

Physical sciences articles within *Nature Communications* Atom RSS feed

Featured

Article
06 January 2025 | [Open Access](#)
Dynamic decrosslinking enables self-healing, reprocessability, and upcycling in polyurethane networks
Dynamically cross-linked thermosets often show decreased performance after numerous reprocessing cycles, limiting their long-term recyclability. Here, the authors introduce dynamic thiolated urea bonds into polyurethane, enabling its thermal-decrosslinking and offering an upcycling route.
Qingming Kong, Yu Tan & Xu Wang

Article
06 January 2025 | [Open Access](#)
Highly efficient exciton-exciton annihilation in single conjugated polymer chains
This work finds that cholesterones on conjugated polymer chains are very efficiently electronically coupled together. Rapid exciton-exciton annihilation ensures that a single chain can only support one or two excitons after 10 ps.
Nicolò J. Partzsch, Olga Vodanovic & Gordon J. Hedley

Article
06 January 2025 | [Open Access](#)
Ferroelectric switching of interfacial dipoles in a Ru/Cr/graphene heterostructure
This study shows that electrically switchable and non-volatile dipoles can form at the interface of graphene and a Ru/Cr when separated by an ultrathin 10H layer. The dipole switching is driven by interfacial charge transfer, is stable without continuous power, and emerges in a narrow temperature window around 30 K.
Soyun Kim, Ju Hyun Yun & Youngsook Kim

Article
06 January 2025 | [Open Access](#)
Soft sonocapacitor with topologically integrated piezoelectric nanospheres enables dual-band closed-loop neuromodulation
Achieving wireless and high charge density neural stimulation remains challenging. To address this issue, the authors develop a sonocapacitor from piezoelectric-dielectric composite nanospheres and two-dimensional carbon.
Zhichong Wei, Fei Jin & Ting Wang

Article
06 January 2025 | [Open Access](#)
Unconventional polaronic ground state in superconducting LiTi₂O₄
The authors study epitaxial thin films of the pyrochlore-sublattice compound LiTi₂O₄ by RIXS and ARPES. They observe competition between strong electron-phonon correlations and strong electron-phonon coupling, giving rise to a nonlocal polaronic ground state in which charge motion and lattice distortions are coupled.
Zubair Hasan Ghafoor, A. Ben & Julia A. Mundy

Article
06 January 2025 | [Open Access](#)
Breaking immiscibility barriers: ultrafast sintering of interlocked Cu-Fe-based composites
Immiscibility limits the performance of positive mixing enthalpy alloys. Here, the authors apply ultrafast sintering and quenching to fabricate mechanically interlocked Cu-Fe composites with good strength and conductivity.
Shi Shi, Zhenhui Wu & Chengwei Wang

Article
06 January 2025 | [Open Access](#)
Unlocking efficient electrocatalytic removal of trace emerging contaminants via synchronized pollutant enrichment and electron delivery
This work clarifies the key electron-transfer limitation in electrocatalytic contaminant removal and delivers a dual-function strategy that boosts efficiency by combining molecular enrichment with precisely controlled charging-discharging.
Yao Pan, Junjie Guo & Xixian Ren

Article
06 January 2025 | [Open Access](#)
Visualization and quantification of lattice strain in battery cathode particles through electron backscatter diffraction imaging
Lattice strain impacts battery cathode performance and cycle life. Here, authors visualize and quantify strain in layered oxides through electron backscatter diffraction imaging, revealing heterogeneous, cycle-dependent distortions that slow Li transport and limit capacity, with irreversible layer bending driving capacity fade.
Wenya Wang, Zhenyuan Li & Linlin Li

Article
06 January 2025 | [Open Access](#)
Stress-trained microalgae robots with probiotics backpack and intestinal brake for inflammatory bowel disease management
IBD involves intestinal ROS overproduction and microbial imbalance, with current delivery systems lacking effective protection and targeting. Here, the authors show the LCN6204-IBD-robot can deliver probiotics and alleviate murine IBD via antioxidant and probiotic.
Ruitong Luo, Jinnel Li & Ruitong Wang

Article
06 January 2025 | [Open Access](#)
NTAC: Neuronal type assignment from connectivity
In this study, the authors develop NTAC, Neuronal Type Assignment from Connectivity, using synaptic connectivity alone to identify cell types with high accuracy within minutes on a standard CPU.
Gregory Schiavone, Ben Jordan & Arin Mathiah

Article
06 January 2025 | [Open Access](#)
Rapid enantioselective fluorescence recognition and chiral separation of free amino acids
Enantioselective recognition and chiral separation of amino acids hold significant importance in chemistry, materials science, and life science. Here, the authors report a water-soluble chiral fluorescent probe that enables visual chiral recognition and separation by incorporating a morpholinium quaternary cation into BINOL frameworks.
Yang Li, Kang Yu & Xiang Ma

Article
06 January 2025 | [Open Access](#)
Shape-morphing active particles with invertible effective polarizability for configurable locomotion and steering
Most active particles studied to date lack the ability to undergo controlled digital transformations and control over their propulsion in response to environmental stimuli. Here, the authors present a class of active particles made from stimuli-responsive materials that exhibit fully reversible shape-dependent propulsion.
Jin Gyun Lee, Seog-jin Jeon & C. Wyatt Shields IV

Article
06 January 2025 | [Open Access](#)
Spatially decoupled electrochemical strategy for lime passivation prevention and sustainable phosphate recovery
A spatially decoupled electrochemical strategy bypasses lime passivation and delivers efficient, cost-effective, and low-carbon phosphate recovery from wastewater, enabling progressive water resource recovery and industrial decarbonization.
Dongqian Chen, Jinghui Li & Yang Lei

Article
06 January 2025 | [Open Access](#)
Field-effect passivation for minimized voltage loss in highly efficient antimony selenosulfide solar cells
The inferior recombination quality and misaligned energy levels at the buffer/absorber layer hinder development of antimony selenosulfide solar cells. Here, authors introduce low-work-function tantalum pentoxide dielectric layer for field-effect passivation, achieving device efficiency of 15.85%.
Anwen Gong, Cong Liu & Yaohua Mai

Article
06 January 2025 | [Open Access](#)
Ultra-wide spectrum photosynapse array with 64k-scale for neuromorphic fusion imaging
Next-generation autonomous systems call for robust perception capabilities in diverse environments. Dun et al. report an ultraviolet-to-mid-infrared photorefractive array with 4K/30 fps gain and efficient in-situ processing capabilities for dynamic trajectory recognition under challenging conditions.
Guan-Hua Dun, Jia-He Zhang & Tian-Ling Ren

Article
06 January 2025 | [Open Access](#)
A liquid metal dynamic wetting strategy for spatiotemporal monitoring of hand movements
This study introduces a flexible, wearable system using a liquid metal dynamic wetting strategy to capture palm and finger movements in real time with high precision, showing potential for applications in XR, teleoperation, and robotics.
Fei Zhen, Nian Li & Chang Wang

Article
06 January 2025 | [Open Access](#)
On-demand laser-induced frequency tuning of coherent magnons in a nanometer-thick magnet at room temperature
On-demand laser-induced frequency tuning of coherent magnons in a 20 nm thick magnet at room temperature is demonstrated. By varying the laser fluence and magnetic field, red- or blue-shift of the frequency up to 40% of its original value is achieved.
Volker Wietfort, Hanchen Wang & Davide Bossini

Article
06 January 2025 | [Open Access](#)
(Hg₂Se)₂ cluster drives giant optical anisotropy and broad infrared transparency
Here authors show that linker (Hg₂Se)₂ cluster enables large birefringence and broad infrared transparency at Hg₂Se₂(Se₂C₆H₄)₂, enabling advanced infrared photonics.
Guangmin Chen, Cui & Shile Pan

Article
06 January 2025 | [Open Access](#)
Decarboxylation photocatalyzed transfer hydrogenation of unsaturated compounds using alcohol as the hydrogen source
Here, the authors disclose a simple and efficient photocatalytic method for the transfer hydrogenation of unsaturated compounds using alcohol as the hydrogen source and low-cost decarboxylate as the photocatalyst.
Ying Zhang, Zheng-Feng Zhang & Cheuk-Wai So

Article
06 January 2025 | [Open Access](#)
Deep learning and superresolution speckles empowered multimode fiber probe for in situ nano-displacement detection and micro-imaging
This work introduces an in-situ nano-displacement measurement system via a multimode fiber probe with superresolution speckles and deep learning. It achieves 10 nm resolution and 99.95% accuracy for water, non-contact sensing in confined spaces.
Lile Wang, Yinei Zhang & Qing Liu

Article
06 January 2025 | [Open Access](#)
Harnessing strengthening-metastability synergy for extreme work hardening in additively manufactured titanium alloys
A new AlTi titanium alloy design tailors the metastability-strengthening synergy and achieves high yield strength with enhanced work hardening and ductility by leveraging a complete, sequential metastable transformation pathway.
Xiaohang Chen, Weiqiang Xie & Jian Lu

Article
06 January 2025 | [Open Access](#)
Revisiting superradiance dynamics from single diamond nanocrystals with a physically consistent model for fluorescence decay
Jakub J. Borkowski, Artur Czerwinski & Piotr Kolarowski

Article
06 January 2025 | [Open Access](#)
Low-noise optomechanical single phonon-photon conversion for quantum networks
Optomechanical crystals are promising building blocks for quantum networks but suffer from thermal mechanical noise. Here the authors demonstrate on-demand conversion of single phonons into high-purity teleported photons with low thermal noise and MHz-scale narrow bandwidth using a quasi-3D optomechanical system.
Jia-Chen Schneider, Rolf Korsch & Simon Gröblacher

Article
06 January 2025 | [Open Access](#)
Palladium-catalyzed asymmetric migratory diarylation of unactivated directing-group-free internal alkenes
Enantioselective carbocyclization of alkenes is a powerful strategy for constructing functionalized sp³-rich molecules. Here, the authors report a palladium-catalyzed asymmetric migratory process that enables highly selective 1,3- and 1,4-dienylation of unactivated trisubstituted alkenes.
Lixin Fan, Yang Xi & Yifeng Chen

Article
06 January 2025 | [Open Access](#)
Homogeneous crystallization via sustained solvent-extraction channels for methylammonium-free all-perovskite tandem solar cells
Despite high efficiencies, all-perovskite tandem solar cells are hindered by thermal instability. Guo et al. address this by introducing a multi-level base morphology which suppresses the formation of dense Cs-rich films in Pb-Sn perovskites to concurrently deliver high performance and stability.
Yi Guo, Mengran Yin & Haoran Tan

Article
06 January 2025 | [Open Access](#)
Flash recycling of spent LiCoO₂ into oxygen-suppressed lithium-replenishing agent for high-performance batteries
Spent LiCoO₂ battery pose challenges for sustainable recycling. Here, the authors develop a flash tube heating method to recycle spent LiCoO₂ into a sulfur-stabilized Li₂O₂ lithium donor, enabling efficient lithium replenishment and improving full-cell durability.
Genqiang Liu, Quan He & Chao Wang

Article
06 January 2025 | [Open Access](#)
Computationally efficient tail distribution-aware large-scale power system overloading risk assessment
The study develops a computational method to assess power system overloading risks efficiently. It uses a surrogate model and resampling mechanism to enhance prediction accuracy near critical thresholds, demonstrating significant time savings and reliability on a large-scale power grid.
Benzhong Tan, Kaitian Ye & Xiaochuan Luo

Article
06 January 2025 | [Open Access](#)
Cycloreversion-enhanced toughness and degradability in mechanochemically embedded end-linked polymer networks
Achieving both high toughness and degradability in mechanochemically containing polymer networks is a challenge. Here, the authors incorporated non-covalent cyclobutane-fused tetrahydropyran-mechanochemically end-linked polymer networks to enhance their toughness and degradability by synthesizing transimino-catalyzed cycloreversion reactions to afford structurally diverse products.
Zhuang Li & Shan Tang

Article
06 January 2025 | [Open Access](#)
The SoftFoot Pro: an anthropomorphic and adaptive soft articulated prosthetic foot
Irregular terrain challenge users of classic prosthetic feet. Here, the authors introduce an adaptive prosthetic foot that equates ground contact pressure and reduces compensatory strategies and gait asymmetries compared with a traditional carbon fibre foot.
Anna Pace, Hiroshi Odmotor & Manuel G. Catalano

Article
06 January 2025 | [Open Access](#)
Crystallization modulation for wide-bandgap perovskites with universal defect passivation toward efficient perovskite/organic tandem photovoltaics
Defect formation and phase instability remain critical challenges for perovskite/organic tandem solar cells. Jiang et al. address this by designing an additive to modulate the crystallization thermodynamics of wide-bandgap perovskite, achieving a record efficiency of 22.1% in a flexible cell.
Ruiquan Jiang, Yikai Yun & Tonglei Bu

Article
06 January 2025 | [Open Access](#)
Detection and identification of vacancy defects in antimony selenide
Antimony selenide is promising photovoltaic material, but the presence of point defects degrades performance. Here the authors use positron annihilation spectroscopy combined with theory to detect and identify vacancy-type point defects.
David J. Kestel, Theodore D. C. Hobson & Kim Dursale

Article
06 January 2025 | [Open Access](#)
A binary-related origin mediated by environmental conditions for blue trapezoid stars
The origin of blue trapezoid stars (BTS) is still unclear. Here the authors show that the BTS and binary factors correlate with the host cluster parameters, indicating that BTS have a binary-related origin mediated by the environment.
Francesco R. Ferraro, Barbara Lanzoni & Giampaolo Piotto

Article
06 January 2025 | [Open Access](#)
Positive liquid-nitrogen-temperature superconductivity driven by perpendicular electric field in the single-bilayer film of La₂NiO₇ at ambient pressure
Bedford superconductivity was observed in La₂NiO₇ ultrathin film grown on the SrCaAlO₃ substrate with T_c ~ 40 K at ambient pressure. Here, the authors proposed that an in-plane strong perpendicular electric field can strongly enhance the T_c in the single-bilayer film of La₂NiO₇ at ambient pressure.
Zhi-Yan Shao, Jia-Hang Ji & Fan Yang

Article
06 January 2025 | [Open Access](#)
WRN structural flexibility showcased through fragment-based lead discovery of inhibitors
In this study, authors employ fragment-based lead discovery to identify WRN inhibitors. The fragment hits reveal an additional allosteric pocket and uncover a previously uncharacterized structural conformation of the WRN helix domain with unique orientations of the ATRase domains.
Rachel L. Jaffe, Mande Marzke & Daniel F. Wynn

Article
06 January 2025 | [Open Access](#)
Mechanochemical upcycling of poly(vinyl chloride) for alcohol halogenation
The mechanochemical dechlorination of poly(vinyl chloride) (PVC) can catalyze reactions through the release of chlorides. Here, the authors use TiO₂ as a contact electron-catalyst to achieve PVC dechlorination via ball-milling for the solvent-free, mechanochemical chlorination of alcohols.
Du Chen, Shengming Li & Zhao Wang

Article
02 January 2025 | [Open Access](#)
Unstable enantioselective electrocatalytic functionalization of tunable alkenes
The tunable enantioselective functionalization of alkene feedstocks represents a highly desirable yet predominantly unexplored tactic for generating high-value scaffolds. Here, the authors report a tunable enantioselective electrolytic system for dehydrogenative allylation, allylhydrogenation, allylation, and hydroboration reactions to afford structurally diverse products.
Yan-Xin Minghao Liu & Chang Guo

Article
02 January 2025 | [Open Access](#)
Addressing general measurements in quantum Monte Carlo
Quantum Monte Carlo is among the most accurate methods for quantum many-body systems but has been hindered by the difficulty of computing arbitrary off-diagonal observables. Wang et al. introduce a universal scheme based on bipartite weight annealing for direct and reliable evaluation of general observables.
Zhiyuan Wang, Zoran Liu & Zhang Yan

Article
02 January 2025 | [Open Access](#)
Formal anti-Markovnikov hydration of alkenes via paired electrolysis intercepting water-splitting
Anti-Markovnikov hydration of unactivated alkenes, the direct addition of water to form terminal alcohols, remains a challenge due to kinetic and thermodynamic barriers. Here, the authors report a paired electrolytic strategy that harnesses water splitting to achieve formal anti-Markovnikov hydration of alkenes in a divided cell.
Yuan-Qiong Huang, Xue Song & Jianchun Wang

Article
02 January 2025 | [Open Access](#)
Stable Cu⁺ sites derived from analogous rectifying interface in Ag₂Cu biphasic aerogels for efficient urea electrocatalysis at low potential
Electrocatalytic production of CO₂ and NO₂⁻ for urea synthesis is constrained by low efficiency. Here, the stable Cu⁺ active sites, regulated by an analogous rectifying interface effect, not only enhance the critical C-N coupling dynamics but also enabled high-performance urea synthesis.
Feng Feng, Shao Wang & Fuping Huang

Article
31 December 2025 | [Open Access](#)
Domain oriented universal machine learning potential enables fast exploration of chemical space of battery electrolytes
Efficient modeling of battery electrolytes is limited by the accuracy-cost trade-off. Here, authors develop a universal machine learning potential to accurately calculate transport and solvation properties across a broad chemical space.
Feng Wang, Hu-Chang Tang & Jun Cheng

Article
31 December 2025 | [Open Access](#)
Scalable photonic reservoir computing for parallel machine learning tasks
Neuromorphic computing processes data faster and with less energy than electronic. Here, authors demonstrate a reconfigurable photonic reservoir computing that performs multiple machine learning tasks in parallel at ultrahigh rates using extremely low energy per operation.
A. Kadir, L. Di Lauro & R. Morandotti

Article
31 December 2025 | [Open Access](#)
Sustainable water oxidation enabled by a complex-doped cobalt oxide electrode
The development of sustainable water oxidation catalysts is crucial for hydrogen production, yet cobalt-based materials often suffer from instability. Here, the authors report that co-doping LiCoO₂ with nickel, iron, and palladium yields a durable electrode with stability of over 2,000 hours.
Hongsheng Wang, Li Bai & Jun Wang

Article
31 December 2025 | [Open Access](#)
Universal complexing agent enabling advanced iron-cerium redox flow batteries
Efficient and durable energy storage is vital for renewable integration. Here, the authors design an aqueous iron-cerium redox flow battery using a universal complexing agent that enhances stability and efficiency, achieving long cycle life and high performance in neutral conditions.
Jiahui Yang, Wei Wei & Zhengyue Sun

Article
31 December 2025 | [Open Access](#)
A handheld photoacoustic-microscopic probe integrating a transparent ultrasound transducer and a fiber scanner
The authors develop a handheld photoacoustic probe integrating a fiber scanner and transparent ultrasound transducer. They demonstrate rapid, high-resolution 3D imaging of vessels and lymphatics in living animals, enabling early-stage translational potential.
Mingyi Jia, Aihua Xian & Chufeng Kim

Article
31 December 2025 | [Open Access](#)
BARCODE: high throughput screening and analysis of soft active materials
BARCODE is an open access software that automates high throughput screening of microassembly video data to produce a unique fingerprint or barcode of performance metrics that enables optimization and accelerates discovery of soft, active materials.
Gaoqiang Chen, Aditya Sriram & Megan T. Valentine

Article
31 December 2025 | [Open Access](#)
Structured liquid-based reconfigurable all-liquid optical fibers
Reconfigurable all-liquid optical fibers enable gigabit-speed communication while offering softness, rapid self-healing, and on-demand reconfiguration, providing a resilient alternative to brittle quartz fibers in diverse application environments.
Si-Qi Zhai, Yifeng Wang & Yu-Chai

Article
31 December 2025 | [Open Access](#)
Quantum advantage for learning shallow neural networks with natural data distributions
There is a current void in understanding quantum learning advantages between two extreme cases (exponential advantage for uniform distributions, no advantage for adversarial distributions). Lewis et al. design an efficient quantum algorithm for learning periodic neurons over non-uniform distributions of classical data and show that this is hard for a broad class of classical algorithms, resulting in an exponential quantum advantage.
Laura Lewis, Dan Glick & Jarrod R. McClean

Article
31 December 2025 | [Open Access](#)
Diffusionless ferroelectric process of irreversible ferroelectric to antiferroelectric phase transition and the rate limit
The authors reveal that the ferroelectric to antiferroelectric phase transition in Pb_{0.95}Te_{0.05}Te_{0.95}Te_{0.05} is an irreversible process exhibiting relaxation behavior and diffusional kinetics.
Mingyue Ge, Bing Han & Zhipeng Gao

Article
31 December 2025 | [Open Access](#)
Intrinsic asymmetric iontronic interfaces for giant power generation
An iontronic electricity generator is developed based on intrinsic asymmetric interfaces and controllable energy release, which achieves giant power generation through irreversible electron-coupled ion oscillation at interfaces.
Haoyan Wang, Jie Qiang & Liangli Qiu

Article
31 December 2025 | [Open Access](#)
Generating crossmodal gene expression from cancer histopathology improves multimodal AI predictions
Multimodal fusion of digital pathology and transcriptomics can improve cancer diagnosis, but remains impractical in clinical settings. Here, the authors develop a crossmodal generative model. Refined to synthesize transcriptomic data from histopathology slides, and show how the combination of these multimodal data improves cancer diagnosis and prognosis prediction.
Samran Day, Christopher R. S. Burrell & Tapaswita Chakraborti

Physical sciences articles within Nature Communications

Featured

Ferroelectric ultraviolet photodetector material with ultrafast response speed

The authors prepare single-domain $\text{SrBi}_{1-x}\text{Ti}_x\text{O}_3$ ferroelectric thin films with a magnetoplasmonic structure through a solid-state reaction. This thin film not only exhibits high remnant polarization but also demonstrates excellent polarization retention characteristics.

Xuesi Yan, Tingting Yan & Chunlin Chen

Topological exciton-polaritons with negative coupling

Negative coupling is an intriguing mechanism for linking lattice sites, enabling phenomena unattainable with positive coupling alone. Here, the authors introduce this unique coupling into the polariton system and generate topological polariton condensation in lattices with negative coupling.

Qipeng Yu, Jinghui He & Jui Lu

Engineered liquid-crystal elastomer unlocks high thermopower for fiber-shaped ion thermoelectric capacitors

Ion thermoelectric materials are promising for harvesting energy, but n -type materials are not as efficient as p -type materials. Here the authors report a homologous n - p -type thermoelectric material using a liquid crystal elastomer network for energy harvesting.

Liqun Cao, Tingting Yan & Weidong Wang

Magnetic memory driven by spin splitting torque in nonrelativistic collinear antiferromagnet

Magnetoresistive devices using spin-split electronic bands with zero net magnetization, making them ideal for integration into spin-based information processing devices. Here Guo, Chen, Zeng, and coauthors demonstrate magnetic memory making use of the all-magnetic spin splitting torque in a three-terminal MRAM device.

Yiqin Guo, Ailiao Chen & Hao Wu

Mode conversion of hyperbolic phonon polaritons in van der Waals terraces

High-order modes of hyperbolic polaritons – hybrid light-matter interactions – in anisotropic van der Waals materials hold potential for nanophotonic applications. Here, the authors report the observation of polariton mode conversion in step-shaped terraces of hexagonal boron nitride and α -MoO₃.

Byung-I Noh, Siba Rishi Chakraborty & Sreyan Dai

Modular assembly of chiral amino acid derivatives and peptides from commonly available feedstocks

α -Amino acids are fundamental components of proteins and natural molecules, with nonnatural variants valued in both academia and industry for their ability to tune chemical, physical, and pharmaceutical properties. Herein, the authors report a photocatalyzed protocol for the synthesis of optically active α -amino amides from readily available aldehydes, amines, and formamides.

Yan-Wei Ding, Zhi-Yuan He & Liu-Zhong Gong

Solar-driven fast photocatalytic hydrogen evolution using size-minimized organic heterojunctions

Organic heterojunction nanoparticles composed of small-molecule photoactive materials achieve subnanometer-scale diameters, overcoming the size constraints of widely used polymer nanoparticles and enabling enhanced photocatalytic performance.

Yiyou Xie, Jiechen Li & Yuzhe Lin

Two-dimensional magnetic tunnel p - n junctions for low-power electronics

Integrating semiconductor p - n junctions with magnetic materials yields van der Waals heterojunctions as an ideal low-power spintronic platform. Zhu et al. report an abnormal zero-bias spin voltage effect arising from non-equilibrium spin diffusion.

Yunkai Zhu, Qiao Wang & Kaiyao Wang

Unforeseen risks due to the use of fluorinated materials for per- and polyfluorinated substance removal

The escalating regulatory pressures on per- and polyfluorinated substances (PFAS) in drinking water highlight the critical and expeditious need for PFAS removal technologies. While innovative fluorinated materials are reported to be a promising avenue for PFAS removal by exploiting fluorine-fluorine (F-F) interactions, their production and applications raise potential concerns about perpetuating the "toxic chemical" cycle.

Shupin Lai, Robert J. Litcher & Dr Chen

Thermal light with enhanced oscillating bunching in field-tested photon-counting LIDAR

A continuous and non-modulated light source with oscillating second-order correlation enables LIDAR measurements with infinite range and picosecond accuracy.

Theodor Staffler, Jörn Clevborg & Vol Zeller

Optical heterostructure in a two-dimensional organic crystal

Optical heterostructures have potential in integrated photonics and optoelectronics but are challenging to prepare in single-component systems. Here, the authors report a polyimide membrane using modified intercalated polymerization methods for stable and highly permeable organic solvent membranes.

Fuzai Zheng, Zhenyong Pan & Gang Han

Polyamide nanofilms with Janus microporous framework for sustainable solvent filtration

Tuning permselectivity and chemical stability is desirable for polymer membranes, though it is challenging to balance these properties. Here the authors report a polyamide membrane using modified intercalated polymerization methods for stable and highly permeable organic solvent membranes.

Fuzai Zheng, Zhenyong Pan & Gang Han

Superadiabatic topological pumping on photonic chips

This work demonstrates superadiabatic topological pumping on photonic chips, achieving a 20-fold device miniaturization and high-efficiency operation across a 650–920 nm bandwidth, paving the way for ultracompact integrated photonic transports.

Jin-Lai Wu, Kai-Hong Xiao & Hong-Bo Sun

Highly reconfigurable neuronlike conductive networks through nanophase structure engineering

Nanomaterials electronics offer trade-offs among biological-like plasticity, electrical performance, and structural integrity. The authors show that non-specific effects in biology can be leveraged to create reconfigurable materials for biionic electronics.

Yue Zhang, Haibo Zhao & Jiajun Fu

Real-time observation of the diffusion-limited formation of a cation-molecule complex

The authors use femtosecond-timed Coulomb explosion to study in real time the bimolecular reaction of a single lithium ion diffusing toward a benzene dimer inside a liquid helium nanodroplet until formation of an ion-molecule complex.

Jeppe K. Christensen, Christian Engelbrecht Petersen & Henrik Stapelfeldt

Exploiting a centrally powered coherent microcomb for light-weight optical transmission

The exponential growth of data traffic demands efficient transmission systems. Here, authors exploit a self-actuation-locked microcomb to achieve high-capacity optical transmission, demonstrating a compact, lightweight system with potential for data centers and edge computing applications.

Jinhao Han, Guofeng Yan & Jian Wang

Ultrafast dynamics of vibronically dressed core excitons in graphite: a femtosecond RIXS perspective

Core excitons are strongly localized excitonic states impacting x -ray absorption and resonant inelastic scattering (RIXS) spectra. Here, the authors demonstrate an application of free electron laser-driven resonant inelastic x-ray scattering to study previously unclear aspects of core exciton-phonon interaction in graphite.

Marco Mallapragada, Renato Volpato & Doro Nicko

Rapid endothelialization of printed vascular grafts by perivascular niche-circulating endothelial progenitor cells

Fast reendothelialization of vascular grafts is important for maintain patency. Here, the authors report on a vascular graft that regenerates the neo-endothelium with lymphatic endothelial cells, which increases the recruitment of circulatory progenitor cells, achieving 90% patency in small-diameter arterial grafts.

Zhe-qian Zhang, Ping-ping Yuan & Wei Wu

High- κ samarium oxysulfate dielectric for two-dimensional electronics with enhanced gate coupling

van der Waals (vdW) dielectric materials with a wide bandgap and high dielectric constant are necessary for the development of 2D electronics. Here, the authors report the synthesis of quasi-vdW layered $\text{Sm}_2\text{O}_3\text{S}_2$ thin crystals, showing a bandgap of ~ 5.4 eV and a dielectric constant ~ 16 , leading to high performance 2D MoS₂ transistors.

Jiahua Yuan, Chuanping Xian & Wei Liu

Amine-level electroconversion of acetylene towards polymer grade ethylene via Pd-H mediated non-spillover hydrogenation

The electrochemical semi-hydrogenation of C_2H_2 to C_2H_4 is a promising process, but the competing hydrogen evolution reaction remains a major obstacle. This work presents a novel catalytic strategy to drive active hydrogen species, thereby improving the Faradaic efficiency for ethylene.

Lai Lai, Xiao Han & Yanting Qiu

Confinement-induced acceleration of CO_2 mineralization through interfacial water thinning

Mineral carbonation offers a scalable route for CO_2 removal. Here, the authors develop a water-thinning strategy to engineer confined interfacial sites that enable carbonation of calcium hydroxide under ambient conditions.

Min Su, Chunli Wang & Zhang Lin

Super-dense point clouds acquired by an ultralight 10 g solid-state single-photon LIDAR

Single-shot ranging enabled by single-photon detection allows dense point clouds to be acquired with greatly reduced laser pulse energy, while enhancing geometrical fidelity through the improved temporal resolution of devices in an ultralight LIDAR.

Tomoki Ohno, Kyohei Udagawa & Tomoki Matsunaga

Aerogel-based 1D electron transport vapor percolator for ultra-fast thermal cooling

The aerogel-based 1D electron transport vapor percolator that reconstructs vapor flow through integrated micro-nano tunnels, enabling ultra-fast cooling up to 1,000 °C.

Hongsheng Wang, Yihong Xu & Yang Si

Geometry-preserving vector field reconstruction of high-dimensional cell-state dynamics using ddtHodge

Cell-state transitions arise from complex gene-expression dynamics. Here, authors develop ddtHodge, a geometry-preserving method based on Hodge decomposition that reconstructs potential landscapes and all dynamic components from RNA velocity, revealing cell-state stability and lineage transitions.

Kyotomitsu Maehara & Yuzuki Chikara

Surface halogenation engineering for reversible silicon-based solid-state batteries

Silicon negative electrodes in solid-state batteries exhibit poor reversibility. Here, the authors demonstrate surface halogenation engineering that suppresses irreversible lithium loss, achieving 94.3% initial Coulombic efficiency and 72% capacity retention over 500 cycles at 25 °C.

Haosheng Li, Yaru Li & Ning Lin

Advancing quantum imaging through learning theory

Current superresolution imaging can beat the Rayleigh limit but struggles with complex imaging tasks. Here the authors use a quantum learning framework to address these challenges and introduce an improved method that enhances superresolution of nearby compact sources.

Yunkai Wang, Changhui Qiu & Sui Zhou

Printable polymer nanocomposites for scalable and architected radiative cooling

Daytime radiative cooling materials typically require high filler loading or porosity. Here, authors introduce photonic-optical coupling to control particle dispersion, enabling printable low-filler (PMMA-ZnO) composites for scalable and durable radiative coolers with versatile architectures.

Kai Zhou, Songtao Tang & Lili Cai

Coupling nitrate electrochemical reduction and nitrite oxidation of ethanol for acetamide synthesis

Conventional amides electrolysis methods confine reactions to solely electrochemical reduction or oxidation processes, resulting in low amides yield rates. Here, the authors report a tandem electrolyzer that couples cathodic nitrate reduction with anodic ethanol oxidation to produce acetamide.

Qikun Hu, Qiuwen Peng & Kian Ping Loh

Highly efficient heterogeneous thermal catalysis for noble-metal-free hydrogen production from formic acid

Finding efficient ways to release hydrogen from liquid carriers is key to advancing clean energy systems. This study introduces a resilient catalyst that drives highly selective hydrogen production from formic acid using low-grade heat.

Liang Qiu, Lin Yao & Baowen Zhou

Magnetically actuated momentum-driven millirobots

The authors developed a 5.82 g magnetically inner-actuated millirobot capable of carrying over 300 times its own weight. The high thrust and payload capability enable it to navigate tough terrains, such as sand, viscous oil, and confined spaces.

Min Wang, Wenlong Wu & Jun Liu

A smart nail platform for wireless subsoil health monitoring via unmanned aerial vehicle-assisted radio frequency interrogation

This work introduces a wireless, battery-free soil sensor that enables subsoil monitoring of moisture and salinity using ground-penetrating radar. The system allows scalable, low-cost deployment across farms, helping improve agricultural efficiency and sustainability.

Yashraj Ramesh, Muhammad Masud Rana & Rahim Rahimi

Population structure reverses selection of variants with proportionally scaled birth and death rates

High reproduction is often associated by higher mortality in models with well-mixed populations. Here, the authors model spatially-structured populations, finding that variants with proportional increases in birth and death rates become disadvantageous, even when they have a higher lifetime reproductive output.

Kazuo I. Komatsu & Dominik Wodarz

In-sensor analog optoelectronic processing of concurrent event and memory signals for dynamic vision systems

High-efficient dynamic vision systems requires capturing instantaneous motion and temporal evolution to infer trajectories, velocities, and even predict future motion. Kim et al. introduce an analog event-memory sensor that is capable of event detection and temporal integration. The proposed architecture can reduce latency, power consumption, and circuit complexity compared to conventional dynamic vision sensors.

Yelim Kim, Myeongsu Park & Won Il Park

Photochromism of pyridine-substituted merocyanine through reversible C-N bond formation

Spiropyran and merocyanine systems are useful due to the photochromic properties, but they have some limitations. Here, the authors report pyridine-substituted merocyanines as photochromic compounds, with a photoinduced C-N bond formation.

He Li, Yu Li & Yipin Shi

Designer RNA nanostructures co-transcribed and self-assembled inside human cell nuclei

The use of nucleic acid-based nanostructures as synthetic biological tools remains challenging, here they present synthetic RNA structures that fold and self-assemble inside human cell nuclei, offering a platform for imaging, sensing, and future therapeutic applications.

Xu Chang, Maoyi Jozsef & Fei Zhang

Spectrally encoded parallel LIDAR driven by super-bunching light

The authors leverage a super-bunching light to develop a spectrally encoded parallel LIDAR that achieves a sub-nanosecond optical detection and supports effective long-range detection beyond conventional pulse-period limitations without requiring additional encoding or decoding.

Xiaodong Zhang, Jinghui Lu & Chenglong Qiu

Buprestidae metamorphosis-inspired stiffening photonic elastomers for shape-color integrated memory and information encryption

Programmable shape-memory polymers are of interest for smart materials, meanwhile the integration of shape and color enriches the applications, here the authors use chiral liquid crystal elastomers affording a shape and color changing material, with dynamic mechanical properties.

Tianqi Ren, Xueping Shao & Jinhua Guo

Aldehyde covalent flame chemistry explains a missing source of organic acids

Using synchrotron vacuum-ultraviolet photoionization mass spectrometry and quantum chemistry, this study uncovers a previously missing process by which aldehydes in engine combustion form organic acids, a finding critical for accurate emissions modeling and mitigation strategies.

Erqiang Liu, Bin Dong & Zhenkang Wang

Mechanochemical ligand-controlled reductoligvergent hydroxylation of alkenes via iron-catalyzed C-H activation

While iron catalysis holds immense promise in organic synthesis due to the comparatively wide availability and low toxicity of the metal, modulation of the catalyst's oxidation state still typically relies on conventional and labor-intensive approaches. Here, the authors integrate mechanochemistry into iron-catalyzed reductoligvergent hydroxylation of alkenes with aldehydes, leading to an efficient generation of alkylated products.

Wenqiang Zhang, Ziyue Liu & Lutz Ackermann

A topological superconductor tuned by electronic correlations

The authors report superconducting topological surface states (TSS) in MnBi grown FeTe/Si films by high-resolution laser ARPES. Near the Fermi level, the surface state disappears due to an electron-connection-driven topological transition associated with decoherence of the d_{xy} -orbital-derived bands.

Haoan Liu, Christopher L. Jacobs & Shoulong Yang

Tuning valley polarization of moiré trapped bixcitations by fine structure occupation in WS₂/WSe₂ heterostructures

The authors show that, by tuning the occupation of moiré-trapped bixcitations in WS₂/WSe₂ heterostructures, their valley polarization can reach 55% at 12 K, highlighting the potential for valleytronic devices.

Yue Jiang, Yongzhi Shi & Xiaoping Wang

Rationally designed Fe-cyclopentadienone with unique orientations for efficient asymmetric hydrogenation of acylsilanes

Fe-cyclopentadienone complexes have been widely utilized in various hydrogenation and dehydrogenation catalytic processes, yet their applications have largely been restricted to non-asymmetric variants. Herein, the authors report the synthesis of a chiral Fe-cyclopentadienone complex and its application in the catalytic asymmetric hydrogenation of acylsilanes.

Chaoqun Xie, Bo-Xuan Yao & Xuefeng Tan

Self-assembly pathways towards floppy colloidal square lattices

Rearrangements govern many properties of materials and molecules, but it has been largely unexplored how to create flexible structures from the bottom up. Here, the authors use colloidal particles to explore how to guide the kinetic self-assembly pathways into ordered structures that maintain flexibility.

Yogesh Shetty, Daniel J. G. Pearce & Daniela J. Kraft

Robust chirality-induced spin selectivity in topologically chiral molecular knots

This study explains the superior spin selectivity (>60%) and high conductivity in molecular knots, through a novel theoretical model based on geometric spin-orbit coupling, directly linking their chiralities to topological results.

Xi Sun, Yali Yuan Zhang & Hua-Hua Fu

Oxygen-modulated engineering of Cu⁰-Cu⁺ interfaces for CO₂-to-C₂H₄ photoreduction

$\text{Ru}_2\text{Cu}_2\text{Cu}^0\text{-Cu}^+\text{Cu}_2\text{O}_2$ catalyst converts CO₂ to fuels via artificial photosynthesis, overcoming O₂ poisoning and sluggish C₂ yield through photochemical interface reconstruction. It achieves 74.3% selectivity for C₂H₄ with 0.3% efficiency.

Yue Ren, Meo Cheng & Naitou Li

Nano-confinement engineering boosts C-N coupling for urea electro-synthesis

This study introduces a nano-confined CuRu catalyst that leverages confinement effects to enhance CO₂-nitrate C-N coupling by improving reaction network and strengthening the stabilization of key reaction intermediates, thereby achieving high urea yield and long-term operational stability.

Jiaxin Du, Yinhao Wu & Xuehao Wu

Factoring an integer with three oscillators and a qubit

The number of qubits needed for Shor's factoring algorithm scales with the size of the integer to be factored. Here, the authors propose an alternative approach that would require only three harmonic oscillators and a qubit, regardless of the size of the integer, but incurring an extensive energy cost.

Lukas Brenner, Lior Laba & Robert Koenig

Small MoC₂ interstitial compound for efficient acidic CO₂ electroreduction to formic acid

Efficient acidic CO₂ reduction to HCOOH at high current density faces challenges of high overpotential, low Faradaic efficiency, and poor stability. This study optimizes these three key metrics by modulating adsorption strength through interstitial doping.

Yongdong Yu, Zuchao Wang & Li Wang

Machine learning-assisted kinetic matching model for rational electrode design in aqueous zinc-ion batteries

Aqueous zinc-ion batteries are safe and affordable but limited by incompatible electrode kinetics. Here, authors present a machine learning framework that resolves this mismatch, enabling the rational design of durable and high-capacity zinc-ion batteries.

Guo Xie, Xiaojing Yao & Zhengming Sun

Ultra-sensitive multi-degree-of-freedom piezoelectric sensor via synergistic hydrogel-ion interactions

Piezoelectric flex-sensors are limited by sensitivity and unidirectional bending response. Here, the authors achieve a high piezoelectric flex-sensitivity by tuning hydrogel-ion interactions, and decoupling of multi-degrees-of-freedom bending via a square prism-shaped fiber structure.

Xue Fang, Hao Ouyang & Raiman Wang

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