystallinity were obtained. In addition, the zwitterionic additive improved the interfacial properties at the perovskite/HTL interface, leading to enhanced charge transport and carrier extraction.

Consequently, the additive-treated films exhibited improved crystallinity and interfacial characteristics, while the corresponding devices showed enhanced photovoltaic performance with increased J_{sc} , V_{oc} , and FF values. These results demonstrate that controlling crystallization dynamics using a zwitterionic additive is an effective strategy for improving film quality and charge transport properties in Sn-Pb perovskite solar cells.

Keywords: Sn-Pb perovskite; zwitter-ion; Sn crystallization control; interface engineering; tandem solar cells

3.67-P [110]: Chemical vapor deposition synthesis of nanostructured V_2O_5 : effect of substrate position

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Abstract:

Vanadium pentoxide (V_2O_5) nanostructures are very important in electronic devices such as transistors and chemical sensors. Chemical vapor deposition is popular for the synthesis of metal oxide nanostructures. However, the morphology and characteristics of are strongly dependent on the synthesis conditions. In this study, we investigated the effect of substrate position on the morphology and quality of the synthesized V_2O_5 nanostructures. The materials were characterized by scanning electron microscopy, X-ray diffraction, and Raman spectroscopy. We pointed out that by simply controlling the substrate position, and precursor, we could prepare V_2O_5 of nanowires, nano thin film, and nanospheres.

Keywords: chemical vapor deposition; vanadium pentoxide; nanostructures

3.68-P [119]: Atomic Layer Deposited SnO₂ on Al Electrodes for Enhanced Water-Induced Triboelectric Energy Harvesting

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Abstract:

Water-induced triboelectric nanogenerators (WI-TENGs) are promising for harvesting low-grade hydraulic energy. In this work, we report a simple and effective strategy to enhance WI-TENG performance by depositing ultrathin SnO₂ films onto Al electrodes using atomic layer deposition (ALD). The SnO₂ interfacial layer was precisely controlled at thicknesses of 2.91, 4.95, 11.20, 17.09, and 22.82 nm to investigate its effect on electrical output. Compared with bare Al, SnO₂-coated electrodes exhibited markedly improved voltage, power density, and load matching behavior. Among all samples, the device with a 11.20 nm SnO₂ layer showed the best overall performance, delivering the highest output voltage of about 1.9 V and a maximum power density of approximately 12.8 $\mu\text{W cm}^{-2}$. The optimal external resistance also increased with SnO₂ thickness, indicating substantial modulation of interfacial charge transport and energy conversion characteristics. The enhancement is attributed to the role of the ALD-grown SnO₂ layer in tuning surface polarization, improving interfacial electrification, and promoting more stable charge trapping on the electrode surface. However, when the oxide layer became too thick, the output performance decreased, likely due to increased transport resistance and suppressed charge transfer. These results demonstrate that ALD-enabled SnO₂ nanoengineering on Al electrodes provides an effective pathway for optimizing water-induced TENGs for blue-energy harvesting and self-powered sensing applications.

Keywords: Atomic layer deposition; SnO₂ thin films; Water-induced triboelectric nanogenerator; Interfacial charge engineering

3.69-P [120]: Dual-site Mn⁴⁺ activation in SrWO₄-Sr₂WO₅ enabling efficient deep-red emission

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Abstract:

A novel Mn^{4+} -doped $\text{SrWO}_4\text{-Sr}_2\text{WO}_5$ phosphor (SWT-SWO: Mn^{4+}) was successfully synthesized using a conventional solid-state reaction method. X-ray diffraction (XRD) analysis confirmed the coexistence of two crystalline phases, SrWO_4 (space group $I4_1/a$ (88)) and Sr_2WO_5 (space group Pnam (62)). Scanning electron microscopy (SEM) images and energy-dispersive X-ray spectroscopy (EDS) demonstrated the high purity of the material after annealing at 900 °C. Under 323 nm excitation, the phosphor exhibits intense deep-red emission centered at 692 nm, attributed to Mn^{4+} ions occupying both tetrahedral and octahedral coordination sites, as supported by photoluminescence excitation (PLE) and photoluminescence (PL) spectra. These findings demonstrate that SWT-SWO: Mn^{4+} phosphor is a promising candidate for tunable deep-red emission in red LED devices and indoor plant cultivation lighting.

Keywords: $\text{SrWO}_4\text{-Sr}_2\text{WO}_5\text{:Mn}^{4+}$ phosphors; Deep-red emission; Dual tetrahedral and octahedral sites

3.70-P [122]: High efficiency Transparent Heaters based on aligned Silver Nanowires fabricated by a Stream-Vapor Method

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Abstract:

Aligned silver nanowire (AgNW) thin films prepared using a stream-vapor alignment strategy exhibit enhanced Joule heating performance and operational stability compared with conventional random AgNW networks, demonstrating their potential as transparent heater electrodes for flexible optoelectronics. In this work, we fabricate aligned AgNW transparent films through a simple solution-based process in which a controlled AgNW ink stream is guided across a substrate while a solvent vapor field regulates evaporation dynamics, flow direction, and capillary interactions, enabling large-area nanowire alignment with tunable density and uniformity. The optimized aligned films reach 112 °C within 40 s under a bias of 7 V, whereas reference random AgNW films exhibit structural failure after reaching only 71 °C at 30 s under 5 V. Compared with random percolation networks, aligned AgNW films show lower percolation thresholds and more efficient conductive pathways, enabling improved electrical conductivity and optical transmittance at reduced nanowire loading. Consequently, aligned transparent heaters demonstrate higher steady-state temperatures, faster heating response, more uniform surface heat distribution, and improved robustness under high current densities relative to randomly oriented AgNW heaters and previously reported slot-die-coated AgNW films.

These results highlight the stream-vapor alignment approach as a scalable route for developing high-performance transparent heaters for next-generation flexible and wearable optoelectronic applications.

Keywords: Silver nanowires; Transparent heaters; Nanowire alignment; Stream-vapor method; Flexible optoelectronics; Transparent conductive electrodes

3.71-P [123]: Synergistic Effects of Silver Nanoparticles and Graphene Nanoplatelets on the Thermal Conductivity of Water-Based Nanofluids

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Abstract:

Silver nanoparticle-decorated graphene (AgNP-Gr) hybrid nanomaterials were successfully synthesized via a facile chemical reduction method using ascorbic acid as an environmentally friendly reducing agent. The synthesized hybrid nanostructures were dispersed in a water-ethylene glycol mixture to prepare stable nanofluids with enhanced heat transfer characteristics. The morphology, microstructure, phase composition, and thermal conductivity of the AgNP-Gr nanofluids were systematically characterized using various analytical techniques. The results confirmed the successful decoration of uniformly distributed silver nanoparticles on the graphene surface, forming a hybrid conductive network that promoted efficient heat transport.

Thermal conductivity measurements revealed that the AgNP-Gr nanofluids exhibited significantly higher thermal conductivity than nanofluids containing either pristine graphene nanoplatelets or silver nanoparticles alone at the same particle concentration. The enhanced thermal performance can be attributed to the synergistic effect between the high intrinsic thermal conductivity of graphene and the excellent electron transport capability of silver nanoparticles, which together facilitate the formation of effective heat-conduction pathways within the base fluid.

Furthermore, the homogeneous dispersion of the hybrid nanostructures contributed to improved stability and heat transfer efficiency. These findings demonstrate that AgNP-Gr hybrid nanofluids are promising advanced heat-transfer media for thermal management systems, heat exchangers, electronic cooling devices, and other energy-related applications requiring superior thermal conductivity.

Keywords: graphene; silver nanoparticles; AgNP-graphene hybrid material; nanofluids; thermal conductivity

3.72-P [126]: Effect of component ratio on the thermochromic behavior of a CVL/BPA/1-Tetradecanol Leuco dye system

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Abstract:

In this study, a thermochromic leuco dye material based on crystal violet lactone (CVL), bisphenol A (BPA), and 1-tetradecanol (TD) as the solvent was prepared and evaluated. FTIR and Raman spectroscopic analyses confirmed the presence of characteristic functional groups in the leuco dye system. The obtained material exhibited a distinct color transition from dark blue at room temperature to nearly colorless upon heating. Colorimetric analysis showed that the color difference increased markedly within the temperature range of

approximately 29.5–34.5 °C, while no significant further color change was observed above 35 °C. This transition range is close to the melting range of pure TD, approximately 36–39 °C, suggesting that the solid–liquid phase transition of the solvent contributes to the thermochromic response. The effects of the mass ratio of the three components, expressed as wCVL:wBPA:wTD, on the thermochromic behavior were investigated using CIE Lab* color parameters. The strongest thermochromic response was obtained at a mass ratio of 1.5:3:60, indicating that the balance among the color former, color developer, and solvent plays an important role in achieving high color contrast. Overall, the results indicate that the thermochromic behavior of the CVL/BPA/TD system can be effectively tuned by adjusting the component ratio. This formulation approach provides a basis for developing temperature-responsive materials for smart labels, temperature-indicating packaging, security printing, and functional coating applications.

Keywords: thermochromic material; leuco dye; color transition; CVL/BPA/TD system

3.73-P [129]: Synthesis of Fe₃O₄/C Composites via Pyrolysis for Energy Storage Applications

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Abstract:

Fe₃O₄/carbon (Fe₃O₄/C) composite materials were synthesized via a pyrolysis method as potential electrode materials for energy storage applications. The composites were prepared by mixing Fe₃O₄ nanoparticles with glucose at different mass ratios, followed by heat treatment at 700 °C under an Ar atmosphere. Their structural, morphological, and electrochemical properties were investigated using X-ray diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM), cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), and galvanostatic charge–discharge (GCD) measurements. XRD patterns confirmed the retention of the crystalline Fe₃O₄ phase after pyrolysis, while Raman spectra revealed the characteristic D and G bands of carbon, indicating successful carbonization of glucose. SEM observations showed that carbon incorporation reduced particle agglomeration and improved particle uniformity. Electrochemical measurements demonstrated that carbon modification enhanced the electrochemical performance of Fe₃O₄ electrodes by improving conductivity and reducing charge-transfer resistance. Among the investigated samples, the Fe₃O₄/C electrode with a Fe₃O₄ to glucose mass ratio of 4:1 exhibited the best electrochemical performance.

Furthermore, the addition of K₂S to the electrolyte improved the redox reversibility and cycling stability of the electrodes. The optimized Fe₃O₄/C electrode delivered a discharge capacity of approximately 620 mAh g⁻¹ at the second cycle and retained about 400 mAh g⁻¹ after 50 cycles. These results suggest that Fe₃O₄/C composites synthesized via pyrolysis are promising electrode materials for energy storage applications.

Keywords: Fe₃O₄/C composites; Pyrolysis; Carbon modification; Energy storage; Fe–air battery

3.74-P [132]: Effect of Silver Nanoparticles on the Microstructure, Thermal Properties, and Antibacterial Performance of PETG Filaments for FDM Printing

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Abstract:

AgNPs/PETG composite filaments were successfully fabricated for fused deposition modeling (FDM) 3D printing applications. In this study, submicron silver nanoparticles (AgNPs, ~0.2 μm) were incorporated into a polyethylene terephthalate glycol (PETG) matrix using a dichloromethane (DCM)-assisted mixing process. Two composite formulations containing 1 wt.% and 2 wt.% AgNPs were prepared and subsequently extruded into filaments with an average diameter of approximately 1.75 mm. The extrusion quality, microstructure, thermal behavior, and antibacterial performance of the resulting filaments were characterized using scanning electron microscopy (SEM), energy-dispersive spectroscopy (EDS), differential scanning calorimetry (DSC), and antibacterial testing against *Escherichia coli* ATCC 25922. The results demonstrated that the AgNPs/PETG composite filaments exhibited good extrudability and enhanced thermal properties compared with PETG. However, partial nanoparticle agglomeration was observed, which likely contributed to the limited antibacterial activity achieved under the current processing conditions.

Nevertheless, the successful fabrication of AgNPs/PETG composite filaments highlights their potential for future applications in functional, antimicrobial, and biomedical products manufactured through FDM technology.

Keywords: AgNPs; PETG; FDM; Biomedical

3.75-P [133]: Porous Nanocarbon as a Functional Additive for Enhancing Thermoelectric Performance of n-type Skutterudites

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Abstract:

We investigated the effects of incorporating nanocarbon (NC) and porous nanocarbon (PNC) on the thermoelectric properties of n-type $\text{Yb}_{0.2}\text{Co}_4\text{Sb}_{12}$ skutterudite (N-SKD).

N-SKD powders were prepared by induction melting and melt spinning, followed by high-energy ball milling with carbon additives and spark plasma sintering to fabricate bulk composites. Microstructural analysis confirmed the uniform distribution of the carbon additives within the skutterudite matrix.

The incorporation of NC introduced an energy-filtering effect at the N-SKD/carbon interfaces, leading to an enhanced Seebeck coefficient and optimized electrical transport properties. To further improve thermoelectric performance, PNC was employed as an additive. The N-SKD/0.01 wt% PNC composite exhibited electrical transport properties comparable to those of the NC-added sample while showing reduced

lattice thermal conductivity due to enhanced phonon scattering by the porous structure. As a result, the N-SKD/0.01 wt% PNC composite achieved a maximum ZT of 1.50 at 716 K. These results demonstrate that porous nanocarbon is an effective additive for simultaneously optimizing electrical transport and reducing lattice thermal conductivity, thereby enhancing the thermoelectric performance of skutterudites for mid-temperature applications.

Keywords: Thermoelectric; Skutterudite; Porous nanocarbon

3.76-P [134]: STUDY ON TITANIUM DIOXIDE THIN FILM CAPPED SnO_2/Pt GAS-SENSING MATERIALS TO MODIFY GAS SELECTIVITY FOR MULTI-SENSOR APPLICATIONS

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Abstract:

Metal Oxide Semiconductor (MOS) gas sensors have been widely studied for safety monitoring and leak detection. In this work, we investigate the influence of TiO_2 thin film filtering layers on the sensing performance of SnO_2/Pt MOS gas sensors toward multi-sensor array applications. TiO_2 layers are deposited of three thickness – 25, 50, and 130 (nm) onto SnO_2/Pt sensing films via DC sputtering methods.

Fabricated sensors then were evaluated against five target gases (H_2 , NH_3 , C_2H_4 , LPG, and H_2S) at operating temperatures ranging from 150 °C to 350 °C. Our results indicate that the TiO_2 overlayer acts as a selective diffusion barrier, modulating the surface depletion layer of the SnO_2/Pt heterostructure in a thickness- and analyte-dependent manner. We found that TiO_2 coverage shifts the optimal H_2 response temperature from 250 °C to 300 °C (the response value at 100ppm at 250 °C is over 100 times, while at 300 °C, it is more approximately 70 times), where the 50 nm overlayer yields the highest sensitivity.

For NH_3 , the response increases monotonically with temperature and becomes thickness-invariant at 300 °C, suggesting uniform analyte flux through the TiO_2 barrier.

C_2H_4 and LPG responses remain too low for reliable selective discrimination. Most notably, the 50 nm capped sensor produces a distinctly anomalous chemiresistive signature for H_2S , revealing strong analyte-specific selectivity.

Keywords: Tin-oxide; platinum; titanium dioxide; thin film; gas sensor; multi-sensor; selectivity; hydrogen; ammonia; ethylene; lpg; hydrogen sulfide

3.77-P [142]: Enhanced Visible-Light Photodegradation of Textile Dyes via Synergistic $\text{SnO}_2/\text{BiOCl}_{0.5}\text{Br}_{0.5}$ -Persulfate System

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Abstract:

SnO₂/BiOCl_{0.5}Br_{0.5} composite photocatalyst was successfully synthesized via a combination of sol–gel and precipitation methods. The structural, morphological, and optical properties of the obtained materials were systematically characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), and UV–vis diffuse reflectance spectroscopy. The characterization results confirmed the successful formation of the heterostructured composite, in which BiOCl_{0.5}Br_{0.5} was uniformly deposited on the surface of SnO₂ particles, providing intimate interfacial contact between the two materials. The photocatalytic performance of the synthesized materials was evaluated through the degradation of Rhodamine B (RhB) under visible-light irradiation. The SnO₂/BiOCl_{0.5}Br_{0.5} composite exhibited moderate photocatalytic activity in the absence of persulfate (PS). However, the introduction of PS significantly enhanced the degradation efficiency, demonstrating the strong synergistic effect between photocatalysis and persulfate activation. The degradation performance was found to be highly dependent on the PS concentration, and an optimal PS dosage resulted in a degradation rate more than ten times higher than that obtained without PS. In addition, the solution pH played a crucial role in the photocatalytic process. The enhanced photocatalytic activity was attributed to the synergistic interaction between the SnO₂/BiOCl_{0.5}Br_{0.5} heterostructure and persulfate, which facilitated charge separation and promoted the generation of highly reactive oxidative species, particularly sulfate radicals. These results demonstrate that the SnO₂/BiOCl_{0.5}Br_{0.5}/PS system is a promising visible-light-driven advanced oxidation process for the efficient removal of organic contaminants from wastewater.

Keywords: SnO₂/BiOCl_{0.5}Br_{0.5}; Persulfate; Photocatalysis; Textile dye degradation; Sulfate radicals

3.78-P [143]: ZnS/WS₂ Heterostructures Prepared by Hydrothermal Method: Structure, Morphology and Optical Properties

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Abstract:

In this study, a ZnS/WS₂ heterostructure was successfully synthesized via a hydrothermal method. ZnS particles were formed on the surface of WS₂ flowers, creating a heterojunction interface favorable for charge transfer. The crystal structure of the samples was investigated by X-ray diffraction (XRD), which confirmed the coexistence of ZnS and WS₂ phases without the presence of any impurity phases, indicating the successful formation of the heterostructure.

The surface morphology and microstructure of the material were examined using scanning electron microscopy (SEM), revealing that ZnS particles were relatively uniformly distributed on the surface of the WS₂ flowers, thereby increasing the interfacial contact area between the two phases. The optical properties of the material were evaluated by photoluminescence (PL) spectroscopy. The results showed that the PL intensity of the ZnS/WS₂ sample was significantly lower than that of pure ZnS, indicating efficient electron-hole separation and reduced radiative recombination due to the formation of the heterostructure.

The obtained results demonstrate that coupling ZnS with WS₂ is an effective strategy for improving the optoelectronic properties of the material. The ZnS/WS₂ heterostructure exhibits promising potential for applications in environmental photocatalysis and gas sensing.

Keywords: ZnS/WS₂; heterostructure; hydrothermal synthesis; gas sensing; photocatalysis

3.79-P [145]: Optical Property Comparison of ZnO/MoS₂ and ZnS/MoS₂ hybrid systems prepared by multiple synthesis methods

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Abstract:

This study focuses on methodologies for investigating oxygen-related defects during the fabrication of ZnO/MoS₂ and ZnS/MoS₂ hybrid materials using hydrothermal, evaporation, and high-energy ball milling methods. The optical properties of the hybrid systems were analyzed through photoluminescence measurements in the visible and near-ultraviolet (NUV) regions. The results indicate that the synthesis methodology significantly influences oxygen- and Zn-related defect formation, as well as interfacial interactions with MoS₂, leading to variations in optical emission behavior. X-ray diffraction (XRD) and scanning electron microscopy (SEM) were used to characterize the crystal structure and morphology of the synthesized materials. The comparative analysis provides insight into defect modulation and optical responses in ZnO/MoS₂ and ZnS/MoS₂ hybrid systems.

Keywords: ZnS/MoS₂; ZnO/MoS₂; optical property; Oxygen-related defects

3.80-P [147]: Microanalysis and Electrochemical behavior of Zn-Bi Alloys in Zinc-Air Battery anode

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Abstract:

Zinc has potential for wider application as an electrode material in Zn-air batteries. Alloying zinc with small amounts of bismuth has been reported to suppress hydrogen evolution reactions and improve the electrochemical performance of the anode. Bismuth, being immiscible in the zinc matrix, segregates as a secondary phase at grain boundaries and acts as a preferential site for hydrogen evolution, thereby reducing parasitic self-corrosion of the zinc anode. This study investigates the effect of bismuth (Bi) addition on the microstructure and electrochemical performance of Zn-xBi alloy anodes (where x = 0.1, 0.5, 1.0, 3.0, and 5.0 wt.%) for Zn-air battery applications.

The alloys were prepared by melting and gravity casting at 700 °C. Phase identification by X-ray diffraction (XRD) confirmed a single-phase hexagonal close-packed (HCP) Zn structure at low Bi contents. In contrast,

a secondary rhombohedral Bi phase appeared and intensified with increasing Bi addition. Scanning electron microscopy with backscattered electron imaging (SEM–BSE) revealed that fine, uniformly dispersed Bi-rich precipitates formed at moderate Bi contents, whereas coarse phase segregation was observed at 5.0 wt.%Bi. Potentiodynamic polarization in 6 M KOH showed corrosion potentials in the range of –1.52 to –1.57 V vs. SCE for all compositions. The Zn–1.0 wt.%Bi alloy exhibited the highest polarization resistance ($\sim 971 \Omega$) and the lowest corrosion current density ($\sim 15.3 \mu\text{A}/\text{cm}^2$), attributed to its fine, homogeneous microstructure. Zn-air battery discharge testing demonstrated an open-circuit voltage of approximately 1.6 V across all compositions, with the Zn–1.0 wt.% Bi anode delivering the highest peak power density of 38 mW/cm². These results indicate that Zn–1.0 wt.%Bi is a promising anode material that offers optimal corrosion suppression and battery performance for Zn-air battery applications.

Keywords: Zinc-bismuth alloy; Zn-air battery; Anode material; Potentiodynamic polarization

3.81-P [149]: An Archimedean spiral turbine-based hybrid triboelectric-electromagnetic nanogenerator for wind energy harvesting

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Abstract:

Urban wind energy harvesting faces persistent challenges due to low wind speeds, high turbulence intensity, and omnidirectional flow variability, which limit the effectiveness of conventional horizontal-axis wind turbines. This study presents the design, fabrication, and characterization of a compact hybrid energy-harvesting system that integrates an Archimedean spiral wind turbine with a coupled triboelectric nanogenerator (TENG) and an electromagnetic generator (EMG). Two rotor configurations were evaluated; the optimized geometry (AT₀₂) achieved a lower cut-in wind speed and favorable aerodynamic performance across the 2.6–8 m/s urban wind range. The TENG module operates in a freestanding rotary mode, utilizing triboelectric layers fabricated via electrospinning.

Evaluation of various functional layer materials identified electrospun PVC nanofibrous as the optimal dielectric.

Incorporating ZnO nanoparticles into the PVC matrix produced a nanocomposite with enhanced tensile strength while preserving comparable electrical output, indicating a viable strategy for improving mechanical durability. In the hybrid configuration, the EMG dominated at higher wind speeds, while the TENG served as a complementary energy source at low speeds. The synergistic effect enables a more stable power output across varying wind conditions. These results demonstrate the feasibility of the hybrid TENG-EMG transducer integrated with an Archimedean spiral rotor for small-scale urban wind energy harvesting.

Keywords: Green-energy harvesting; Hybrid triboelectric nanogenerators; Archimedean turbine; Electrospun nanofiber

3.82-P [153]: Pyrene-Based Molecular Modification of WS₂ for van der Waals Heterojunction Interfaces

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Abstract:

Two-dimensional transition metal dichalcogenides (TMDs) are promising platforms for constructing van der Waals heterojunctions through noncovalent surface modification.

In our previous studies, the surface modification of MoS₂ with anthracene-based modifiers enabled the formation of long-lived charge-separated states,[1] whereas related hybrids composed of MoSe₂ and C₆₀ dendrons were applied to photocatalytic hydrogen evolution via photoinduced electron-transfer processes.[2] These findings indicate that the molecular design of surface modifiers with strong interfacial interactions is crucial for controlling the photophysical properties of TMD-based nanohybrids. In this study, we designed and synthesized new pyrene derivatives as surface modifiers for WS₂, because only a limited number of studies have reported the adsorption of pyrene on WS₂. [3,4] Pyrene derivatives are expected to exhibit stronger affinity for WS₂ than anthracene- or C₆₀-based derivatives, thereby facilitating surface modification and enabling more effective control of the photophysical properties of WS₂-based nanohybrids. The synthesis of the newly designed pyrene derivatives is shown in Figure 1. After confirming their molecular structures, we prepared WS₂/pyrene nanohybrids by wet processing, following our previously reported procedures.[1,2] The structural characterization and photophysical properties of the resulting WS₂/pyrene van der Waals heterojunctions were then investigated.

Keywords: Nanohybrid; Transition metal dichalcogenide; TMD; Heterojunction; Pyrene; Photoinduced electron transfer

3.83-P [155]: Fabrication of Ag/rGO composite as effective conductive ink filler via green synthesis using plant extracts

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Abstract:

Metal-polymer/graphene composites have attracted significant attention in electronic and energy-related applications due to their outstanding electrochemical activity, high electrical conductivity, mechanical robustness, and excellent processability. Among them, conductive inks based on graphene/rGO and metal nanoparticles offer great potential for flexible and high-performance electronic devices by combining superior conductivity with enhanced stability and flexibility.

Nevertheless, the scalable and environmentally friendly synthesis of graphene-based materials and metal nanoparticles, particularly Ag nanoparticles, for the fabrication of low-cost, good dispersivity and high-quality conductive inks remains a critical challenge. Green synthesis is a sustainable, cost-effective method for nanomaterial production that uses plant extracts, bacteria, or fungi to replace toxic chemicals. Many extracts from the plants have been successfully used as green reductants for this purpose. In this work, we

report a simple, inexpensive, and eco-friendly protocol for the preparation of silver-reduced graphene oxide nanocomposites (Ag/rGO) using *Cleistocalyx operculatus* leaves extract as a reductant. The obtained Ag/graphene nanocomposite were characterized by transmission electron microscopy (TEM), energy dispersive spectroscopy mapping (EDX mapping), X-ray diffraction (XRD), UV-Vis spectroscopy and fourier transform infrared spectroscopy (FTIR). A pronounced surface plasmon resonance (SPR) band observed in the UV-visible spectrum of the Ag/rGO nanocomposite, centered around 400 nm, confirms the characteristic plasmonic behavior of Ag nanoparticles. The obtained results reveal that Ag nanoparticles (AgNPs), with sizes ranging from 10–20 nm, are uniformly dispersed and firmly anchored on the surface of the rGO nanosheets, which served as one of promising conductive ink fillers for printable flexible electronics.

Keywords: Ag nanoparticles; Reduced graphene oxide (rGO); Conductive ink; Green synthesis; *Cleistocalyx operculatus* leaves extract

Acknowledgments: This research is funded by Vinh University.

3.84-P [157]: Enhanced Hydrogen Evolution Reaction Kinetics Using Advanced Heterostructured Cobalt-Copper Phosphide Nanorods Supported on a Three-Dimensional Foam

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Abstract:

The sluggish reaction kinetics and the high cost of noble-metal-based electrocatalysts remain major challenges for large-scale hydrogen generation through electrochemical water splitting. Herein, advanced heterostructured cobalt-copper phosphide (Co-Cu-P) nanorods supported on a three-dimensional foam substrate were successfully fabricated through a facile synthesis strategy. The unique heterostructure combines the favorable hydrogen adsorption characteristics of cobalt phosphide with the enhanced electronic conductivity induced by copper incorporation, leading to accelerated charge-transfer kinetics and improved intrinsic catalytic activity. In addition, the vertically aligned nanorod architecture provides abundant exposed active sites and short ion diffusion pathways, while the three-dimensional foam framework offers a highly conductive network and open porous channels for efficient electrolyte penetration and rapid gas release. Therefore, the Co-Cu-P nanorod catalyst exhibits remarkable hydrogen evolution performance with a low 83.7 mV at 10 mV cm⁻², small Tafel slope 120.2 mV dec⁻¹, and rapid charge-transfer characteristics in alkaline electrolyte. Furthermore, the catalyst demonstrates outstanding long-term durability and electrochemical stability under continuous operation for 50 h. This work provides an effective strategy for designing high-performance transition-metal phosphide electrocatalysts and highlights the great potential of heterostructured Co-Cu-P nanomaterials for next-generation hydrogen production technologies.

Keywords: Co-Cu-P; Hydrogen evolution reaction; Heterostructure; Electrocatalysis; Nanorods

Acknowledgement: This work was supported by the Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 103.02-2025.122.

3.85-P [159]: Sol–Gel Synthesis, Structural Characterization, and Photoluminescence Properties of TCP:Eu³⁺ Phosphor

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Abstract:

Tricalcium phosphate materials doped with Eu³⁺ ions (TCP:Eu³⁺) were successfully synthesized via the sol–gel method followed by heat treatment. The effects of key synthesis parameters, including calcination temperature, Eu³⁺ doping concentration, and pH, on phase formation, morphology, and photoluminescent properties were systematically investigated. The crystalline structure and elemental composition were characterized by X-ray diffraction (XRD) and energy-dispersive X-ray spectroscopy (EDX), respectively. The morphology of the samples was examined using scanning electron microscopy (SEM). Upon excitation at 270 nm và 394 nm, the TCP:Eu³⁺ phosphors exhibited a strong red emission centered at approximately 610 nm, corresponding to the ⁵D₀ → ⁷F₂ transition of Eu³⁺ ions. The emission intensity was strongly influenced by the synthesis conditions, with optimal parameters leading to enhanced luminescence efficiency due to improved crystallinity and uniform dopant distribution. These results demonstrate that TCP:Eu³⁺ phosphors synthesized via the sol–gel method are promising multifunctional materials for fluorescent forensic detection and related biomedical applications.

Keywords: Keywords:; TCP:Eu³⁺; sol – gel; fluorescent powder

3.86-P [160]: Optical thermometry based on energy transfer between Tb₃₊ and Eu₃₊ ions in LaF₃ nanophosphors

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Abstract:

Tb₃₊/Eu₃₊ co-doped LaF₃ luminescent nanoparticles were synthesized via a simple co-precipitation method. The crystal structure, morphology, and luminescence properties of the obtained samples were studied using X-ray diffraction (XRD), transmission electron microscopy (TEM), EDX spectroscopy, and luminescence spectroscopy (PL). XRD results confirmed the formation of a phase LaF₃ hexagonal structure. TEM observations showed the nanoparticles to be nearly cubic with sizes ranging from approximately 30 to 50 nm.

Under 360 nm excitation, the luminescent particles exhibited characteristic emission of both Tb^{3+} and Eu^{3+} ions. The strong green emission at 542 nm is attributed to the Tb^{3+} ($^5\text{D}_4\text{-}^7\text{F}_5$) transition, while the strong orange-red emission concentrated at 591 and 618 nm originates from the Eu^{3+} ($^5\text{D}_0\text{-}^7\text{F}_1$ and $^5\text{D}_0\text{-}^7\text{F}_2$) transitions. The enhanced Eu^{3+} emission along with the simultaneous presence of Tb^{3+} luminescence suggests an efficient energy transfer process between Tb^{3+} and Eu^{3+} ions in the LaF_3 host matrix.

The fluorescence intensity ratio (FIR) technique was applied using the non-thermally coupled transitions of Tb^{3+} and Eu^{3+} . This luminescent material exhibits the maximum relative sensitivity (Sr) of 2.5% K^{-1} at 303 K.

Keywords: LaF_3 nanoparticles; Eu^{3+} luminescence; co-doping; optical thermometry; non-thermally coupled

3.87-P [169]: Carbonation Behavior of Black Mass Recovered from NCM-Based Spent Lithium-ion Batteries by $\text{CO}_2(\text{g})$

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Abstract:

The rapid growth in lithium-ion battery (LIB) demand has driven interest in developing efficient recycling processes to recover valuable metals from spent LIBs. In this study, NCM-based black mass (B/M) powder, consisting of cathode active materials, graphite anode material (C), and impurities including Al, was used as the starting material. As a fundamental study for the selective separation and recovery of Li, isothermal roasting experiments were conducted in a CO_2 atmosphere (500–1,000 °C, p_{CO_2} = 0.1–0.5 atm). The reduction behavior of the cathode materials was investigated through thermogravimetric analysis (TGA) and off-gas analysis.

Li_2CO_3 formation was observed under all tested conditions. A peak Li recovery of 99.4% was achieved at approximately 730 °C under p_{CO_2} = 0.5 atm. However, above ~800 °C, the recovery progressively declined due to the formation of insoluble LiAlO_2 from reactions between Li_2CO_3 and Al impurities. At temperatures exceeding ~860 °C, the Boudouard reaction became prominent, resulting in rapid CO evolution. Concurrently, Ni and Co oxides were reduced by CO and residual carbon, contributing to a sharp drop in sample mass. While higher CO_2 partial pressure accelerated the Boudouard reaction kinetics, it had a negligible effect on the final degree of reduction. Therefore, the results indicate the need for optimized roasting conditions and Al impurity removal during pre-treatment to maximize Li recovery.

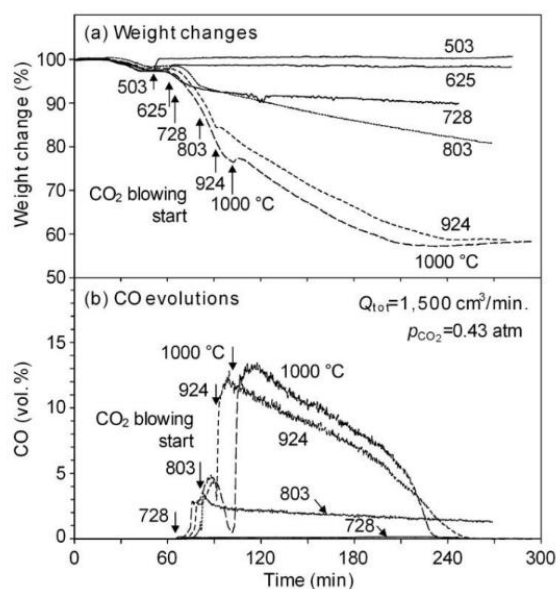


Fig. 1. Weight changes and CO evolution during isothermal roasting at $p_{\text{CO}_2} = 0.43$ atm.

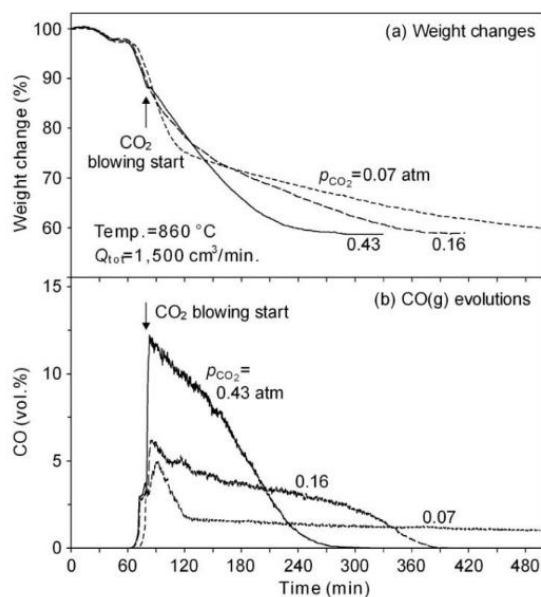


Fig. 2. Weight changes and CO evolution during isothermal roasting at 860 °C.

Keywords: spent Li-ion battery; carbonation; black mass; thermogravimetric analysis; Boudouard reaction

3.88-P [173]: Electrochemical Investigation of NiCoFe Co-deposition in an Ethylene Glycol-Based Non-aqueous Electrolyte

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Abstract:

Medium entropy alloys have attracted considerable attention owing to their unique physicochemical and functional properties. In this study, the electrochemical co-deposition behavior of a NiCoFe system was investigated in an ethylene glycol-based non-aqueous electrolyte containing Ni^{2+} , Co^{2+} , and Fe^{3+} ions. Cyclic voltammetry was employed to examine the electrochemical characteristics of the mixed electrolyte on a glassy carbon electrode. The obtained voltammograms exhibited broad and overlapping redox responses, indicating simultaneous electrochemical interactions among the metallic species during the co-deposition process. Scan-rate-dependent studies revealed a linear relationship between the cathodic peak current density and the square root of the scan rate, suggesting that the electrodeposition process is predominantly diffusion-controlled. Based on the cyclic voltammetry results, NiCoFe deposits were subsequently prepared on Cu substrates using chronoamperometry. The combined cyclic voltammetry and chronoamperometry analyses demonstrate the feasibility of electrochemical co-deposition of the NiCoFe system from an ethylene glycol-based electrolyte and provide insights into its deposition mechanism.

Keywords: Ni-Co-Fe system; Electrochemical behavior; Co-electrodeposition; Non-aqueous electrolyte; Cyclic voltammetry

3.89-P [174]: Electrochemical Investigation of Electrodeposited FeCo Thin Films in NaCl Electrolyte

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Abstract:

Iron and cobalt are earth-abundant transition metals that exhibit diverse electrochemical properties and are of significant interest for energy and electrochemical applications. In this study, FeCo thin films were prepared by electrodeposition, and their electrochemical behavior was investigated in a 50 mM NaCl electrolyte. Cyclic voltammetry was employed to examine the redox characteristics of the deposited films, while chronoamperometry was used to evaluate their electrochemical response under constant applied potentials.

The cyclic voltammetry profiles revealed distinct oxidation and reduction processes associated with the electrochemical activity of FeCo in chloride-containing media.

Scan-rate-dependent measurements provided insights into the charge-transfer and mass-transport processes occurring at the electrode/electrolyte interface. Comparative analysis of the cyclic voltammetry and chronoamperometry results highlighted differences in the electrochemical behavior of FeCo thin films. The findings contribute to a better understanding of the electrochemical characteristics of transition-metal electrodes in NaCl electrolytes and provide a basis for their potential application in electrochemical systems.

Keywords: FeCo thin film; Electrodeposition; Cyclic voltammetry; Chronoamperometry; NaCl electrolyte

3.90-P [175]: Effects of Current Density and Heat Treatment on the Composition, Crystal Structure, and Magnetic Properties of Electrodeposited Ni-Fe Soft Magnetic Alloy Films

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Abstract:

With the miniaturization and increasing integration of electromagnetic devices, the demand for soft magnetic thin films with low coercivity and excellent magnetization characteristics has continued to increase. Ni-Fe permalloy is a representative soft magnetic alloy with potential applications in magnetic sensors, magnetic shielding films, and micro-electromagnetic devices. In this study, Ni-Fe alloy films with a thickness of approximately 8 μm were electrodeposited on Cu substrates, and the effects of current density (1.0 – 3.0 A/dm²) and heat treatment at 370°C for 2 h under high vacuum on their composition, crystal structure, and magnetic properties were investigated.

X-ray fluorescence (XRF) analysis revealed that the Fe content increased from 16.06 to 19.20 wt.% as the current density increased. This behavior was attributed to the anomalous codeposition characteristic of electrodeposited Ni-Fe alloys. Vibrating sample magnetometer (VSM) analysis showed that the film deposited at 2.5 A/dm² exhibited the lowest coercivity before heat treatment, with a value of 13.29 Oe. After heat treatment, the coercivity of the film deposited under the same condition decreased to 9.25 Oe, indicating

the most favorable soft magnetic behavior among the investigated samples. X-ray diffraction (XRD) analysis confirmed an increase in crystallite size and changes in the crystal structure after heat treatment, which are considered to contribute to stress relaxation and enhanced domain-wall motion. However, an increase in coercivity after heat treatment was observed under several current-density conditions, suggesting that the effect of heat treatment depends on the alloy composition and initial microstructure of the electrodeposited film.

These results demonstrate that the magnetic properties of electrodeposited Ni-Fe soft magnetic films can be effectively controlled through current density and heat-treatment conditions. Furthermore, optimization of the electrodeposition process requires consideration of the combined effects of alloy composition and microstructural evolution.

Keywords: Ni-Fe alloy; Soft magnetic thin film; Electrodeposition; Permalloy; Coercivity

3.91-P [178]: Synthesis of red-emitting fluorescent powder $\text{BaAl}_2\text{O}_4\text{:Eu}^{3+}$ for fingerprint detection applications

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Abstract:

$\text{BaAl}_2\text{O}_4\text{:Eu}^{3+}$ phosphors were synthesized via a sol-gel method to develop a stable orange-red emitting material with potential applications in luminescent imaging and latent fingerprint detection. X-ray diffraction analysis confirmed the successful formation of the BaAl_2O_4 phase, with crystallinity significantly improving as the calcination temperature increased. The photoluminescence excitation spectrum exhibited a broad charge-transfer band in the ultraviolet region associated with the $\text{O}^{2-} \rightarrow \text{Eu}^{3+}$ transition, together with several characteristic intra-4f excitation peaks of Eu^{3+} , with the strongest excitation located at 393 nm. Under 393 nm excitation, the phosphor showed intense orange-red emission with characteristic peaks centered at approximately 590, 616 and 700 nm, corresponding to the $^5\text{D}_0 \rightarrow ^7\text{F}_1$, $^5\text{D}_0 \rightarrow ^7\text{F}_2$ and $^5\text{D}_0 \rightarrow ^7\text{F}_4$ transitions, respectively. The emission intensity reached a maximum at an Eu^{3+} concentration of 0.8 mol%, followed by a decrease at higher concentrations due to concentration quenching. Time-resolved photoluminescence measurements further confirmed the concentration-dependent competition between radiative and non-radiative relaxation processes.

The CIE chromaticity coordinates of approximately (0.60, 0.40) indicate stable orange-red emission with good color purity. In addition, the synthesized $\text{BaAl}_2\text{O}_4\text{:Eu}^{3+}$ phosphor demonstrated excellent performance in latent fingerprint visualization under UV illumination, clearly revealing ridge patterns and fine fingerprint details with high contrast. These findings highlight the potential of $\text{BaAl}_2\text{O}_4\text{:Eu}^{3+}$ as a promising red-emitting phosphor for solid-state lighting and forensic fingerprint detection applications.

Keywords: Eu^{3+} ions; $\text{BaAl}_2\text{O}_4\text{:Eu}^{3+}$; fingerprint; red-emitting

3.92-P [181]: Sustainable Fabrication of Oil/Water Separation Membranes from Electronic Packaging Polystyrene Waste via Electrospinning

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Abstract:

Waste expanded polystyrene (ePS) derived from electronic packaging was recycled into nanofibrous membranes for oil/water separation via electrospinning. PS waste was dissolved in a mixture of N,N-dimethylformamide (DMF)/tetrahydrofuran (THF) solvents. The effects of solution concentration and applied voltage on fiber morphology were investigated. Electrospinning was conducted at solution concentrations of 10–15 wt%, applied voltages of 15–20 kV, and a fixed tip-to-collector distance of 20 cm. The optimized conditions were obtained using a 1:1 ratio of DMF to THF, a PS concentration of 15%, and a voltage of 20 kV. Under these conditions, the electrospinning process produced smooth, uniform nanofibers without beads or defects. SEM images showed that the fibers had an average diameter in the range of 600 to 900 nm.

Water contact angle measurements confirmed the hydrophobicity of the membrane, indicating its suitability for selective oil absorption and oil/water separation. The results demonstrate that electronic packaging waste can be converted into functional separation membranes through a simple electrospinning process, thereby providing a promising route for simultaneous plastic waste reutilization and oily wastewater treatment.

Keywords: Electrospinning; waste expanded polystyrene; oil/water separation

3.93-P [184]: Influence of Annealing Time on the Characterization of Sb₂S₃ Thin Films

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Abstract:

Antimony triselenide (Sb₂Se₃) thin films were successfully fabricated by magnetron sputtering at room temperature, followed by post-annealing in a selenium atmosphere. The as-deposited films were annealed at 320 °C for different durations ranging from 0 to 30 minutes to investigate the influence of annealing time on their structural, optical, and electrical properties. The crystal structure was characterized by X-ray diffraction (XRD), surface morphology was examined using scanning electron microscopy (SEM), electrical properties were evaluated through Hall-effect measurements, and optical properties were analyzed by photoluminescence (PL) spectroscopy. The as-deposited Sb₂Se₃ thin films exhibited an amorphous structure, while their crystallinity improved significantly with increasing annealing time. The optimal annealing condition was found to be 320 °C for 20 minutes. Under this condition, the films showed enhanced crystallinity and improved crystal quality. Furthermore, the crystallite size increased markedly, reaching several hundred nanometers.

These structural improvements were accompanied by favorable changes in the optical and electrical properties of the films. The results demonstrate that annealing time plays a crucial role in determining the crystallinity and optoelectronic properties of Sb₂Se₃ thin films. The optimized films exhibit promising potential as absorber layers for photovoltaic and solar cell applications

Keywords: Sb₂Se₃ thin films; RF-magnetron sputtering method; absorber layer; annealing time

3.94-P [189]: Entropy-Stabilized Oxide/MXene Interfaces for Aqueous Zinc-Ion Batteries: A Functional Materials Framework for Durable Energy Storage

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Abstract:

Aqueous zinc-ion batteries are attractive candidates for stationary storage because zinc is abundant, inexpensive, and compatible with non-flammable electrolytes, yet their practical deployment remains constrained by cathode dissolution, sluggish Zn²⁺ diffusion, dendritic zinc growth, and parasitic hydrogen evolution. This paper develops a functional materials framework for entropy-stabilized high-entropy oxide/MXene interfaces as durable electrode and interphase architectures for aqueous zinc-ion batteries. The research object is the coupled oxide–MXene interface in which multi-principal-element oxide lattices provide configurational disorder, lattice distortion, redox multiplicity, and defect-tolerant hosts, while MXenes contribute electronic conductivity, surface functionality, and ion-transport pathways. The study is bounded to peer-reviewed literature published from 2021 to 2026 on high-entropy oxides, MXene-mediated zinc storage, aqueous zinc battery electrolytes, and interface engineering. Using a structured review and mechanism-mapping methodology, the paper synthesizes evidence into four design axes: entropy-stabilized phase selection, oxygen-vacancy and valence engineering, conductive two-dimensional interfacial scaffolding, and solvation-aware electrode/electrolyte coupling. The analysis shows that high-entropy oxide/MXene composites are best understood not as simple capacity-enhancing additives but as adaptive interfaces capable of distributing strain, moderating Zn²⁺ adsorption energy, suppressing active-material dissolution, and bridging ionic and electronic transport. However, unresolved issues remain, including phase-purity verification, MXene oxidation, scalable low-temperature synthesis, and inconsistent reporting of practical metrics. The paper recommends an integrated protocol combining CALPHAD or machine-learning screening, operando spectroscopy, standardized lean-electrolyte testing, and life-cycle-aware materials selection to accelerate translation from laboratory cells to robust, sustainable zinc-based energy-storage devices, particularly for grid applications requiring safety, cost discipline, long service life, and resilience under variable conditions.

Keywords: Aqueous zinc-ion batteries; High-entropy oxides; MXenes; Sustainable energy storage; Zn²⁺ intercalation

3.95-P [190]: Investigation of the catalytic properties of metal (Pt, Ag) on Al₂O₃ support layer for SnO₂ thin films gas sensor

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Abstract:

SnO₂ based chemiresistive gas sensors have been extensively investigated owing to their high sensitivity, chemical stability, and compatibility with microfabrication technologies. In this work, Pt and Ag decorated SnO₂/Al₂O₃ thin-film sensors were fabricated on SiO₂/Si substrates by RF/DC magnetron sputtering combined with photolithography and lift-off processes. A 100 nm Al₂O₃ interlayer was incorporated to enhance oxygen adsorption and increase the density of catalytically active sites. Pt overlayers with thicknesses of 5, 12, and 40 nm and Ag overlayers with thicknesses of 1, 3, and 6 nm were deposited to investigate the influence of catalyst thickness on gas-sensing characteristics. The sensors were evaluated toward NH₃ (20–200 ppm), H₂S (1–10 ppm), and H₂ (20–200 ppm) at operating temperatures between 150 and 300 °C. Pt decoration significantly enhanced the NH₃ sensing performance, yielding a maximum response of approximately 152 toward 200 ppm NH₃, together with pronounced NH₃ selectivity. In contrast, Ag decoration preferentially improved H₂S detection, resulting in a maximum response of approximately 142 toward 10 ppm H₂S. The optimized sensors exhibited stable and repeatable performance over 11 consecutive sensing cycles. The enhanced sensing behavior is attributed to the synergistic effects of electronic sensitization induced by Schottky barrier modulation and chemical sensitization associated with oxygen spillover at the noble metal–SnO₂ interface. These findings demonstrate that catalyst thickness plays a critical role in tailoring both sensitivity and selectivity, and provide an effective strategy for the development of selective SnO₂ based gas sensors for ppm-level detection of toxic gases.

Keywords: SnO₂ thin film; Al₂O₃ support layer; noble metal decoration; chemiresistive gas sensor; NH₃ gas sensor; H₂S gas sensor

3.96-P [193]: Effect of Ru Content on the Acidic Oxygen Evolution Reaction Characteristics of Ti/Ir–Ru–Ta Mixed Oxide Electrodes

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Abstract:

Water electrolysis has attracted considerable attention as an environmentally friendly hydrogen production technology that can be integrated with renewable energy sources.

However, the oxygen evolution reaction (OER) occurring at the anode is a major factor limiting the overall efficiency of water electrolysis because of its sluggish reaction kinetics and high overpotential. In particular, proton exchange membrane water electrolysis (PEMWE), which operates under acidic conditions, requires the development of anode catalyst electrodes that simultaneously exhibit high OER activity and long-term stability. Ir-based oxides are representative catalyst materials with relatively high stability under acidic OER conditions, and the formation of mixed oxides containing Ta can contribute to improved durability of the

catalyst layer. Meanwhile, Ru-based oxides exhibit high OER activity; therefore, the incorporation of Ru into Ir–Ta mixed oxide electrodes is expected to enhance their catalytic activity.

In this study, Ir–Ru–Ta mixed oxide coatings were formed on Ti substrates by a thermal decomposition method to develop highly active acidic OER electrodes for application as PEM water electrolysis anodes. The Ru content was selected as the primary variable, while the Ir and Ta contents, coating conditions, and heat-treatment conditions were kept constant to investigate the effect of Ru composition on the characteristics of the catalyst electrodes. The surface morphology and elemental distribution of the fabricated electrodes were analyzed using scanning electron microscopy and energy-dispersive X-ray spectroscopy (SEM/EDS). Their OER catalytic activity under acidic electrolyte conditions was evaluated by linear sweep voltammetry (LSV), Tafel analysis, and electrochemical impedance spectroscopy (EIS).

In addition, chronopotentiometry (CP) was performed to compare the electrochemical stability of the electrodes with different Ru contents.

By analyzing changes in overpotential, reaction kinetic characteristics, and charge-transfer resistance as a function of Ru content, this study aimed to elucidate the effect of Ru incorporation on the acidic OER activity of Ir–Ta-based mixed oxide electrodes. This study provides a compositional design strategy for achieving an appropriate balance between activity and stability in Ir–Ru–Ta mixed oxide electrodes through optimization of the Ru content, and is expected to contribute to the development of high-performance OER catalyst electrodes for PEM water electrolysis anode applications.

Keywords: Water electrolysis; Oxygen evolution reaction; PEMWE; Ir–Ru–Ta mixed oxide; Thermal decomposition

3.97-P [198]: Thermoelectric Transport in BP/SnP₃ Composites: Reduced Thermal Conductivity with Preserved ZT

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Abstract:

Embedding metallic secondary phases into a thermoelectric matrix can modify charge and phonon transport, offering a potential route to optimize the thermoelectric figure of merit. In this work, metallic SnP₃ inclusions were formed within a Black Phosphorus (BP) matrix by adding Sn to red phosphorus during high-energy ball milling, followed by spark plasma sintering. The effects of SnP₃ inclusions on thermoelectric transport were systematically investigated.

The electrical conductivity increased from ~2600 S m⁻¹ for pristine BP to 3145 and 4554 S m⁻¹ at 300 K for composites containing 5 and 10 wt.% Sn, respectively, while the Seebeck coefficient decreased only moderately. Meanwhile, the thermal conductivity decreased throughout 300–550 K and became lower than those of both pristine BP and pure SnP₃ (~15 W m⁻¹ K⁻¹ at 300 K). This reduction is attributed to enhanced phonon scattering at the BP/SnP₃ interfaces.

Although the increase in electrical conductivity was partly offset by a reduction in the Seebeck coefficient, the simultaneous decrease in thermal conductivity preserved the overall ZT, indicating effective decoupling of electrical and thermal transport. These findings demonstrate that metallic inclusions can serve as an effective strategy for tailoring the thermoelectric performance of composite materials.

Keywords: Thermoelectric; Spark plasma sintering; Tin phosphide; Black phosphorus

3.98-P [205]: A Highly Efficient TE-Pass Mode Multiplexer on an InGaAsP/InP Platform Using an Adiabatic Tapered Directional Coupler

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Abstract:

A highly efficient TE-pass mode multiplexer is proposed and numerically investigated on an InGaAsP/InP deep-etched ridge waveguide platform. The complex refractive index of the material platform is calculated using the Tanguy model for accurate device simulation. The proposed structure employs a TE-pass filtering section, implemented by either a bent waveguide or a polarization converter, followed by an asymmetric adiabatic tapered directional coupler.

Through dispersion engineering, the phase-matching condition between the guided modes is satisfied, allowing efficient TE₀-to-TE₁ mode conversion and subsequent multiplexing with the TE₀ channel at the output. The simulated device exhibits crosstalk below -20 dB and stable operation over a 5-nm wavelength range centered at 1550 nm, while the insertion loss varies according to the adopted TE-pass filtering design.

Keywords: InGaAsP/InP waveguides; Mode-division multiplexing; Adiabatic tapered coupler

3.99-P [213]: Effect of high CO concentration toward sensing properties of α -FeOOH nanomaterials using a quartz crystal microbalance

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Abstract:

In this study, α -FeOOH nanorods (NRs) are synthesised by a simple one-step co-precipitation method with low-cost and high-performance. The gas-sensing properties of as-prepared samples were investigated by weighing the mass of a target gas using quartz crystal microbalance (QCM). The target gas in this experiment was carbon monoxide (CO) within the concentration range of 25 to 500 ppm at room temperature in dried air. The results indicated that the response and sensing mechanism of α -FeOOH NRs were significantly affected and changed when a QCM sensor coated with α -FeOOH NRs was exposed to high concentrations of CO (> 150 ppm).

In addition, the considerable influence of high CO concentration on the adsorption capacity and gas sensitivity of iron oxides in general, and α -FeOOH NRs in particular, has proved the existence of a reaction between iron oxide nanomaterials and CO at room temperature. The results show that the α -FeOOH NRs

have exhibited a promising CO-sensing mechanism for CO sensor applications at high concentration and room temperature.

Keywords: CO; α -FeOOH; QCM; Gas sensors

3.100-P [214]: Research on the fabrication of Ga_2O_3 nanowires using CVD method for application in Deep UV photodetector

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Abstract:

We report a high-performance deep-ultraviolet (DUV) photodetector based on a β -phase Gallium Oxide (Ga_2O_3) nanowire network. The β - Ga_2O_3 nanowires were synthesized via a two-step Chemical Vapor Deposition process at 600 °C.

Structural and morphological properties were characterized using X-ray diffraction and scanning electron microscopy.

After the second growth stage, the nanowires exhibited increased diameter, roughened surfaces, and abundant branching structures that interconnected the initial nanowire network, forming a highly conductive pathway. The fabricated photodetector demonstrates an ultra-low dark current and over one order of magnitude enhancement in photocurrent under 254 nm illumination. The device shows stable and repeatable on–off switching behavior, with distinct stepwise photocurrent responses under varying illumination intensities at a bias voltage of 20 V. In addition, fast photoresponse characteristics were achieved, with a rise time of ~ 0.15 s and a decay time of ~ 0.09 s.

These results indicate that the β - Ga_2O_3 nanowire network, fabricated via a simple two-step process, offers high sensitivity, excellent solar-blind selectivity, and rapid response speed, making it a promising candidate for next-generation DUV photodetector applications.

Keywords: Ga_2O_3 ; nanowires; Deep UV; Photodetector CVD

3.101-P [216]: A-/B-Site Engineering of AgNbO_3 -Based Relaxor Antiferroelectric Ceramics for High-Efficiency Energy Storage

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Abstract:

Lead-free antiferroelectric ceramics have attracted significant attention for advanced dielectric energy-storage applications owing to their fast charge–discharge capability and high power density. Among them, AgNbO₃-based ceramics are considered promising candidates because of their large polarization response and field-induced phase transition behavior. However, their practical application is still limited by high remanent polarization (Pr), low breakdown strength (Eb), and large hysteresis loss. In this study, synergistic A-/B-site engineering was employed to optimize the structure and energy-storage performance of AgNbO₃-based ceramics.

A series of (Ag_{1–4x}Li_xNd_x)(Nb_{0.8}Ta_{0.2})O₃ ceramics were synthesized using a conventional solid-state reaction method. Ta⁵⁺ substitution at the B-site was introduced to suppress Nb⁵⁺ off-centering and octahedral tilting, thereby stabilizing the nonpolar phase. Simultaneously, Li⁺/Nd³⁺ codoping at the A-site induced local chemical disorder and promoted relaxor-antiferroelectric-like behavior through nanodomain formation. Structural evolution was investigated by X-ray diffraction, Raman spectroscopy, and transmission electron microscopy, revealing reduced lattice distortion, suppressed octahedral tilting, and the development of nanoscale domains with increasing dopant concentration.

The optimized composition, ANT-0.03LN, exhibited a slim polarization–electric field loop with reduced Pr and enhanced Eb, leading to superior energy-storage performance. A high recoverable energy density of 7.2 J cm^{–3} and an energy-storage efficiency of 92.3% were achieved under a moderate electric field of 327 kV cm^{–1}.

Furthermore, the ceramic showed excellent frequency stability over 10–300 Hz and thermal stability from 25 to 125 °C. Ultrafast discharge behavior with $t_{0.9} \approx 40$ ns and a peak power density of 172 MW cm^{–3} further demonstrated its potential for high-power capacitor applications.

These results highlight the effectiveness of synergistic A-/B-site engineering in tailoring relaxor-antiferroelectric behavior and provide a viable strategy for developing high-performance lead-free dielectric energy-storage ceramics.

Keywords: AgNbO₃; Relaxor Antiferroelectrics; Energy Storage Ceramics

3.102-P [217]: Nanodomain Formation in Defect-Engineered KNLN Single Crystals for High-Performance Flexible Dielectric Capacitors

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Abstract:

High-performance flexible dielectric capacitors are highly demanded for advanced energy storage systems; however, conventional lead-free polycrystalline ceramics suffer from limited performance due to random grain orientations and structural defects. In this study, we report the successful synthesis of defect-engineered Ca-doped KNLN single-crystal microcubes via a molten-salt method and elucidate their nanodomain formation mechanism. Unlike traditional relaxor ferroelectrics that rely primarily on chemical disorder, we demonstrate a novel physical origin for relaxor behavior:

during the oriented attachment growth process, lattice dislocations emerge to relieve local strain, fundamentally driving the formation of nanoscale domains (10–40 nm).

Furthermore, Ca doping effectively suppresses the concentration of oxygen vacancies and modulates crystal symmetry, thereby preventing domain pinning and facilitating smooth polarization switching. Consequently, the optimal KNLN-0.01Ca single crystal exhibits an outstanding recoverable energy density (W_{rec}) of 2.66 J/cm³ and an efficiency (η) of 78.7% under 100 kV/cm. By integrating these single-crystal microcubes into a flexible PDMS polymer matrix, the fabricated flexible dielectric capacitors achieve a remarkably enhanced breakdown strength of 350 kV/cm, yielding a high W_{rec} of 5.76 J/cm³ and an efficiency of 88%. Notably, the composite device demonstrates an ultrafast discharge time ($t_{0.9}$) of 20 ns, an ultrahigh power density of 70 MW/cm³, and exceptional mechanical and electro-thermal cycling stability. This work provides profound physical insights into defect-driven nanodomain formation and establishes a robust paradigm for designing next-generation high-power flexible energy storage devices.

Keywords: Lead-free KNLN single crystals; Molten-salt synthesis; Defect engineering; Nanodomain formation; Relaxor ferroelectrics; Flexible dielectric capacitors

3.103-P [219]: Research on the fabrication of Ga doped ZnO thin film using mist-CVD method

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Abstract:

This study employed the Mist Chemical Vapor Deposition (Mist-CVD) technique to fabricate gallium-doped zinc oxide (GZO) transparent thin films with the aim of improving the electrical and optical properties of the material. The GZO films were deposited on sapphire substrates at temperatures ranging from 400 to 900 °C with carrier gas flow rates between 700 and 1000 sccm. Various characterization techniques, including X-ray diffraction (XRD), energy-dispersive X-ray spectroscopy (EDX), scanning electron microscopy (SEM), Hall effect measurements, and UV-Vis transmittance spectroscopy, were employed to investigate the crystal structure, elemental composition, surface morphology, electrical properties, and optical properties of the films. The results revealed that all GZO films exhibited a polycrystalline structure with the characteristic hexagonal wurtzite crystal structure of ZnO.

These findings demonstrate that GZO transparent conductive thin films are promising materials for applications in transparent electrodes, optoelectronic devices, solar cells, and gas sensors.

Keywords: mist-CVD; Ga doped ZnO; thin film

3.104-P [220]: SnO₂/Cr (40nm/20nm) thin film for H₂S gas sensing

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Abstract:

In this study, SnO₂/Cr (40 nm/20 nm) bilayer thin films were fabricated by DC magnetron sputtering using a two-mask photolithography process for the detection of hydrogen sulfide (H₂S) gas. Chromium (Cr) was employed as a low-cost, non-noble metal catalyst to replace conventional noble metals (Pt, Pd, Au) in enhancing the gas sensing performance of SnO₂. Gas sensing measurements were performed at operating temperatures ranging from 250 to 400 °C under H₂S concentrations of 2.5, 5, and 10 ppm. The sensor response showed a monotonic increase with H₂S concentration at all temperatures. The optimal sensing performance was achieved at 350 °C, where the sensor exhibited a response of ~2.0 at 10 ppm H₂S with good linearity, rapid response–recovery kinetics, and complete baseline recovery. At 400 °C, the highest response (~2.7 at 10 ppm) was observed but accompanied by degraded reversibility due to stronger chemisorption of reaction by-products. These results demonstrate that SnO₂/Cr bilayer thin-film sensors offer a promising, cost-effective alternative to noble-metal-decorated metal oxide sensors for sensitive and selective H₂S detection at ppm-level concentrations.

Keywords: SnO₂ thin film; Cr catalyst; DC magnetron sputtering; H₂S gas sensor

3.105-P [222]: High-performance room-temperature humidity sensor based on Fe₂O₃ nanorod arrays

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Abstract:

In this work, Fe₂O₃ nanorod arrays were successfully synthesized on Al₂O₃ substrates with pre-patterned Au interdigitated electrodes via a hydrothermal method followed by thermal annealing. The morphology and structural properties of the synthesized materials were systematically investigated using FE-SEM, TEM, elemental mapping, and X-ray diffraction. The results reveal the formation of well-defined nanorod structures with lengths of ~ 300 nm and diameters of ~50 nm. This morphology provides a large specific surface area and abundant active sites for water adsorption, which is beneficial for humidity sensing applications. The sensor exhibits a pronounced increase in electrical response with increasing humidity and demonstrates particularly high sensitivity at approximately 86% RH. The sensor also shows good repeatability and operational stability during multiple humidity exposure cycles. The enhanced sensing

performance is attributed to the porous nanorod structure that promotes water adsorption and facilitates proton conduction through the Grotthuss mechanism at high humidity levels.

Keywords: Hydrothermal synthesis; Humidity sensor; Interdigitated electrodes

3.106-P [231]: Engineering Exceptional Points in Coupled Spintronic Nano-Oscillators

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Abstract:

Spintronic nano-oscillators are nanoscale devices built from magnetic tunnel junctions (MTJs) — the same CoFeB/MgO thin-film stacks used in magnetic memory — in which a DC current drives the magnetization into steady microwave-frequency oscillations. Beyond their established role in microwave signal generation, coupling such devices together turns them into a compact, room-temperature, CMOS-compatible platform for engineering rich physical behaviour. Here we use two coupled vortex-based MTJ oscillators to realize and control exceptional points (EPs) — special operating conditions of non-Hermitian (gain–loss) systems at which two oscillation modes and their properties merge. The coupling between the two devices is set entirely electrically: a variable-gain amplifier tunes its strength while a phase shifter tunes its nature, driving a continuous transition from mode repulsion (an avoided crossing) to mode attraction (mode merging). By balancing gain and loss through the spin-transfer-torque effect, we reach exceptional points and map their location in the current–phase parameter space. Steering the device along a closed five-step trajectory that encircles an EP, we reveal its topological signature: the two oscillation modes are swapped after a single loop — observed as a frequency shift of about 0.4 MHz — and restored only after a second loop.

These results show that engineered magnetic thin-film devices offer a versatile, tunable testbed for non-Hermitian physics, with prospects for ultra-sensitive radiofrequency detection and neuromorphic computing [Ho et al., Newton (2026)].

Keywords: Magnetic Tunnel Junctions; Spin-Torque Nano-Oscillators; Exceptional Points; Non-Hermitian Physics; Coupled Oscillators; Radiofrequency Devices

3.107-P [232]: A ZnO/Al/N nanoflowers based sensor for room temperature CO detection under UV illumination

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Abstract:

In this research, a simple tip sonication strategy for the formation of ZnO/Al/N nanoflowers for an improved room temperature CO gas sensor device under UV light activation was studied. The morphology and structure properties of ZnO/Al/N nanoflower were studied under diversified analytical methods such as X-ray diffraction, Transmission electron microscopy, and other surface area measurements.

The gas sensing was investigated and analyzed carefully at room temperature through a variety of analyses. The ZnO/Al/N nanoflowers display an enhanced response toward CO at room temperature under UV effect. The light effect and its enhanced mechanism toward sensor optimization were studied. The sensor can reach the gas concentration limit at 5 ppm.

Keywords: Gas sensor; Tip sonication; Room temperature; ZnO/Al/N nanoflowers

3.110-P [266]: Enhancing H₂S Capture on Activated Carbon via Heteroatom Doping: A computational study

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Abstract:

Hydrogen sulfide (H₂S) is a highly toxic and corrosive gas commonly found in biogas and industrial emissions, posing significant risks to human health, the environment, and industrial infrastructure. While activated carbon (AC) is a widely used adsorbent for H₂S removal due to its high surface area and cost-effectiveness, the atomistic mechanisms governing its capture efficiency, especially regarding surface modifications, require further clarification. This work systematically investigates the adsorption behavior of H₂S on AC using van der Waals (vdW) corrected density functional theory (DFT) calculations. To represent the active surfaces of activated carbon, coronene-based models were employed, including heteroatom-doped configurations, compared to the pristine coronene. We explored the effects of substituting carbon atoms with nitrogen (N) and boron (B) in various structural forms, such as graphitic, pyrrolic, and pyridinic sites on H₂S adsorption. Our results demonstrate that while the interaction between H₂S and pristine coronene is dominated by physisorption through long-range vdW forces, heteroatom doping significantly enhances the binding affinity. Electronic structure analyses, including density of states and charge density difference, reveal that nitrogen and boron-doped AC models provide the most effective active sites for capturing H₂S. The enhanced adsorption strength is attributed to a combination of orbital hybridization, increased electrostatic attractions, and the formation of hydrogen bonds specifically in the nitrogen-doped systems. These findings provide a fundamental theoretical basis for the rational design of high-performance, sustainable carbon-based materials optimized for efficient biogas purification.

Keywords: H₂S capture; activated carbon; coronene models; heteroatom doping; vdW-corrected DFT

Acknowledgements: This research is conducted within the framework of IUC-QNU Program phase 1 under the project code VN2022IUC044A101.

3.111-P [267]: Research on the fabrication of bridged PtSe₂/SnO₂ heterostructures for room-temperature NH₃ gas sensor applications

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Abstract:

SnO₂-based gas sensors exhibit high sensitivity and excellent chemical stability; however, their practical application is often limited by the requirement for elevated operating temperatures. In this study, a bridged PtSe₂/SnO₂ heterostructure was successfully fabricated by combining chemical vapor deposition (CVD) and sputtering-assisted selenization. SnO₂ nanowires with lengths of approximately 20 μm and diameters of 30–40 nm were synthesized via CVD, while PtSe₂ films were obtained by sputtering Pt for deposition times ranging from 2 to 6 s, followed by thermal selenization. The morphology, elemental composition, crystal structure, and surface characteristics of the prepared materials were systematically characterized using FESEM, EDS, XRD, Raman spectroscopy, and AFM. Gas-sensing measurements revealed that the PtSe₂/SnO₂ sensor exhibited excellent NH₃ sensing performance at room temperature, achieving a response of approximately 142% toward 500 ppm NH₃ and maintaining good stability over 10 consecutive sensing cycles. The enhanced sensing performance is attributed to the formation of the PtSe₂/SnO₂ heterojunction and the bridged architecture, which facilitate charge transport and promote gas–surface interactions. These results demonstrate that the bridged PtSe₂/SnO₂ heterostructure is a promising candidate for high-performance room-temperature NH₃ sensing with low power consumption.

Keywords: PtSe₂; SnO₂ nanowires; bridged heterostructure; NH₃ sensor; room-temperature gas sensing; heterojunction

4.4. Computational Materials Science

4.07-P [49]: Electronic-structure insights into CO adsorption on X₈ metal clusters (X = Ag, Au, Cu, Pd, Pt): A DFT study using NBO, ESP, UV–Vis and DOS analyses

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Abstract:

Carbon monoxide adsorption on nanosized metal clusters is important for designing gas adsorption materials, chemical sensors and catalytic systems. In this work, density functional theory calculations were performed to investigate the interaction of a single CO molecule with X₈ metal clusters, where X represents Ag, Au, Cu, Pd and Pt.

Geometry optimizations and vibrational frequency calculations were carried out using the PW₉₁ functional, with the cc-pVDZ-PP basis set for metal atoms and the cc-pVDZ basis set for C and O atoms. The electronic origin of CO adsorption was examined using natural bond orbital (NBO), electrostatic potential (ESP), UV-Vis absorption and density of states (DOS) analyses. Pt₈ and Pd₈ show the smallest HOMO-LUMO gaps of 0.395 and 0.552 eV, respectively, whereas Ag₈ has the largest gap of 2.305 eV.

CO preferentially adsorbs at top sites on Ag₈, Au₈, Cu₈ and Pt₈, while Pd₈ stabilizes CO at a hollow site, indicating a multicenter Pd-CO interaction. The calculated adsorption energies range from -53.794 to -236.789 kJ mol⁻¹, following the order Ag₈CO < Cu₈CO < Au₈CO < Pd₈CO < Pt₈CO. The calculated bond

length and stretching frequency of free CO are in good agreement with experimental values, supporting the reliability of the computational approach. Compared with free CO, the strongest CO activation occurs in Pd₈CO, where the C-O bond length increases to 1.200 Å and the stretching frequency decreases to 1732.93 cm⁻¹. NBO analysis confirms that metal-CO bonding involves both σ -donation from CO to the metal cluster and π -backdonation from metal d orbitals to the antibonding orbital of CO.

UV-Vis and DOS analyses reveal metal-dependent electronic redistribution after CO adsorption. Overall, Pd₈ and Pt₈ exhibit stronger CO interactions, whereas Ag₈ shows weaker binding, providing useful insights for selecting metal clusters for CO adsorption, gas-sensing and catalytic applications.

Keywords: DFT; CO adsorption; metal clusters; NBO; UV-Vis; DOS; gas sensing

4.08-P [56]: Corrosion Behavior of Micro-Alloyed Steel in 3.5 wt.% NaCl Solution: Combined Experimental and Atomic-Scale Simulations

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Abstract:

This study investigates the corrosion behavior of API-grade steels microalloyed with Cr, Mo, and V in a 3.5 wt.% NaCl solution using a combined experimental and theoretical approach. Electrochemical measurements together with experimental analyses were integrated with density functional theory (DFT) calculations and molecular dynamics (MD) simulations to clarify the initial adsorption and oxidation processes. The addition of Cr markedly improved corrosion resistance by facilitating the formation of dense and protective oxide layers, including α -(Fe,Cr)OOH and Fe_xCr_{3-x}O₄ ($1 \leq x \leq 1.5$). The co-addition of V enhanced early stage surface reactivity through strong oxygen adsorption and significant charge transfer, promoting initial oxidation while subsequently reducing anodic dissolution due to increased Fe escape energy. Furthermore, V inhibited the formation of coarse M₇C₃ carbides by promoting the precipitation of fine V-rich carbides, thereby retaining more Cr in solid solution. The incorporation of small amounts of Mo further improved corrosion resistance by enhancing water adsorption and stabilizing surface oxides with limited charge transfer. In contrast, excessive carbide formation in steels with higher Cr content and slightly elevated carbon levels significantly deteriorated corrosion resistance; however, this effect was effectively alleviated through water quenching. The quenched sample exhibited the highest corrosion resistance. Overall, these findings provide valuable insights into alloy design and heat treatment strategies for improving corrosion performance in marine environments.

Keywords: Micro-alloyed steel; Corrosion product; 3.5 wt.% NaCl Solution; DFT calculation; MD Simulation

4.09-P [117]: Machine learning-based prediction of mechanical properties in 5000-series aluminum alloys

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Abstract:

5000-series aluminum alloys are widely used in automotive and structural applications due to their excellent combination of lightweight characteristics and mechanical properties. However, optimizing these properties through conventional experimental approaches requires significant time and cost. To address this issue, this study develops machine learning models to predict mechanical properties based on alloy composition and processing conditions.

A dataset consisting of 118 samples was used, with input variables including alloy composition (Fe, Mn, Si, Mg, Cu, Cr, Zn in wt%) and cold working conditions. The target variables were 0.2% proof stress, tensile strength, and elongation. Several regression models, including multiple regression, Ridge regression, and Lasso regression, were applied and evaluated using mean absolute error (MAE) and the coefficient of determination (R^2). In addition, an artificial neural network (ANN) model was introduced to capture nonlinear relationships among variables. The results showed that Lasso regression achieved high prediction accuracy for 0.2% proof stress and tensile strength ($R^2 \approx 0.93$ – 0.96), indicating strong correlations with key factors such as Mg content and processing conditions. The ANN model also demonstrated high performance ($R^2 \approx 0.91$ – 0.93) by effectively learning nonlinear interactions.

In contrast, elongation showed low prediction accuracy in all models, suggesting insufficient feature representation and complex underlying mechanisms. These findings indicate that machine learning, particularly ANN, is effective for predicting strength-related properties of aluminum alloys and has strong potential for accelerating materials design and optimization.

Keywords: Aluminum alloys; Mechanical properties; Artificial neural network

4.10-P [118]: High-Throughput Screening of Hard and Stable Materials Using Machine Learning

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Abstract:

Hard materials are of great industrial importance, yet the exhaustive search for novel candidates across vast chemical spaces using density functional theory (DFT) is computationally prohibitive. In this study, we developed a random forest model to predict the bulk modulus of inorganic materials exclusively from 17 compositional parameters (Magpie features), bypassing the need for crystal structure information.

The generalization performance of the model was rigorously validated using 5-fold cross-validation on a dataset of 10,987 materials, achieving a reliable predictive accuracy of $R^2 = 0.827$. Furthermore, through SHAP (Shapley Additive exPlanations) analysis, we visualized the basis of the model's predictions to ensure physical validity. The analysis revealed that the mean ground state volume per atom (mean GSvolume_pa)

is the most critical feature, exhibiting a clear negative correlation with the bulk modulus. This demonstrates that the machine learning model autonomously captured the fundamental materials science principle that denser atomic packing yields higher hardness.

Finally, by combining the predicted bulk modulus with thermodynamic formation energy data obtained from DFT, we conducted a high-throughput screening over an unexplored database of approximately 130,000 materials. Through this multi-objective screening, we successfully identified 153 promising candidates that balance both high hardness and thermodynamic stability, notably including transition metal nitrides and oxides (e.g., Hf-N, Zr-N, Ta-Ti-N, and Re-O). These findings provide a robust, reliable, and physically interpretable data-driven guideline for the experimental synthesis of next-generation hard materials.

Keywords: machine learning; hard materials; random forest; SHAP analysis; high-throughput screening; transition metal nitrides

4.11-P [179]: A review of DFT methods for competitive H₂ adsorption on small platinum clusters under the influence of CO, SO₂, and H₂O

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Abstract:

Small platinum clusters (Ptn, n < 20) are important quantum models for understanding H₂ adsorption and catalytic behavior in hydrogen fuel cells. However, the accuracy of density functional theory (DFT) calculations for Ptn and Ptn-adsorbate systems depends strongly on the exchange-correlation functional, basis set, relativistic treatment, dispersion correction, and isomer-search strategy. This review evaluates representative computational approaches, including GGA-PW91/PAW, PBE/PW91, B3LYP/LANL2DZ, B3PW91/LANL2DZ, B3PW91/Def2-TZVP, B3PW91/aug-cc-pVTZ-PP, and dispersion-corrected hybrid methods such as BB3PW91-D3(BJ) and PBE0-D3(BJ). These methods are assessed based on their ability to reproduce experimentally relevant descriptors, including Pt-Pt bond lengths, vibrational frequencies, ionization potentials, electron affinities, vertical detachment energies, adsorption energies, and charge-transfer behavior.

Benchmark data show that PW91/PAW describes Pt₂ with a Pt-Pt bond length of 2.379 Å compared with the experimental value of 2.333 Å, and a vibrational frequency of 215.6 cm⁻¹ compared with 222.26 cm⁻¹ experimentally, indicating reasonable accuracy for basic Pt-Pt bonding. For adsorption competition involving H₂, CO, SO₂, and H₂O, GGA-level methods are computationally efficient but may be insufficient for accurately describing CO/Pt interactions, while SO₂ adsorption energies on Pt surfaces of approximately -1.85 to -2.47 eV indicate strong occupation of Pt active sites relative to H₂O. Based on the reviewed evidence, an appropriate computational protocol should combine efficient preliminary isomer screening with final geometry optimization and frequency analysis using B3PW91-D3(BJ)/aug-cc-pVTZ-PP for Pt and aug-cc-pVTZ for H, C, O, and S. Selected validation using PBE0-D3(BJ) or Def2-TZVP is recommended to balance accuracy, computational cost, and available computing resources. This integrated protocol provides a practical framework for studying competitive H₂ adsorption on small Ptn clusters under the influence of CO, SO₂, and H₂O.

Keywords: Platinum clusters; hydrogen adsorption; DFT benchmarking; fuel cell catalysts; computational protocol

4.12-P [185]: Electrochemical Simulation of TSV Copper Filling Based on the Polarization Behavior of Organic Additives

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Abstract:

Through-Silicon Vias (TSVs) are vertical interconnect structures that penetrate silicon wafers. Compared to conventional planar interconnect methods, they enable shorter electrical connection paths and higher integration density. To achieve defect-free Cu filling within TSVs, it is necessary to control the additives in such a way as to suppress excessive deposition at the via entrance while relatively maintaining Cu growth at the bottom.

In this study, we analyzed the polarization behavior of an acid copper sulfate plating bath containing gelatin and thioflavin T, and simulated the Cu deposition behavior inside the TSV based on the measured polarization curves.

Gelatin and Thioflavin T exhibited a tendency for their behavior toward the Cu reduction reaction to either accelerate or inhibit depending on the additive concentration, suggesting the possibility of controlling local deposition rates based on differences in additive distribution along the depth of the TSV. The measured polarization curves were applied as electrode reaction boundary conditions to analyze the current density distribution and time-dependent Cu filling profile inside a TSV with an aspect ratio of 1:5. The purpose of this simulation was to analyze the difference in local plating rates between the via entrance and the bottom under conditions involving gelatin and thioflavin T additives, and to identify additive compositions and plating conditions that are conducive to bottom-up filling.

Furthermore, we aim to verify the validity of the model by comparing the predicted filling geometry with the results of actual TSV cross-sectional observations.

Keywords: Additive; Cu electroplating; Polarization curve; Simulation; TSV

4.13-P [191]: Tight-Binding Simulation of Electronic Band Structure and Transport in Armchair Graphene Nanoribbons under Uniaxial Strain

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Abstract:

This computational study comprehensively investigates the electronic band structure and quantum transport properties of Armchair Graphene Nanoribbons (AGNRs) utilizing a nearest-neighbor Tight-Binding (TB) Hamiltonian. While intrinsic bulk graphene behaves as a zero-gap semimetal, our Python-based simulation

models π -electron interactions to reveal how lateral quantum confinement transitions the material into a 1D semiconductor with a tunable energy gap essential for digital logic applications. We systematically analyze width-dependent band gap oscillations, computationally confirming that AGNRs strictly categorize into three structural families ($N = 3p, 3p+1, 3p+2$) whose gaps generally decay proportionally to the inverse of the ribbon width ($1/W$).

For a representative $N=10$ ribbon belonging to the $3p+1$ family, the model demonstrates a pronounced semiconducting gap and explicitly captures the emergence of sharp Van Hove singularities within the Density of States (DOS) at the band extrema. Furthermore, we explore the emerging field of "straintronics" by simulating the impact of uniaxial tensile strain up to 20% along the periodic axis. By dynamically modifying carbon-carbon hopping integrals via the Harrison relation and accounting for a transverse Poisson contraction ratio of ≈ 0.165 , we demonstrate how mechanical deformation actively breaks lattice symmetry. This strain shortens "vertical" bonds while stretching "angled" bonds, thereby altering hopping energies and effectively modulating both the band gap and carrier effective mass. Finally, utilizing the Landauer-Büttiker formalism, we calculate ballistic transport properties to reveal robust, integer-quantized conductance steps in standard units of $2e^2/h$. These findings directly correspond to the activation of sub-band channels, validating the 1D quantum wire behavior of AGNRs and highlighting the immense potential of strain-engineered graphene for tunable nano-electromechanical systems (NEMS) and flexible optoelectronic devices.

Keywords: Graphene Nanoribbons; Tight-Binding Model; Strain Engineering; Band Structure; Quantum Transport

4.14-P [194]: Augmenting Modal-Based Damage Detectability in Aerospace Assemblies: A Worst-Case and Gap Metric Approach to Identify Median-Masked Risks

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Abstract:

Structural integrity assessments for hybrid aerospace assemblies frequently rely on tracking modal frequency shifts to diagnose localized stiffness degradation.

Traditional Structural Health Monitoring (SHM) frameworks typically evaluate the "typical response" defined as the median normalized frequency shift across tracked modes.

However, this study identifies a critical diagnostic vulnerability termed "median-masked" risk: localized damage can induce severe frequency shifts in a single governing mode while the aggregate median response remains misleadingly below standard 1–2% detection thresholds.

Relying solely on median statistics therefore risks misclassifying highly vulnerable structural regions as dynamically stable. To address this limitation, we propose a multi-metric diagnostic methodology utilizing a high-fidelity parametric Finite Element Analysis (FEA) framework. We applied a scalar damage factor, representing up to 50% stiffness reduction, across four primary metallic regions of a satellite assembly: the base, middle, mounting, and side plates. To maintain physically consistent mode tracking during simulated structural degradation, we enforced strict one-to-one modal correspondence by maximizing the Modal Assurance Criterion (MAC). We augmented standard protocols with a worst-case metric (maximum

frequency shift among matched modes) and a gap metric (the mathematical difference between peak and typical responses). Simulations reveal that while the middle plate demonstrates the highest typical sensitivity (a 13.98% median shift at 50% damage), the mounting plate exposes the most extreme "median-masked" vulnerability. At maximum degradation, the mounting plate exhibited a negligible typical response of 0.92%, yet suffered a severe worst-case frequency shift of 24.10%, producing a massive 23.18% gap. Furthermore, shape similarity degradation ($MAC < 0.9$) occurred as early as 10% severity in the mounting plate, highlighting mode-shape evolution as a vital early-warning indicator. These findings confirm that integrating typical, worst-case, and gap metrics is essential to uncover hidden localized vulnerabilities in complex aerospace structures.

Keywords: Damage Detectability; Modal Assurance Criterion (MAC); Satellite Structures; Stiffness Degradation; Structural Health Monitoring (SHM)

4.15-P [195]: Parameters identification of the 2NN-MEAM interatomic potential for the Ni–W–C system using Density functional theory (DFT) and Molecular Dynamics (MD) Simulations

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Abstract:

This study presents a methodology for identifying the parameters of the 2NN-MEAM interatomic potential for the ternary Ni–W–C system. Density functional theory (DFT) calculations were first performed using the Quantum Espresso package to evaluate the binding energies of representative structures, which served as reference data for determining the parameters of the MEAM-2NN interatomic potential. Subsequently, molecular dynamics (MD) simulations were carried out using the LAMMPS code to predict the binding energies of six distinct phases: Ni₆W₆C, Ni₁₀(WC)₃, Ni₃W₆C, Ni₃W₃C, Ni₂W₄C, and Ni₂W₁₁C₄. For the standard crystallographic atlas-based structures, the relative deviations between the MD predictions and DFT calculations ranged from 0.97% for Ni₃W₆C to 7.83% for Ni₁₀(WC)₃. Furthermore, when randomly distributed atomic configurations were considered, the discrepancies between the MD and DFT results were significantly reduced, ranging from 0.14% for Ni₆W₆C to 3.06% for Ni₂W₄C. These results demonstrate that the developed 2NN-MEAM interatomic potential accurately reproduces the binding energies of both ordered and disordered Ni–W–C configurations, indicating its reliability and transferability for large-scale atomistic simulations of Ni–W–C-based materials.

Keywords: Ni-W-C; DFT; MD; 2NN-MEAM; Identification

4.16-P [196]: First-principles study of the crystal structure and electronic band structure of Zn-doped ϵ -Ga₂O₃

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Abstract:

Gallium oxide (Ga_2O_3) is an ultra-wide bandgap oxide semiconductor, outstanding for its exceptional optical and electronic properties and its ability to operate in harsh environments, making it a promising material for optoelectronic and high-power devices. Ga_2O_3 exists in several polymorphic structures, most notably the thermodynamically stable β -phase (monoclinic) and the metastable ϵ -phase (orthorhombic). Doping zinc (Zn) into the ϵ - Ga_2O_3 lattice, denoted as ϵ -ZGO, can be considered an effective strategy for tuning the material properties. This study explores the thermodynamic stability, lattice distortion, and electronic band structure evolution of the ϵ -ZGO system using first-principles calculations combined with the cluster expansion method. The mixing enthalpy calculated over the full Zn concentration (x) range from $x = 0$ to 1, shows that the β phase is always more thermodynamically stable than the ϵ phase. The substitution of Zn^{2+} for Ga^{3+} sites cause significant distortions in the lattice parameters and unit-cell volume due to the difference in ionic radius, while also promoting the self-organization of Zn ions into highly ordered configurations at $x = 0.375$ in the ϵ -phase lattice and $x = 0.25$ in the β -phase lattice. Analysis of the band structure and partial density of states (PDOS) shows that Zn significantly narrows the bandgap of ϵ - Ga_2O_3 and shifts the Fermi level downward toward the valence band. The simulated absorption spectra indicate that, as the Zn content increases, the absorption band shifts significantly from the deep UVC region (100–280 nm) toward longer wavelengths in the UVB and UVA ranges (280–400 nm). These results provide a theoretical basis for elucidating the mechanisms of structural distortion and bandgap engineering in Zn doped ϵ - Ga_2O_3 , contributing to the design of future optoelectronic devices based on this material.

Keywords: Gallium oxide; DFT; first-principles; ϵ - Ga_2O_3 ; Zn-doped; ZGO

4.17-P [211]: High-efficiency PbS-IBr quantum dot solar cells achieved through systematic optimization of absorber/ETL/HTL layer thickness

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Abstract:

Lead sulfide quantum dots (PbS QDs) are promising for infrared (IR) solar cells due to their narrow bandgap, yet achieving high performance remains challenging. This work systematically investigates the thickness effects of the absorber, electron transport layer (ETL), and hole transport layer (HTL) on device performance via SCAPS-1D simulation. By optimizing these layer thicknesses, a peak theoretical power conversion efficiency (PCE) of 16.56% was achieved under AM1.5G illumination, accompanied by a high external quantum efficiency (EQE) of 79.72% at 1300 nm.

These insights provide clear structural guidelines for fabricating high-efficiency PbS QD infrared photovoltaics.

Keywords: PbS QDs; ETL; HTL; SCAPS-1D; solar cells

4.112-P [269]: Numerical Simulation and Experimental Validation of Vacuum Quenching in SKD61 Hot-Work Tool Steel

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Abstract:

This study investigates the vacuum quenching behavior of SKD61 hot-work tool steel through a combined numerical–experimental approach. Using DEFORM-HT, the C-ring specimen was modeled to predict thermal gradients, phase transformations, and residual stress development during quenching. Experiments under 3 and 6 bar gas pressure validated the simulations through hardness testing and microstructural observation. Results showed that higher quenching pressure (6 bar) markedly reduced $t_{8/5}$ (average cooling rate 800–500 °C) times and increased the average cooling rate between 800–500 °C, thereby accelerating martensitic transformation. Hardness values rose slightly in thin regions (53.6 HRC vs. 52.7 HRC at 3 bar), but increased surface–core thermal gradients indicated greater residual stress and higher distortion risk. Microstructures confirmed dominant martensite with retained austenite and bainite fractions at high cooling rates. The close agreement between simulations and experiments validates DEFORM-HT as a reliable predictive tool for optimizing vacuum quenching parameters. The findings provide practical guidance for die and mold manufacturing, with future work extending to square specimens and forging dies.

Keywords: SKD61; heat treatment; DEFORM-HT; quench distortion; residual stress; vacuum furnace; vacuum quenching

4.5. Material related technology

5.07-P [4]: Burning behavior of $\text{Ba}(\text{NO}_3)_2/\text{Mg}$ pyrotechnic compositions: Effect of composition, relative density, and binder content

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Abstract:

The burning behavior of $\text{Ba}(\text{NO}_3)_2$ -Mg-based pyrotechnic compositions was investigated as a function of Mg content, relative density expressed as the ratio of actual density to calculated density $\rho_{\text{actual}}/\rho_{\text{calculated}}$, and binder addition. The compositions were prepared by dry mixing, granulation, drying, and compaction, and their burning rates were measured. The results showed that the burning rate exhibited a pronounced non-monotonic dependence on composition, with the maximum value obtained in the fuel-rich region at approximately 64 wt.% Mg, rather than at the stoichiometric ratio. At the ratio $\rho_{\text{actual}}/\rho_{\text{calculated}} = 0.75\text{--}0.80$, the maximum burning rate reached 16.09 mm/s, while at a lower relative density of 0.45–0.50, it increased significantly to approximately 37–38 mm/s. The addition of 6 wt.% phenol-formaldehyde resin substantially reduced the burning rate over the entire composition range without significantly shifting the optimum composition. The results show that the burning behavior of $\text{Ba}(\text{NO}_3)_2$ -Mg compositions is governed not only by formulation stoichiometry, but also by structural factors such as compaction degree and binder content.

Keywords: $\text{Ba}(\text{NO}_3)_2$ -Mg; pyrotechnic composition; burning rate; relative density; phenol-formaldehyde resin

5.08-P [6]: Research on Establishing Reasonable Sewing Time for Pocket Assembly of Jackets based on the Application of the MTM Method and the GSD Predetermined Time System

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Abstract:

In the digital technology era, textile and garment enterprises have adapted through technological innovation, investing in modern machinery and automation to enhance productivity, reduce labor costs, and accelerate delivery schedules. In Vietnam, most companies operate under the Cut–Make–Trim (CMT) method, with jackets as the primary export product. These garments consist of pocket assembly with complex structures and operations, often leading to inefficiencies. This paper presents a study on establishing rational sewing times for zipper welt pocket operations using MTM analysis and the GSD predetermined time system.

The research results define standard sewing times for representative operations in the zipper welt pocket process. Furthermore, theoretical times are compared with actual sewing times recorded from workers on industrial production lines for multi-layer outer jackets, providing insights into productivity gaps and opportunities for optimization.

Keywords: Sewing time; GSD; Jacket; Digital technology; CMT(Cut - Make - Trim); MTM

5.09-P [9]: Parallelism-Based Detection of Seam Parameter Deviations for Automated Garment Inspection Using PCA and Normal Distance Analysis

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Abstract:

In the garment manufacturing industry, the inspection of dimensional parameters in accordance with technical specifications plays a crucial role in ensuring both the aesthetic quality and mechanical durability of products. In particular, for seam types such as edge stitching, topstitching, and hemming, a key requirement is that the seam must maintain a constant distance and remain parallel to the fabric edge. However, this quality inspection process is still predominantly performed manually, leading to inconsistencies and difficulties in meeting real-time inspection requirements on production lines.

To address this issue, this study proposes a geometric-based approach for automatically detecting seam parameter deviations by formulating the problem as an evaluation of the parallelism between the seam and the fabric edge. Specifically, Principal Component Analysis (PCA) is employed to determine the tangent and normal directions of the seam. The distance between the seam and the fabric edge is then computed based on the normal distances between corresponding point pairs on the two curves.

During data acquisition, garment samples often exhibit fabric distortions such as wrinkling or curling, resulting in local geometric deformations between the seam and the fabric edge. This may lead to inaccurate assessments, where the system incorrectly identifies seam misalignment while the actual cause is fabric deformation. To mitigate this issue, the proposed method performs local deviation analysis by segmenting the seam into consecutive segments of fixed length (1 inch), rather than evaluating the entire seam globally. Subsequently, global deviation is determined by analyzing the average normal distances of the segmented regions.

Experimental results on a dataset of 1,036 real-world images show that the proposed method achieves an accuracy of 97.55%, with an average processing time ranging from 0.2 to 0.5 seconds per image, depending on the seam length.

These results demonstrate the effectiveness and real-time applicability of the method in automated seam quality inspection systems.

Keywords: Seam deviation detection; Geometric parallelism analysis; Principal Component Analysis (PCA); Normal distance measurement; Automated quality inspection.

5.10-P [10]: Building the Dimensions System for Clothes of Head Body of Vietnamese Male Elderly People

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Abstract:

Against the backdrop of rapid population ageing in Vietnam, age-related changes in body morphology among older adults have created an urgent need for the development and standardization of anthropometric data. However, there remains a lack of a dedicated head anthropometric sizing system for this population, posing challenges for the design and development of products such as protective equipment, medical devices, and healthcare products.

In response to this need, this study aims to develop a head anthropometric sizing system for Vietnamese elderly males aged 60 to 80 years. The study was conducted using direct measurements of 184 elderly male participants across three regions: Hanoi, Ninh Binh, and Ho Chi Minh City. The collected data were processed using SPSS 22.0. In particular, Principal Component Analysis (PCA) was applied to identify the key anthropometric dimensions, while the Pearson's test was employed to examine the normal distribution of the anthropometric variables, thereby providing a scientific basis for size classification.

The results established an optimal sizing system consisting of 11 size groups, achieving a coverage rate of 98.88% for elderly males, with each size group representing at least 1.05% of the surveyed sample. This sizing system provides a scientific database to support anthropometric-based product design, thereby improving usability and enhancing the quality of life for the elderly.

Keywords: Head anthropometric sizing system; Principal Component Analysis (PCA); elderly males aged 60–80; anthropometric data; SPSS software

5.11-P [11]: Design and Evaluation of a Rapid CO₂ Release Mechanism for Elderly Fall-Protection Airbags

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Abstract:

Falls represent a significant health risk for the elderly, often resulting in severe or life-threatening injuries. Among contemporary protective solutions, smart wearable airbags have emerged as a proactive technology capable of detecting falls and providing immediate cushioning. While sensors and microprocessors handle detection, the system's effectiveness depends critically on the rapid gas-release mechanism, which must deploy compressed gas into the airbag within milliseconds to ensure timely impact attenuation.

This paper presents a comparative analysis of several CO₂ cartridge activation mechanisms developed by our research group. These designs are evaluated based on structural complexity, operating principles, response latency, reliability, and ease of fabrication. Experimental results indicate that the electro-mechanical activation mechanism is the most effective solution, meeting the rigorous requirements of rapid deployment. Upon receiving an electronic activation signal, the mechanism automatically releases a locking pin, allowing the mechanical energy stored in a compressed spring to drive a needle into a miniature CO₂ cartridge. The proposed design demonstrates high operational reliability and significant potential for integration into personal protective equipment, particularly for enhancing the safety of the elderly.

Keywords: Elderly people; smart wearable airbag system; CO₂ cartridge activation mechanism; rapid gas-release mechanism

5.12-P [18]: INFLUENCE OF FABRIC LOOP LENGTH ON THE COMPRESSION FORCE OF KNITTED FABRIC TUBES APPLIED TO MEDICAL TEXTILE

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Abstract:

Knitted fabrics are widely used in various biomedical fields due to their superior properties, including elasticity, softness, breathability, and adaptability to the human body form. This study focuses on investigating the influence of loop length on fabric horizontal extension and on the compression pressure exerted by knitted bandages preparing by cotton/acrylic (50%/50%) yarn in flat knitted machine. Experimental results showed that as the loop length of single-knitted fabric tubes varied (10.08 mm, 11.56 mm, 13.18 mm and 15.26 mm), the actual compression pressure significantly decreased, respectively (70.5 mmHg, 30.4 mmHg, 22.2 mmHg, 12.1 mmHg). Moreover, in increasing fabric looplength the horizontal extension increased clearly with the value of 35%, 80%, 96%, 128% at 40 gF, corresponding to looplength of 10.08 mm, 11.56 mm, 13.18 mm and 15.26 mm. This tendency could be applied to design the knitted

products with the required extension and compression suitable for special applications such as medical textile.

Keywords: Knitted fabric tubes; Looplenth; Compression; Extension; Medical textile

5.13-P [19]: COMPRESSION KNITTED SOCK DESIGN FOR VARICOSE VEINS USING LAPLACE EQUATION

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Abstract:

Pressure-generating textile products are commonly used in medical support devices such as compression bandages, medical stockings, and functional garments to improve blood circulation and assist in the treatment of vascular-related conditions. This research investigated difference between actual compression 70.5 mmHg, 30.4 mmHg, 22.2 mmHg, 12.1 mmHg and theorical compression calculated by Laplace equation for four knitted tubes made by V-bed machine of 7 gauge. Then, the study proposed incorporating a correction factor into the Laplace equation for cases involving fabric tube with small diameters. Furthermore, the developed Laplace equation was applied to design medical compression stockings with gradually decreasing pressure from the ankle to the calf, aiming to optimize circulatory support.

Results indicated that the difference between theoretical pressure and actual pressure after adjustment fell within the range of 15%–18%, demonstrating the feasibility of the proposed method for compression knitted sock design for varicose veins.

Keywords: Knitted fabric design; Laplace equation; Compression knitted sock

5.14-P [21]: An Investigation of Factors Influencing Individual Fashion Age Using Random Forest Approach

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Abstract:

Individual fashion age is a perceptual indicator that reflects the age at which an individual is perceived by others based on appearance, style, and external expressions, rather than actual chronological age. This study aims to explore and evaluate the influence of both quantitative personal factors (chronological age, income, expenditure, weight, and height) and qualitative attributes (gender, educational level, marital status, fashion style, hair color, lifestyle, etc.) on individual fashion age.

Data were collected from 400 participants aged 18 to 77 residing in Hanoi. Descriptive analysis was employed to identify the distributional characteristics and trends of the observed variables. A Random Forest (RF) model was then developed to identify and rank the most influential factors affecting individual fashion

age. The results indicate that chronological age, income, marital status, lifestyle, and fashion-related expenditure exert significant effects.

Notably, chronological age exhibits the highest %IncMSE value, confirming its dominant role in visual perceptions of individual fashion age. This study contributes to the theoretical understanding of social visual perception and highlights the importance of distinguishing between chronological age and fashion age when developing fashion product strategies

Keywords: Individual fashion age; Visual age perception; Random Forest; Lifestyle and demographic factors

5.15-P [31]: Study on the Correlation Between the Structural Properties of TiO₂ Treated Cotton Fabrics and UV Protection Performance for Outerwear Applications

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Abstract:

Cotton fabrics are widely used in outerwear products due to their excellent breathability, moisture absorption, softness, and comfort properties. However, conventional cotton fabrics generally exhibit limited resistance to ultraviolet (UV) radiation and may not adequately protect users under increasingly intense solar exposure conditions caused by climate change and environmental factors. This study was conducted to investigate the correlation between the structural properties of cotton fabrics treated with titanium dioxide (TiO₂) and their UV protection performance for outerwear applications, while still maintaining the comfort and wearability properties of the material. The results showed that TiO₂ treatments significantly improved the UV protection capability of cotton fabrics through enhanced UV absorption and scattering effects. Furthermore, the study contributed to identifying the relationship between fabric structure and UV protection efficiency, thereby proposing suitable parameters for developing functional outerwear products with enhanced UV-protective performance and improved consumer safety.

Keywords: Functional Cotton Fabric; Titanium dioxide; UV-blocking; Structural Properties; Outerwear

5.16-P [55]: Evaluating and Optimizing FDM 3D Printing Parameters on the Compressive Strength of TPU Parts using the Taguchi Technique

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Abstract:

Thermoplastic Polyurethane (TPU) is highly valued in Fused Deposition Modeling (FDM) for its exceptional elasticity, durability, and energy absorption. These properties make TPU an ideal material for customized orthopedic insoles, specifically designed to support individuals with flat feet by distributing

plantar pressure. However, the mechanical behavior of FDM-printed TPU parts under compressive loads is highly sensitive to the selected printing parameters.

Therefore, this study evaluates and optimizes these variables to maximize compressive strength using the Taguchi technique.

To streamline the process, an L_9 (3^3) orthogonal array was utilized to evaluate three primary parameters: infill pattern (Gyroid, Honeycomb, Tri-hexagon), layer height (0.15, 0.20, 0.25 mm), and infill density (10%, 20%, 30%).

Cylindrical TPU specimens were fabricated via FDM and subjected to quasi-static compression testing to measure their peak compressive stress.

Analysis of Variance (ANOVA) demonstrated that infill density is the most dominant factor governing compressive strength, accounting for 58.17% of the variance. Infill pattern and layer height showed minor contributions of 6.93% and 4.33%, respectively. The highest recorded peak stress was 0.002117 kN/mm² (Honeycomb, 0.20 mm layer height, 30% density). Concurrently, the Signal-to-Noise (S/N) ratio analysis identified the theoretical optimal combination as the Honeycomb pattern, 0.15 mm layer height, and 30% infill density.

In short, this study provides a reliable guide for choosing the best FDM 3D printing settings. The results show that a high infill density with a Honeycomb pattern gives the highest strength. These ideal settings help make strong, custom 3D-printed shoe insoles that comfortably support flat feet and absorb shocks.

Keywords: FDM 3D Printing; Thermoplastic Polyurethane (TPU); Taguchi Technique; Compressive Strength; Orthopedic Insoles

5.17-P [65]: Effect of loop length on the thermo-physiological comfort properties of cotton rib knitted fabric

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Abstract:

With the escalating demand for high-performance apparel, thermo-physiological comfort has become a critical focus for textile designers and manufacturers. Fabric structural parameters play a pivotal role in determining these comfort characteristics. This study investigates the influence of loop length on the thermo-physiological properties of cotton rib-knitted fabrics. Five variations of 2x1 rib structures were produced using Ne 30 combed cotton yarn with loop lengths ranging from 3.7 mm to 4.1 mm. The samples were evaluated for air permeability, water vapor permeability, and overall moisture management capacity (OMMC). Experimental results indicate that while increasing loop length significantly enhances air and water vapor permeability, it simultaneously results in a decline in OMMC, which dropped from 3.5 to 3.0. Based on these findings, a loop length of 3.9 mm is recommended for summer T-shirt applications, as it achieves an optimal balance of comfort, demonstrating favorable air permeability (1.167 l/m²/s), water vapor permeability (0.035 g/cm².24h) and a superior OMMC of 3.5.

Keywords: loop length; rib knitted fabric; thermo-physiological comfort properties

5.18-P [74]: Effects of Bra Structure on Breast Morphology and Aesthetic Appearance in Large-Breasted Women

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Abstract:

This study aimed to evaluate the effects of bra structure on breast morphology and aesthetic appearance in large-breasted women, while clarifying the mechanisms through which bra design parameters influence aesthetic perception. An experimental study was conducted on four types of size 85C bras involving ten large-breasted female participants. Fifteen bra dimensional parameters, ten nude breast measurements, and the corresponding breast measurements after wearing each bra were directly measured.

The overall breast aesthetic index (NI) was evaluated using an expert assessment method. The experimental data were analyzed using Pearson correlation, Principal Component Analysis (PCA), linear regression, mixed-model ANOVA, Mediation Analysis, Random Forest, and Partial Dependence Plot (PDP) techniques in R software. The results showed that bras significantly altered breast morphology, particularly through lifting, gathering, and shaping mechanisms. Nonlinear models indicated that changes in five post-bra breast dimensions had the strongest influence on the overall breast aesthetic index (NI), with optimal deformation ranges identified for achieving the highest aesthetic performance. The study confirms that the influence of bras on breast aesthetics operates through multifactorial and nonlinear morphological transformation mechanisms, thereby providing a scientific basis for the design of bras suitable for large-breasted women.

Keywords: Bra; large breasted women; breast morphology; aesthetic appearance; Random Forest; morphological deformation

5.19-P [76]: The effect of down- filled fabric parameters on shrinkage coefficient, thickness, and thermal resistance of clothing

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Abstract:

Down and feathers are commonly used in clothing products requiring high thermal insulation, contributing significantly to the sustainable use of livestock by-products. Controlling the effect of structural parameters of down-filled clothing is essential for designing products that achieve both thermal insulation and a good fit. This paper presents the results of a study on the simultaneous effect of down clothing parameters, including down density and quilting dimension, on the thermal resistance, thickness, and shrinkage coefficient of down-filled fabric structures. The investigated range of these parameters are down density of 0.009-0.045 g/cm² and quilting dimension of 5.5-10.8 cm. Design Expert software was used to design experiments and analyze the results. The research results show that down density has a more pronounced

and significant influence on thermal resistance, thickness, and shrinkage coefficient of down-filled fabric structures compared to the influence of quilting dimension.

The effect of down density on the thermal resistance of the down-filled structure is stronger with a larger quilting dimension, and vice versa. The shrinkage coefficient of the down-filled fabric structure is mainly influenced by down density. The impact of quilting dimension on shrinkage coefficient is negligible, while quilting width significantly affects thermal resistance and thickness of structures. First-order regression models are shown to fit these relationships. Applying these regression models to predict heat resistance and design parameters of down-filled garments contributes to proactively designing thermal clothing and effectively developing this products for export.

Keywords: down clothing; down-filled fabric; thermal resistance; shrinkage coefficient; down density

5.20-P [83]: Study on Dry Defibration Technology of Leather Waste from the Footwear Industry for Producing Fiber and Powder Mixtures

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Abstract:

Leather waste generated from the footwear industry represents a significant source of solid waste containing high collagen content and considerable potential for reuse in composite material production. This study focuses on evaluating the feasibility of dry defibration of leather waste to produce granular, fibrous, and powdered materials without chemical pretreatment prior to grinding. Two types of leather materials, namely grain cow leather and split cow leather, were investigated. Experimental processes were carried out using a shredding roller mill and a hammer mill in order to evaluate the mechanical disintegration behavior of leather materials. The results showed that the dry grinding method was capable of reducing leather waste from initial centimeter-scale dimensions into particles and fibers smaller than 2.5 mm. The shredding roller mill produced materials with relatively uniform size distribution while preserving the collagen fiber structure, whereas the hammer mill provided stronger mechanical destruction and generated finer powder materials. The structural characteristics of each leather type significantly affected grinding efficiency; split cow leather was easier to process due to its looser fibrous structure and lower mechanical strength compared with grain cow leather. The dry defibration method offers several advantages, including a simple processing procedure, the elimination of chemical wastewater generation, and compatibility with sustainable recycling approaches in the footwear industry. The findings of this study provide an important scientific basis for selecting appropriate processing technologies for recycling leather waste in polymer composite manufacturing and other recycled material applications.

Keywords: Leather waste; Dry grinding; Hammer milling; Shredding roller mill; Collagen fibers; Recycling

5.21-P [84]: Study on Wet Defibration Technology for Recycling Leather Waste from the Footwear Industry into Fiber and Powder Mixtures

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Abstract:

The Vietnamese footwear industry generates a large amount of leather waste during manufacturing processes. Most of this waste is currently disposed of through landfilling or incineration, resulting in the loss of valuable natural collagen resources and causing environmental pollution.

This study focuses on evaluating the feasibility of wet defibration technology for recycling leather waste into fibrous and powder materials used in recycled composite production. The investigated materials included grain cow leather and split cow leather generated from footwear manufacturing processes. Prior to grinding, the leather samples were chemically treated using NaOH and H₂SO₄ solutions with different concentrations and soaking durations in order to weaken collagen cross-linking and enhance the mechanical disintegration of the material. The results showed that chemical pretreatment had a significant influence on the defibration efficiency of leather waste.

In alkaline and acidic media, the collagen structure swelled, and cross-links were partially broken, facilitating the conversion of leather into fine fibers and powders after grinding. The degree of leather decomposition strongly depended on the type of chemical, treatment concentration, and soaking time. Split cow leather exhibited faster degradation behavior than grain cow leather due to its looser fibrous structure. The wet grinding method produced materials with relatively small and uniform particle sizes, making them suitable for use as reinforcing fillers in polymer composite materials. The findings of this study contribute to the development of environmentally friendly recycling solutions and enhance the utilization value of leather waste generated by the footwear industry.

Keywords: Leather waste; Wet defibration; Collagen; Polymer composite materials; Leather recycling.

5.22-P [87]: Study on the Mechanical and Physical Properties of Nonwoven Fabrics for Medical Applications

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Abstract:

Nonwoven fabrics are currently widely used in the medical field due to their lightweight structure, softness, ease of processing, and ability to satisfy requirements related to hygiene and user safety. However, for medical products, the mechanical strength and structural stability of materials are always critical factors because they directly affect durability and practical performance during use. Based on these requirements, this study was conducted to evaluate several fundamental mechanical and physical properties of three nonwoven fabric samples used for medical applications in order to identify the most suitable material for specialized uses. The investigated properties included fabric mass per unit area, thickness, tensile strength, and tear strength. The tests were carried out according to standard testing methods for technical textile materials.

The experimental results revealed significant differences among the fabric samples in terms of structural characteristics and load-bearing capacity. Fabrics with tighter fiber bonding structures and higher mass

density generally exhibited greater tensile and tear strength. In contrast, samples with looser fiber structures were softer and more flexible but showed lower mechanical resistance.

In addition, the study demonstrated that fabric mass and thickness had a considerable influence on the mechanical properties of nonwoven fabrics. Through comprehensive analysis and comparison, the study identified the fabric sample possessing the most suitable mechanical and physical characteristics for medical applications requiring high durability and structural stability. The findings provide a scientific basis for the selection and development of nonwoven materials for medical and healthcare applications.

Keywords: Nonwoven fabrics; Medical materials; Tensile strength; Tear strength; Mechanical and physical properties

5.23-P [90]: Evaluation of Hygienic and Comfort Performance of Medical Nonwoven Fabrics

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Abstract:

In the medical and healthcare fields, the hygienic and comfort properties of textile materials play a particularly important role because they directly influence user comfort, protective performance, and hygienic efficiency during use. Nonwoven fabrics are currently widely utilized in various medical products due to their softness, lightweight structure, and cost-effective manufacturing capability. However, different materials exhibit varying levels of absorbency and breathability; therefore, evaluating the hygienic properties of these materials is essential for selecting fabrics suitable for practical medical applications. This study investigated three nonwoven fabric samples used in medical applications through several performance indicators, including water absorbency, air permeability, and the amount of water removed from the hands after washing. The tests were conducted according to standard testing methods for medical textile materials. The experimental results demonstrated that the fiber bonding structure and porosity of the materials significantly affected moisture transport behavior, breathability, and water absorption efficiency.

Fabrics with more porous structures generally exhibited better air permeability but lower water retention capability. In contrast, samples with higher fiber density showed improved water absorption performance and more effective removal of moisture from the skin surface after hand washing. Through a comprehensive analysis of hygienic and comfort-related properties, the study identified the fabric sample most suitable for medical applications requiring both high absorbency and good breathability. The findings provide a scientific basis for the selection and development of nonwoven materials for current medical and healthcare applications.

Keywords: Nonwoven fabrics; Medical materials; Water absorbency; Air permeability; Comfort properties

5.24-P [106]: Experimental investigation on waterproof materials and seam sealing technology in outdoor wear production

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Abstract:

Waterproof and windproof garments are being widely applied in daily life, sports, and work. Waterproof coated fabrics are developing alongside apparel materials including sewing threads, seam tapes, and bonding technologies to create waterproof seams in clothing. This paper presents the results of an experimental study on the waterproof ability of double stitch seams using anti-wicking threads and seam tape on 100% polyester polyurethane-coated fabric. The waterproof ability of seams was measured by maximum water pressure that the seam can withstand before leaking in hydrostatic test of ISO 811. The research results showed that seams using anti-wicking threads improved waterproof property by 1.1 to 1.2 times compared to seams using conventional threads, but the maximum pressure resistance remained lower than the requirement of 3 psi for seams on waterproof fabrics for apparel using. Seams using waterproof tape have a 6.7 to 8.1 times higher waterproof capability compared to seams without tape when using the same thread and a maximum pressure of 4.8 to 5.1 psi.

Sealed seams using anti-wicking thread have a maximum pressure of 5.0 to 5.3 psi, 6.2 to 7.7 times higher than seams using anti-wicking thread only. The comparisons also show that using larger size thread and needles simultaneously can reduce seam waterproof capability by up to 23.5% compared to when seams not using seam tape, and only a maximum reduction of 5.9% compared to when using seam tape. These research results contribute to the effective use of apparel materials, improve the seam sealing technology of outdoor wear, and promote the development of these products in the future.

Keywords: outdoor wear; seam sealing; anti-wicking thread; waterproof bonding tape

5.25-P [203]: Functionalization of Green-Synthesized Zero-Valent Iron Nanoparticles on Polyester Nonwoven Fabric Using Alginate for Dye Removal

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Abstract:

Dye wastewater poses significant risks to aquatic ecosystems and human health. In this study, polyester nonwoven fabric was functionalized with zero-valent iron nanoparticles (nZVIs) and alginate, resulting in a composite membrane capable of removing dye. The nZVIs were green synthesized from the *Cleistocalyx operculatus* leaf extract and play a main role in dye removal. Alginate is purified from brown seaweed, a natural polysaccharide, and used as a binder between nZVIs and nonwoven fabric.

Nonwoven fabric acts as a carrier, containing nZVIs particles, facilitating the easy recovery and reuse of nZVIs. SEM, XRD, and FTIR analyses confirmed the successful immobilization of zero-valent iron nanoparticles (nZVI) on the polyester fabric surface. The results demonstrated that the functional fabric with nZVIs and alginate achieved excellent removal of Methylene Blue (MB), with a removal efficiency exceeding 75% after eight uses. The combination of high dye removal efficiency, excellent reusability, environmentally friendly synthesis, and cost-effective scalable fabrication highlights the strong potential of the developed fabric as a sustainable and practical material for real-world wastewater treatment applications.

Keywords: alginate; dye removal; green synthesis; nonwoven fabric; zero-valent iron nanoparticles

5.26-P [218]: Analyzing the impact of key factors on thread consumption norms for the 401 stitch on denim fabric

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Abstract:

The research investigates the impact of key factors on thread consumption norms for the 401 stitch applied to denim fabric. Using survey questionnaires and interviews, data were collected from garment enterprises in Vietnam.

The research identifies the structural characteristics of denim-based products and analyzes the elements involved in establishing thread consumption norms. The findings highlight the relative influence of each factor, providing practical insights for optimizing sewing standards and improving efficiency in garment production. Three denim fabric samples with different fabric weights were selected for experimental testing. For each type of fabric, tests were carried out with two, three, and four layers, corresponding to the characteristics and structural requirements of seam connections in the product. In addition, the study examined cases with the same number of fabric layers and stitch density in order to evaluate the impact of stitch density and seam thickness on thread consumption norms. The results indicate that factors such as fabric weight, number of fabric layers, and stitch density all exert a certain influence on thread consumption norms. This research contributes to establishing a foundation for determining appropriate thread consumption norms, thereby supporting effective production management and enhancing the accuracy of material consumption standards developed by technical staff in the garment industry, particularly for denim products.

Keywords: 1. Denim fabric; 2. 401 stitch; 3. Thread consumption norms; 4. Stitch density; 5. Number of fabric layers

5.27-P [227]: Influence of tuck loop ratio on air permeability of pique knitted fabric and experiment-3D simulation correlation

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Abstract:

This study designs and produces six knitted fabric samples, including one Single jersey control sample and five pique samples with tuck loop ratios of 1:1, 1:2, 1:3, 1:4, and 1:5. The samples are knitted on a Weihaan machine with a gauge of E7, after being designed using HQpds software. Air permeability is determined experimentally and compared with 3D simulation results on WeftKnit to evaluate the relationship between porosity and air permeability of the fabric.

The results show that the tuck loop ratio significantly affects air permeability. As the tuck loop ratio increases, air permeability tends to increase, but at high ratios of 25% or more, air permeability decreases.

Additionally, porosity from 3D simulation shows a strong correlation with experimental air permeability, indicating that 3D simulation can support the prediction of fabric air permeability.

Keywords: Pique knitted fabric; tuck loop ratio; air permeability; 3D simulation; porosity
