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Article
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High-power hybrid commutated converter for carbon-neutral power transmission

The study presents a high-power hybrid commutated converter system that combines forced and recovery-enhanced commutation to enable reliable, efficient long-distance transmission of renewable energy, validated at 120 kV/360 MW in real-world projects.

Chaoqun Xu, Zongze Wang & Rong Zeng

Article
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Modeling network evolution by multi-agent reinforcement learning

This paper introduces NEMARL, a multi-agent reinforcement learning framework for network evolution that models node-level decision making and coordination. The approach reproduces key network properties, fits real-world data, and demonstrates effectiveness across multiple scenario tests.

Dong Li, Tianwei Lin & Petter Holme

Article
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Catalytic electrophilic arene C–H chlorination by rethinking the century-old willgerodt reagent

Authors synthesize a variant of a decades-old chlorinating reagent and show its competence in catalytic electrophilic arene C–H chlorination.

Qi-Qi Hu, Yao Xiang & Youwei Xie

Article
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Proton trap engineered electric swing adsorption for scalable and cost-effective direct air capture

Direct air capture is essential for reducing atmospheric CO2 but is limited by efficiency and cost. Here, authors engineer a proton-trap sorbent that enables faster, lower-cost CO2 removal using electric swing adsorption, achieving high uptake and stability.

Yao Shen, Kai Pang & Shihan Zhang

Article
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In-tandem electrocatalysis via Ni single atoms and reconstructed Cu single clusters for CO_2-to-acetone reduction

Electrochemical CO_2 conversion to multi-carbon products is hindered by inefficient C–C coupling. Here, the authors report a nickel single atom/copper single cluster catalyst that achieves high acetone selectivity through tandem catalysis, confinement, and in situ-formed Cu^0/Cu^+ sites.

Tonglin Yang, Fangqi Yang & Wenlei Zhu

Article
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Reversible layered/non-layered phase transition in a topological semimetal

Phase transitions in layered materials can differ significantly from those in non-layered materials. Here, the authors demonstrate a reversible phase transition between layered and non-layered phases in the semimetal $PtBi_2$, resulting in a layered/non-layered topological phase transition.

Qingrong Liang, Jiali Chen & Shoujun Zheng

Article
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On the nature of chemical short-range order evolution

In situ synchrotron dilatometry and atomistic simulations indicate that changes between chemical short-range order states (evolving local chemical distributions) are governed by a kinetic arrest phenomenon rather than a thermodynamic transition.

Guilherme C. Stumpf, Yifan Cao & Francisco G. Coury

Article
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Dynamic catalytic interface driven three-step synergistic mechanism for boosting ammonia and hydroxylamine synthesis

The microscopic mechanism of nitrate-to-ammonia electrosynthesis remains ambiguous given the complex dynamic catalytic interface. Here, the authors report a three-step synergistic mechanism that enhances the interaction among interfacial H_2O transport, *H generation, and *NOx hydrogenation.

Yuxiang Li, Junliang Xie & Fang Jiang

Article
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Root-inspired hierarchical hydrogel-electrode interface enables ultrasensitive sensing

Hydrogels are promising for physiological signal monitoring, though they are challenging to optimize surface engineering without compromising signal stability. Here the authors report a root-inspired hydrogel electrode for low pressure sensing.

Jie Tang, Yuan He & Peng Li

Article
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Self-adaptive Ni nanoparticles in perovskite $LaNi_{1-x}Al_xO_3/CaO$ for durable CO_2 capture and in-situ conversion

Integrated CO_2 capture and conversion is promising for carbon neutrality, but the high-temperature deactivation of dual-functional materials (DFMs) limits its practicality. Here, the authors develop adaptive metallic nanocatalysts via in situ exsolution–dissolution in perovskite DFMs, enabling self-adjustment during cyclic CO_2/CH_4 redox switching and mitigating sintering and coking.

Bin Shao, Zhonghao Jia & Jun Hu

Article
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Coverage engineering by shell-number-controlled nanoconfinement enables nitric oxide electroreduction in the ppm regime

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Converting ppm-level NO into ammonia is challenging as reactants and intermediates are easily lost from catalyst surfaces. Here, the authors report quantifiable nanoconfinement as a coverage engineering strategy to nonlinearly enrich these species, improving ppm-level NO electroreduction activity.

Shanyuhan Jin, Daliang Xu & Xuanhao Wu

Article

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Small-scale photonic Kolmogorov-Arnold networks using standard telecom nonlinear modules

Photonic neural networks usually rely on power-hungry optical-electronic conversions for nonlinearity. Here, authors build a Kolmogorov-Arnold network whose every edge is one telecom module-an interferometer, amplifier and attenuators-trained end-to-end with a differentiable physics model.

Luca Nogueira Calçado, Sergei K. Turitsyn & Egor Manuylovich

Article

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Ammonia at the net-zero crossroads

This study shows that even under optimistic green technology rollout, net-zero ammonia production remains unachievable by 2050, revealing hidden infrastructure demands that challenge assumptions of unchecked demand growth.

Thorin Daniel, Qiong Cai & Jin Xuan

Article

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Hardware acceleration of simulated annealing for constraint satisfaction problems

Simulated annealing outperforms brute-force search in finding optimal solutions for computationally intensive tasks. Pannone et al. report a simulated annealing accelerator using 2D-material-based CMOS transistors to achieve high energy efficiency, search acceleration, and increased scalability.

Andrew Pannone, Rishikesh T. Nair & Saptarshi Das

Article

21 July 2026 | Open Access

Enhancing Phonon Group Velocities and Interfacial Heat Conduction for Efficient and Stable Perovskite Solar Cells

Low thermal conductivity of hole-transport layers in perovskite solar cells causes heat buildup, energy loss, and reduced stability. Wu et al. introduce a copper bismuth oxide composite layer to improve heat flow, achieving higher efficiency and long-term device stability.

Xing Wu, Yu Chen & Qiang Peng

Article

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Interfacial depletant partitioning for lattice-tunable colloidal assembly

Colloidal systems have the potential to mimic complex self-assembly processes found in nature, which can lead to innovative materials with tailored properties. This study introduces an approach using depletant partitioning to dynamically modulate the size and stability of colloidal assemblies through temperature changes, achieving finely tunable lattice variations and expanding the possibilities for colloidal-based materials.

Timothy F. Niper, Laura Galeano Tirado & Jairo A. Díaz A

Article

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Ultrafast multi-level control of sub-50 nm skyrmions in a Pd-intercalated van der Waals magnet

Huai Zhang et al. demonstrate that Pd intercalation in $Fe_{3-\delta}GaTe_2$ stabilizes 43 nm room-temperature skyrmions. On this platform, femtosecond laser pulses enable multi level skyrmion generation for neuromorphic computing.

Huai Zhang, Bei Ding & Junming Liu

Article

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Solar and thermal dual-band electrochromic windows for energy-efficient buildings

Traditional electrochromic windows cannot regulate long wave infrared thermal radiation. Here, the authors report a solar and thermal dual-band electrochromic window that independently modulates solar transmission and thermal emissivity, enabling year-round building energy savings.

Jian Chen, Jianwei Hu & Yan Jin

Article

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Monolithic 6-Axis Force/Torque Sensing by a Single Ultrathin Piezoceramic Shell

A monolithic 6-axis force/torque sensor utilizing a single ultrathin piezoceramic shell achieves high sensitivity and decoupling accuracy through intrinsic mechanical deformation. This design simplifies calibration and enhances integration into robotics and wearable devices.

Shoulu Gong, Xingyu Wei & Lei Shao

Article

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Integrated device for optoacoustically-guided ultrasound surgery

High-intensity focused ultrasound can treat disease by heating tissue, but monitoring the treatment is difficult. Here, the authors use 3D optoacoustic imaging integrated with ultrasound therapy to safely guide the treatment in animal models, paving the way for safer, more precise brain therapies.

Isaac Esteban, Nima Mahkam & Hector Estrada

Article

21 July 2026 | Open Access

Quantum adiabatic transport in a quantum anomalous Hall insulator

This work reports on an advancement in achieving robust electrical transport in a topological insulator, which promises applications in metrology, a field of science that defines physical units.

Kajetan M. Fijalkowski, Martin Klement & Laurens W. Molenkamp

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Article

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Trans-scale spin Seebeck effect in nanostructured bulk composites based on magnetic insulator

This study demonstrates a three-dimensional bulk composite architecture based on magnetic insulators that extends spin Seebeck thermoelectric conversion beyond thin-film interfaces.

Sang J. Park, Keisuke Hirata & Ken-ichi Uchida

Article

21 July 2026 | Open Access

Shared cloud interactions unveil a candidate binary-system supernova pair with no known analogue

Most stars are found in binaries, but no surviving pair of supernova remnants from the same stellar system has been found. Here, the authors show that progenitors of supernova remnants IC 443 and G189.6+3.3 may be a binary system.

Miltiadis Michailidis, Marianne Lemoine-Goumard & Nicola Omodei

Article
20 July 2026 | Open Access

Giant nonlinear Hall effect in isospin symmetry broken bilayer graphene

Spontaneous isospin symmetry breaking can strongly influence quantum nonlinear transport. Here, the authors observe a giant nonlinear Hall conductivity in dual-gated Bernal bilayer graphene that manifests strongly in a field-driven isospin polarized phase.

Hao Chen, Qifeng Hu & Kian Ping Loh

Article
20 July 2026 | Open Access

Ligand relay catalysis enables asymmetric migratory dearomative annulation of *N*-heteroarenes

Despite their importance in ligand development, functional materials, and drug discovery, chiral N-spiroheterocycles remain challenging synthetic targets. Here, the authors report a cobalt-catalyzed asymmetric migratory dearomative annulation of electron-deficient N-heteroarenes enabling streamlined access to these frameworks.

Zhiyong Song, Xinyu Li & Shaolin Zhu

Article
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Relaxor-like ferroelectric response and achiral–chiral switching in an amorphous molecular solid

Relaxor ferroelectrics provide a fertile platform for reconfigurable electronics, yet their fluctuating dipolar networks lack intrinsic mechanisms for symmetry modulation. Using a salicylideneaniline derivative that undergoes a UV-triggered achiral-to-chiral transition the authors show that structural disorder reshapes coupled chiroptical and polarization dynamics.

Hanyu Liu, Yuqin Xiong & Shenqiang Ren

Article
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Transversal fault tolerant distributed quantum computing operations

Scalable quantum computers may be built by linking smaller modules, but errors on the connections pose a challenge. Here, authors simulate fault-tolerant operations across noisy links, showing distributed quantum computing can achieve very low error rates and guiding future hardware design.

John Stack, Ming Wang & Frank Mueller

Article
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Improving thermal shock resistance of segmented thermoelectric devices via metal foam integration

This work proposes a Ni foam composite solder layer, which not only optimizes the solder's thermal expansion coefficient but also exhibits substantial plastic deformation during thermal shock, synergistically mitigating interfacial thermal stress.

Kuai Yu, Jiayue Du & Jiehe Sui

Article
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Unlocking solar-derived CO_2 conversion to hydrocarbons over plasmonic Cu-Fe tandem catalysts under industrially relevant conditions

Solar-derived conversion of CO_2 into hydrocarbons offers a sustainable alternative to mitigate carbon emissions but achieving efficient C-C coupling under photothermal conditions remains challenging. Here, we report a potassium-promoted Cu_2Fe_1 tandem catalyst that enables highly selective CO_2-to-hydrocarbons conversion under industrially relevant conditions.

Xinhuilan Wang, Alejandra Rendón-Patiño & Jorge Gascon

Article
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Quantitative Prediction of Exchangeable Proton Chemical Shifts

The authors develop a framework integrating machine-learning molecular dynamics with the ShiftML3 machine-learning shielding mode to accurately predict NMR chemical shifts of exchangeable protons in solution, outperforming DFT approaches in capturing solvation effects.

Ondřej Socha, Jana Pavlišová & Martin Dračínský

Article
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Alkyne Migratory Insertion Enabled Dynamic Kinetic Asymmetric Dearomatization of Unactivated Racemic Biaryls

Catalytic asymmetric dearomatization transforms planar aromatics into valuable 3D chiral architectures. Here, the authors report palladium-catalysed enantioconvergent dearomatization of unactivated naphthalenes via alkyne migratory insertion.

Yongjian Yang, Xuening Li & Xueliang Huang

Article
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DNA-programmed galvanic Ostwald ripening in nanoparticle assemblies

Ostwald ripening is a stochastic process in nanoparticle systems. Here, the authors use DNA origami to program contact-dependent, localized galvanic Ostwald ripening, directing growth pathways to build asymmetric nanostructures with intense plasmonic hotspots.

Xin Luo, Jun Zhu & Hanadi F. Sleiman

Article
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Engineering ion migration and interface chemistry via covalent organic framework-enhanced polymer electrolytes for fast-charging sodium solid-state batteries

Solid-state sodium batteries are hindered by slow ion transport and unstable electrode–electrolyte interfaces. Here, the authors develop a covalent organic framework - enhanced polymer electrolyte that promotes the formation of stable dual-gradient interphases, leading to improved rate capability and cycling stability.

Yongbiao Mu, Chen Li & Lin Zeng

Article
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Neural dynamics of temporal interference stimulation monitoring by soft liquid metal interfaces across neural systems

Temporal interference stimulation enables non-invasive deep brain modulation, but its physiological effects remain unclear. Here, the authors developed a soft liquid metal neural interface to investigate TIS across brain organoids and mouse brains, revealing changes in neural dynamics

Enji Kim, Wonjung Park & Jang-Ung Park

Article
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B-type host stars revealed by exoplanets around massive secondary-clump giant stars

Planets around massive B-type stars at intermediate orbital distances remain largely unexplored. Here, the authors show that four evolved planet-hosting stars, HD 2952, HD 120084, HIP 65891, and HIP 67537, are secondary-clump giants descended from B-type progenitors, demonstrating that such planetary systems can exist around massive stars.

Wen-Xu Lin, Sheng-Bang Qian & Ming Lian

Article
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Vibrating membrane bioreactors enhance nutrient removal and energy efficiency in municipal wastewater treatment

This study demonstrates that vibrating membrane bioreactors outperform conventional aerated systems in fouling control, energy consumption, and chemical use for more sustainable wastewater treatment, based on nearly 800 days of full-scale operation.

Weichen Lin, Tao Xue & Xia Huang

Article

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Confined water-selective highways in a densified photothermal membrane enable ultrafast purification of complex wastewater

Confined water selective highways within a densified photothermal membrane enable ultrafast and stable solar driven interfacial evaporation, achieving high-rate clean water production while rejecting highly concentrated ions and strongly polar VOCs, even under extreme conditions

Jie Li, Qiang Jia & Liangti Qu

Article

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Fluorine-free acetonitrile-based electrolytes with anion-reinforced solvation chemistry for sustainable sodium-ion full batteries

Acetonitrile-based electrolytes have poor stability in sodium-ion batteries. Here, the authors introduce ethyl methyl carbonate to modulate anion-enhanced solvation, forming inorganic-rich interfaces that improve compatibility with hard-carbon anodes and enable long-term stable battery performance.

Xu Xu, Jian Chen & Lin Li

Article

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Enhanced energy storage in tungsten bronze-based ferroelectrics and MLCCs via a multi-coating engineering

The authors construct tungsten bronze–perovskite composites with a SiO_2 coating, forming a dual-core-shell architecture. This design yields a high energy density of 23.2 J/cm^3 and 92.8% efficiency in multilayer ceramic capacitors, due to enhanced polarization and breakdown strength, alongside excellent thermal and fatigue stability.

Limin Guo, Jiaming Liu & Xiaohui Wang

Article

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Covalency stabilizes high energy vanadium oxide positive electrode for sustainable aqueous zinc-ion batteries

Aqueous zinc-ion batteries are limited by cathode instability during cycling. Here, authors stabilize vanadium oxide via fluorine incorporation, where enhanced covalency suppresses structural degradation, enabling 60,000 cycles long lifetimes and practical pouch cells powering drones.

Fan Zhang, Hanqin Yin & Ziqi Sun

Article

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An integrated multi-THz tunable linear isolator based on electro-optic non-reciprocal strong coupling

Optical isolators are essential photonic devices, but magneto-optic materials are not foundry compatible. This study presents an integrated electro-optic isolator with multi-THz tunability and very high isolation figure of merit.

Gwan In Kim, Violet Workman & Gaurav Bahl

Article

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Wireless light-gated photoelectrochemical microneedle wearables for zero-bias longitudinal monitoring in interstitial fluid

Continuous metabolic monitoring in interstitial fluid remains difficult. Here, authors develop a wireless light-gated microneedle wearable that performs zero-bias photoelectrochemical sensing and tracks uric acid dynamics in disease models.

Huichuang Wang, Zepeng Huang & Zhonghai Zhang

Article

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Amine-linked heteroporous covalent organic framework for synergistic anti-infective therapy of post-traumatic osteomyelitis

Treatment of post-traumatic osteomyelitis is challenging because drug delivery is hindered by biofilms and acidic lesions. Here, the authors develop an acid-resistant, heteroporous COF for sustained vancomycin/felodipine release from calcium phosphate cement.

Saisai Ge, Xiaobin Chen & Ruitao Cha

Article

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Scale-bridging interface design enables high-performance sustainable thermoelectrics

By linking device contacts with internal material interfaces, this study introduces a scale-bridging design that improves charge transport and heat management, enabling thermoelectric modules to convert waste heat into electricity more efficiently.

Gang Wu, Airan Li & Takao Mori

Article

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Coordination electrochemistry taming reversible hypervalent bromine redox for energetic six-electron-transfer lithium-bromine battery

Conversion-type bromine batteries offer energy-storage potential but face limited electron transfer. Here, authors design an ethyl viologen dibromide positive electrode to unlock a six-electron redox process, boosting capacity and voltage via synergistic bromine conversion and lithium-ion storage.

Rumeng Feng, Wenyu Xu & Xinliang Li

Article

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Coulomb interaction-stabilized isolated narrow bands with Chern numbers $\mathcal{C} > 1$ in twisted rhombohedral trilayer-bilayer graphene

Fractional Chern states with high Chern numbers could host exotic non Abelian phases but lack realistic zero field material platforms. Here, the authors propose that interactions in twisted rhombohedral trilayer-bilayer graphene generate narrow high Chern bands with near ideal quantum geometry, identifying regimes favorable for fractionalized states.

Võ Tiến Phong & Cyprian Lewandowski

Article

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Imaging of gate-controlled suppression of superconductivity via the Meissner effect

Supercurrents flowing through thin superconducting nanowires can be quenched by applying a gate voltage, an effect known as gate-controlled suppression of superconductivity. Here, using a scanning nitrogen-vacancy magnetometer at sub-Kelvin temperatures, the authors report that this phenomenon also manifests in a suppression of Meissner screening and is thus not restricted to transport.

K. J. Knapp, U. Ognjanović & C. L. Degen

Article

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Learning ordinality-aware multimodal representations for composite materials design

Composite materials design is difficult due to complex, continuous design space. This work builds ORDER, a multimodal framework linking microstructures and descriptors with preserved property trends, aiding prediction, retrieval, and microstructure generation.

Xinyao Li, Hangwei Qian & Ivor Tsang

Article

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Escape-induced temporally correlated noise driven crossover in growth kinetics and universality class

The experimental realization of how temporally correlated noise influences growth universality classes remained unconfirmed. Authors demonstrate a direct crossover from the Villain- Lai-Das Sarma (VLDS) to the temporally correlated noise-driven KPZ (TCN-KPZ) universality class and identify adatom escape as the microscopic origin of the correlated noise, establishing a direct link between atomistic kinetics to macroscopic morphological evolution.

Mrinal Manna, Sourav Mukherjee & Rajib Batabyal

Article

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Stable high-valent iridium single atoms for high-temperature CO_2 electrolysis

Single-atom catalysts offer high efficiency but face aggregation and degradation at elevated temperatures. Here, the authors introduce a thermally stable high-valent iridium single-atom catalyst to enhance CO_2 electrolysis in solid oxide electrolysis cells.

Shaowei Zhang, Shuo Wang & Xinhe Bao

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