CHEMWATCH

Bulletin Board

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ASIA PACIFIC

China Proposes 4 Chemicals for Inventory of Existing Chemical Substances in China (IECSC) Inclusion

2025-08-19

On August 11, 2025, the Ministry of Ecology and Environment (MEE) announced that it has reviewed applications submitted to add certain chemical substances to the Inventory of Existing Chemical Substances in China (IECSC). The review was conducted in line with the Measures for the Environmental Management Registration of New Chemical Substances (MEE Order 12,) and the accompanying Guidelines.

MEE determined that four chemical substances meet the requirements outlined in Article 3 of MEE Order 12 and related provisions of the Guidelines. These substances are now proposed for inclusion in the IECSC and have been published on the MEE website for public comment.

The public may submit feedback via the methods specified on the MEE website between August 11 and August 22, 2025.

What does Proposed for Supplementation Mean?

Proposed for Supplementation indicates that, after preliminary review by the MEE, a substance is intended to be added to the official Inventory and is now undergoing a public comment period. The substance is not yet formally listed in the IECSC but has passed the initial documentation review stage.

Read More

CIRS, 19-08-25

https://www.cirs-group.com/en/chemicals/china-proposes-4-chemicals-for-inventory-of-existing-chemical-substances-in-china-iecsc-inclusion

It's time to submit your annual declaration for 2024–25

2025-08-21

Who must make an annual declaration for 2024–25?

All introducers (importers or manufacturers) must make an annual declaration if they introduced an industrial chemical for commercial purposes between 1 September 2024 and 31 August 2025. By submitting an annual declaration, you are declaring that your chemical introductions

during the 2024–25 registration year were authorised under the Industrial Chemicals Act 2019.

New video now available?

We've just published a new video that walks you through the annual declaration process.

It's a great way to get a quick overview of what you need to know.

How to submit an annual declaration?

The annual declaration form is on AICIS Business Services and due by 30 November 2025 for all chemicals that you introduced during the last AICIS registration year between 1 September 2024 and 31 August 2025.

There are 6 AICIS introduction categories and you must choose which one(s) apply.

Read More

AICIS, 21-08-25

https://www.industrialchemicals.gov.au/news-and-notices/its-time-submit-your-annual-declaration-2024-25

Do you need to submit a post-introduction declaration (PID) for 2024-25?

2025-08-21

If you worked out that your chemical introduction is in the 'exempted' category and you first introduced (imported or manufactured) it between 1 September 2024 and 31 August 2025, you must submit a PID in AICIS Business Services if your introduction is:

- a polymer of low concern
- a low-concern biological polymer
- categorised as very low risk for human health and the environment.

Due date: 30 November 2025.

Important to know

1. A PID is a one-off declaration only for some exempted introductions.
2. Don't resubmit if you already submitted a PID previously and your introduction circumstances haven't changed.

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3. If you've introduced more than one type of exempted introduction that requires a PID, you must submit a separate declaration for each. Example: You introduced 2 chemicals for the first time in the exempted category during 2024-25 – one a polymer of low concern (PLC) and the other an introduction categorised as very low risk for human health and the environment. This means you'll need to submit 2 separate declarations, one for each introduction.
4. Agents or consultants can submit PIDs on behalf of the registered introducer (importer or manufacturer).

Learn more

Learn about this declaration, including a video about PIDs and detailed instructions on how to submit the form.

Read More

AICIS, 21-08-25

https://www.industrialchemicals.gov.au/news-and-notices/do-you-need-submit-post-introduction-declaration-pid-2024-25

Taiwan Environmental Technology Water PFAS Standards

2025-08-19

Starting in July 2027, Taiwan will begin enforcing legal limits on PFAS (Per- and Polyfluoroalkyl Substances) in public drinking water. Water suppliers will be required to monitor PFAS levels, report any exceedances, and implement appropriate treatment systems—or face fines of up to USD $20,000 (based on an exchange rate of 1:30).

This regulatory move reflects growing global health concerns over PFAS—often referred to as "forever chemicals"—and aligns Taiwan with U.S. and EU environmental standards. It also presents a valuable opportunity for U.S. water technology companies to export proven PFAS mitigation solutions.

With significant public investment in water infrastructure and a strong national focus on ESG performance, Taiwan is actively seeking advanced, reliable solutions. U.S. firms that build partnerships with local integrators, engage with the Taiwan Water Corporation, and adapt their products to local needs will be well-positioned for success.

U.S. companies with expertise in PFAS treatment, advanced filtration, monitoring technologies, and water quality solutions are encouraged to participate in Taiwan International Water Week, taking place October 29–31, 2025, in Taipei.

Read More

Market Intelligence, 19-08-21

https://www.trade.gov/market-intelligence/taiwan-environmental-technology-water-pfas-standards

PFAS chemicals detected in sewage sludge at 34 locations across Japan

2025-08-20

Potentially harmful PFAS chemicals have been detected in sewage sludge at 34 wastewater treatment plants across Japan, with globally regulated PFOS found in nearly all of the samples, a study by a Kyoto University team showed Wednesday.

The study supports the view that the chemicals have spread nationwide. The Japanese government is promoting the use of sludge as fertilizer, but has not set guideline values for the amount of PFAS in sludge byproducts.

PFAS is a general term for a group of over 10,000 artificial chemicals that include PFOS, or perfluorooctanesulfonic acid, and PFOA, or perfluorooctanoic acid.

Known as forever chemicals because they are highly resistant to breakdown and accumulate in soil and water as environmental pollutants, PFAS are used in various products such as firefighting foam and nonstick cookware coatings.

"There is a possibility that PFOS, which is feared to pose health damage, is contained in sewage sludge in Japan in general," said Kazuyuki Oshita, associate professor at Kyoto University, who analyzed the findings.

"It is desirable that the accumulation of data will lead to the creation of a guideline in the future," Oshita said.

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Kyodo News, 20-08-25

https://english.kyodonews.net/articles/-/59522

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AMERICA

Clean Water Action Celebrates New Jersey's Landmark PFAS Victory! Aggressive Action is Needed to Protect our Drinking Water Sources

2025-08-07

A federal court settlement worth more than $2 billion, the largest environmental settlement ever reached by a single state, is set to fund the cleanup of widespread PFAS contamination at four former DuPont industrial sites across New Jersey, state officials announced Monday.

PFAS (per-and poly-flouroalkyl substances) are a class of human-made chemicals that are toxic even in very low concentrations. Because they are stain and oil resistant and repel water, PFAS have been widely used since the 1950s in many common consumer products, including carpets, clothing, cookware, cosmetics, and food packaging. These "forever chemicals" are highly persistent and mobile in the environment, which means they bioaccumulate and travel unchanged through streams, rivers, and other water bodies, including drinking water sources. PFAS are linked to serious health problems including damage to liver, thyroid, and pancreatic function, immune system harm, hormone disruption, high cholesterol, and cancer.

"The ruling is obviously a significant victory and excellent start that should provide an example of perseverance for the other 49 states and a wake-up call to major corporations doing business involving PFAS," said Colron Chambers, NJ Board Co-Chair, Clean Water Action.

"Clean Water Action is making sure policymakers hear that wake-up call and start acting on PFAS pollution where it starts. If we keep manufacturing and using PFAS chemicals, they will lead to the need for more drinking water treatment and thus higher costs for communities and our water bills," said Jeff Carter, President & CEO, Clean Water Action.

Read More

Clean Water Action, 07-08-25

https://cleanwater.org/releases/clean-water-action-celebrates-nj-landmark-pfas-victory

California regulators back moves to boost zero-emissions vehicles as feds take on state's standards

2025-08-18

California regulators on Tuesday vowed to strengthen their commitment to slashing harmful vehicular emissions as the Trump administration ramps up efforts to overturn the state's pollution policies.

"Clean air efforts are under siege, putting the health of every American at risk," said Liane Randolph, chair of the California Air Resources Board (CARB), on a Tuesday press call.

"California is continuing to fight back and will not give up on cleaner air and better public health — we have a legal and moral obligation," she added.

Randolph spoke alongside the publication of a new CARB report that outlined ways the state could fight back: by accelerating zero-emission vehicle (ZEV) adoption via increased private investment, government incentives and changes in ZEV fuel pricing.

The report, submitted to Gov. Gavin Newsom (D), identified these specific priority action areas and others relating to state regulations and ZEV procurement, as requested by the governor in a June executive order.

Read More

The Hill, 18-08-25

https://fox5sandiego.com/the-hill-california-politics/california-regulators-back-moves-to-boost-zero-emissions-vehicles-as-feds-take-on-states-standards/amp/

EUROPE

Predisposal Radioactive Waste Management (PREDIS) Project Final Achievements and Impacts Overview

2025-08-14

The PREDIS project on Predisposal of Radioactive Waste has succeeding in developing and implementing new methods, processes and technologies for treatment of challenging low-level waste (LLW) and intermediate level waste (ILW) streams. Over the 4-year duration, this Euratom project of 47 partners from 17 Member States has worked in close collaboration with

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25 End User industrial members to advance the technologies associated with predisposal issues. This has included characterisation followed by treatment, conditioning and processing of metallics, liquid organic and solid organic wastes as well as with digitalization technologies for assessing performance of concrete waste packages and pre-disposal storage. Long-term modelling and performance testing have been done to verify the safety and effectiveness of the new or enhanced solutions. Value Assessments were done for some of the new solutions to ensure implementors would have sufficient tools for making choices about the potential implementation. This included life-cycle assessment of quantitative sustainability indicators and life cycle-costing for economic indicators. The project also addressed new guidance on Waste Acceptance Criteria and contributed with a revised Strategic Research Agenda to guide future predisposal activities, complimentary to the holistic waste management programme. Knowledge Management actions were also an integral part of the whole project to foster competence development and capturing knowledge. Actions included training, mobility, and guidance especially through online forums such as webinars and digital training. This paper provides a snapshot of some of the key outcomes and impacts from the project, from technical as well as strategic and knowledge perspectives.

Read More

European Commission, 14-08-25

https://publications.jrc.ec.europa.eu/repository/handle/JRC142362

Nordic Swan Ecolabel buildings

2025-08-21

Can a building be ecolabelled? Yes! If the building is built under controlled conditions, with consideration for both the environment and human health. But how can you prove it? This is where the Nordic Swan Ecolabel comes in!

Applying for generation 3 or generation 4?

Generation 3 - Small houses, apartment buildings and buildings for schools and pre-schools

Licence applicants applying after February 28, 2023 with planned construction start before September 30, 2024 can apply under Generation 3. They should complete their certification by September 30, 2026.

Generation 4 - New buildings: residential, educational and office buildings

The type of buildings that can be ecolabelled are offices, educational buildings (schools, kindergartens and day-cares) and residential buildings such as small houses, apartments, town houses, student housing and homes for the elderly or for persons with disabilities.

Read More

The Nordic Swan Ecolabel, 21-08-25

https://www.svanen.se/en/nordic-swan-ecolabel-buildings/

Ozone onslaught across Southern Europe continues with six alarm threshold spikes already this year

2025-08-21

Italy has experienced six spikes in dangerous ground-level ozone pollution this year, as levels reached beyond the 240 mg/m3 alarm threshold [1] with devasting consequences for human and environmental health warns civil society. While ozone levels regularly breach EU air quality standards (anything above 120 mg/m3), the alarm threshold has only been breached once in the past three years.

Exacerbated by heatwaves, similar peaks have been recorded across Southern Europe, yet civil society warn that little is being done at EU and national level to address one of the main precursors of ozone: methane, a powerful greenhouse gas. This week's soaring temperatures have led to the latest example of levels exceeding EU air quality standards.

In 2022, exposure to ozone caused an estimated 70,000 premature deaths and €2 billion in crop losses across the EU [3]. Despite commitments made by the EU under the Global Methane Pledge [4], little has been done to tackle methane emissions, especially in the agricultural sector (responsible for 56% of all human-made methane emissions), where emissions are only projected to decrease by 3% by 2050 [5].

Read More

EEB, 13-08-25

https://eeb.org/ozone-onslaught-across-southern-europe-continues-with-six-alarm-threshold-spikes-already-this-year/

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ECHA publishes updated PFAS restriction proposal

2025-08-20

The European Chemicals Agency (ECHA) has published the updated proposal to restrict per- and polyfluoroalkyl substances (PFAS) under the EU's chemicals regulation, REACH. The update has been prepared by the authorities from Denmark, Germany, the Netherlands, Norway and Sweden, who submitted the initial proposal in January 2023.

Helsinki, 20 August 2025 – The five authorities, acting as the Dossier Submitter, have completed their evaluation of the more than 5 600 scientific and technical comments received from third parties during the 2023 consultation. Based on the evidence gathered, they have updated their initial restriction proposal. This updated report, called the Background Document, forms the basis for ECHA's committees' opinions. This document may still be updated further, based on the evaluation of the committees.

The five authorities have, among other things, identified and carried out assessments for eight sectors that were not specifically named in the initial proposal. These sectors are:

- printing applications;
- sealing applications;
- machinery applications;
- other medical applications, such as immediate packaging and excipients for pharmaceuticals;
- military applications;
- explosives;
- technical textiles; and
- broader industrial uses, such as solvents and catalysts.

In addition, they have considered alternative restriction options, beyond a full ban or a ban with time-limited derogations for certain applications. These options involve conditions allowing the continued manufacture, placing on the market or use of PFAS where the risks can be controlled. These alternative options have been assessed by the Dossier Submitter for:

- PFAS manufacturing;
- transport;
- electronics and semiconductors;
- energy;

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- sealing applications;
- machinery applications; and
- technical textiles.

ECHA's scientific committees for Risk Assessment (RAC) and for Socio-Economic Analysis (SEAC) continue to evaluate the proposed restriction. The Agency aims to provide the European Commission with a transparent, independent, and high-quality RAC and SEAC opinion as soon as possible.

The European Commission will ultimately decide on the restriction in consultation with the EU Member States.

Read More

ECHA, 20-08-25

https://echa.europa.eu/-/echa-publishes-updated-pfas-restriction-proposal

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Janet's Corner

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Who Am I?

2025-08-29

I am element number 14. I am a metalloid, meaning I have properties of both metals and nonmetals. You'll find me everywhere in modern technology, forming the basis of computer chips and solar cells due to my unique semiconducting abilities. I'm the second most abundant element in Earth's crust, often found in sand and quartz. I have a relatively high melting point and a grayish, lustrous appearance.

(Send in your answers and get a surprise Chemwatch merch from us for free)

I am element number 14.

Diethyl Sulfate

2025-08-29

Diethyl sulfate is a highly toxic and likely carcinogenic chemical compound with formula (C2H5)2SO4. [1] It is the diethyl ester of sulfuric acid and exists at room temperature as a colourless oily liquid with a faint peppermint odour. Diethyl sulfate is slightly soluble in water, but miscible with alcohol, diethyl ether, and most polar solvents. It readily decomposes in hot water to ethyl hydrogen sulfate and ethyl alcohol. [1,2]

USES [2,3]

The primary use of diethyl sulfate is as a chemical intermediate (ethylating agent) in synthesis of ethyl derivatives of phenols, amines, and thiols; as an accelerator in the sulfation of ethylene; and in some sulfonation processes. It is used to manufacture dyes, pigments, carbonless paper, and textiles. It is an intermediate in the indirect hydration (strong acid) process for the preparation of synthetic ethanol from ethylene. Smaller quantities are used in household products, cosmetics, agricultural chemicals, pharmaceuticals, and laboratory reagents. In 1966, it was used as a mutagen to create the Luther variety of barley.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- The most probable routes of exposure to diethyl sulfate are by dermal contact or inhalation during its production or use.
- Individuals may also be exposed to diethyl sulfate in the ambient environment from fugitive emissions.

Routes of Exposure

The routes of potential human exposure to diethyl sulfate are inhalation, ingestion, and dermal contact during its production and use.

HEALTH EFFECTS [4]

Acute Health Effects

- No information is available on the acute effects of diethyl sulfate in humans.

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- Tests involving acute exposure of rats, mice, and rabbits have demonstrated diethyl sulfate to have moderate acute toxicity when ingested and high acute toxicity from dermal exposure.

Carcinogenicity

- In an epidemiological study, an excess mortality rate from laryngeal cancer was associated with occupational exposure to high concentrations of diethyl sulfate.
- In one study, rats exposed to diethyl sulfate by gavage (experimentally placing the chemical in the stomach) developed tumours in the forestomach. In another study, local tumours and metastasis of the lung were observed in rats exposed by subcutaneous injection.
- EPA has not classified diethyl sulfate with respect to potential carcinogenicity.

SAFETY

First Aid Measures [5]

- **General advice:** Consult a physician. Show safety data sheet to the doctor in attendance.
- **If inhaled:** Move person into fresh air. If not breathing, give artificial respiration. Consult a physician.
- **In case of skin contact:** Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.
- **In case of eye contact:** Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.
- **If swallowed:** Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

Workplace Controls & Practices [4]

- Avoid contact with skin, eyes and clothing.
- Wash hands before breaks and immediately after handling the product.

Personal Protective Equipment [5]

The following personal protective Equipment is recommended when handling diethyl sulfate:

- **Eye/face protection:** Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
- **Skin protection:** Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands. The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
- **Body Protection:** Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
- **Respiratory protection:** Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

REGULATION

United States

No workplace exposure standards established.

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6. http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/772/Workplace-exposure-standards-airborne-contaminants.pdf

Scientists pioneer sustainable carbon capture from shrimp waste

2025-08-26

Researchers at the University of Sharjah have developed an innovative method to transform shrimp waste, which is typically discarded in large quantities by the seafood industry, into a valuable carbon product capable of capturing carbon dioxide (CO_2).

This breakthrough offers a sustainable solution to both waste management and climate change mitigation.

Led by Dr. Haif Al-Jomard, the team has introduced a novel waste-to-carbon technology that utilizes shrimp shells, heads, and intestinal tracts to produce activated carbon.

This material demonstrates excellent CO_2 adsorption capabilities, positioning it as a promising candidate for industrial carbon capture applications, adds Dr. Al-Jomard.

"Our study turns shrimp waste into a high-performance carbon product. This not only addresses the environmental challenges posed by seafood waste but also contributes to global efforts to reduce greenhouse gas emissions and climate change mitigation."

Published in the journal Nanoscale, the research outlines a process involving pyrolysis of shrimp waste to produce biochar, followed by acid treatment, chemical activation and ball milling. The resulting activated carbon exhibits strong CO_2 capture performance and long-term stability across multiple adsorption–desorption cycles.

Shrimp, lobster, and crab shell processing generates up to 8 million tons of waste annually, much of which is discarded. The study utilized white shrimp waste—specifically shells and heads—sourced from Souq Al Jubail in Sharjah, in the United Arab Emirates, with the shrimp originally harvested in Oman. The waste was meticulously cleaned and air-dried before processing.

Professor Chaouki Ghenai, co-author and expert in Sustainable and Renewable Energy at the University of Sharjah, emphasized the economic and environmental benefits of the method. "This approach offers a cost-effective route to producing activated carbon, turning a problematic waste stream into a high-performance, efficient, and environmentally friendly product with wide-ranging applications."

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Activated carbon derived from shrimp waste has potential uses beyond carbon capture, including air and water purification, solvent recovery, gold extraction, and even medical applications. In the context of carbon capture, utilization, and storage (CCUS), the material could be adopted by industries such as power generation, cement, steel manufacturing and petrochemicals.

The researchers highlight that their method aligns with the principles of the circular economy, resource efficiency, and waste valorization, eliminating waste and pollution by reducing overall resource consumption and converting by-products into valuable and highly efficient resources.

"Our findings validate a scalable and sustainable strategy for shrimp waste valorization," they write. "The combined thermal, chemical and mechanical treatments of shrimp waste enhance both the textural and chemical properties of the final activated carbon material, making it a viable solution for climate change mitigation."

This pioneering work not only showcases the potential of shrimp waste as a resource but also sets a foundation for future innovations in sustainable carbon capture technologies.

Phys Org, 26 August 2025

https://phys.org

This tiny iron catalyst could transform the future of clean energy

2025-08-27

Proton exchange membrane fuel cells (PEMFCs), often referred to as "hydrogen power banks," are clean energy devices that generate electricity from hydrogen and oxygen with only water as a byproduct. Characterized by high efficiency, rapid start-up, and zero emissions, they hold great promise in transportation, portable electronics, and stationary power generation. Unfortunately, PEMFCs currently rely heavily on scarce and expensive platinum as a catalyst, making their widespread adoption impractical.

Now, however, a team of Chinese scientists has developed a high-performance iron-based catalyst for these fuel cells that could potentially reduce reliance on platinum. The new design, described as "inner activation, outer protection," enables record efficiency and long-term durability.

The findings were published in Nature.

Traditional Fe/N-C catalysts typically rely on outer surface of graphene or carbon supports, limiting the exposure of active sites and hindering their practical application. In general, PEMFCs have also been hampered by overly strong binding with oxygen intermediates, poor reaction kinetics, and vulnerability to Fenton reactions in oxidative environments (e.g., H2O2 and ·OH), leading to metal leaching and performance degradation.

To address these challenges, the research team led by Prof. Dan Wang (currently at Shenzhen University) and Prof. ZHANG Suojiang from the Institute of Process Engineering of the Chinese Academy of Sciences developed an inner curved-surface single-atom iron catalyst (CS Fe/N-C) with a unique nanoconfined hollow multishelled structure (HoMS). Each nano hollow particle, about 10 nm × 4 nm in size, consists of multiple shells where Fe atoms are concentrated on the inner layers at high density.

This catalyst is composed of numerous nano HoMS dispersed on 2D carbon layers, with single-iron-atom sites primarily embedded within the inner curved surface of the nano HoMS. The outer graphitized carbon layer of the nano HoMS not only effectively weakens the binding strength of the oxygenated reaction intermediates but also reduces the hydroxyl radical production rate, forming a distinctive "inner activation, outer protection" microenvironment. The Fe/N-C catalyst delivers one of the best-performing platinum-group-metal-free PEMFCs.

Synchrotron X-ray absorption spectroscopy revealed that these inner Fe atoms predominantly exhibit a +2 oxidation state and an FeN4C10 coordination structure. Mössbauer spectroscopy further confirmed that 57.9% of the Fe sites are in a catalytically active low-spin D1 state.

Theoretical calculations showed that increasing curvature alone strengthens intermediate binding and hinders desorption, thereby reducing catalytic activity. However, introducing a nitrogen-doped carbon outer shell with Fe vacancies induces significant electrostatic repulsion (0.63-1.55 eV) between the outer-layer nitrogen atoms and the oxygen atoms of adsorbed intermediates on the inner shell. This repulsion weakens the binding strength, breaks the linear scaling relationship among ΔG*OH, ΔG*O, and ΔG*OOH, and significantly enhances the catalytic performance.

According to the researchers, the catalyst achieved an oxygen reduction overpotential as low as 0.34 V, which is far better than that of planar structure. It also suppressed hydrogen peroxide formation and improved

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selectivity and durability. Additionally, it delivered a record power density of 0.75 W cm-2 under 1.0 bar H2-air with 86% activity retention after more than 300 hours of continuous operation.

This work establishes a new type of CS Fe/N-C for highly active and durable oxygen reduction catalysis in fuel cells. The graphitized outer N-C layer effectively weakens the binding strength of oxygenated intermediates and suppresses ·OH generation, thereby improving both activity and stability. It provides a new paradigm for developing high-performance catalysts for next-generation electrocatalyst.

Science Daily, 27 August 2025

https://sciencedaily.com

Scientists crack indole's toughest bond with copper, unlocking new medicines

2025-08-26

Indole, a molecule made up of a six-membered benzene ring fused to a five-membered ring containing nitrogen, forms the core structure of many biologically active compounds. Derivatives of indole, where hydrogen atoms are replaced by various chemical groups, are naturally produced by plants, fungi, and even the human body.

Due to their properties, indoles have gained attention as a backbone for synthesizing a wide variety of drugs. Since 2015, the U.S. Food and Drug Administration has approved 14 indole drugs to treat conditions, such as migraines, infections, and hypertension. Chemists have developed many strategies to attach different chemical groups to indoles. Some approaches introduce new groups directly onto the ring, while others involve temporary structural changes through intermediates. However, modifying specific positions on the indole ring, such as the C5 carbon, remains a challenge due to its low reactivity.

In a recent study, researchers at Chiba University, Japan, reported a method for selectively attaching an alkyl group to the C5 position of indole using a relatively inexpensive copper-based catalyst, which produced the desired product in yields of up to 91%. This method offers a more affordable and scalable approach for modifying indoles, which could be especially valuable in drug development.

The study, led by Associate Professor Shingo Harada, included Mr. Tomohiro Isono, B.Pharm., Ms. Mai Yanagawa, M.Pharm., and Professor

Tetsuhiro Nemoto from the Graduate School of Pharmaceutical Sciences at Chiba University, and was published online in the journal Chemical Science.

"We developed a direct, regioselective C5-H functionalization reaction of indoles under copper catalysis. The resulting compounds contain structural features commonly found in natural indole alkaloids and drug molecules, highlighting the usefulness of this approach for making biologically important compounds," says Dr. Harada.

The reaction uses carbenes, highly reactive carbon species that can form new carbon-carbon bonds. In an earlier study, the team used rhodium-based carbenes to attach groups at the C4 position of indole, guided by unsaturated enone groups placed at the 3-position. In this study, they used a similar strategy but altered the reaction conditions to target the C5 position instead.

They tested the reaction using a model compound, N-benzyl indole with an enone group, together with dimethyl α-diazomalonates as the carbene source and different combinations of rhodium, copper, and silver salts as catalysts. Initially, the desired C5-functionalized product formed only in small amounts, with yields up to 18%. However, when they used a combination of copper and silver salts (Cu(OAc)2·H2O and AgSbF6), the yield rose to 62%. Upon carrying out further optimizations, such as adjusting the solvent volume and increasing the concentration, they improved the yield to 77%.

The reaction proved to be highly versatile, working with a wide range of indoles. When the enone group was replaced at the 3-position with a benzoyl group, the yield increased to 91%. Successful reactions were also observed with indoles bearing other substituents, such as methoxybenzyl, allyl, and phenyl groups, opening the door to the synthesis of structurally diverse molecules.

To uncover the reaction mechanism, the team carried out quantum chemical calculations, which suggested that the carbene does not react directly at C5. Instead, it first forms a bond at the C4 position, creating a strained three-membered ring. This intermediate then rearranges, shifting the new bond to the C5 position. The copper catalyst plays a critical role in making this pathway possible by stabilizing the intermediate and lowering the energy barrier for the rearrangement.

This copper-catalyzed strategy offers a reliable and cost-effective approach for modifying indoles at the C5 position, producing compounds

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that closely resemble biologically active indole-based agents. Dr. Harada highlights the method's potential for drug discovery by stating, "While it may not cause a significant shift right away, it could foster steady progress in drug discovery, leading to a small yet beneficial long-term impact."

The team is continuing its research, exploring other metal-carbene reactions to develop more selective and efficient strategies for constructing indole-based molecules that might one day contribute to the treatment of specific diseases.

Science News, 26 August 2025

https://sciencenews.com

Chemists develop four-charge storage molecule to advance artificial photosynthesis

2025-08-28

A research team from the University of Basel, Switzerland, has developed a new molecule modeled on plant photosynthesis: under the influence of light, it stores two positive and two negative charges at the same time. The aim is to convert sunlight into carbon-neutral fuels.

Plants use the energy of sunlight to convert CO2 into energy-rich sugar molecules. This process is called photosynthesis and is the foundation of virtually all life: animals and humans can "burn" the carbohydrates produced in this way again and use the energy stored within them. This once more produces carbon dioxide, closing the cycle.

This model could also be the key to environmentally friendly fuels, as researchers are working on imitating natural photosynthesis and using sunlight to produce high-energy compounds: solar fuels such as hydrogen, methanol and synthetic gasoline. If burned, they would produce only as much carbon dioxide as was needed to produce the fuels. In other words, they would be carbon-neutral.

A molecule with a special structure

In the journal Nature Chemistry, Professor Oliver Wenger and his doctoral student Mathis Brändlin have now reported on an important interim step toward achieving this vision of artificial photosynthesis: they have developed a special molecule that can store four charges simultaneously under light irradiation—two positive ones and two negative ones.

The intermediate storage of multiple charges is an important prerequisite for converting sunlight into chemical energy: the charges can be used to drive reactions—for example, to split water into hydrogen and oxygen.

The molecule consists of five parts that are linked in a series and each performs a specific task. One side of the molecule has two parts that release electrons and are positively charged in the process. Two on the other side pick up the electrons, which causes them to become negatively charged. In the middle, the chemists placed a component that captures sunlight and starts the reaction (electron transfer).

Two steps using light

In order to generate the four charges, the researchers took a stepwise approach using two flashes of light. The first flash of light hits the molecule and triggers a reaction in which a positive and a negative charge are generated. These charges travel outward to the opposite ends of the molecule.

With the second flash of light, the same reaction occurs again, so that the molecule then contains two positive and two negative charges.

Works in dim light

"This stepwise excitation makes it possible to use significantly dimmer light. As a result, we are already moving close to the intensity of sunlight," explains Brändlin. Earlier research required extremely strong laser light, which was a far cry from the vision of artificial photosynthesis. "In addition, the charges in the molecule remain stable long enough to be used for further chemical reactions."

That being said, the new molecule has not yet created a functioning artificial photosynthesis system. "But we have identified and implemented an important piece of the puzzle," says Oliver Wenger.

The new findings from the study help to improve our understanding of the electron transfers that are central to artificial photosynthesis.

"We hope that this will help us contribute to new prospects for a sustainable energy future," says Wenger.

Phys Org, 25 August 2025

https://phys.org

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Gut microbes may flush 'forever chemicals' from the body

2025-07-11

Expelling toxic "forever chemicals" from the body may take guts — or at least, their microbes.

Some microbes found in the human gut can absorb some per- and polyfluoroalkyl substances, or PFAS, researchers report July 1 in Nature Microbiology. Mice harboring those bacteria in their guts excreted PFAS in their feces, suggesting microbes are intestinal allies that flush forever chemicals from the body.

Bacteria often encounter many potentially stressful chemicals such as pesticides and have mechanisms to deal with them. But "from the bacterial perspective, chemicals are chemicals," says Kiran Patil, a molecular biologist at the University of Cambridge. Previous studies had showed that gut microbes can pick up and store unintended targets such as therapeutic drugs. But it was unknown how those bacteria respond to pollutants including PFAS that people might consume in food or water.

PFAS are essential components in waterproof or stain-resistant products, including nonstick cookware and rain gear. But the chemicals are linked to health problems such as high cholesterol, developmental delays and certain cancers, prompting a search for alternatives. PFAS are detectable in nearly all people living in the United States, according to the U.S. Centers for Disease Control and Prevention.

The team exposed human gut bacteria to two common forms of PFAS and other pollutants. At various concentrations, multiple bacterial strains, including E. coli, soaked up PFAS in lab dishes, storing forever chemicals in clumps inside their cells, Patil says. The microbes amassed between 20 and 75 percent of the chemicals with no negative effects.

What's more, the gut bacteria of so-called "humanized" mice — animals whose intestines have been cleared of existing microbes and replaced with kinds that live in people — had more PFAS in their poop than microbe-free mice. The finding suggests that gut bacteria can carry forever chemicals out of the body in feces.

To determine if the same happens in people, researchers could track differences in gut microbiomes and PFAS levels in people from the same place, Patil says. Or people could take probiotics containing forever chemical-absorbing bacteria to test if levels go down.

Many efforts focus on removing PFAS from the environment, but the findings could help researchers find ways to clear them from the body, too. "Our [gut microbiome] does a lot of things for us," Patil says. "And maybe they are doing something positive to help us with PFAS."

Science News, 11 July 2025

https://sciencenews.org

Scientists found a new way to turn sunlight into fuel

2025-08-26

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This model could also be the key to environmentally friendly fuels, as researchers are working on imitating natural photosynthesis and using sunlight to produce high-energy compounds: solar fuels such as hydrogen, methanol and synthetic petrol. If burned, they would produce only as much carbon dioxide as was needed to produce the fuels. In other words, they would be carbon-neutral.

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Science News, 26 August 2025

https://sciencenews.com

Strontium-based crystals may boost fuel cells and smart energy devices

2025-08-18

Solid oxide fuel cells (SOFC) can help extend the range of electric cars using a range of fuels, and run stationary power generators, with minimal emissions. The trouble is, these cells require awfully high temperatures to operate.

A combined effort by researchers from South Korea and Japan might help tackle that: the team has developed a new crystalline material that can release and capture oxygen on demand, as if it was breathing. That allows for efficient electricity production from hydrogen with low emissions from fuel cells, and without breaking down over repeated use.

The crystal is actually a metal oxide comprising strontium, iron, and cobalt. By heating it to a relatively low temperature of about 752 °F (400 °C), it can be made to release oxygen when needed. This tackles the challenge of operating in harsher conditions involving much higher temperatures for oxygen control, and replaces other materials used in this process that were too fragile to use repeatedly.

"This is a major step towards the realization of smart materials that can adjust themselves in real time," explained Professor Hiromichi Ohta from Japan's Hokkaido University, who co-authored the paper on this tech that appeared in Nature Communications last week. "The potential applications range from clean energy to electronics and even eco-friendly building materials."

Going beyond fuel cells, it can also feature in small devices called thermal transistors that can control heat transfer in electronics, and also in smart windows for adjusting heat flow as needed to maintain indoor temperatures.

New Atlas, 18 August 2025

https://newatlas.com

Natural enzyme expands possibilities for peptide drug discovery

2025-08-25

A team of researchers from the University of Utah and Sethera Therapeutics has uncovered a powerful new way to build more stable and drug-like peptides, opening the door to medicines that could target diseases long considered "undruggable." Their findings are published last week in the Proceedings of the National Academy of Sciences.

In the paper titled, "Diverse thioether macrocyclized peptides through a radical SAM maturase," the team studied a natural enzyme, called PapB, that can "staple" peptides into circular structures known as macrocycles. What makes PapB so unusual is that it combines flexibility and precision: It works on many different building blocks—including those that biology

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usually rejects—yet still creates a single, predictable bond. In one gentle step, it transforms linear peptides into sturdy, ring-shaped molecules that are more stable, resistant to breakdown, and better suited for drug development.

Many peptide drugs are stabilized with disulfide bonds, which break down in the body, or rely on complicated, costly, and time-consuming chemical methods to achieve the same effect. The PapB, however, streamlines the process, creating durable "stapled" peptides that drug developers can program with unprecedented ease. This opens vast new chemical space for peptide medicines, including scaffolds associated with better cell penetration and oral dosing—two qualities essential for advancing peptide therapeutics.

PapB overcomes these issues by combining breadth with precision, delivering a programmable, one-step solution for generating robust peptide macrocycles that broaden the landscape for therapeutic design.

According to the lead author, Karsten Eastman, CEO and Co-founder of Sethera Therapeutics, "Peptides that behave both like small molecules and biologics at the same time—that's the goal. This enzyme lets us program a durable thioether 'staple' across an unusually wide range of backbones in a single enzymatic step, massively expanding the design space we can test against difficult-to-hit biological targets.

"For discovery teams, that means faster iteration, richer and more diverse libraries, and scaffolds with the stability and permeability profiles needed to move from an intriguing hit to a viable therapeutic lead."

A new horizon for peptide therapeutics

This breakthrough positions PapB as a sequence-agnostic thioether ligase, opening unprecedented chemical space for peptide drug discovery. By bridging the gap between biological selectivity and chemical flexibility, Sethera and University of Utah researchers are enabling next-generation peptide therapeutics aimed at targets previously considered "undruggable."

"What's unusual here is not just promiscuity… it is promiscuity with control. PapB accepts D- and β-amino acids and even N-methylated backbones, yet still places a single thioether exactly where the chemistry demands. That combination opens a practical route to stable, macrocyclic peptide scaffolds that were previously difficult to impossible to access

with synthetic methods alone," said Vahe Bandarian, Ph.D., Professor of Chemistry, University of Utah; CSO and Co-Founder, Sethera Therapeutics.

With this discovery, researchers now have a programmable, one-step method for making peptide macrocycles that combine stability, diversity, and drug-like properties. The breakthrough offers a powerful new tool for biotech and pharma teams seeking next-generation treatments in areas where traditional drugs have failed.

Phys Org, 25 August 2025

https://phys.org

A tiny chip may have solved one of clean energy's biggest problems

2025-08-28

For decades, researchers around the world have searched for alternatives to iridium, an extremely rare, incredibly expensive metal used in the production of clean hydrogen fuels.

Now, a powerful new tool has found one -- within a single afternoon.

Invented and developed at Northwestern University, that tool is called a megalibrary. The world's first nanomaterial "data factory," each megalibrary contains millions of uniquely designed nanoparticles on one tiny chip. In collaboration with researchers from the Toyota Research Institute (TRI), the team used this technology to discover commercially relevant catalysts for hydrogen production. Then, they scaled up the material and demonstrated it could work within a device -- all in record time.

With a megalibrary, scientists rapidly screened vast combinations of four abundant, inexpensive metals -- each known for its catalytic performance -- to find a new material with performance comparable to iridium. The team discovered a wholly new material that, in laboratory experiments, matched or in some cases even exceeded the performance of commercial iridium-based materials, but at a fraction of the cost.

This discovery doesn't just make affordable green hydrogen a possibility; it also proves the effectiveness of the new megalibrary approach, which could completely change how researchers find new materials for any number of applications.

The study was published on August 19 in the Journal of the American Chemical Society (JACS).

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"We've unleashed arguably the world's most powerful synthesis tool, which allows one to search the enormous number of combinations available to chemists and materials scientists to find materials that matter," said Northwestern's Chad A. Mirkin, the study's senior author and primary inventor of the megalibrary platform. "In this particular project, we have channeled that capability toward a major problem facing the energy sector. That is: How do we find a material that is as good as iridium but is more plentiful, more available and a lot cheaper? This new tool enabled us to find a promising alternative and to find it rapidly."

A nanotechnology pioneer, Mirkin is the George B. Rathmann Professor of Chemistry at Northwestern's Weinberg College of Arts and Sciences; professor of chemical and biological engineering, biomedical engineering and materials science and engineering at the McCormick School of Engineering; and executive director of the International Institute for Nanotechnology. Mirkin co-led the work with Ted Sargent, the Lynn Hopton Davis and Greg Davis Professor of Chemistry at Weinberg, professor of electrical and computer engineering at McCormick and executive director of the Paula M. Trienens Institute for Sustainability and Energy.

'Not enough iridium in the world'

As the world moves away from fossil fuels and toward decarbonization, affordable green hydrogen has emerged as a critical piece of the puzzle. To produce clean hydrogen energy, scientists have turned to water splitting, a process that uses electricity to split water molecules into their two constituent components -- hydrogen and oxygen.

The oxygen part of this reaction, called the oxygen evolution reaction (OER), however, is difficult and inefficient. OER is most effective when scientists use iridium-based catalysts, which have significant disadvantages. Iridium is rare, expensive and often obtained as a byproduct from platinum mining. More valuable than gold, iridium costs nearly $5,000 per ounce.

"There's not enough iridium in the world to meet all of our projected needs," Sargent said. "As we think about splitting water to generate alternative forms of energy, there's not enough iridium from a purely supply standpoint."

'Full army deployed on a chip'

Mirkin, who introduced the megalibraries in 2016, decided with Sargent that finding new candidates to replace iridium was a perfect application for his revolutionary tool. While materials discovery is traditionally a slow and daunting task filled with trial and error, megalibraries enable scientists to pinpoint optimal compositions at breakneck speeds.

Each megalibrary is created with arrays of hundreds of thousands of tiny, pyramid-shaped tips to print individual "dots" onto a surface. Each dot contains an intentionally designed mix of metal salts. When heated, the metal salts are reduced to form single nanoparticles, each with a precise composition and size.

"You can think of each tip as a tiny person in a tiny lab," Mirkin said. "Instead of having one tiny person make one structure at a time, you have millions of people. So, you basically have a full army of researchers deployed on a chip."

And the winner is…

In the new study, the chip contained 156 million particles, each made from different combinations of ruthenium, cobalt, manganese and chromium. A robotic scanner then assessed how well the most promising particles could perform an OER. Based on these tests, Mirkin and his team selected the best-performing candidates to undergo further testing in the laboratory.

Eventually, one composition stood out:a precise combination of all four metals (Ru52Co33Mn9Cr6 oxide). Multi-metal catalysts are known to elicit synergistic effects that can make them more active than single-metal catalysts.

"Our catalyst actually has a little higher activity than iridium and excellent stability," Mirkin said. "That's rare because oftentimes ruthenium is less stable. But the other elements in the composition stabilize ruthenium."

The ability to screen particles for their ultimate performance is a major new innovation. "For the first time, we were not only able to rapidly screen catalysts, but we saw the best ones performing well in a scaled-up setting," said Joseph Montoya, a senior staff research scientist at TRI and study co-author.

In long-term tests, the new catalyst operated for more than 1,000 hours with high efficiency and excellent stability in a harsh acidic environment.

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It is also dramatically cheaper than iridium -- about one-sixteenth of the cost.

"There's lots of work to do to make this commercially viable, but it's very exciting that we can identify promising catalysts so quickly -- not only at the lab scale but for devices," Montoya said.

Just the beginning

By generating massive high-quality materials datasets, the megalibrary approach also lays the groundwork for using artificial intelligence (AI) and machine learning to design the next generation of new materials. Northwestern, TRI and Mattiq, a Northwestern spinout company, have already developed machine learning algorithms to sift through the megalibraries at record speeds.

Mirkin says this is only the beginning. With AI, the approach could scale beyond catalysts to revolutionize materials discovery for virtually any technology, such as batteries, biomedical devices and advanced optical components.

"We're going to look for all sorts of materials for batteries, fusion and more," he said. "The world does not use the best materials for its needs. People found the best materials at a certain point in time, given the tools available to them. The problem is that we now have a huge infrastructure built around those materials, and we're stuck with them. We want to turn that upside down. It's time to truly find the best materials for every need -- without compromise."

About the study

The study, "Accelerating the pace of oxygen evolution reaction catalyst discovery through megalibraries," was supported by the Toyota Research Institute, Mattiq and the Army Research Office, a directorate of the U.S. Army Combat Capabilities Development Command Army Research Laboratory (award number W911NF-23-1-0285). This publication was made possible with the support of The Bioindustrial Manufacturing and Design Ecosystem (BioMADE); the content expressed herein is that of the authors and does not necessarily reflect the views of BioMADE.

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Science Daily, 28 August 2025

https://sciencedaily.com

Scientists re-create a legendary golden fabric from clam waste

2025-08-11

Shimmering like spun gold, sea silk fabric is so lustrous that some believe it inspired the Greek legends of Jason's quest for the Golden Fleece. For centuries, artisans in the Mediterranean have passed down the art of spinning the silk, which comes from the beardlike tufts of the giant clam Pinna nobilis. But the clam's endangered species status has made it hard to keep the tradition alive.

Now, scientists have re-created the legendary fabric using discarded parts of Atrina pectinata, a related clam species farmed extensively in South Korea for food. They've also identified the precise molecular structure and formation behind sea silk's everlasting golden hue, the researchers report July 29 in Advanced Materials.

"So much of this species' fiber is thrown out as waste when it could be used as a new source of sea silk, says Dong Soo Hwang from the Pohang University of Science and Technology in Korea. "If we collect it instead, we may open a new branch of sustainable luxury."

Sea silk has long been made from the giant clam P. nobilis, which is native to the Mediterranean and can grow up to four feet long. The earliest known mention of the silk dates back to the second century, when Tertullian, a Carthaginian lawyer turned Christian writer, described it in De Pallio: "Nor was it enough to comb and sow the materials for a tunic; it was necessary also to fish for one's dress; for fleeces are obtained from the sea, where shells of extraordinary size are furnished with tufts of mossy hair."

The silk comes from the clam's byssus threads, wispy but strong threads that anchor it to seaweed, sand, and stone. Traditionally, the threads are carefully harvested and rinsed in seawater to remove seaweed and sand, then washed with soft water to draw out salt and left to air dry. Next, the fibers are meticulously combed to enhance their glossy sheen and spun

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on wooden spindles. After being soaked in lemon juice for 24 to 36 hours, a final round of washing, drying and combing concludes the process.

The resulting sea silk is "fine as children's hair," says Felicitas Maeder, a researcher at the Natural History Museum of Basel in Switzerland. "A glove would feel like nothing at all," says study coauthor Jimin Choi, a biological engineer also at the Pohang University of Science and Technology.

But since 1992, the European Union has banned the harvesting of P. nobilis, and following a massive die-off, it was officially classified as endangered in 2019. Then, Hwang and his team had discovered that the threads of A. pectinata, a closely related clam, shared striking physical and chemical similarities to the endangered species — and importantly, A. pectinata is already widely available in Korea. "Whenever you go to a seafood restaurant or Costco [in Korea], most of the [scallops] you're eating are Atrina," Hwang says.

Importantly, the byssus of A. pectinata is usually discarded as waste. To Choi and Hwang, this was the perfect opportunity for upcycling. When they replicated the traditional sea silk production process, they successfully created golden threads from A. pectinata that were virtually indistinguishable from those of the endangered P. nobilis.

This came as no surprise to Maeder, who has spent decades collaborating with Mediterranean sea silk artisans to piece together the fabric's history. One weaver, Arianna Pintus from Carbonia, Italy, had already independently discovered A. pectinata threads could work just as well, Maeder says.

The researchers also uncovered what gives sea silk its shimmering golden hue. Unlike most animal-based fibers like wool or silk, which are made from long, fibrous proteins, the team found that sea silk is primarily composed of spherical proteins called photonins. These globular proteins assemble into nanofibrils that twist together in helical bundles.

Like butterfly wings or soap bubbles, the shimmer arises from how light reflects off nanostructures. In untreated byssus, iron ions mask the effect. But a soak in citric acid — the lemon bath — removes the iron, clearing the way for the golden hue to emerge.

Because sea silk's golden luster comes from structure rather than pigment, the color "doesn't fade for more than 1,000 years," Choi says.

Globular proteins are typically unstable, Hwang says. But in sea silk, photonins are reinforced by a mesh of sugars and matrix proteins that

provide additional strength and durability. The more ordered the protein structure is within the fibers, the more brilliant the structural color becomes, the researchers note.

These findings could not only help revive sea silk production, but also engineer nontoxic golden pigments for use in textiles or cosmetics, Hwang says. "I'm hoping maybe someone in Louis Vuitton may see our work and contact us about sending a sample."

Science News, 11 August 2025

https://sciencenews.org

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Scientists discover a strange new magnet that bends light like magic

2025-08-25

Researchers have uncovered the magnetic properties and underlying mechanisms of a novel magnet using advanced optical techniques. Their study focused on an organic crystal believed to be a promising candidate for an "altermagnet"- a recently proposed third class of magnetic materials. Unlike conventional ferromagnets and antiferromagnets, altermagnets exhibit unique magnetic behavior.

Details of their breakthrough were published recently in the journal Physical Review Research.

"Unlike typical magnets that attract each other, altermagnets do not exhibit net magnetization, yet they can still influence the polarization of reflected light," points out Satoshi Iguchi, associate professor at Tohoku University's Institute for Materials Research. "This makes them difficult to study using conventional optical techniques."

To overcome this, Iguchi and his colleagues applied a newly derived general formula for light reflection to the organic crystal, successfully clarifying its magnetic properties and origin.

The group also comprised Yuka Ikemoto and Taro Moriwaki from the Japan Synchrotron Radiation Research Institute; Hirotake Itoh from the Department of Physics and Astronomy at Kwansei Gakuin University; Shinichiro Iwai from the Department of Physics at Tohoku University; and Tetsuya Furukawa and Takahiko Sasaki, also from the Institute for Materials Research.

The team's newly derived general formula for light reflection was based on Maxwell's equations and is applicable to a wide range of materials, including those with low crystal symmetry, such as the organic compound studied here.

This new theoretical framework also allowed the team to develop a precise optical measurement method and apply it to the organic crystal κ-(BEDT-TTF)2Cu[N(CN)2]Cl. They successfully measured the magneto-optical Kerr effect (MOKE) and extracted the off-diagonal optical conductivity spectrum, which provides detailed information about the material's magnetic and electronic properties.

The results revealed three key features in the spectrum: (1) edge peaks indicating spin band splitting, (2) a real component associated with crystal

distortion and piezomagnetic effects, and (3) an imaginary component linked to rotational currents. These findings not only confirm the altermagnetic nature of the material but also demonstrate the power of the newly developed optical method.

"This research opens the door to exploring magnetism in a broader class of materials, including organic compounds, and lays the groundwork for future development of high-performance magnetic devices based on lightweight, flexible materials," adds Iguchi.

Science Daily, 25 August 2025

https://sciencedaily.com

New method enables self-assembly of robust and soft porous crystals with unique gas sorption properties

2025-08-25

The development of highly complex chemical systems, self-assembled by the donor-acceptor and/or noncovalent interactions, lies at the core of supramolecular chemistry.

Recently, increasing attention has been paid to structurally adaptable molecular systems and robust noncovalent microporous materials (NPMs), also known as molecular porous materials (MPMs) or porous molecular crystals (PMCs), based on the self-assembly of discrete molecules driven by weak interactions. The utilization of molecular metal clusters as building units of NPMs is a promising strategy, combining the versatile functionality of organic and inorganic subunits with the softness and flexibility of molecular solids controlled by noncovalent interactions.

However, the development of robust porous functional frameworks based on self-assembly driven by noncovalent forces is still highly challenging.

Now, researchers from the Institute of Physical Chemistry, Polish Academy of Sciences in Warsaw and Warsaw University of Technology led by Prof. Janusz Lewiński, in collaboration with Prof. David Fairen-Jimenez from Cambridge University, have developed an efficient method for the preparation of a nanosized Ni(II) hydroxyquinolinato(L)-carbonato(CO3) cluster, [Ni10(μ6-CO3)4(L)12].

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"This decanuclear cluster, depending on the crystallization conditions, self-assembles into either of two microporous frameworks: diamondoid WUT-1(Ni) and pyrite WUT-2(Ni). The transitions between both polymorphs can also be selectively triggered by temperature or exposure to vapors of a particular organic solvent, which is accompanied by the easy recovery of crystallinity by the materials from the noncrystalline phase," said Dr. Iwona Justyniak, a co-author of the study.

Remarkably, both materials exhibit excellent thermal and chemical stability under aerobic as well as aqueous conditions, and demonstrate interesting gas adsorption properties. WUT-1(Ni) exhibits significant enhancement in gas uptake compared to the previously reported isostructural Zn(II) analog, WUT-1(Zn), representing one of the highest H2 uptakes among NPMs.

In turn, tighter voids of the ultramicroporous WUT-2(Ni) framework facilitate selective interactions with gas molecules, resulting in outstanding selectivity in the adsorption of CO2 over CH4 and N2. "Thus, a simple substitution of Zn(II) by Ni(II) in isostructural clusters not only increased their chemical stability but also significantly enhanced the interactions of the WUT-1-type framework with gas molecules," added Ph.D. student Katarzyna Sołtys-Brzostek, the study's first author.

The findings demonstrate the profound role of the character of metal centers in the self-assembly of isostructural nanoclusters, as well as the

properties of the resulting microporous frameworks. Moving forward, the insight gained should aid in the development of advanced porous solid-state materials.

Phys Org, 25 August 2025

https://phys.org

Plaque-hunting nanoparticles detect and disarm the driver of heart disease

2025-08-26

A new generation of "theranostic" nanoparticles has been shown to both detect and reduce plaques in the arteries. Nanoparticles absorbed by immune cells in the arteries, where they work to lower inflammation and draw out harmful cholesterol, offer an entirely new way of not just diagnosing but fighting heart disease without drugs.

Researchers at the South Australian Health and Medical Research Institute (SAHMRI), working with scientists in Toronto, Sydney and Melbourne, have engineered porphyrin-lipid nanoparticles, or Por-NPs, which measure just 20 nanometers in width – many times smaller than many viruses like influenza and COVID-19 – coated with a peptide called R4F. This peptide directs the nanoparticles to seek out macrophages, the immune cells that absorb cholesterol in artery walls. This is an important stage – as when these macrophages become overloaded trying to "clean up" too much cholesterol, they swell and turn into foam cells that contribute to plaque build-up and inflammation.

This process is known as atherosclerosis – the build-up of fatty, inflamed plaques in arteries – and is a leading cause of heart attacks and strokes. While statins and other cholesterol-lowering drugs reduce risk, they can't easily identify or directly shrink dangerous plaques once they form.

"One of the key challenges in treating atherosclerosis is that inflammation fuels plaque build-up, creating a vicious cycle," said study lead Dr Victoria Nankivell from SAHMRI. "Our nanoparticles help break that cycle, which could lead to better long-term outcomes for patients."

The nanoparticles have two main features: the porphyrin-lipid core naturally glows under certain light and can also be tagged with a radioactive isotope called copper-64. That means the particles can be tracked in living tissue, flagging early signs of heart disease. At the same time, once they are taken up by macrophages, they help those cells offload

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some of their stored cholesterol and suppress the natural inflammatory response.

It's not the first time nanoparticles have been explored as a way to treat arterial build-up and inflammation, with scientists at Michigan State

University and Stanford University developing a different model based on the same principle – tiny particles that can eat away portions of the plaques that cause heart attacks. And, in 2024, the Michigan University scientists reported promising results from their most recent arterial-clearing nanotechnology.

In this latest study, the researchers used mice predisposed to atherosclerosis, with the animals also fed a high-fat diet. Following treatment, PET and fluorescence scans could identify the nanoparticles inside arterial plaques and monitor changes. In mice with early signs of atherosclerosis, the nanoparticles shrunk plaque size by 23%, compared with untreated mice. And in mice with more advanced conditions, with unstable plaques that are more likely to rupture, treatment reduced the plaque size by 52%.

The nanoparticles also changed the immune system activity that fuels plaque growth. Levels of monocytes – inflammatory white blood cells that move into artery walls and become macrophages – fell by 32%. What's more, inside the plaques themselves, the number of monocytes was cut by 81%, compared with untreated mice, and the genes that normally drive inflammation inside the arterial walls were dialed down.

"What sets these nanoparticles apart is their ability to interact directly with immune cells in the arteries, drawing out cholesterol and helping the body process it more effectively," Nankivell said.

After doing their work in the arteries, most of the nanoparticles ended up in the liver, which absorbed them and processed the cholesterol they were carrying – much like the organ would do normally with cholesterol. And the researchers found no evidence of harmful build-up in the liver, suggesting this cholesterol clearing system functioned as usual.

"These nanoparticles don't just detect arterial plaque in arteries, they can also suck it up and take it to the liver, lowering inflammation," Nankivell added.

While still in the early stages of development, the nanoparticle technology has the potential to be used in conjunction with existing treatments to better manage heart disease. in the future, Por-NPs could offer

cardiologists a way to both see and treat dangerous plaques before they cause major events.

It also adds to the fast-growing field of nanomedicine, which is being explored for treating cancer, infectious diseases, neurological disorders and diabetes, as well as playing a key role in more advanced medical imaging.

The research was published in the journal Materials Today Bio.

New Atlas, 28 August 2025

https://newatlas.com

A simple trick just made tiny lasers more powerful than ever

2025-08-23

For years, engineers have sought better ways to build tiny, efficient lasers that can be integrated directly onto silicon chips, a key step toward faster, more capable optical communications and computing. Today's commercial lasers are mostly made from III-V semiconductors grown on specialized substrates -- a process that makes them difficult and costly to combine with mainstream silicon technology. All-inorganic perovskite films have emerged as a promising alternative because they can be produced inexpensively, work with many substrate types, and offer strong optical properties. But one major obstacle has stood in the way: at room temperature, it has been difficult to get perovskite lasers to run in continuous or near-continuous modes without quickly losing their charge carriers to an effect known as Auger recombination.

A research team at Zhejiang University has now demonstrated a simple method to overcome this problem, leading to record-setting performance for perovskite lasers under near-continuous operation. As reported in Advanced Photonics, their approach uses a volatile ammonium additive during the annealing process of polycrystalline perovskite films. This additive triggers a "phase reconstruction" that removes unwanted low-dimensional phases, reducing channels that accelerate Auger recombination. The result is a pure 3D structure that better preserves the charge carriers needed for lasing, without adding significant optical loss.

To understand the improvement, the team analyzed how electrons and holes recombine under different pumping conditions. Auger recombination -- where energy from a recombining electron-hole

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pair is given to another carrier instead of emitted as light -- becomes especially problematic when the input light is delivered in longer pulses or continuous beams. In those situations, carrier injection occurs on a timescale similar to or longer than the Auger lifetime, leading to rapid carrier loss and preventing the build-up of population inversion needed for lasing. By suppressing this process, the researchers were able to sustain the carrier densities required for efficient stimulated emission.

With their optimized films, the team built a single-mode vertical-cavity surface-emitting laser (VCSEL) that achieved a low lasing threshold of 17.3 $\mu J/cm^2$ and an impressive quality factor of 3850 under quasi-continuous nanosecond pumping. This performance marks the best reported to date for a perovskite laser in this regime.

The results point toward a practical route for making high-performance perovskite lasers that could work under true continuous-wave or electrically driven conditions -- key milestones for their integration into future photonic chips and potentially flexible or wearable optoelectronic devices.

Science Daily, 23 August 2025

https://website

This Plant-Inspired Molecule Could Be the Key to Artificial Photosynthesis

2025-08-27

Swiss researchers have designed a plant-inspired molecule that mimics photosynthesis and can hold four electric charges when exposed to light.

This ability to store multiple charges could be the key to creating solar fuels such as hydrogen, methanol, or synthetic petrol — fuels that would be carbon-neutral because they release only as much CO2 as was used to produce them.

Harnessing Plant-Inspired Solar Power

Plants capture sunlight and use it to transform carbon dioxide into sugars that store energy. This process, known as photosynthesis, underpins nearly all life on Earth. The sugars produced by plants serve as fuel for animals and humans, who release the stored energy by breaking them down. That process returns carbon dioxide to the atmosphere, completing the natural cycle.

Scientists hope to use this same principle as a guide for developing clean fuels. By copying the way plants convert light, researchers aim to generate energy-rich compounds directly from sunlight. These solar fuels include hydrogen, methanol, and synthetic petrol. When burned, they would release only the same amount of carbon dioxide that was originally required to create them. In effect, the entire process would be carbon-neutral.

A Molecule That Stores Four Charges

In Nature Chemistry, Professor Oliver Wenger and doctoral student Mathis Brändlin describe an important advance toward this goal of artificial photosynthesis. They have engineered a specially designed molecule that, when exposed to light, can hold four charges at the same time – two positive and two negative.

Being able to temporarily store several charges is a crucial step in turning sunlight into usable chemical energy. Those charges can then be applied to trigger reactions, such as splitting water into hydrogen and oxygen.

The molecule itself is built from five linked components, each with a distinct role. On one end, two parts release electrons and in doing so become positively charged. At the opposite end, two other parts absorb those electrons and turn negatively charged. At the center, the researchers placed a light-sensitive unit that captures solar energy and initiates the electron transfer.

Two Flashes of Light, Four Charges

In order to generate the four charges, the researchers took a stepwise approach using two flashes of light. The first flash of light hits the molecule and triggers a reaction in which a positive and a negative charge are generated. These charges travel outward to the opposite ends of the molecule. With the second flash of light, the same reaction occurs again, so that the molecule then contains two positive and two negative charges.

Works Even in Dim Light

"This stepwise excitation makes it possible to use significantly dimmer light. As a result, we are already moving close to the intensity of sunlight," explains Brändlin. Earlier research required extremely strong laser light, which was a far cry from the vision of artificial photosynthesis. "In addition, the charges in the molecule remain stable long enough to be used for further chemical reactions."

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That being said, the new molecule has not yet created a functioning artificial photosynthesis system. "But we have identified and implemented an important piece of the puzzle," says Oliver Wenger. The new findings from the study help to improve our understanding of the electron transfers that are central to artificial photosynthesis. "We hope that this will help us contribute to new prospects for a sustainable energy future," says Wenger.

Sci Tech Daily, 27 August 2025

https://scitechdaily.com

Indole chemistry advance could accelerate drug development with precise targeting

2025-08-25

Indole, a molecule made up of a six-membered benzene ring fused to a five-membered ring containing nitrogen, forms the core structure of many biologically active compounds. Derivatives of indole, where hydrogen atoms are replaced by various chemical groups, are naturally produced by plants, fungi, and even the human body.

Due to their properties, indoles have gained attention as a backbone for synthesizing a wide variety of drugs. Since 2015, the U.S. Food and Drug Administration has approved 14 indole drugs to treat conditions, such as migraines, infections, and hypertension.

Chemists have developed many strategies to attach different chemical groups to indoles. Some approaches introduce new groups directly onto the ring, while others involve temporary structural changes through intermediates. However, modifying specific positions on the indole ring, such as the C5 carbon, remains a challenge due to its low reactivity.

In a recent study, researchers at Chiba University, Japan, reported a method for selectively attaching an alkyl group to the C5 position of indole using a relatively inexpensive copper-based catalyst, which produced the desired product in yields of up to 91%. This method offers a more affordable and scalable approach for modifying indoles, which could be especially valuable in drug development.

The study, led by Associate Professor Shingo Harada, included Mr. Tomohiro Isono, B.Pharm., Ms. Mai Yanagawa, M.Pharm., and Professor Tetsuhiro Nemoto from the Graduate School of Pharmaceutical Sciences

at Chiba University, and was published online in the journal Chemical Science on July 15, 2025.

"We developed a direct, regioselective C5-H functionalization reaction of indoles under copper catalysis. The resulting compounds contain structural features commonly found in natural indole alkaloids and drug molecules, highlighting the usefulness of this approach for making biologically important compounds," says Dr. Harada.

The reaction uses carbenes, highly reactive carbon species that can form new carbon-carbon bonds. In an earlier study, the team used rhodium-based carbenes to attach groups at the C4 position of indole, guided by unsaturated enone groups placed at the 3-position. In this study, they used a similar strategy but altered the reaction conditions to target the C5 position instead.

They tested the reaction using a model compound, N-benzyl indole with an enone group, together with dimethyl α-diazomalonates as the carbene source and different combinations of rhodium, copper, and silver salts as catalysts. Initially, the desired C5-functionalized product formed only in small amounts, with yields up to 18%. However, when they used a combination of copper and silver salts ($Cu(OAc)_2 \cdot H_2O$ and $AgSbF_6$), the yield rose to 62%. Upon carrying out further optimizations, such as adjusting the solvent volume and increasing the concentration, they improved the yield to 77%.

The reaction proved to be highly versatile, working with a wide range of indoles. When the enone group was replaced at the 3-position with a benzoyl group, the yield increased to 91%. Successful reactions were also observed with indoles bearing other substituents, such as methoxybenzyl, allyl, and phenyl groups, opening the door to the synthesis of structurally diverse molecules.

To uncover the reaction mechanism, the team carried out quantum chemical calculations, which suggested that the carbene does not react directly at C5. Instead, it first forms a bond at the C4 position, creating a strained three-membered ring. This intermediate then rearranges, shifting the new bond to the C5 position. The copper catalyst plays a critical role in making this pathway possible by stabilizing the intermediate and lowering the energy barrier for the rearrangement.

This copper-catalyzed strategy offers a reliable and cost-effective approach for modifying indoles at the C5 position, producing compounds that closely resemble biologically active indole-based agents. Dr. Harada

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highlights the method's potential for drug discovery by stating, "While it may not cause a significant shift right away, it could foster steady progress in drug discovery, leading to a small yet beneficial long-term impact."

The team is continuing its research, exploring other metal-carbene reactions to develop more selective and efficient strategies for constructing indole-based molecules that might one day contribute to the treatment of specific diseases.

Phys Org, 25 August 2025

https://phys.org

Magnets could be simple way to enhance oxygen generation on a mission to Mars

2025-08-22

Commercially available magnets could significantly improve the efficiency of water splitting in a microgravity environment. These types of device would be used to supply astronauts with oxygen during long-term missions but they are less effective in low gravity. The international team of researchers, from the US, UK and Germany, who made the discovery, also developed two proof-of-concept devices which they claim could, with further testing in low gravity environments, be used in future space missions.

Ensuring astronauts have access to a reliable and continuous supply of oxygen during deep space missions has been a challenge since the early days of space exploration in the 1960s. Currently, in microgravity environments oxygen is produced using electrochemical water-splitting, which requires complex mechanical components and a significant amount of energy. The process is further complicated by the fact that in the weightlessness of microgravity, gas bubbles do not float upwards like they do on Earth. Instead, they tend to stick to the surface of the electrode, inhibiting the reaction.

Putting Mars within reach

To address these challenges, the team set out to engineer electrochemical cells that would help to simplify the way oxygen is generated in space. 'In the case of a Mars transit mission, the reliability of the oxygen production system … is still not high enough to support a long-term mission,' explains Álvaro Romero-Calvo, an aerospace engineer at the Georgia Institute of Technology and a member of the team. 'The problem is that there are so

many moving components and centrifuges and pumps and hydrogen sensors and so on in a closed loop operating in reduced gravity, that all those spare components stack up and add a lot of mass to your system.'

Incorporating off-the-shelf neodymium magnets into electrolysis devices, the team developed a passive phase separation system that pushed the bubbles away from the electrodes and collected them at designated spots. Romero-Calvo explains that there are two main forces being demonstrated in their work: diamagnetic force and magnetohydrodynamics. The magnetohydrodynamic effect works to improve gas bubble detachment from the electrode surface causing them to swirl around, while the diamagnetic effect helps to direct the gas bubbles to specific collection points.

'What we're ultimately trying to do is to separate gas bubbles – oxygen and hydrogen – from the water or the electrolyte, without moving parts or centrifuges or pumps or anything like that,' says Romero-Calvo.

To investigate the impact of these two forces the researchers used a drop tower to generate brief periods of microgravity during free fall lasting a total of 9.3 seconds. Using this approach, they found that the magnet enhanced water electrolysis with current density improvements of up to 240% in microgravity, compared with electrolysis devices without a magnet.

To exploit these effects, the researchers developed two simple proof-of-concept devices – one a proton-exchange membrane electrolyser cell that uses diamagnetic forces for efficient oxygen and hydrogen gas collection and the other a magnetohydrodynamic drive cell that causes vortical gas–liquid phase separation. In microgravity, they found that the devices achieved water splitting with an efficiency close to that achievable on Earth.

'The goal of these two proof-of-concept devices is, can we induce gas separation in microgravity to produce oxygen and separate it within the same device … in a very simple way?' says Romero-Calvo.

Long-term testing

The team are now looking to assess the long-term performance of the system. 'We need long-term microgravity conditions, either through a suborbital rocket, which is something we're going to launch in the near future, or through orbital experiments,' he adds. 'The second part is that many innovations that happen at the electrode or the cell level

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… work very well in a tiny, little cell but when you try to make it fit for astronauts for six months, it doesn't really work that well. So, the scale up is something we're working on as well.'

Mark Symes, an electrochemist at the University of Glasgow, described the work as 'super cool' and 'a tour de force' of doing electrolysis in difficult conditions. 'Electrolysis in space is a huge issue, particularly if you're going to go and live or have a semi-permanent base on the moon or Mars, you're not going to want to ferry oxygen backwards and forwards from Earth endlessly,' he explains.

'What's really cool about this magnetic work, is there are no moving parts, so you just have a standard electrolyser with a magnet. Basically, the magnetic field is producing a convection and a sort of jitter that pushes these bubbles off before they get too large.'

However, Symes says he was left with several questions about the work. 'I didn't see, at least in the main paper, that they measure the purity of those gases, and that's obviously something that you would want to do; you would want to make sure that your level of hydrogen in your oxygen was below the explosion limit, otherwise you wouldn't want to put that on the spacecraft.'

'The other question I had was around their current density, so the rate at which they can make gas per unit area of electrode,' he adds. 'For both the devices … they're very much towards the lower end of what you'd want – 150 milliamps per centimetre squared. It's not great – for reference, a conventional electrolyser on Earth would run at least an amp per centimetre squared, so at least 10 to 20 times more. So, you'd want to boost that current density whilst keeping the gases separate.'

Chemistry World, 22 August 2025

https://chemistryworld.com

Novel carbon–carbon main chain polymers feature densely packed cyclic units

2025-08-25

The most common method for synthesizing polymers with a carbon–carbon main chain backbone is vinyl polymerization, by which many industrially important polymers, including common plastics such as polyethylene and polypropylene, are synthesized. This method uses the

reaction of a C=C double bond of vinyl compounds used as monomers, and thus the main chain backbone is generated from two-carbon units.

Conversely, C1 polymerization is a complementary method for preparing carbon–carbon main chain polymers, where the carbon-based backbone is constructed from one-carbon units by utilizing the unique reactivity of monomers such as diazoacetate and sulfoxonium methylide.

Therefore, functional groups derived from the monomer can be introduced at every main chain carbon atom, and characteristic properties and functions are expected to emerge due to higher accumulation of the functional groups compared to the corresponding vinyl polymers bearing the same functional groups on every other carbon atom.

A team from Ehime University previously succeeded in developing "C1 cyclopolymers" by conducting cyclopolymerization (additional polymerization that proceeds while forming cyclic structures in the main chain) of bifunctional diazoacetates.

These C1 cyclopolymers have a unique structure, where all the main chain carbons are incorporated into a cyclic framework. Their physical properties are of interest because they have a structure in which cyclic repeating units are more densely accumulated than cyclopolymers obtained from the cyclopolymerization of corresponding divinyl compounds (C2 cyclopolymers).

However, due to the synthetic difficulty of bifunctional diazoacetates, there were limitations on the synthesizable polymer structures.

In a new study, now published in Macromolecules, the Ehime team attempted to develop a new synthetic method for bifunctional diazoacetates that overcomes these limitations and to perform C1 cyclopolymerization of the resulting monomers. As a result, they succeeded in developing new monomer syntheses using pentaerythritol, one of the polyhydric alcohols, as a starting material.

By using bifunctional diazoacetates obtained with these methods, the team succeeded in synthesizing novel C1 cyclopolymers with diverse ring sizes (9- to 19-membered rings) and functional groups (such as urethane linkage capable of forming hydrogen bonds within the cyclic framework).

Furthermore, investigation of the thermal properties of a series of the obtained C1 cyclopolymers revealed that they possessed significantly higher glass transition temperatures compared to the corresponding C1 polymers without cyclic structures.

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These results provide new insights into the molecular design of carbon–carbon main chain polymers and are expected to lead to new polymer materials with improved properties.

Phys Org, 25 August 2025

https://phys.org

Chinese Scientists Develop Breakthrough Catalyst for Clean Propane Conversion

2025-07-29

Scientists have pioneered a water- and light-driven method for converting propane at near-room temperature, opening the door to sustainable, low-energy catalysis.

Propane dehydrogenation (PDH) is a chemical process that requires a large input of heat, typically needing temperatures above 600°C when carried out using traditional thermo-catalytic methods. These high temperatures pose several issues, including high energy usage, degradation of the catalyst through sintering, and the buildup of carbon deposits known as coke. Scientists have long sought ways to overcome these limitations and carry out PDH at or near room temperature, which remains a key challenge in the field of catalysis.

A new study published in Nature Chemistry offers a promising solution. Led by Prof. Tao Zhang and Prof. Aiqin Wang from the Dalian Institute of Chemical Physics at the Chinese Academy of Sciences (CAS), in collaboration with Prof. Yi Gao's team at the Shanghai Advanced Research Institute of CAS, the researchers introduced a novel approach.

They developed a water-assisted PDH process that uses a copper single-atom catalyst (SAC) and is driven by a combination of light and heat, known as photo-thermo catalysis. This method enables efficient conversion of propane into propylene at much lower temperatures than previously possible.

Efficient Reaction at Near-Room Temperature

By using a Cu1/TiO2 SAC, researchers achieved PDH under near-ambient conditions in a water vapor atmosphere. In a continuous-flow fixed-bed reactor, the reaction temperature was reduced to just 50–80 °C, achieving a maximum reaction rate of 1201 μmol gcat-1 h-1.

Researchers revealed that Cu single atoms, water vapor, and light illumination all played essential roles in the propane-to-propylene conversion.

Through photocatalytic water splitting on the Cu1/TiO2 SAC, hydrogen and hydroxyl species were generated. Hydroxyl radicals subsequently adsorbed on the catalyst surface, abstracting hydrogen atoms from propane to form propylene and water. Water acted catalytically without being consumed. This mechanism fundamentally differs from traditional PDH and oxidative dehydrogenation of propane.

Furthermore, researchers demonstrated that the developed route could be extended to the dehydrogenation of other light alkanes, including ethane and butane. The reaction could even be directly driven by sunlight using the Cu1/TiO2 SAC.

"Our study not only provides a new way for PDH but also establishes a paradigm for conducting high-temperature reactions driven by solar energy," said Prof. Xiaoyan Liu, one of the corresponding authors of the study.

Sci Tech Daily, 29 July 2025

https://scitechdaily.com

A simple trick just made tiny lasers more powerful than ever

2025-08-23

For years, engineers have sought better ways to build tiny, efficient lasers that can be integrated directly onto silicon chips, a key step toward faster, more capable optical communications and computing. Today's commercial lasers are mostly made from III-V semiconductors grown on specialized substrates -- a process that makes them difficult and costly to combine with mainstream silicon technology. All-inorganic perovskite films have emerged as a promising alternative because they can be produced inexpensively, work with many substrate types, and offer strong optical properties. But one major obstacle has stood in the way: at room temperature, it has been difficult to get perovskite lasers to run in continuous or near-continuous modes without quickly losing their charge carriers to an effect known as Auger recombination.

A research team at Zhejiang University has now demonstrated a simple method to overcome this problem, leading to record-setting performance

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for perovskite lasers under near-continuous operation. As reported in Advanced Photonics, their approach uses a volatile ammonium additive during the annealing process of polycrystalline perovskite films. This additive triggers a "phase reconstruction" that removes unwanted low-dimensional phases, reducing channels that accelerate Auger recombination. The result is a pure 3D structure that better preserves the charge carriers needed for lasing, without adding significant optical loss.

To understand the improvement, the team analyzed how electrons and holes recombine under different pumping conditions. Auger recombination -- where energy from a recombining electron-hole pair is given to another carrier instead of emitted as light -- becomes especially problematic when the input light is delivered in longer pulses or continuous beams. In those situations, carrier injection occurs on a timescale similar to or longer than the Auger lifetime, leading to rapid carrier loss and preventing the build-up of population inversion needed for lasing. By suppressing this process, the researchers were able to sustain the carrier densities required for efficient stimulated emission.

With their optimized films, the team built a single-mode vertical-cavity surface-emitting laser (VCSEL) that achieved a low lasing threshold of 17.3 $\mu J/cm^2$ and an impressive quality factor of 3850 under quasi-continuous nanosecond pumping. This performance marks the best reported to date for a perovskite laser in this regime.

The results point toward a practical route for making high-performance perovskite lasers that could work under true continuous-wave or electrically driven conditions -- key milestones for their integration into future photonic chips and potentially flexible or wearable optoelectronic devices.

Science Daily, 22 August 2025

https://sciencedaily.com

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