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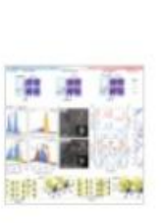
Featured

Article
23 May 2025 | Open Access

Lab-on-device investigation of phase transition in MoO$_x$ semiconductors



Controlling phase transitions in MoOx semiconductors is challenging. Here, the authors develop a lab-on-device system to modulate proton intercalation, achieving conductance modulation and enabling electrochemical memory and neural network applications.

Xiaoci Liang, Dongyue Su & Yang Chai

Article
23 May 2025 | Open Access

inCu-click: DNA-enhanced ligand enables live-cell, intracellular click chemistry reaction with copper catalyst

Tracking biomolecules in living cells requires fast but gentle labeling. Here, authors introduce inCu-click, a DNA-conjugated ligand that localizes copper to enable efficient intracellular CuAAC, allowing live-cell fluorescent labeling of lipids and proteins without toxicity.

Keqing Nian, Yifang Liu & Sara H. Rouhanifard

Article
23 May 2025 | Open Access

Harnessing natural embodied intelligence for spontaneous jellyfish cyborgs

This study reveals that jellyfish swimming can be guided and predicted using electrical stimulation and machine learning, illustrating how embodied intelligence shapes both spontaneous and stimulus-evoked behaviors.

Dai Owaki, Max Austin & Kohei Nakajima

Article
22 May 2025 | Open Access

Near-visible integrated soliton microcombs with detectable repetition rates

Integrated optical frequency combs are powerful tools for optical spectroscopy. Here, authors demonstrate low-power, detectable-rate soliton microcombs from telecom to visible bands, including wavelength-multiplexed operation, using ultra-low-loss silicon nitride waveguides.

Peng Liu, Qing-Xin Ji & Kerry J. Vahala

Article
22 May 2025 | Open Access

Real-space observation of the dissociation of a transition metal complex and its concurrent energy redistribution

Metal carbonyl complexes show photoreactivity interesting for catalytic and biological applications. Here the authors capture the structural dynamics of the photodissociation of iron pentacarbonyl in real space and time using ultrafast X-ray scattering.

Aviad Schori, Elisa Biasin & Adi Natan

Article
22 May 2025 | Open Access

Selection of self-assembled configurational isomers from a dynamic library via a multivariant optimization process

Using simple artificial molecules to mimic complicated phenomena in living systems requires the selection of suitable species from a library using multivariate optimization processes. Here, the authors develop a dynamic combinatorial library of configurational isomers for molecular self-assembly through the rational design of a low-symmetric gear-shaped amphiphile and show selective isomer generation with external stimulus.

Hongye Chen, Tsukasa Abe & Shuichi Hiraoka

Article
22 May 2025 | Open Access

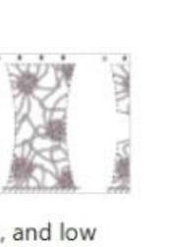
Vat photopolymerization of stretchable foam with highly entangled and crosslinked structures

Vat photopolymerization 3D printed flexible polymer foams are applicable to thermal insulation, sound absorption, noise reduction, and biomedicine but the high cross-linking density of the generally used resin prevents their further processing into foam parts. Here, the authors show an additive manufacturing polyurethane foam preparation method to balance fabrication accuracy and expansion ratio.

Haoyu Gao, Xianmei Huang & Lixin Wu

Article
22 May 2025 | Open Access

Unusually long polymers crosslinked by domains of physical bonds



Crosslinked polymers often suffer from increased modulus with decreased fatigue threshold or large hysteresis. Here the authors achieve high modulus, high fatigue threshold, and low hysteresis in a network of unusually long polymer chains crosslinked by domains of physical bonds.

Xianyang Bao, Zheqi Chen & Zhigang Suo

Article
22 May 2025 | Open Access

Bioresorbable, wireless dual stimulator for peripheral nerve regeneration

Wireless bioresorbable stimulators are promising therapeutic implants that naturally dissolve after use. Here, the authors developed a device that operates for months and enables simultaneous multi-site stimulation, preventing early muscle atrophy and accelerating reinnervation in nerve injury models.

Hak-Young Ahn, Jordan B. Walters & John A. Rogers

Article
22 May 2025 | Open Access

Catalytic ammonia formation from dinitrogen, water, and visible light energy

The production of green ammonia is important for the development of next-generation carbon-free energy carriers. Here, the authors demonstrate visible-light-driven catalytic ammonia formation from dinitrogen and water under ambient conditions using tertiary phosphines in the presence of molybdenum and iridium complexes.

Yasuomi Yamazaki, Yoshiki Endo & Yoshiaki Nishibayashi

Article
22 May 2025 | Open Access

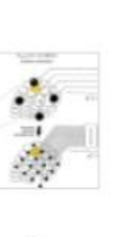
Photoelectrochemical biosensor with single atom sites for norepinephrine sensing and brain region synergy in epilepsy

Distinguishing norepinephrine (NE) from structurally similar neurotransmitters in complex in vivo environments is a significant challenge. Here authors report a photoelectrochemical biosensor which uses Zn single atoms on TiO$_2$ to allow selective in vivo NE quantification in various brain regions.

Shiting Gu, Dawei Xu & Zhonghai Zhang

Article
22 May 2025 | Open Access

Bridging circuit modeling and signal analysis to understand the risk of crosstalk contamination in brain recordings

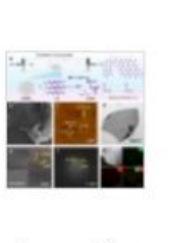


Signal recording from hundreds of microelectrodes on ultra-thin and flexible arrays is a challenge in neurotech. Here, the authors show that these recordings are compromised by crosstalk. An algorithm was developed to eliminate crosstalk offline, helping to come closer to ground truth data.

Maria F. Porto Cruz, Elena Zucchini & Thomas Stieglitz

Article
22 May 2025 | Open Access

Synthesis of hexagonal boron arsenide nanosheets for low-power consumption flexible memristors



2D hexagonal boron arsenide (h-BAs) is predicted to show interesting electronic and thermal properties, but its synthesis has so far remained elusive. Here, the authors report a method to synthesize 2D crystalline h-BAs nanosheets, showing their application for the realization of rigid and flexible low-power memristors.

Zenghui Wu, Yuxuan Zhang & Johnny C. Ho

Article
22 May 2025 | Open Access

Cell trajectory modulation: rapid microfluidic biophysical profiling of CAR T cell functional phenotypes

CAR T cell manufacturing faces significant challenges that impact cell quality and in vivo efficacy. This necessitates reliable cellular characterization methods. Here the authors present a real-time, label-free, microfluidic method that profiles cellular biophysical properties and correlates them to activation state and CAR T potency, facilitating the rapid phenotypic cell assessment during production.

Kerwin Kwek Zeming, Kai Yun Quek & Jongyoon Han

Article
21 May 2025 | Open Access

Nickel-embedded three-in-one pyridyl-quinoline-linked covalent organic framework photocatalysts for universal C(sp^2) cross-coupling reactions

Metallaphotocatalysis enables cross-couplings under mild conditions but homogeneous dual metallaphotocatalysts often suffer from low catalyst stability or high metal loading. Here, the authors report nickel-incorporated pyridyl-quinoline-linked covalent organic frameworks serving as robust and efficient heterogeneous metallaphotocatalysts for C(sp^2) cross coupling reactions.

Hong Jiang, Weigang Zhang & Jie Wu

Article
21 May 2025 | Open Access

Reactive oxygen species responsive nanomotors for gene edited metabolic disruption and immunotherapy

Nanomotor delivery has the potential to improve therapeutic outcomes. Here, the authors use the natural reactive oxygen species gradient in the tumour microenvironment to target delivery of CRISPR/Cas9 gene editing plasmids using reactive oxygen species responsive nanomotors for metabolic disruption and immunotherapy.

Zhiyong Liu, Xiaowei Luan & Yujun Song

Article
21 May 2025 | Open Access

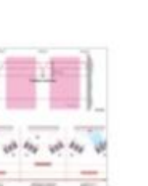
Parallelizing analog in-sensor visual processing with arrays of gate-tunable silicon photodetectors

Xiong et al. report two scalable in-sensor visual processing arrays based on dual-gate silicon photodiodes, parallelizing the temporal and spatial information analysis. The bipolar analog output captures the amplitude of event-driven light changes, facilitating the classification of dynamic motions and static images.

Zheshun Xiong, Wen Liang & Guangyu Xu

Article
21 May 2025 | Open Access

Low temperature deposition of functional thin films on insulating substrates enabled by selective ion acceleration using synchronized floating potential HiPIMS



This study introduces an interesting ionized physical vapor deposition concept. The technique enables tailored ion acceleration on insulating substrates resulting in high-quality thin films at low deposition temperatures.

Jyotish Patidar, Oleksandr Pshyk & Sebastian Siol

Article
21 May 2025 | Open Access

Cation-self-shielding strategy promises high-voltage all-Prussian-blue-based aqueous K-ion batteries

Prussian blue analogues are promising for aqueous batteries but interstitial water effects remain underexplored. Here, authors develop a cation-self-shielding strategy with dihydroxyacetone to stabilize water-rich Prussian blue analogues for application in K-ion batteries.

Qiubo Guo, Shuai Han & Yong-Sheng Hu

Article
21 May 2025 | Open Access

Nano-engineered thin-film thermoelectric materials enable practical solid-state refrigeration

The authors demonstrate nano-engineered thin film thermoelectric materials are attractive for practical solid-state refrigeration with semiconductor manufacturing and ultra-low 0.003-cc materials usage.

Jake Ballard, Matthew Hubbard & Rama Venkatasubramanian

Article
21 May 2025 | Open Access

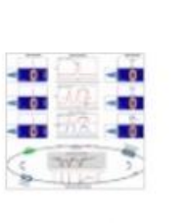
An amphoteric and hydrogen-bond-rich artificial α-amino acid for highly durable aqueous redox flow batteries

Organic redox flow batteries face solubility and stability challenges. Here, authors develop Cys-OHAQ, a redox molecule whose zwitterionic structure and hydrogen bonding from cysteine side chains enhance solubility, redox reversibility, and molecular stability.

Pengbo Zhang, Yuzhu Liu & Zhong Jin

Article
21 May 2025 | Open Access

On-demand tailoring soliton patterns through intracavity spectral phase programming

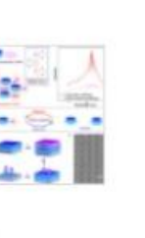


Multi-pulse oscillations are prevalent phenomena in mode-locked lasers and microresonators. Here, the authors achieve the on-demand tailoring of multiple solitons via spectral phase programming, resulting in soliton patterns with separations following constant, geometric, and arithmetic sequences.

Heze Zhang, Chao Zeng & Dong Mao

Article
21 May 2025 | Open Access

Switchable narrow nonlocal conducting polymer plasmonics



Conducting polymer plasmonics provides tuneability but weak low-quality resonances which limit practical applications. Here, authors induce collective lattice resonances of PEDOT nanoantenna arrays, enabling intense and switchable nano-optical resonances with quality factors improved up to 10 times.

Dongqing Lin, Yulong Duan & Magnus P. Jonsson

Article
21 May 2025 | Open Access

High-energy and fast-charging lithium metal batteries enabled by tuning Li$^+$-solvation via electron-withdrawing and lithiophobicity functionality

The electrochemical stability window and Li$^+$ transport limit the energy-dense and fast-charging capability of lithium metal batteries. Here, authors report a trifluoride ether-based electrolyte to stabilize energy-dense lithium metal batteries under high current rates.

Guangzhao Zhang, Tong Zhang & Yonghong Deng

Article
21 May 2025 | Open Access

Redox-active electrolyte-based printed ionologic devices

Conventional capacitors store charge under opposite polarization. Here, the authors design a printed asymmetric system, where a redox-active electrolyte enables selective charge storage. This approach allows voltage control and efficient logic operations, showing promise for future ionic computing.

Hanfeng Zhou, Przemyslaw Galek & Stefan Kaskel

Article
21 May 2025 | Open Access

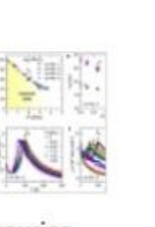
Reconfigurable terahertz optoelectronic logic through charge-density-wave phase engineering

The authors make a terahertz device utilizing collective electronic states in 1T-TaS$_2$ that achieves reconfigurable logic operations through dynamic charge-density-wave phase manipulation. The device shows exceptional performance metrics and enables secure multicolor recognition for next-generation encrypted communications.

Xin Sun, Kening Xiao & Weida Hu

Article
21 May 2025 | Open Access

Pressure tuning of competing interactions on a honeycomb lattice

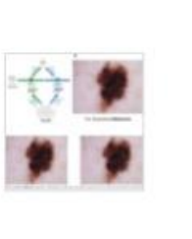


Kitaev interactions on a honeycomb lattice can potentially lead to a quantum spin liquid state. Unfortunately, materials hosting Kitaev interactions also host Heisenberg interactions favouring long range order. Here, Sakrikar, Shen, Poldi and coauthors find that the relative strength of the Heisenberg and Kitaev interactions can be tuned by pressure in Ag$_3$LiRh$_2$O$_6$.

Piyush Sakrikar, Bin Shen & Fazel Tafti

Article
21 May 2025 | Open Access

Dermatologist-like explainable AI enhances melanoma diagnosis accuracy: eye-tracking study

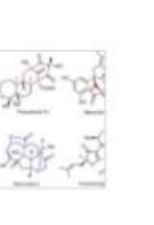


Artificial intelligence (AI) system is known to improve dermatologists' diagnostic accuracy for melanoma. This group applies the eye-tracking technology on dermatologists when diagnosing dermoscopic images of melanomas and reports improved balanced diagnostic accuracy when using an X(explainable) AI system comparing to the standard one.

Tirtha Chanda, Sarah Haggenmueller & Titus J. Brinker

Article
20 May 2025 | Open Access

Switchable organocatalytic enantioselective sulfenocyclization of cyclohexadienes enabling chemodivergent access to chiral bicyclo[m.n.1] ring systems

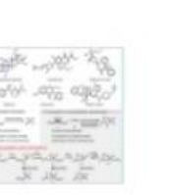


The precise control over regio- and stereoselectivity from the same substrate represents a significant challenge in organic chemistry. Here, the authors present a switchable organocatalytic enantioselective carbosulfenylation/sulfenolactonization of cyclohexa-1,4- dienes to access chiral bicyclo[m.n.1] ring systems, which can be guided by tuning the substituent of the sulfenylating agent.

Bing-Qian Zhang, Lei Chen & Jun Deng

Article
20 May 2025 | Open Access

Modular access to alkylfluorides via radical decarboxylative-desulfonylative *gem*-difunctionalization



Fluorine-containing compounds play a critical role in life sciences, driving extensive research into efficient fluorination methods over the past decades. Here, the authors report a radical-mediated synthesis of alkyl fluorides via decarboxylative-desulfonylative gem-difunctionalization under photochemical conditions.

Xianjin Wang, Haotian Li & Chen Zhu

Article
20 May 2025 | Open Access

Asymmetric total synthesis of benzenoid cephalotane-type diterpenoids through a cascade C(sp^2) & C(sp^3)–H activation

Cephalotane diterpenoids, featuring unique and complicated carbon skeletons and remarkable antitumor activities have been gaining increasing attention. Here, the authors report the asymmetric and divergent total synthesis of benzenoid cephalotane-type diterpenoids containing the identical 6/6/6/5 tetracyclic and the bridged δlactone skeleton with different oxidation states.

Xiangxin Li, Zhaoxu Lu & Zhixiang Xie

Perspective
20 May 2025 | Open Access

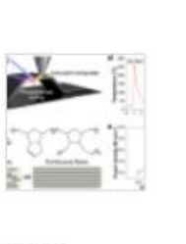
Standardization guidelines and future trends for PET hydrolase research

Enzymatic depolymerization of polyethylene terephthalate (PET) towards monomer recycling is a promising strategy for a bio-based circular plastic economy, but progress is limited by the lack of standard guidelines for assessing and comparing the depolymerization efficiency catalysed by various PET hydrolases. In this Perspective, the authors identify critical research gaps in sourcing novel PET hydrolases and specify crucial requirements for selecting and optimizing them for specific application scenarios.

Ren Wei, Peter Westh & Uwe T. Bornscheuer

Article
20 May 2025 | Open Access

Additive manufacturing of carbon fiber-reinforced thermoset composites via in-situ thermal curing

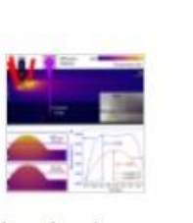


Fiber-reinforced polymer composites are lightweight structural materials used in a wide range of applications, but manufacturing of composites requires expensive tooling and long, energy-intensive processing. Here, the authors report rapid, scalable, and energy-efficient additive manufacturing of fiber-reinforced thermoset composites, while eliminating the need for tooling or support materials.

Carter F. Dojan, Morteza Ziaee & Mostafa Yourdkhani

Article
20 May 2025 | Open Access

Evolution of dislocations during the rapid solidification in additive manufacturing

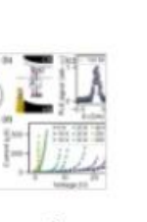


This study aims to address a critical knowledge gap concerning the unique microstructure in 3D-printed metals by quantitatively investigating the phase and dislocation density during the printing process using operando synchrotron X-ray diffraction.

Lin Gao, Yan Chen & Tao Sun

Article
20 May 2025 | Open Access

Single V2 defect in 4H silicon carbide Schottky diode at low temperature

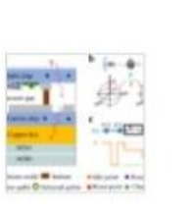


Integration of color centers in wide-band semiconductors with electronic and photonic devices is required for their applications in quantum technologies. Here the authors report electronic, optical and spin control of a single vacancy center in a 4H-SiC Schottky diode integrated with optical microstructures.

Timo Steidl, Pierre Kuna & Jörg Wrachtrup

Article
20 May 2025 | Open Access

Cosmic-ray-induced correlated errors in superconducting qubit array

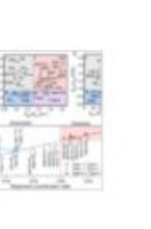


The correlated errors in superconducting qubits have been linked to high-energy particle impacts from cosmic rays, but a direct observation has been lacking. Here, the authors measure the quasiparticle bursts and correlated errors and separate the contributions of cosmic-ray muons and γ-rays in a 63-qubit processor.

Xuegang Li, Junhua Wang & Hai-Feng Yu

Article
20 May 2025 | Open Access

A path towards high lithium-metal electrode coulombic efficiency based on electrolyte interaction motif descriptor



Electrolyte interactions critically govern battery performance yet lack precise design principles. The authors introduce interaction motif descriptors to design an electrolyte enabling 99.7% Li-metal Coulombic efficiency for 4.5 V batteries.

Ruhong Li, Xiaoteng Huang & Xiulin Fan

Article
20 May 2025 | Open Access

Automated design of scaffold-free DNA wireframe nanostructures

Most of computer-aided design tools in DNA nanotechnology are committed to the scaffolded DNA origami method. Here, the authors present an automated design pipeline BRAIDS for creating DNA wireframe nanostructures based on a scaffold-free molecular self-assembly approach.

Wen Wang, Abdulmelik Mohammed & Bryan Wei

Article
20 May 2025 | Open Access

Field emission effect in triboelectric nanogenerators

Performance of triboelectric nanogenerators is primarily restricted by contact electrification, air breakdown, and dielectric breakdown effects. Here, field emission and its limitation for triboelectric nanogenerators performance are investigated.

Di Liu, Yikui Gao & Jie Wang

Article
20 May 2025 | Open Access

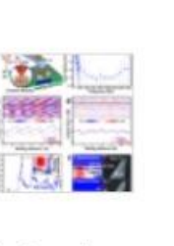
Iron-catalyzed aliphatic C–H functionalization to construct carbon–carbon bonds

Developing synthetic catalysts that mimic the enzyme activity of cytochrome P450 enzymes while avoiding oxygenation remains a challenge, especially for intermolecular carbon–carbon bond formation reactions. Here, the authors report an iron/bioinspired ligand catalyst that uses hydrogen peroxide to enable undirected methylene C–H functionalization with 1,4- quinones and azines.

Lulu Zhou, Hengrui Cai & Wei Han

Article
20 May 2025 | Open Access

Tuning friction force and reducing wear by applying alternating electric current in conductive AFM experiments

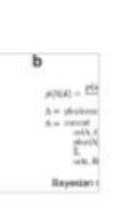


Friction and wear cause widespread energy loss and damage. Here, the authors propose a strategy to reduce friction and wear through inducing dynamic electronic density redistribution via alternating electric current.

Aisheng Song, Jian-Xun Zhao & Tian-Bao Ma

Article
20 May 2025 | Open Access

Modeling rapid language learning by distilling Bayesian priors into artificial neural networks



Children can learn language from very little experience, and explaining this ability has been a major challenge in cognitive science. Here, the authors combine the flexible representations of neural networks with the structured learning biases of Bayesian models to help explain rapid language learning.

R. Thomas McCoy & Thomas L. Griffiths

Article
20 May 2025 | Open Access

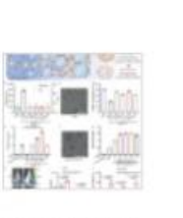
An acid-free process to prepare battery grade nickel and cobalt sulfates from complex resources

An acid-free atmospheric leaching process extracts 97.4% Ni and 98.8% Co from critical minerals, limits iron dissolution (4.7%), and reduces CO$_2$ emissions by 59.5%, offering a sustainable alternative for battery-grade metal production.

Qing Zhang, Xiaohong Zheng & Zhi Sun

Article
20 May 2025 | Open Access

Freezing induced incorporation of betaine in lipid nanoparticles enhances mRNA delivery

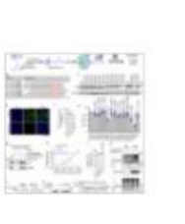


Cryoprotectants are needed for the storage of lipid nanoparticles (LNPs). Here, the authors report on a study which shows that freezing can be harnessed to reformulate LNPs in a way that both preserves their integrity and boosts mRNA delivery after sub-zero storage by increasing endosomal escape.

Xingdi Cheng, Xia Zheng & Jianjun Wang

Article
20 May 2025 | Open Access

DNA nanoflower Oligo-PROTAC for targeted degradation of FUS to treat neurodegenerative diseases



Targeted degradation has the potential to treat diseases associated with pathological protein build up. Here, the authors report on an oligo-PROTAC which degrades FUS, a protein associated with frontotemporal dementia, demonstrating delivery on DNA nanoflowers for increase blood-brain barrier crossing and retention.

Ruixin Ge, Miao Chen & Songbo Xie

Article
20 May 2025 | Open Access

Atrial fibrillation detection via contactless radio monitoring and knowledge transfer

Atrial fibrillation is a prevalent and serious arrhythmia associated with increased morbidity and mortality worldwide. Here the authors show a contactless, operation-free, and device-free AF detection framework utilizing artificial intelligence-powered radio technology, achieving performance comparable to conventional ECG-based methods.

Yuqin Yuan, Jinbo Chen & Yan Chen

Article
19 May 2025 | Open Access

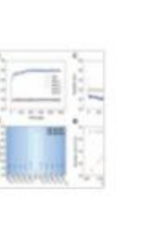
Copper-catalyzed photoinduced carbonylation of C1-C3 gaseous alkanes

The direct carbonylation of C-H bonds on gaseous hydrocarbon feedstocks provides a straightforward approach to accessing short-chain carboxylic acid derivatives. Here, the authors report a direct carbonylation of methane, ethane, and propane under blue LED irradiation at ambient temperature, synthesizing short-chain carboxylic acid derivatives.

Le-Cheng Wang & Xiao-Feng Wu

Article
19 May 2025 | Open Access

Grain boundary amorphization as a strategy to mitigate lithium dendrite growth in solid-state batteries

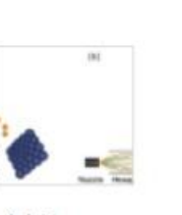


Solid-state lithium batteries suffer from lithium dendrite formation that compromises safety. Here, authors reveal how grain boundary structures affect lithium behavior and show that selective amorphization can suppress dendrites and enhance battery stability.

Yiwei You, Dexin Zhang & Shunqing Wu

Article
19 May 2025 | Open Access

Rotational orientation control of a ground state ortho-H$_2$ dissociation on a metal surface

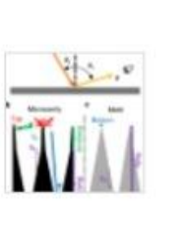


The rotational orientation of a molecule affects the outcome of a molecule-surface collision. Here, the authors achieve control of this quantum property for H$_2$ colliding with a nickel surface and study its role in elastic and reactive collisions.

H. Chadwick, G. Zhang & G. Alexandrowicz

Article
19 May 2025 | Open Access

Engineering flexible superblack materials



Flexible superblack materials are crucial for minimizing stray light, complicating object identification, and serving as low reflectance standards, however it is challenging due to scalability and durability issues. Here the authors show a superblack material which is scalable, durable and flexible.

Yucheng Yang, Botond Sánta & Matthew R. Rosenberger

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Featured

Article
19 May 2025 | Open Access

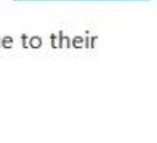
Structural reconfiguration of interacting multi-particle systems through parametric pumping

Configuration control of non-conservative multi-body systems is challenging. Here, the authors develop a general method using parametric pumping to selectively excite and destroy undesired structures to populate a targeted one, and demonstrate it with acoustically levitated particle systems.

Qinghao Mao, Brady Wu & Heinrich M. Jaeger

Article
19 May 2025 | Open Access

Excitonic topology and quantum geometry in organic semiconductors

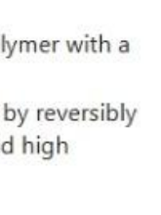


Excitons can exhibit topologically non-trivial states. Here, the authors theoretically demonstrate that excitons can exhibit controllable topology and localization properties due to their geometry in organic polymers.

Wojciech J. Jankowski, Joshua J. P. Thompson & Robert-Jan Slager

Article
19 May 2025 | Open Access

On-demand, readily degradable Poly-2,3-dihydrofuran enabled by anion-binding catalytic copolymerization

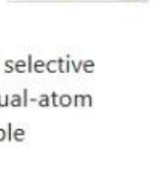


Copolymerization with cleavable comonomers is a versatile approach to generate vinyl polymer with a viable end-of-life option. Here, the authors show that an anion binding catalyst seleno cyclodiphosph(V)azanes enables the efficient cationic copolymerization with cyclic acetals by reversibly activate both different dormant species to achieve both high living chain end retention and high molecular weight.

Zhen Zhang, Wenxiu Li & Youhua Tao

Article
19 May 2025 | Open Access

Suppressing CO$_x$ in oxidative dehydrogenation of propane with dual-atom catalysts



Propane oxidative dehydrogenation offers a promising path for propylene production, but selective propylene formation with minimal COx remains challenging. Here, the authors introduce dual-atom catalysts achieving just 5.2% COx selectivity at 46.1% propane conversion (520 °C) with stable performance for over 1000 hours.

Yongbin Yao, Jingnan Wang & Xi Wang

Article
19 May 2025 | Open Access

An aggregation-induced conformation locking strategy facilitates the activation of lipase biocatalyst

Lipase is one of the most important industrial biocatalysts with wide applications, but its catalytic efficiency is often hindered by a closed lid conformation. Here, the authors present an aggregation-induced conformation locking strategy that enables the facile synthesis of highly activated lipase hybrid biocatalysts.

Anlian Huang, Zhi-Wei Li & Gangfeng Ouyang

Article
19 May 2025 | Open Access

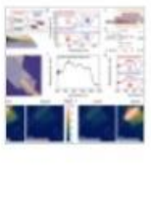
A tungsten polyoxometalate mediated aqueous redox flow battery with high open-circuit voltage up to 2 V

As a promising large-scale energy storage device, aqueous redox flow batteries face challenges with water splitting. Here, authors present polyoxometalate anolyte with a low redox potential which exhibits dynamic pH value changes during charging and discharging.

Weipeng Li, Weizhuo Xu & Wei Liu

Article
19 May 2025 | Open Access

Polarization-sensitive in-sensor computing in chiral organic integrated 2D p-n heterostructures for mixed-multimodal image processing



In-sensor computing minimizes latency by directly processing data at the point of capture. Here, authors optimize this process by integrating polarization-sensitive detectors into the computing framework, enabling the superposition of two filtering operations within a single circuit.

Je-Jun Lee, Seong-Jun Han & Do Kyung Hwang

Article
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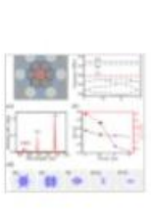
Cavity quantum electrodynamics with moiré photonic crystal nanocavity

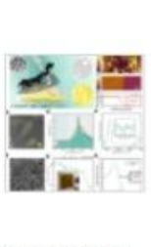


Twisted photonic crystals enable a strong light-matter interaction due to the flatband and high Q factor. Here, authors demonstrate Purcell enhancement between single quantum dots and Moiré nanocavities, with a PL intensity enhancement of about 8.4 times and a Purcell factor around 3.0.

Sai Yan, Hancong Li & Xiulai Xu

Article
19 May 2025 | Open Access

A molecularly engineered large-area nanoporous atomically thin graphene membrane for ion separation



Atomically thin graphene membranes with sub-1-nm pores show promise for ion/molecular separation, osmotic energy generation, and energy storage. Here the authors present the fabrication of large-area nanoporous atomically thin graphene membranes with narrow pore size distributions and positive charges via a bottom-up molecular anchoring approach.

Ziwen Dai, Pengrui Jin & Huanting Wang

Article
19 May 2025 | Open Access

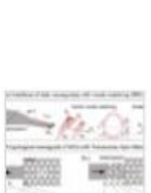
Electronic interferometry with ultrashort plasmonic pulses

The development of electronic flying qubits requires the ability to generate and control single-electron excitations. Here the authors demonstrate quantum coherence of ultrashort single-electron plasmonic pulses in an electronic Mach-Zehnder interferometer, revealing a non-adiabatic regime at high frequencies.

Seddik Ouacel, Lucas Mazzella & Christopher Bäuerle

Article
19 May 2025 | Open Access

Efficient coupling of topological photonic crystal waveguides based on transverse spin matching mechanism



Topological photonic structures enable robust light transport but face coupling challenges. The authors demonstrate transverse spin matching governs the coupling between the topological waveguide and waveguide, achieving 96.3% theoretical and 94.2% experimental transmission efficiencies.

Bojian Shi, Qi Jia & Weiqiang Ding

Article
19 May 2025 | Open Access

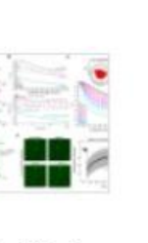
Molecular simulations of enzymatic phosphorylation of disordered proteins and their condensates

Here, the authors implement molecular dynamics simulations to model ATP-driven enzymatic reactions, revealing how the enzyme CK1δ phosphorylates condensates of the neurodegeneration linked protein TDP-43 and triggers the dissolution of condensates.

Emanuele Zippo, Dorothee Dormann & Lukas S. Stelzl

Article
19 May 2025 | Open Access

LLPS REDIFINE allows the biophysical characterization of multicomponent condensates without tags or labels



REDEFINE is a label-free approach for characterizing biomolecular condensates based on NMR diffusion experiments, determining parameters of biphasic condensates, namely partitioning, diffusion coefficients, droplet size, permeability, and chemical exchange.

Mihajlo Novakovic, Yaning Han & Frédéric H.-T. Allain

Article
19 May 2025 | Open Access

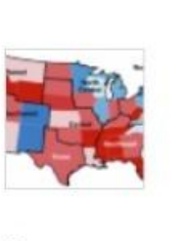
Three distinct strategies lead to programmable aliphatic C−H oxidation in bicyclomycin biosynthesis

C−H bond functionalization is widely used in chemical synthesis but achieving regio- and stereoselectivity is still challenging. Here, the authors report the mechanism of three Fe(II)/α-ketoglutarate-dependent dioxygenases in bicyclomycin biosynthesis, which depicts the natural strategy to sequentially hydroxylate specific C−H bonds of similar substrates (cyclodipeptides)

Lian Wu, Jun-Bin He & Jiahai Zhou

Article
19 May 2025 | Open Access

State-led climate action can cut emissions at near-federal costs but favors different technologies

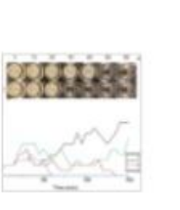


In the absence of federal decarbonization, states can drive significant greenhouse gas emissions reductions at comparable costs to federal action, with particular reliance on electrification of end uses and a decarbonized power grid.

Gavin Mouat, Christopher Galik & Jeremiah X. Johnson

Article
19 May 2025 | Open Access

Lineage-dependent variations in single-cell antibiotic susceptibility reveal the selective inheritance of phenotypic resistance in bacteria



Prior work on antibiotic resistance focused on genetic changes. In this work, authors analysed heterogeneous responses of isogenic bacterial cells to antibiotics, revealing heritable phenotypic resistance that selectively enriches robust lineages in populations.

Wesley Stine, Tatsuya Akiyama & Minsu Kim

Article
19 May 2025 | Open Access

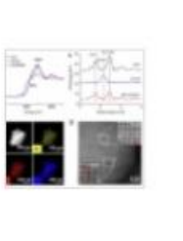
Streaks on martian slopes are dry

The global, geostatistical analysis of half a million albedo features - so-called slope streaks - suggests that modern Mars’ slopes do not commonly experience transient flows of water or brines.

Valentin Tertius Bickel & Adomas Valantinas

Article
18 May 2025 | Open Access

Distinctly different active sites of ZnO-ZrO$_2$ catalysts in CO$_2$ and CO hydrogenation to methanol reactions

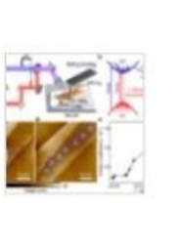


The active site of a solid catalyst depends strongly on the specific reaction. Here, the authors reveal distinct active sites for CO$_2$ and CO hydrogenation to methanol over ZnO-ZrO$_2$, using experimental surface kinetics, structural characterization, and theoretical modeling.

Jieqiong Ding, Yao Peng & Weixin Huang

Article
18 May 2025 | Open Access

Ultrafast dynamics of electronic friction energy dissipation in defective semiconductor monolayer

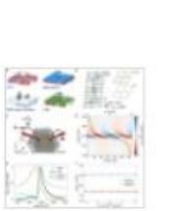


Electronic friction energy dissipation in semiconductor devices significantly impacts performance limits, yet the dynamic mechanisms remain unclear. Here, we demonstrate that defects accelerate electronic energy dissipation, enhancing friction.

Rui Han, Shihong Chen & Huan Liu

Article
18 May 2025 | Open Access

Spin-torque skyrmion resonance in a frustrated magnet

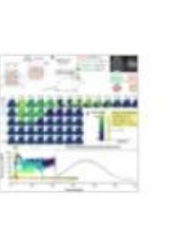


Fe$_3$Sn$_2$ hosts very robust magnetic skyrmions, stabilized via frustration, rather than the typical Dzyaloshinskii-Moriya interaction. Here, Bernstein et al. using a spin torque skyrmion resonance, detect key features of this skyrmion phase in the observed resonances, and find that this can be tuned via an applied current.

Nirel Bernstein, Hang Li & Amir Capua

Article
18 May 2025 | Open Access

Electroconvulsive therapy generates a postictal wave of spreading depolarization in mice and humans

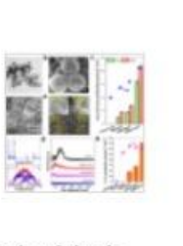


The underlying mechanism of electroconvulsive therapy remains not fully understood. Here, the authors use optical neuroimaging in mice and humans to show that electroconvulsive therapy elicits a second brain event after seizure—spreading depolarization—a previously hidden phenomenon that may help to understand and optimize this treatment.

Zachary P. Rosenthal, Joseph B. Majeski & Ethan M. Goldberg

Article
17 May 2025 | Open Access

Shielded bifunctional nanoreactor enabled tandem catalysis for plasma methane coupling



Non-thermal plasma enables direct methane conversion to valuable C$_2$ hydrocarbons, but selectivity is hindered by C$_2$H$_6$ formation and over-dehydrogenation. Here, the authors present a shielded bifunctional nanoreactor with a hollow, mesoporous design that curbs CH$_4$ overactivation and enhances selective C$_2$H$_2$ and C$_2$H$_4$ production under plasma activation.

Chunqiang Lu, Yaolin Wang & Kongzhai Li

Article
17 May 2025 | Open Access

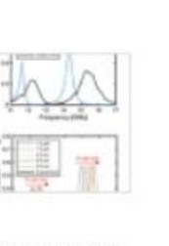
Cation-driven phase transition and anion-enhanced kinetics for high energy efficiency zinc-interhalide complex batteries

Aqueous Zn-halogen batteries suffer from efficiency loss due to polyhalide shuttling and chaotic Zn plating. Here, authors demonstrate a cation-anion synergy strategy that suppresses shuttling and directs uniform Zn deposition, achieving 95.2% high energy efficiency.

Wei Zhong, Hao Cheng & Yingying Lu

Article
17 May 2025 | Open Access

Hyperspectral imaging of microwave metasurfaces with deeply subwavelength resolution



Penketh et al. develop an approach for mapping the frequency response of thousands of meta-atoms in a microwave metasurface simultaneously, leading to the formation of detailed hyperspectral images. The approach—applicable to a wide range of metasurfaces - may overcome fabrication challenges for translation of such metasurfaces to real-world devices.

Harry Penketh, Cameron P. Gallagher & Euan Hendry

Article
17 May 2025 | Open Access

Carbon fibre production using an ecofriendly water-soluble precursor

Carbon fibre is a lightweight next-generation material with various applications, but its production often requires expensive and toxic organic solvents, as well as highly energy-intensive heating processes. Here, the authors describe the polymerisation and spinning of carbon fibre using water, along with the implementation of a rapid heating process to reduce energy consumption.

Takuya Morishita, Mamiko Narita & Nozomu Shigemitsu

Article
17 May 2025 | Open Access

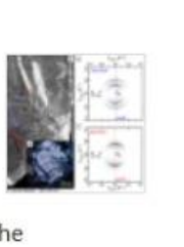
Plasmonic coffee-ring biosensing for AI-assisted point-of-care diagnostics

Penketh et al. develop an approach for mapping the frequency response of thousands of meta-atoms in a microwave metasurface simultaneously, leading to the formation of detailed hyperspectral images. The approach—applicable to a wide range of metasurfaces – may overcome fabrication challenges for translation of such metasurfaces to real-world devices.

Kamyar Behrouzi, Zahra Khodabakhshi Fard & Liwei Lin

Article
17 May 2025 | Open Access

Duality and degeneracy lifting in two-dimensional electron liquids on SrTiO$_3$(001)



Surface structures can have an important effect on the traits of two-dimensional electron liquids. Here, the authors demonstrate how the surface terminations of SrTiO$_3$(001) affect the mechanism and properties of the two-dimensional electron liquid.

Igor Sokolović, Eduardo B. Guedes & J. Hugo Dil

Article
17 May 2025 | Open Access

Characteristic scales and adaptation in higher-order contagions

People organize in groups and contagions spread across them, meanwhile groups can evolve as people adaptively move in response to the spread. Here, authors show how keeping key dynamical correlations offers new insights on contagion processes and opens the study of adaptive group-structured systems.

Giulio Burgio, Guillaume St-Onge & Laurent Hébert-Dufresne

Article
17 May 2025 | Open Access

High performance relaxor ferroelectric textured ceramics for electrocaloric refrigeration

The authors achieve a high electrocaloric temperature change (ΔT = 3.9 K) in c-textured BaTiO$_3$-KNbO$_3$ ceramics via compositional tuning and grain orientation engineering. The ΔT variation remain within ±10% across 30–80 °C, demonstrating exceptional stability.

Xuexin Li, Jingfei Li & Fei Li

Article
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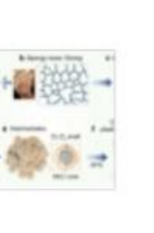
Tough and strong bioinspired high-entropy all-ceramics with a contiguous network structure



To overcome the limitation of service temperatures below 1000 °C for bioinspired ceramics, this work develops tough and strong bioinspired all-ceramics featuring a contiguous network structure that can endure temperatures up to 1300 °C.

Zijie Zhu, Yiwen Liu & Yanhui Chu

Article
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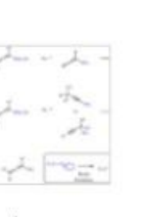
Electrochemical synthesis of allenyl silanes and allenyl boronic esters

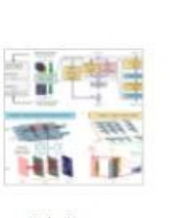


The electrochemical synthesis of allenyl silanes and boranes is reported. This approach relies on the electrochemical generation of silyl or boryl radicals and their subsequent addition to propargyl acetates or carbonates.

Tingting Feng, Tony Biremond & Thomas Poisson

Article
17 May 2025 | Open Access

Optical neural engine for solving scientific partial differential equations

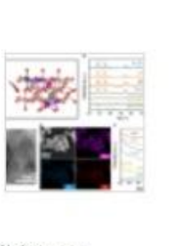


Solving partial differential equations is the cornerstone of scientific and engineering development. Here, authors show a high-performance optical neural engine architecture, combining diffractive optics and optical matrix multipliers, to solve a variety of equations in broad scientific domains.

Yingheng Tang, Ruiyang Chen & Weilu Gao

Article
17 May 2025 | Open Access

Synergistic niobium and manganese co-doping into RuO$_2$ nanocrystal enables PEM water splitting under high current



Ruthenium-based catalysts for the acidic oxygen evolution reaction under high current exhibit poor stability. Here, the authors develop a doped ruthenium oxide nanocrystal, which improves water splitting performance by stabilizing lattice oxygen and limiting the ruthenium site valence oscillation.

Bichen Yuan, Qian Dang & Xiaoming Sun

Article
17 May 2025 | Open Access

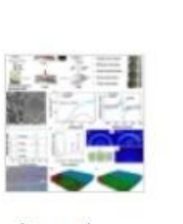
Linear magnet with fluid-solid-switchable cells for flexible devices

Controlling magnetization orientation and assembling high-coercivity micro-magnets at the microscale has been challenging due to harsh operational requirements and limited spatial precision. The authors present a stretchable linear magnet with programmable magnetization enabled by laser-activated phase-change microcells, achieving efficient and reversible reorientation under mild conditions.

Qiyu Deng, Hengjia Zhu & Liqiu Wang

Article
16 May 2025 | Open Access

Pressurized organic electrodes enable practical and extreme batteries



Organic batteries are promising for sustainable energy storage but face challenges in performance and cost. Here, authors develop pressurized organic electrodes with high capacity and durability under practical and extreme conditions, advancing organic batteries toward real-world applications.

Zhixiao Xu, Yunkai Xu & Xiaolei Wang

Article
16 May 2025 | Open Access

Lightweight error-tolerant edge detection using memristor-enabled stochastic computing

Song et al. report stochastic edge detection enabled by integrating memristor-based stochastic number encoders with logic gates to perform bitwise logic operations with statistical probabilities. A hardware Roberts cross operator achieves 95% less computational cost while withstands up to 50% bit-flip errors.

Lekai Song, Pengyu Liu & Guohua Hu

Article
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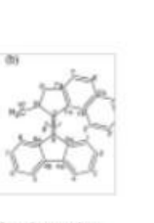
Dynamics of a light-driven molecular rotary motor in an optical cavity

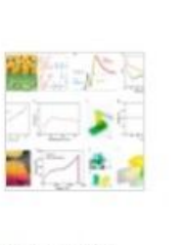


Changing characteristics of light-driven molecular motors during their action is an unsolved problem. Here, the authors propose to use coupling with photon confined in an optical cavity to manipulate the speed of rotation of molecular motors.

In Seong Lee, Michael Filatov & Seung Kyu Min

Article
16 May 2025 | Open Access

Bioinspired learning and memory in ionogels through fast response and slow relaxation dynamics of ions

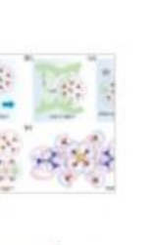


Ionogels have been integrated into soft robotics, though it is challenging to design gels with learning and memory capabilities. Here the authors introduce ionic-double-layer ionogel using cation-π interactions to program the ionogel.

Ning Zhou, Ting Cui & Peiyi Wu

Article
16 May 2025 | Open Access

Fast single metal cation conduction in ion-water aggregated aqueous battery electrolytes

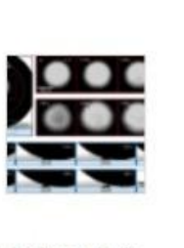


Here, the authors introduce guanidinium sulfate into metal sulfate aqueous solutions to construct ion-water aggregated electrolytes for fast single-ion conduction, achieving uniform and stable metal plating/stripping for application in aqueous batteries.

Chen Xu, Huijian Wang & Xiao Liang

Article
16 May 2025 | Open Access

Electrolyte droplet spraying in H$_2$ bubbles during water electrolysis under normal and microgravity conditions



Electrogenerated gas bubbles impair the efficiency of electrolysis and require a deeper insight into their dynamics. Here, the authors describe a transport mechanism in which electrolyte droplets from the coalescence of microbubbles are sprayed into H$_2$ bubbles.

Aleksandr Bashkatov, Florian Bürkle & Kerstin Eckert

Article
16 May 2025 | Open Access

Trifluoroethanol-assisted asymmetric propargylic hydrazination to α-tertiary ethynylhydrazines enabled by sterically confined pyridinebisoxazolines

Copper-catalyzed asymmetric propargylic substitution of α-tertiary propargylic electrophiles using hydrazines and hydroxylamines can access multifunctional α-tertiary hydrazines or hydroxylamines. Here the authors use a sterically confined pyridinebisoxazolines to improve yields and enantioselectivity, supported by NMR analysis and theoretical calculations.

Yi Gong, Zheng Zhang & Jian Zhou

Article
16 May 2025 | Open Access

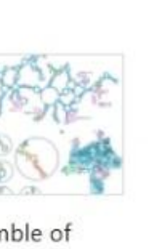
LipidIN: a comprehensive repository for flash platform-independent annotation and reverse lipidomics

LipidIN is an advanced framework designed for flash platform-independent lipid annotation. Featuring a comprehensive 168.5-million lipid fragment library with the intelligent models, LipidIN improves annotation accuracy, speed, and coverage.

Hao Xu, Tianhang Jiang & Shu-Hai Lin

Article
16 May 2025 | Open Access

Ensemble refinement of mismodeled cryo-EM RNA structures using all-atom simulations

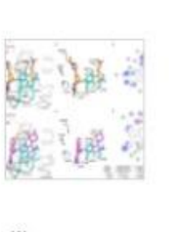


Cryo-EM often misrepresents flexible RNA molecules by averaging their conformations. Here, the authors combine cryo-EM data with all-atom simulations to refine a dynamic ensemble of complex RNA macromolecules, revealing the limits of single-structure models in flexible regions.

Elisa Posani, Pavel Janoš & Giovanni Bussi

Article
16 May 2025 | Open Access

Identification of naturally occurring drug-resistant mutations of SARS-CoV-2 papain-like protease

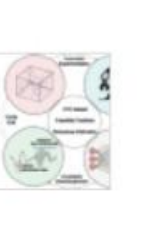


This study identifies E167, Y268, and Q269 as drug-resistant hotspots for SARS-CoV papain-like protease inhibitors that bind to the BL2 loop and groove region, which are valuable in informing the design of the next-generation PLpro inhibitors.

Haozhou Tan, Qianru Zhang & Jun Wang

Article
15 May 2025 | Open Access

Towards global reaction feasibility and robustness prediction with high throughput data and bayesian deep learning

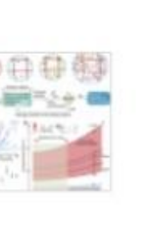


Although theoretical advances in the reactivity of organic compounds have progressed rapidly, a complete understanding of the causal relationships between molecular structures and reaction outcomes based solely on first principles remains elusive. Here, the authors use an in-house HTE platform to conduct over 11,000 distinct acid amine couplings, with an accompanying Bayesian neural network model that gives a prediction accuracy of 89.48% for reaction feasibility.

Haowen Zhong, Yilan Liu & Xiaoxue Wang

Article
15 May 2025 | Open Access

Bioinspired nondissipative mechanical energy storage and release in hydrogels via hierarchical sequentially swollen stretched chains



Materials with efficient mechanical energy storage are found in Nature, though synthesizing hydrogels mimicking these properties are challenging. This study shows by sequentially swelling hydrogels the mechanic properties can be properly balanced.

Henri Savolainen, Negar Hosseiniyan & Olli Ikkala

Article
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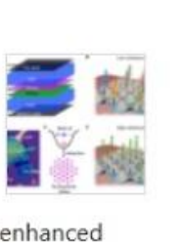
Enhanced coherence from correlated states in WSe$_2$/MoS$_2$ moiré heterobilayer



The interaction between correlated states and the excitonic emission coherence in van der Waals moiré systems remains largely unexplored. Here, the authors report evidence of enhanced interlayer exciton emission coherence in twisted WSe$_2$/MoS$_2$ heterobilayers, attributed to exciton-exciton and exciton-electron interactions.

Qinghai Tan, Abdullah Rasmita & Wei-bo Gao

Article
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Photoexcited nitroarene-enabled carbon chain-elongated oxidation of alkenes via tandem oxidative cleavage and dipolar cycloaddition

Chain-elongating oxidations enable molecular complexity to be carefully and logically assembled. Herein, the authors report a photoexcited nitroarene-enabled regioselective chain-elongated oxidation of alkenes via tandem oxidative cleavage and dipolar cycloaddition, providing a broad range of synthetically-useful isoxazolidines from readily available enol ethers or styrene and derivatives.

Xuqiang Guo, Xinwen Cui & Mengchun Ye

Article
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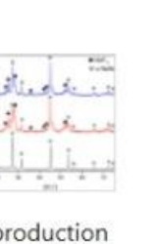
Rare earth metals production using alternative feedstock that eliminates HF



This work reports the metallothermic production of rare earth (RE) Nd metal using NaNdF$_4$ as an alternative fluoride salt, without HF use or generation, enabling safer, scalable production of critical RE metals for advanced technologies and industry

Anirudha Karati, Harshida Parmar & Ikenna C. Nlebedim

Article
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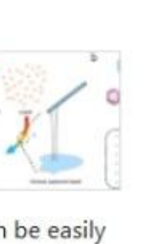
Full-color processible afterglow organic small molecular glass



Organic afterglow materials have gained significant attention in recent years but developing long-lasting, highefficiency, full-color small molecule afterglow systems which can be easily processed remain challenging. Here the authors design a processable molecular glass and employ it as a host in a host-guest strategy to address these challenges.

Yufeng Xue, Zongliang Xie & Bin Liu

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