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Featured

Article
30 May 2025 | Open Access

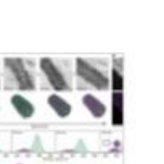
Short-range order controlled amphoteric behavior of the Si dopant in Al-rich AlGaN

The authors show that the amphoteric nature of the Si dopant that prevents efficient *n*-type doping in high Al-content AlGaN alloys is controlled by the ordering of the Ga and Al atoms in the immediate surroundings of the Si atom.

Igor Prozheev, René Bès & Filip Tuomisto

Article
29 May 2025 | Open Access

Synthesis of noble metal nanoarrays via agglomeration and metallurgy for acidic water electrolysis



Current noble metal catalysts enable efficient proton exchange membrane water electrolysis but suffer from instability. Here, the authors report an agglomeration and smelting strategy to create ruthenium-based nanoarray catalysts, enabling water electrolysis for over 500 hours at 1 A cm^{-2}.

Jiawei Tao, Ruiqin Gao & Huibin Qiu

Article
29 May 2025 | Open Access

Design of circularly polarized phosphorescence materials guided by transfer learning

High luminescence dissymmetry in materials can be achieved through twisted stacking of achiral anisotropic layers. Here the authors use machine-learning techniques to predict this stacking and realize circularly-polarized-phosphorescence materials.

Xu Liu, Yihan Zhang & Gang Zou

Article
29 May 2025 | Open Access

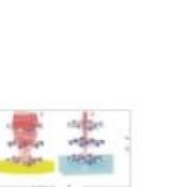
High-entropy-doping effect in a rapid-charging $\mathrm{Nb_2O_5}$ lithium-ion battery negative electrode

Doping of $\mathrm{Nb_2O_5}$ materials without phase changes has been proven difficult, with successful doping depending on different factors such as ionic radius similarity. In this work, the authors introduce a high-entropy-doping approach to $\mathrm{Nb_2O_5}$ without phase change with rapid-charging capabilities as a negative electrode for lithium-ion batteries.

Junling Xu, Fuqiang Xie & Zhipeng Sun

Article
29 May 2025 | Open Access

Boosting classical and quantum nonlinear processes in ultrathin van der Waals materials



The efficiency of nonlinear optical processes in 2D materials is often reduced by weak light-matter interactions and crystal symmetry constraints. Here, the authors report the enhancement of classical second-harmonic generation in hexagonal boron nitride and quantum spontaneous parametric down-conversion in $\mathrm{NbOCl_2}$ flakes by combining them with Au or $\mathrm{SiO_2}$/Au substrates.

Xiaodan Lyu, Leevi Kallioniemi & Weibo Gao

Article
29 May 2025 | Open Access

Hexafluorophosphate additive enables durable seawater oxidation at ampere-level current density

Seawater electrolysis at ampere-level current densities demands durable anodes for practical hydrogen production. Here, the authors report that a single non-oxygen anion enables dual modulation of surface and interlayer structures, stabilizing layered double hydroxide anodes for over 5,000 hours.

Xun He, Yongchao Yao & Xuping Sun

Article
29 May 2025 | Open Access

Super-resolution imaging in whole cells and tissues via DNA-PAINT on a spinning disk confocal with optical photon reassignment

Zaza and colleagues demonstrate that DNA-PAINT on a spinning disk confocal microscope with optical photon reassignment enables high-resolution imaging across large fields and imaging depths, resolving nanoscale protein organisation in both cells and tissues.

Cecilia Zaza, Megan D. Joseph & Sabrina Simoncelli

Article
29 May 2025 | Open Access

Oxygen-doped carbon-supported palladium nanoparticles boost the tandem hydrogenation–acetalization–hydrogenolysis of phenols and diphenyl ethers to cyclohexyl ethers

The one-pot hydrotreatment of phenols to cyclohexyl ethers is crucial but difficult to achieve for fine chemical synthesis. Here, the authors prepare surface oxygen-doped carbonsupported Pd nanoparticles and demonstrate tandem hydrogenation–acetalization–hydrogenolysis of phenol to cyclohexyl methyl ether with high yield.

Lang Jiang, Xiang Li & Qiang Deng

Article
29 May 2025 | Open Access

Visualizing hot carrier dynamics by nonlinear optical spectroscopy at the atomic length scale

Here, by realising nonlinear optical spectroscopy at the atomic length scale, the authors capture complex energy-dependent dynamics of hot carriers in a single molecule. The hot carrier and the nonlinear-wave mixing signals are enhanced at the regions of high local density of states in the molecule.

Yang Luo, Shaoxiang Sheng & Manish Garg

Article
29 May 2025 | Open Access

Scaled CO Electroreduction to Alcohols

The electrocatalytic upgrading of $\mathrm{CO_2}$/CO provides a promising route to produce carbon-neutral alcohols but suffers from product loss to crossover and dilution. Here, the authors report on a CO reduction electrolyzer that recovers over 85% of alcohol without dilution, which is then scaled to 800 cm^2.

Panagiotis Papangelakis, Colin P. O'Brien & David Sinton

Article
29 May 2025 | Open Access

Quantum dot LEDs emitting broadband vortex beams

The authors demonstrate quantum dot LEDs that emit broadband directional vortex beams. This work contributes to expanding the functionalities offered by LEDs, endowing them with features that are usually associated with lasers.

Guillaume Boulliard, Iännis Roland & Aloyse Degiron

Article
29 May 2025 | Open Access

Kramers nodal lines in intercalated $\mathrm{TaS_2}$ superconductors

The authors study the non-centrosymmetric achiral material $\mathrm{In_xTaS_2}$ by angle-resolved photoemission spectroscopy and quantum oscillations. They find that it hosts an "ideal" Kramers nodal line, well isolated at the Fermi level.

Yichen Zhang, Yuxiang Gao & Ming Yi

Article
29 May 2025 | Open Access

Discovery of the α-emitting isotope ^{210}Pa

The study of isotopes away from the beta stability valley is crucial for the understanding of nuclear structure, especially for neutron-deficient heavy nuclei. Here, the authors report the observation of the alpha-decay isotope 210-protactinium (Pa), extending the alpha-decay systematics of underexplored regions of the nuclides chart.

M. M. Zhang, J. G. Wang & S. G. Zhou

Article
29 May 2025 | Open Access

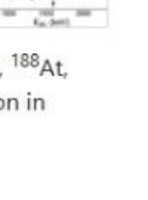
New proton emitter ^{188}At implies an interaction unprecedented in heavy nuclei

Particle radiation studies have been one of the elementary keystones since the dawn of the nuclear physics. Here, the authors discovered the heaviest proton emitting isotope to date, ^{188}At, that points to a trend change in binding energy systematics, further implying a novel interaction in heavy nuclei.

Henna Kokkonen, Kalle Auranen & Martin Venhart

Article
29 May 2025 | Open Access

Overcoming the trade-off between conductivity and strength in copper alloys through undercooling



Copper alloys with high strength and conductivity are essential for modern industries. Here, the authors find an approach to enhance the conductivity of Cu-Be alloys by inducing spherical Be-rich clusters through deep undercooling.

Bowen Zhang, Pingda Xu & Fuping Dai

Article
29 May 2025 | Open Access

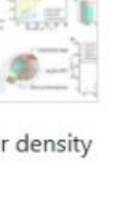
High-performance $\mathrm{Ag_2Se}$-based thermoelectrics for wearable electronics

The authors report a flexible thermoelectric film, comprising $\mathrm{Ag_2Se}$ and reduced graphene oxide, achieving a power factor of 37 μW cm^{-1} K^{-2} in the film and a normalized power density of over 9.8 μW cm^{-2} K^{-2} in the out-of-plane device.

Lin Zhang, Xiao-Lei Shi & Zhi-Gang Chen

Article
29 May 2025 | Open Access

A single spin in hexagonal boron nitride for vectorial quantum magnetometry



Defects in materials can be used to detect magnetic fields at the nanoscale. Here the authors show that a carbon-related defect in hexagonal boron nitride acts as a robust nanoscale sensor capable of vectorial magnetic field detection.

Carmem M. Gilardoni, Simone Eizagirre Barker & Hannah L. Stern

Article
28 May 2025 | Open Access

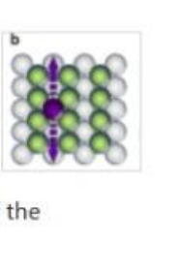
Anisotropic atom motion on a row-wise antiferromagnetic surface

Atom diffusion on surfaces is a fundamental process, which is widely believed to be independent of magnetic interactions. Here, the authors demonstrate that the symmetry of the magnetic state restricts adatom movement to one dimension.

Felix Zahner, Soumyajyoti Haldar & André Kubetzka

Article
28 May 2025 | Open Access

In situ and real-time ultrafast spectroscopy of photoinduced reactions in perovskite nanomaterials



Asynchronous and interferometric transient absorption is used to spectroscopically investigate perovskite nanomaterials undergoing light-induced reactions during measurements, monitoring the associated real-time ultrafast photophysical changes of materials.

Gi Rim Han, Mai Ngoc An & Minhaeng Cho

Article
28 May 2025 | Open Access

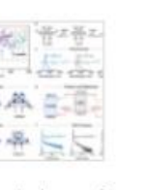
Stable narrowband blue OLEDs by modulating frontier molecular orbital levels

Multiple resonance (MR) emitters with narrowband luminescence typically suffer from inadequate frontier molecular orbital levels. Here, authors incorporate cyano motifs at peripheral sites of the MR backbone to adjust the energy levels, realizing device efficiency of over 23% for stable devices.

Xiao-Chun Fan, Xun Tang & Xiao-Hong Zhang

Article
28 May 2025 | Open Access

Chiral dual-annihilator model for controllable photon upconversion and multi-dimensional optical modulation

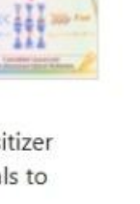


Triplet-triplet annihilation upconversion efficiency is limited by the energy matching of the sensitizer and acceptor parts. Here, the authors report a dual annihilator system in chiral liquid crystals to achieve efficient circularly polarized emission.

Honghan Ji, Zhiwang Luo & Pengfei Duan

Article
28 May 2025 | Open Access

Elastic circular organic microcrystals prepared by photoinduced delamination

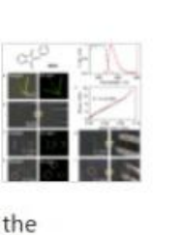


Circular organic crystals could be useful as components in flexible organic optoelectronics, but their shape is not easy to obtain. Here, the authors report a method for the formation of quasicircular crystals by photoinduced bending then delamination of a parent crystal.

Chengde Ding, Baolei Tang & Hongyu Zhang

Article
28 May 2025 | Open Access

Plasmon mode engineering with electrons on helium



Trapping electrons on a superfluid helium surface provides access to collective quantum phenomena and a platform for circuit quantum electrodynamics (cQED). Here, the authors demonstrate precision spatial and frequency engineering of plasmonic modes in a hybrid electron-on-helium system, opening the door towards integration of plasmon physics within future cQED-like devices.

Camille A. Mikolas, Niyaz R. Beysengulov & Johannes Pollanen

Article
28 May 2025 | Open Access

Shape memory polymer surfaces with controllable roughness for multiscale switchable dry adhesion

Switchable control of adhesion is an important feature applicable for robotic manipulation, medical adhesives, and scalable microassembly. Here, the authors leverage the shape memory effect of shape memory polymers to modulate surface roughness, thereby enabling switchable adhesion across multiple scales.

Junhyung Kim, Seungbeom Kim & Seok Kim

Article
28 May 2025 | Open Access

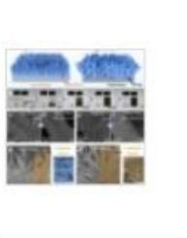
Interlayer-bonded Ni/$\mathrm{MoO_2}$ electrocatalysts for efficient hydrogen evolution reaction with stability over 6000 h at 1000 mA cm^{-2}

The mechanical stability of catalytic electrodes is crucial for anion exchange membrane water electrolysis. Here, the authors report a corrosion strategy to construct an electrode with high mechanical stability by anchoring a blade-shaped catalytic layer onto a dense interlayer.

Anrui Dong, Gaoxin Lin & Licheng Sun

Article
28 May 2025 | Open Access

Self-packaged stretchable printed circuits with ligand-bound liquid metal particles in elastomer



Conventional stretchable circuit fabrication requires complex packaging to prevent leakage. Here the authors introduce a self-packaging stretchable circuit enabled by in situ sintering of ligand-bound liquid metal particles, allowing scalable, leakage-free, multilayer integration.

Hyeonyeob Seo, Gun-Hee Lee & Seongjun Park

Article
28 May 2025 | Open Access

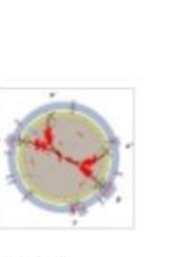
Test of local realism via entangled \(\Lambda \bar{\Lambda }\) system

While Bell inequalities have been violated several times—mostly in photonic systems—their violations within particle physics experiments are less explored. Here, the BESIII Collaboration showcases Bell-violating nonlocal correlations between entangled hyperon pairs.

M. Ablikim, M. N. Achasov & J. Zu

Article
28 May 2025 | Open Access

Copper-catalyzed enantioselective three-component radical 1,4-perfluoroalkylamination of 1,3-dienes



Catalytic enantioselective three-component aminative difunctionalization of 1,3-dienes offers a straightforward methodology to access chiral allylic amines, but using anilines as aminating reagents is underdeveloped. Here, the authors report a copper-catalyzed enantioselective radical three-component 1,4-perfluoroalkylamination of 1,3-dienes with anilines and perfluoroalkyl reagents.

Xiaoyan Shangguan, Lihan Zhu & Qian Zhang

Article
28 May 2025 | Open Access

Direct synthesis of N-trifluoromethyl amides via photocatalytic trifluoromethylamidation

The synthesis of N-$\mathrm{CF_3}$ amides is of great interest, but the direct preparation of these compounds via established amidyl radical chemistry remains underexplored. Here, the authors report the synthesis of N-(N-$\mathrm{CF_3}$ imidoyloxy) pyridinium salts and demonstrate their utility as trifluoromethylamidyl radical precursors in photocatalytic trifluoromethylamidation reactions.

Ru-Zhong Zhang, Yang Liu & Mang Wang

Article
28 May 2025 | Open Access

Conformal hexagonal boron nitride encapsulation of graphene-skinned glass fiber fabric for enhanced electrical stability

Hexagonal boron nitride (h-BN) encapsulation is important to improve the performance of graphene devices, but it is normally restricted by exfoliation and transfer methods. Here, the authors report the conformal h-BN encapsulation for the hierarchical configuration of large-scale graphene-skinned glass fiber fabrics via chemical vapor deposition, leading to improved electrical and thermal stability.

Xiaomin Yang, Yuyao Yang & Yue Qi

Article
28 May 2025 | Open Access

Searching for dark matter with a spin-based interferometer

Interferometric detection schemes exploit phase-sensitive combination of spatially separated observation to increase sensitivity. Here, the authors combine data from two atomic comagnetometers separated by 860 km to improve limits on axion-like particles across nine orders of magnitude of mass range.

Daniel Gavilan-Martin, Grzegorz Lukasiewicz & Arne Wickenbrock

Article
28 May 2025 | Open Access

Estimating small area population from health intervention campaign surveys and partially observed settlement data

A two-step Bayesian model improves small area population estimates by integrating health campaign data or household surveys with incomplete satellite settlement maps. It reduces errors by up to 73%, offering a practical solution in regions where traditional methods face limitations.

Chibuzor Christopher Nnanatu, Amy Bonnie & Andrew J. Tatem

Article
28 May 2025 | Open Access

Bioadhesive hydrogel-coupled and miniaturized ultrasound transducer system for long-term, wearable neuromodulation

Transcranial focused ultrasound can be used for neuromodulation, but its use in wearable systems remains challenging. The authors present a miniaturised wearable ultrasound device, integrated with a bioadhesive hydrogel for stable, long-term somatosensory cortical stimulation.

Kai Wing Kevin Tang, Jinmo Jeong & Huiliang Wang

Article
28 May 2025 | Open Access

Expanded ribosomal synthesis of non-standard cyclic backbones in vitro

The ribosome has evolved to link standard amino acids into proteins via peptide bonds. Here, authors expand its chemistry to directly synthesize novel 5- and 6- membered cyclic backbones from noncanonical monomers, revealing new ribosomal potential for advanced biopolymer design.

Kanghun Lee, Hyeongwoo Park & Joongoo Lee

Article
27 May 2025 | Open Access

Elastocapillary sequential fluid capture in hummingbird-inspired grooved sheets

Efficient small-scale fluid capture and transport is essential for point-of-care diagnostics but faces trade-offs between speed, volume, and flow resistance. Inspired by hummingbirds, the proposed elastocapillary device enables rapid, passive fluid capture and aliquoting, combining capillarity and elasticity for optimal performance.

Emmanuel Siéfert, Benoit Scheid & Jean Cappello

Article
27 May 2025 | Open Access

Regulating orbital interaction to construct quasi-covalent bond networks in Pt intermetallic alloys for high-performance fuel cells

Pt-based alloy cathode catalysts in proton exchange membrane fuel cells face persistent challenges, including rapid oxidation and loss of transition metal/Pt. Here, the authors report a covalentization concept in intermetallic L1$_2$-structure Pt-based alloys to boost stability in fuel cells.

Xuan Liu, Yuhan Wang & Qing Li

Article
27 May 2025 | Open Access

Cell-guiding microporous hydrogels by photopolymerization-induced phase separation

Microporous hydrogels have potential in 3D tissue culture, but precise control over pore formation is challenging. Here, the authors report the use of photopolymerization-induced phase separation to prepare hydrogels suitable for 3D cell culture and bioprinting.

Monica Z. Müller, Margherita Bernero & Xiao-Hua Qin

Article
27 May 2025 | Open Access

Expedient access to bora-butenolide bioisosteres by counteranion-mediated *trans*-hydroboration of alkynes

Boron-containing drug candidates have garnered increasing attention due to their pharmacological properties and application in boron neutron capture therapy. Here, the authors report a transition metal-free anti-addition of pinacolborane to alkynes, facilitated by the counteranion effect for the facile construction of bora-butenolide bioisosteres.

Yuan-Wen Liu, Yu Liu & Hongming Jin

Article
27 May 2025 | Open Access

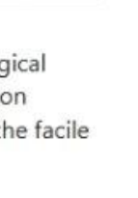
Chiral polaron formation on the edge of topological quantum matter

Mobile impurities can be useful probes of quantum states. Here, the authors theoretically identify polarons formed on the edge of topological insulating states, termed chiral polarons, that can be used to probe topological matter.

Amit Vashisht, Ivan Amelio & Nathan Goldman

Article
27 May 2025 | Open Access

Blood-triggered self-sealing and tissue adhesive hemostatic nanofabric



Seepage can be an issue in haemostatic dressings. Here, the authors combine anionic and cationic nanofibers, which can absorb surface blood and form a seal, encapsulating blood components and forming a rapid thrombus while remaining biocompatibility and biodegradation properties.

Yan Fang, Linyu Wang & Haiqing Liu

Article
27 May 2025 | Open Access

Interlayer engineering of lattice dynamics and elastic constants of 2D layered nanomaterials under pressure

Pressure-induced modulation of interlayer coupling and elastic constant in two-dimensional layered materials is quantitatively described through a unified chain model, offering insights into the tunable mechanical behaviors under extreme conditions.

Guoshuai Du, Lili Zhao & Yabin Chen

Article
27 May 2025 | Open Access

Coherently confined single-metal-atom chains in 2D semiconductors

Single-metal-atom chains (SMACs) possess unique quantum properties yet suffer from structural instability. Here, the authors develop a computational protocol to screen transition metals capable of forming SMACs that are coherently confined in $\mathrm{MoS_2}$ twin boundaries and stabilised by surrounding lattices. Their theoretical predictions are validated by experimentally synthesised Co, Ni, Pd, and Pt atomic chains.

Wen Qin, Shasha Guo & Zhuhua Zhang

Article
27 May 2025 | Open Access

A reconfigurable arbitrary retarder array as complex structured matter

Retarder arrays enable advanced photonic applications but are limited by controllable flexibility. Here, authors demonstrate a compound modulator that creates synthetic tuneable retarder arrays, offering unprecedented dynamic control of light, enabling new beam generation, analysis, and correction.

Chao He, Binguo Chen & Andrew Forbes

Article
27 May 2025 | Open Access

Memristive Bellman solver for decision-making

Bellman equation is widely applied in solving dynamic optimization problems. Here, the authors present a memristive Bellman solver reducing the computational complexity and improving energy efficiency for advanced decision-making process.

Zhe Feng, Zuheng Wu & Qi Liu

Article
27 May 2025 | Open Access

Mercapto-functionalized scaffold improves perovskite buried interfaces for tandem photovoltaics

It is generally more difficult to modify the buried interfaces compared to top interfaces in tin-lead perovskite subcells. Here, the authors employ a mercapto-functionalized mesoporous silica layer as a scaffold for perovskite, realizing maximum efficiency of 29.6% for double-junction tandem solar cells.

Jianan Wang, Shuaifeng Hu & Wei Chen

Article
27 May 2025 | Open Access

Cu(I)-catalysed chemo-, regio-, and stereoselective radical 1,2-carboalkynylation with two different terminal alkynes

Transition-metal-catalyzed asymmetric multicomponent reactions with two similar substrates often suffer from the lack of strategies to control the chemo-, regio-, and stereoselectivity. Here, the authors report a Cu(I)-catalyzed asymmetric radical 1,2-carboalkynylation of two different terminal alkynes and alkyl halides with chemo-, regio-, and stereoselectivity.

Jun-Qian Bian, Li Qin & Xin-Yuan Liu

Article
27 May 2025 | Open Access

Understanding shell coating effects to overcome quenching in single anisotropic upconversion nanoparticles

Shell coatings reduce luminescence quenching in spherical nanoparticles for upconversion, but individual nanorods are less well studied. Here, the authors investigate the effects of coatings on individual nanorods and show that their effectiveness depends on power density and shell types.

Yangjian Cai, Ming Lu & Jiajia Zhou

Article
27 May 2025 | Open Access

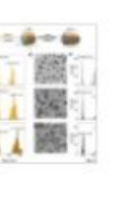
A self-sufficient system for fog-to-water conversion and nitrogen fertilizer production to enhance crop growth

In this work, authors demonstrate a self-sufficient fog harvester system that simultaneously produces nitrogen-based nutrients for fertilizer via spark-driven nitrogen fixation. The device has the potential to enhance crop growth sustainably without additional energy input or pollutant emissions.

Zhenwen Zhang, Tong Li & Steven Wang

Article
27 May 2025 | Open Access

Near-infrared II cyanine fluorophores with large stokes shift engineered by regulating respective absorption and emission



Fluorescence bioimaging in the second near-infrared (NIR-II) window facilitates in vivo diagnosis and treatment of diseases, but NIR-II fluorophores with large Stokes shifts are scarce. Here, the authors report an asymmetrical cyanine framework that exhibits NIR-II fluorescence and large Stokes shift (167–260 nm), enabling clear imaging of the fine bone structure of the mouse knee joint.

Diankai Liu, Ziou He & Wen Shi

Comment
26 May 2025 | Open Access

Multifunctional interface engineering enables efficient and stable inverted organic photovoltaics

The efficiency and light stability of inverted organic photovoltaics have been limited by the defects and photocatalytic reactivity of metal oxides transport layer. Here, authors discuss the recent progress and potential solutions for this technology to be put into production and industrialization.

Bowen Liu, Jian Qin & Chang-Qi Ma

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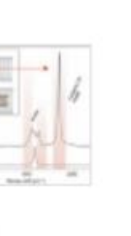
Featured

Article
26 May 2025 | Open Access

Anharmonic effects control interaction of carbyne confined in carbon nanotubes shaping their vibrational properties

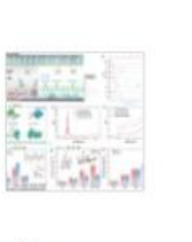


Carbynes are bulk linear chains of carbon atoms that can be stabilized inside carbon nanotubes. Here the authors show that while electronic states of tube and chain are decoupled, their vibrational structure is strongly altered by anharmonic interactions.

Emil Parth, Andrea Corradini & Thomas Pichler

Article
26 May 2025 | Open Access

Electron displacement polarization of high-dielectric constant fiber separators enhances interface stability



Electrostatic effects of separators under internal electric field is crucial for Li metal batteries. Here, authors develop a high dielectric constant fiber separator that shows substantial polarization under electric field to facilitate a robust and low-resistance solid-electrolyte interphase.

Tao Zhang, Xiaoqing Zhu & Meifang Zhu

Article
26 May 2025 | Open Access

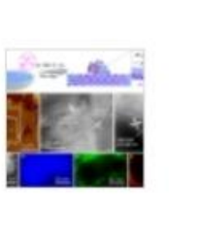
Solid-state eutectic electrolyte via solvation regulation for voltage-elevated and deep-reversible Zn batteries

Problems at interior metal plating/stripping and low voltage hinder the development of Zn batteries. Here, the authors propose a nonflammable ternary solid-state eutectic electrolyte via solvation regulation, contributing to deep-reversible Zn plating/stripping and voltage increase of full batteries.

Wei Ling, Funian Mo & Yan Huang

Article
26 May 2025 | Open Access

Boosted charge and proton transfer over ternary Co/Co$_3$O$_4$/CoB for electrochemical nitric oxide reduction to ammonia

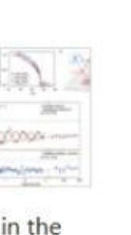


The electrochemical NH$_3$ synthesis from NO reduction faces challenges, including weak NO adsorption and sluggish proton supply. Here, the authors report a ternary Co/Co$_3$O$_4$/CoB heterostructure promotes NO adsorption while boosting H$_2$O dissociation and subsequent hydrogenation to produce NH3.

Xiaoxuan Fan, Zhenyuan Teng & Dengsong Zhang

Article
26 May 2025 | Open Access

Frustrated phonon with charge density wave in vanadium Kagome metal

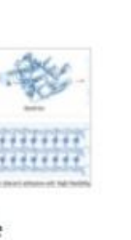


The underlying mechanism behind charge density wave formation in Kagome metals is still not fully understood. Here, the authors propose that the phonon modes become frustrated in the charge density wave phase of CsV$_3$Sb$_5$.

Seung-Phil Heo, Choongjae Won & Changyong Song

Article
26 May 2025 | Open Access

An in-situ assembled cobweb-like adhesive with high processability



Flexible low temperature adhesives are highly desired, though preserving these properties at low temperatures is challenging. Here the authors show a cobweb-inspired flexible adhesive, resistant to low temperatures, and can be fabricated without solvent on the kilogram scale.

Xiaoming Xie, Runhan Li & Ya-Qian Lan

Article
26 May 2025 | Open Access

Provoking tumor disulfidptosis by single-atom nanozyme *via* regulating cellular energy supply and reducing power

The therapeutic applications of disulfidptosis are promising but underexplored. Here, the authors report a strategy for inducing tumor disulfidptosis via interrupting cellular energy supply and reducing power by integrating a copper single-atom nanozyme and glucose oxidase.

Wenxin Yu, Duo Jin & Yangzhong Liu

Article
26 May 2025 | Open Access

Chromatic forecasting hydrogels for anti-icing applications

An icing forecast hydrogel device encapsulating ice-nucleating proteins colorimetrically predicts ice formation with high accuracy. The device successfully activated a wind turbine deicing system 70 min before ice accumulation.

Wenxuan Hou, Xiaofei Chen & Zhiyuan He

Article
26 May 2025 | Open Access

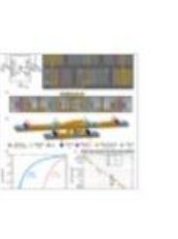
Magnetic geometry induced quantum geometry and nonlinear transports

Nonlinear transport has recently been shown to allow efficient detection of the Néel vector, however, antiferromagnets hosting nonlinear transport are assumed rare, due to the required strong spin-orbit coupling. Here, Zhu, Li and coauthors find that the magnetic order itself can yield large nonlinear transport.

Haiyuan Zhu, Jiayu Li & Qihang Liu

Article
26 May 2025 | Open Access

Enabling static random-access memory cell scaling with monolithic 3D integration of 2D field-effect transistors

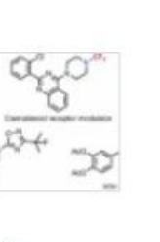


The downscaling process of conventional static random-access memory (SRAM) cells has recently slowed down, posing challenges for future electronic devices. Here, the authors demonstrate ~40% reduction in cell area and improved interconnect length for 2-tier 3D-integrated SRAM cells based on 2D MoS$_2$ transistors.

Muhtasim Ul Karim Sadaf, Ziheng Chen & Saptarshi Das

Article
26 May 2025 | Open Access

A mild and practical approach to *N*-CF$_3$ secondary amines via oxidative fluorination of isocyanides

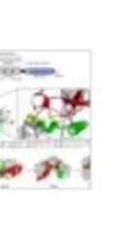


The efficient preparation of inherently unstable N-CF3 secondary amines remains a challenge in synthetic chemistry. Herein, the authors present the synthesis of this type of compounds via oxidative fluorination of isocyanides using iodine as the oxidant, silver fluoride as the fluorinating reagent, and tert-butyldimethylsilane as the proton precursor.

Jia-Luo Fu, Jun-Yunzi Wu & Qingjiang Li

Article
26 May 2025 | Open Access

High-speed atomic force microscopy and 3D modeling reveal the structural dynamics of ADAR1 complexes



In this study, the authors combine 3D modeling and high-speed atomic force microscopy (HS-AFM) to elucidate the structural basis for the regulation of ADAR1, focusing on the interface regions of the deaminase domain involved in ADAR1 dimerization.

Madhu Biyani, Yasuhiro Isogai & Miki Nakajima

Article
26 May 2025 | Open Access

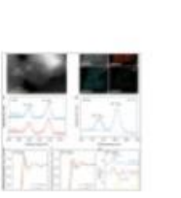
Sieving pore design enables stable and fast alloying chemistry of silicon negative electrodes in Li-ion batteries

Silicon electrodes promise high energy for lithium-ion batteries but face swelling and durability issues. Here, the authors design a sieving-pore design that enables stable, fast-charging silicon electrodes with long cycle life, low expansion, and industrial-scale potential.

Jiaxing He, Youzhi Deng & Quan-Hong Yang

Article
25 May 2025 | Open Access

Ampere-level co-electrosynthesis of formate from CO$_2$ reduction paired with formaldehyde dehydrogenation reactions

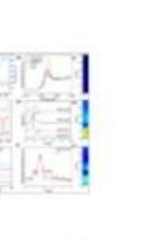


Developing high-productive and energy-saving systems in formate electrosynthesis is attractive but challenging. Here, the authors report an efficient Rh-dispersed In$_2$O$_3$ catalyst for CO$_2$ reduction, benefiting the ampere-level formate coproduction when pairing with anodic aldehyde oxidative dehydrogenation.

Zhengyuan Li, Peng Wang & Jingjie Wu

Article
25 May 2025 | Open Access

Boosting the activity in the liquid-phase hydrogenation of S-containing nitroarenes by dual-site Pt/CeO$_2$ catalysts design



Liquid-phase hydrogenation of nitroarenes is a key industrial process, but conventional supported metal nanoparticles often suffer deactivation in the presence of sulfur-containing groups. Here, the authors design a dual-site Pt/CeO$_2$ catalyst that enables selective hydrogenation of S-nitroarenes by separating catalytic roles.

Xiaomin Ren, Jiayi Huang & Yuefeng Liu

Article
25 May 2025 | Open Access

Nucleophilic aromatic substitutions enable diversity-oriented synthesis of heterocyclic atropisomers via non-atropisomeric intermediates

Atropisomers are sterically hindered molecules whose formation typically proceeds via atropisomeric intermediates and encumbered transition states. Here, the authors report regio- and chemoselective nucleophilic aromatic substitution (S$_N$Ar) reactions for the synthesis of heterobiaryl C—N atropisomers, via non-atropisomeric intermediates and transition states.

Michal Šimek, Paritosh Dey & Paulo H. S. Paioti

Article
25 May 2025 | Open Access

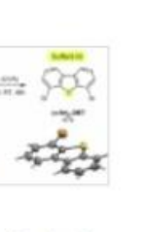
Origin of compact exoplanetary systems during disk infall

Compact exoplanetary systems masses have a similar mass ratio compared to the host star's mass. Here, authors propose that these planets are surviving remnants of planet accretion during the end stages of stellar infall.

Raluca Rufu & Robin M. Canup

Article
24 May 2025 | Open Access

Photoinduced modulation of the oxidation state of dibenzothiophene *S*-oxide molecules on an insulating substrate



On-surface chemistry can overcome the limitations of in-solution synthesis but so far has been limited to metal substrates and unconventional mechanisms, thereby precluding a direct transposition of classic organic reactions. Herein, the authors report the photoinduced deoxygenation of dibenzothiophene S-oxide on insulating alkali halide surfaces in ultra-high vacuum.

Mélissa Hankache, Valentin Magné & Laurent Nony

Article
24 May 2025 | Open Access

Single-shot reconstruction of three-dimensional morphology of biological cells in digital holographic microscopy using a physics-driven neural network

Here, the authors demonstrate MorpHoloNet: a physics-driven, coordinate-based deep learning model enabling single-shot reconstruction of 3D morphology and refractive index distribution of biological cells in digital holographic microscopy without angular scanning.

Jihwan Kim, Youngdo Kim & Sang Joon Lee

Article
24 May 2025 | Open Access

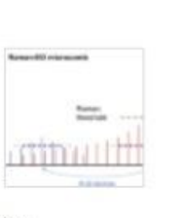
Orbital-level band gap engineering of RuO$_2$ for enhanced acidic water oxidation

Improving oxygen evolution in acidic water electrolysis is vital for advancing clean hydrogen production. Here, the authors report that doping ruthenium oxide with selenium enhances efficiency and durability by tuning orbital band gaps, improving electron flow, and stabilizing oxygen vacancies.

Xing Wang, Wei Pi & Na Yao

Article
24 May 2025 | Open Access

Self-locked broadband Raman-electro-optic microcomb



Optical frequency combs power technologies like communication but face stability issues in miniaturization. Here, authors present a self-locked microcomb in a lithium niobate chip by combining electro-optic, Kerr, and Raman effects, achieving a 300 nm span and low noise without external feedback.

Shuai Wan, Pi-Yu Wang & Chun-Hua Dong

Article
24 May 2025 | Open Access

Real-time 3D temperature reconstruction in microwave cancer hyperthermia from scarce temperature measurements

Microwave hyperthermia enhances cancer treatment but needs precise temperature control. Here, the authors present a method to provide real-time 3D temperature monitoring with minimal invasiveness, by matching a patient-specific library of simulations to a set of scarce and noisy measurements.

Rossella Gaffoglio, Giorgio Giordanengo & Giuseppe Vecchi

Article
24 May 2025 | Open Access

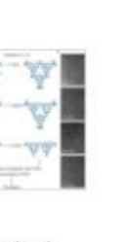
Mapping in situ the assembly and dynamics in aqueous supramolecular polymers

The dynamic behavior of supramolecular polymers in aqueous environments remains poorly understood due to the assembly pathway complexity. Here, the authors present a combinatorial titration methodology to probe in situ a binary assembly mechanism between spheroidal micelles and β-sheet polymers of peptide amphiphiles, which collectively govern supramolecular dynamics.

Huachuan Du, Ruomeng Qiu & Samuel I. Stupp

Article
24 May 2025 | Open Access

Tracking life and death of carbon nitride supports in platinum-catalyzed vinyl chloride synthesis

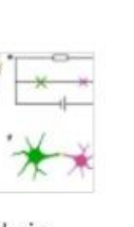


The restructuring of carbon-based supports under reaction conditions limits catalyst stability for vinyl chloride synthesis. Here, the authors report that hydrogen chloride generates defect sites on carbon nitride supports, promoting acetylene polymerization and accelerating catalyst deactivation.

Vera Giulimondi, Mikhail Agrachev & Javier Pérez-Ramírez

Article
24 May 2025 | Open Access

Topological phase locking in stochastic oscillators

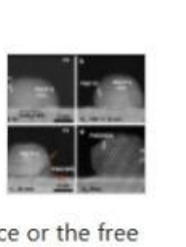


The dynamics of most nanomachines are stochastic, activated by thermal fluctuations. Here, authors find that, when two such nanomachines are mechanically coupled to each other, their dynamics can become almost deterministic, as they activate each other without the need for thermal fluctuations.

Michalis Chatzittofi, Ramin Golestanian & Jaime Agudo-Canalejo

Article
24 May 2025 | Open Access

Interface engineering to regulate oxidation dynamics of supported nanoparticles

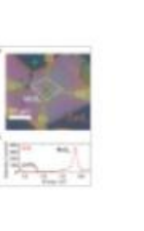


This work demonstrates that epitaxial match at the oxide-support interfaces plays a critical role in determining whether supported metal nanoparticles oxidize from the interface or the free surface in oxygen, thereby enabling controlled oxidation.

Shiyuan Chen, Kai Zhang & Yong Wang

Article
24 May 2025 | Open Access

Nonlinear photovoltaic effects in monolayer semiconductor and layered magnetic material hetero-interface with *P*- and *T*-symmetry broken system



Unlike typical PN junction based photovoltaic devices, bulk photovoltaic effects can exceed the Shockley-Queisser limit for efficiency, with open circuit voltages larger than the material bandgap. Here, Asada et al demonstrate a finite spontaneous photocurrent in a van der Waals heterostructure with broken P- and T-symmetry.

Shuichi Asada, Keisuke Shinokita & Kazunari Matsuda

Article
24 May 2025 | Open Access

Dimensional reduction in Cs$_2$AgBiBr$_6$ enables long-term stable Perovskite-based gas sensing

A long-chain alkylamine strategy enables stable halide double perovskite sensors with CO detection as low as 20 ppb and ambient air durability up to 270 days, achieving excellent sensitivity and stability.

Wen Ye, Hong-Zhen Lin & Jian-Mei Lu

Article
24 May 2025 | Open Access

Directed evolution of aminoacyl-tRNA synthetases through in vivo hypermutation

Genetic code expansion (GCE) enables the incorporation of new amino acids into proteins. Here, authors demonstrate the rapid OrthoRep-driven evolution of aminoacyl-tRNA synthetases for GCE, increasing the building blocks available to protein engineering and the scale and ease for achieving GCE.

Yuichi Furuhata, Gordon Rix & Chang C. Liu

Article
24 May 2025 | Open Access

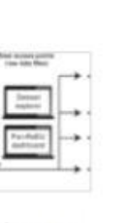
3D hydrogel platform with macromolecular actuators for precisely controlled mechanical forces on cancer cell migration

Mechanical forces play a critical role in regulating cancer cell behavior. Here, Li et al. report a 3D hydrogel platform embedded with near-infrared responsive macromolecular actuators for precise mechanical stimulation of specific integrin subtypes in ovarian cancer cells to investigate how different force parameters affect cell migration and invasion.

Bohan Li, Qingyu Fu & Yijun Zheng

Article
24 May 2025 | Open Access

Enabling pan-repository reanalysis for big data science of public metabolomics data

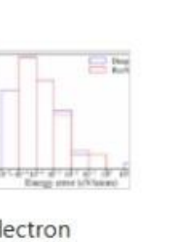


Public untargeted metabolomics data hold great promise for discovery but are difficult to access across repositories. Here, the authors develop universal identifiers and harmonized metadata to integrate major databases, enabling streamlined analysis and expanded research possibilities.

Yasin El Abiead, Michael Strobel & Mingxun Wang

Article
23 May 2025 | Open Access

Image super-resolution inspired electron density prediction

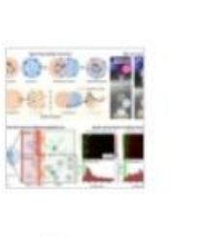


Machine learning prediction of electronic structure remains a general challenge. Here, the authors have developed a model with high accuracy and transferability by treating the electron density as a 3D greyscale image and adapting techniques from the image super-resolution computer vision field.

Chenghan Li, Or Sharir & Garnet Kin-Lic Chan

Article
23 May 2025 | Open Access

Fusogenic lipid nanoparticles for rapid delivery of large therapeutic molecules to exosomes



Exosomes have huge potential for drug delivery, but drug loading can be difficult. Here, the authors report on fusogenic lipid nanoparticles which, when mixed with exosomes rapidly fuse, non-destructively loading large drugs without compromising exosome biological functions, and demonstrate neurological application.

Gamsong Son, Jiyoung Song & Hojun Kim

Article
23 May 2025 | Open Access

Stomata-targeted nanocarriers enhance plant defense against pathogen colonization

Stomata are key entry points for plant pathogens. Here, the authors engineer stomata-targeted nanoparticles to reduce bacterial colonization while preserving stomatal function, enabling a more precise strategy to enhance crop defence.

Suppanat Puangpathumanond, Heng Li Chee & Tedrick Thomas Salim Lew

Article
23 May 2025 | Open Access

A physics-informed and data-driven framework for robotic welding in manufacturing

This study presents a physics informed neural network which monitors and directs the melt pool in a robotic welding and additive manufacturing scenario. Combining X-ray and real time melt pool data, forward prediction of properties is provided.

Jingbo Liu, Fan Jiang & Manabu Tanaka

Article
23 May 2025 | Open Access

Inverse design of metal-organic frameworks using deep dreaming approaches

Metal-organic frameworks offer vast design potential for advanced applications. Here, authors apply deep dreaming for inverse design, directly modifying structures using an interpretable model that unifies property prediction and material generation.

Conor Cleeton & Lev Sarkisov

Article
23 May 2025 | Open Access

Dynamic polarization control of Ni electrodes for sustainable and scalable water electrolysis under alkaline conditions

Developing efficient and stable oxygen evolution catalysts is challenging, especially for large-scale electrolyzers. Here, the authors introduce a dynamic polarization strategy that enhances the oxygen evolution activity of Ni electrodes via the incorporation of Fe3+, ensuring long-term stability in large-area electrolyzer stacks.

Sanghwi Han, Sungjun Kim & Jeyong Yoon

Article
23 May 2025 | Open Access

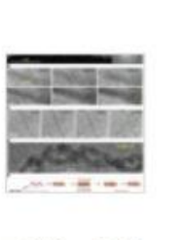
Atom interferometry in an Einstein Elevator

We present atom interferometry performed in a laboratory-scale Einstein Elevator over several days with high reproducibility. This table-top experiment enables long-term metrological assessments of quantum inertial sensors in microgravity.

C. Pelluet, R. Arguel & B. Battelier

Article
23 May 2025 | Open Access

Observation of nanoparticle coalescence during core-shell metallic nanowire growth in colloids via nanoscale imaging

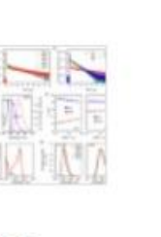


The kinetic pathways driving morphological changes in core-shell metallic nanowires are crucial for their functional properties. Here authors reveal a three-step deposition process, and influence nanoparticle size and surface roughness.

Dahai Yang, Xingyu Zhang & Xiaohui Song

Article
23 May 2025 | Open Access

Temperature dependency of energy shift of excitonic states in a donor–acceptor type TADF molecule

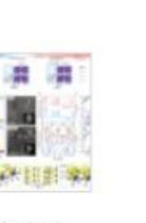


Thermally activated delayed fluorescence (TADF) has attracted much attention to developing high efficiency organic light-emitting diodes. Here, authors revisit the thermal behavior of a TADF material and report the temperature dependence of excitonic state energies which has not been focused so far.

Youichi Tsuchiya, Keito Mizukoshi & Chihaya Adachi

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

Control of magnetic transitions via interlayer engineering in ferroelectric H$_2$O–OH systems

The authors present a strategy for controlling magnetic phase transitions in two-dimensional ferroelectrics, showing that electron pairing governs transitions between ferromagnetic and nonmagnetic states, tunable via electric fields.

Jingyan Chen, Qiaoxiao Zhao & Yanchao Wang

Article
23 May 2025 | Open Access

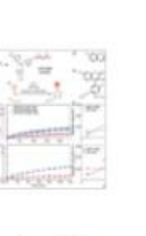
Toward high-current-density and high-frequency graphene resonant tunneling transistors

2D devices with negative differential resistance are desired for multivalued logic applications, but they are normally limited by low current densities and operational frequency. Here, the authors report graphene/hexagonal boron nitride/graphene resonant tunnelling transistors with room temperature peak current density up to 2700 μA/μm^2 and operational frequencies up to 11 GHz.

Zihao Zhang, Baoqing Zhang & Aimin Song

Article
23 May 2025 | Open Access

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

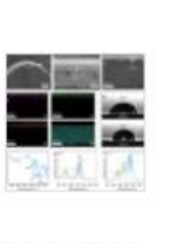


Tracking biomolecules in living cells requires fast but gentle labeling. Here, authors introduce inCu-click, a DNA-conjugated ligand that localizes copper to enable efficient intracellular CuAAC, allowing live-cell fluorescent labeling of lipids and proteins without toxicity.

Keqing Nian, Yifang Liu & Sara H. Rouhanifard

Article
23 May 2025 | Open Access

An electrochemically driven hybrid interphase enabling stable versatile zinc metal electrodes for aqueous zinc batteries

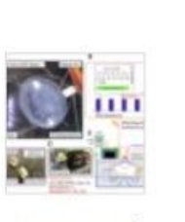


Practical applications of zinc metal electrodes are hindered by dendrite growth and side reactions. Here, authors propose an electrochemically driven artificial solid interphase forming via in-situ conversion of a phosphate ester-based protective layer. This approach enables stable versatile zinc negative electrodes for aqueous zinc batteries.

Dingtao Ma, Fan Li & Peixin Zhang

Article
23 May 2025 | Open Access

Harnessing natural embodied intelligence for spontaneous jellyfish cyborgs

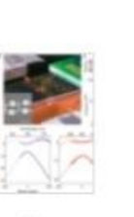


This study reveals that jellyfish swimming can be guided and predicted using electrical stimulation and machine learning, illustrating how embodied intelligence shapes both spontaneous and stimulus-evoked behaviors.

Dai Owaki, Max Austin & Kohei Nakajima

Article
22 May 2025 | Open Access

Near-visible integrated soliton microcombs with detectable repetition rates

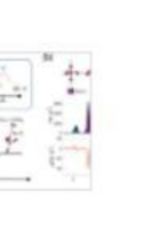


Integrated optical frequency combs are powerful tools for optical spectroscopy. Here, authors demonstrate low-power, detectable-rate soliton microcombs from telecom to visible bands, including wavelength-multiplexed operation, using ultra-low-loss silicon nitride waveguides.

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

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