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ASIA PACIFIC

Taiwan proposes new PFAS regulation covering 269 substances, impacting importers, manufacturers, and the broader supply chain ahead of 2026.

2025-08-05

Taiwan's Ministry of Environment has announced a draft regulation to list 269 per- and polyfluoroalkyl substances (PFAS) as chemical substances of concern. The proposed rule—open for public comment until 4 September 2025—will enter into force on 1 January 2026, creating new compliance duties across manufacturing, import, and distribution sectors.

The regulation introduces concentration thresholds and operational controls that will apply to PFAS used across a wide range of industries, including electronics, textiles, chemicals, and consumer goods. Professionals throughout the manufacturing value chain must now assess their portfolios for affected PFAS and prepare for new labelling, reporting, and authorisation obligations.

What the Draft PFAS Regulation Proposes?

Under the draft, Taiwan classifies PFAS into three categories:

- Perfluoroalkyl acids and precursors
- Polymers
- Gases

A control concentration of 0.1% applies to all listed substances. For perfluoroalkyl acids and related compounds, operations exceeding 1% concentration require official approval, monthly record-keeping, and quarterly reporting. For polymers and gases, the same obligations apply if the concentration exceeds 30%. Products below these thresholds must still carry specific labelling if above 0.1%.

Read More

Foresight, 05-08-25

https://www.useforesight.io/news/taiwan-proposes-new-pfas-regulation-affecting-269-substances-by-2026

AMERICA

US EPA proposes end to mandatory greenhouse gas reporting

2025-09-12

The U.S. Environmental Protection Agency proposed on Friday a rule to end a mandatory program requiring 8,000 facilities to report their greenhouse gas emissions - an effort the agency said was burdensome to business, but which leaves the public without transparency around the environmental impact of those sources.

The agency said mandatory collection of GHG emissions data was unnecessary because it is "not directly related to a potential regulation and has no material impact on improving human health and the environment."

WHY IT'S IMPORTANT?

The rule responds to a day-one executive order issued by President Donald Trump aimed at removing barriers to unleashing more U.S. energy, particularly fossil fuels. It is the latest in a series of major regulatory rollbacks undoing previous U.S. efforts to combat climate change.

Earlier this summer, the EPA announced plans to repeal the "endangerment finding" that enabled the agency to regulate greenhouse gas emissions from vehicles and stationary sources.

If finalized, the proposal would remove reporting obligations for most large facilities, all fuel and industrial gas suppliers, and CO2 injection sites.

Read More

Reuters, 12-09-25

https://www.reuters.com/legal/litigation/us-epa-proposes-end-mandatory-greenhouse-gas-reporting-2025-09-12/

Controversial nonstick pan ban clears critical hurdle in California

2025-09-13

The California State Assembly narrowly approved a controversial bill Friday evening that would ban popular nonstick cookware products from being sold in the state starting in 2030.

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The measure bans cookware containing perfluoroalkyl and polyfluoroalkyl substances, more commonly referred to as PFAS, from being sold in the state. It would also ban a new "cleaning product, dental floss, juvenile product, food packaging, or ski wax" that contains PFAS from being sold starting in 2028.

The Assembly approved the measure in a 41 to 19 vote, with 20 assemblymembers not voting. The bill still needs a final concurrence vote in the Senate before it can be sent to Gov. Gavin Newsom for his signature to make it law. Isabella Jimenez, a spokesperson for Assemblymember Damon Connolly, who was managing the proposal, told SFGATE in an email that their office expects the bill to pass that vote.

Newsom has not indicated whether he would sign the bill if it makes it to his desk.

Read More

SFGate, 13-09-25

https://www.sfgate.com/politics/article/california-non-stick-pfas-pan-ban-21045797.php

EPA pursues new tactic to undo PFAS drinking-water limits

2025-09-16

Key Insights

- The US Environmental Protection Agency is asking a court to throw out the part of its 2024 rule limiting per- and polyfluoroalkyl substances (PFAS) in drinking water that the agency previously announced it would roll back and then rework.
- Such court action would be significantly faster than if the agency undid the limits on its own, and it would eliminate public feedback on the rollback.
- An environmental group says that asking the court to take the rollback action would help the EPA "evade public accountability." But the water utilities that are challenging the rule in court say the public would have a chance to comment later, when the agency proposes revised versions of the limits.

The US Environmental Protection Agency is turning to a federal appeals court to seek quick elimination of the agency's 2024 limits on four per- and polyfluoroalkyl substances (PFAS) in drinking water.

Read More

c&en, 16-09-25

https://cen.acs.org/policy/chemical-regulation/EPA-pursues-new-tactic-undo/103/web/2025/09

US Seeks Pause in PFAS Superfund Case as EPA Weighs Rule (2)

2025-09-09

The Department of Justice is asking a federal court to pause litigation seeking to recover costs for cleaning up two specific PFAS, indicating the EPA may decide that the chemicals are no longer hazardous Superfund substances.

The motion submitted Monday to the US District Court for the District of South Carolina sends the strongest signal to date that the Trump administration may seek to withdraw last year's regulation that made perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or Superfund law.

No decision has been made, DOJ told the court that's overseeing multidistrict litigation over aqueous film forming foam (AFFF), a fire suppressant made with per- and polyfluoroalkyl substances (PFAS) such as PFOA and PFOS.

But, spending time on CERCLA claims could be a "futile" use of the court's time and efforts, wrote Sanya Shahrasbi, a Department of Justice attorney representing the federal government.

Read More

Bloomberg Law, 09-09-25

https://news.bloomberglaw.com/environment-and-energy/us-seeks-pause-in-pfas-superfund-case-as-epa-weighs-rules-fate

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Trump EPA Announces Next Steps on Regulatory PFOA and PFOS Cleanup Efforts, Provides Update on Liability and Passive Receiver Issues

2025-09-17

U.S. Environmental Protection Agency (EPA) Administrator Lee Zeldin announced next steps regarding regulatory efforts to address cleanup of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS).

"When it comes to PFOA and PFOS contamination, holding polluters accountable while providing certainty for passive receivers that did not manufacture or generate those chemicals continues to be an ongoing challenge. I have heard loud and clear from the American people, from Congress, and from local municipalities about this particular issue. EPA intends to do what we can based on our existing authority, but we will need new statutory language from Congress to fully address our concerns with passive receiver liability. The Trump Administration is fully committed to ensuring all Americans have the cleanest air, land, and water," said EPA Administrator Zeldin.

EPA's progress on Per- and Polyfluoroalkyl Substances (PFAS) started under the first Trump Administration, and that historic work continues today. At this time, EPA is retaining the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) hazardous substance designation for PFOA and PFOS and will be initiating future rulemaking to establish a uniform framework governing designation of hazardous substances under section 102(a) of CERCLA moving forward.

On September 17, 2025, the U.S. Department of Justice (DOJ) submitted a court filing on behalf of EPA as part of ongoing litigation related to the designation of PFOA and PFOS as CERCLA hazardous substances. The agency is currently retaining the rule that became effective on July 8, 2024.

Read More

US EPA, 17-09-25

https://www.epa.gov/newsreleases/trump-epa-announces-next-steps-regulatory-pfoa-and-pfos-cleanup-efforts-provides

EUROPE

Three reasons why circular textiles can't work without data

2025-09-10

In the shift to a circular textile system, it's easy to focus on the visible parts—collection bins, sorting technology, recycling plants, resale platforms. But there's an invisible layer that makes or breaks all of it: data.

Without reliable, shared data, municipalities, businesses, and recyclers are left guessing. With it, they can design smarter systems, reduce waste, and build the trust needed for citizens and companies to participate. We can't really solve any of the problems at scale without data.

Here are three reasons why (and this is not an exhaustive list):

1. Data as the plumbing of circularity

Think of data like plumbing. If the pipes don't connect, nothing flows. Right now, different actors use different terms and formats. For example, "pre-consumer waste" means one thing to a municipality, another to a recycler. That confusion clogs the system.

When actors across the chain use the same information in the same format—fibre composition, volumes, destinations—things move smoothly. For example, a European textile pre-processor once faced rejection rates of 25–30% because materials arriving didn't match their needs. By measuring incoming deliveries and sharing results with suppliers, they cut rejects to below 5%. Same suppliers, same machinery, but better data.

Read More

Zero Waste Europe, 10-09-25

https://zerowasteeurope.eu/2025/09/three-reasons-why-circular-textiles-cant-work-without-data/

Parliament adopts new EU rules to reduce textile and food waste

2025-09-09

- 2030 targets to reduce food waste

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- Producers to cover costs of collecting, sorting and recycling waste textiles
- Each European generates 132 kg of food waste and 12 kg of clothing and footwear waste per year

On Tuesday, Parliament gave its final green light to new measures to prevent and reduce waste from food and textiles across the EU.

Cutting down food waste

The updated legislation will introduce binding food waste reduction targets, to be met at national level by 31 December 2030: 10% from food processing and manufacturing and 30% per capita from retail, restaurants, food services and households. These targets will be calculated in comparison to the amount generated as an annual average between 2021 and 2023. Following Parliament's request, EU countries will have to take measures to ensure that economic operators having a significant role in the prevention and generation of food waste (to be identified in each country) facilitate the donation of unsold food that is safe for human consumption.

Producers to cover costs of collecting, sorting and recycling waste textiles

Producers that make textiles available in the EU will have to cover the costs of their collection, sorting and recycling, through new producer responsibility (EPR) schemes to be set up by each member state, within 30 months of the directive's entry into force. These provisions will apply to all producers, including those using e-commerce tools and irrespective of whether they are established in an EU country or outside the Union. Micro-enterprises will have an extra year to comply with the EPR requirements.

The new rules will cover products such as clothing and accessories, hats, footwear, blankets, bed and kitchen linen, and curtains. On Parliament's initiative, EU countries may also set up EPR schemes for mattress producers.

Read More

European Parliament, 09-09-25

https://www.europarl.europa.eu/news/en/press-room/20250905IPR30172/parliament-adopts-new-eu-rules-to-reduce-textile-and-food-waste

EU ban on several hazardous chemicals used in cosmetics enters into force

2025-09-11

A European Union (EU) ban on several hazardous chemicals in cosmetics and personal care products (such as shampoo and deodorants) entered into force on 1st September 2025. This is an important example of how EU regulation protects people's health from harmful chemicals.

Under the EU's Cosmetics Regulation, if a chemical is classified as carcinogenic, DNA-damaging or toxic for reproduction – often called a CMR – then it will trigger a ban on its use in cosmetic products. A number of hazardous chemicals (including bisphenol AF, tetrabromobisphenol-A, dibutyltin oxide and 4-methylimidazole) were classified as CMRs in 2023. They were then added to the list of chemicals that are restricted in cosmetics and personal care products under the EU law in May 2025, with entry into force (the date the ban applies from) set for 1st September. So from 1st September 2025, the use of these chemicals in these products is banned in the EU, which is a great win for consumers.

A chemical called TPO (trimethylbenzoyl diphenylphosphine oxide) is another chemical included in the ban. TPO was widely used in gel nail polishes to help them dry faster and last longer. The chemical was classified in the EU as toxic to reproduction after studies linked exposure to TPO to long-term fertility issues in animals. It was also classified as a skin sensitiser, meaning it can cause skin allergies.

Read More

Chemtrust, 11-09-25

https://chemtrust.org/news/eu-ban-hazardous-chemicals-cosmetics/

INTERNATIONAL

IUPAC defends contested project to redefine PFAS

2025-09-09

A controversial project to redefine the family of environmentally persistent chemicals known as per- and poly-fluoroalkyl substances (PFAS) continues to divide opinions among the chemistry community. While some believe that standardising the language used to define PFAS will enable clearer and more effective regulation of the substances, others are concerned that

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any new definitions will be too narrow and have questioned the motives of those behind the initiative.

Back in June, 20 world experts in PFAS issued a public statement expressing serious concerns about the project, which is being led by the International Union of Pure and Applied Chemistry (Iupac). The statement's authors were worried that the effort is 'politically and/or economically, rather than scientifically motivated' and that any new definitions could be used by 'parties with vested interests to influence regulations'.

At the American Chemical Society (ACS) meeting in Washington, DC on 19 August the ACS invited attendees to participate in a townhall discussion about the definition of PFAS and hear about the status of this Iupac initiative.

Read More

Chemistry World, 09-09-25

https://www.chemistryworld.com/news/iupac-defends-contested-project-to-redefine-pfas/4022116.article

Test No. 443: Extended One-Generation Reproductive Toxicity Study

2025-06-25

This Test Guideline is designed to provide an evaluation of reproductive and developmental effects that may occur as a result of pre- and postnatal chemical exposure as well as an evaluation of systemic toxicity in pregnant and lactating females and young and adult offspring. In the assay, sexually-mature males and females rodents (parental (P) generation) are exposed to graduated doses of the test substance starting 2 weeks before mating and continuously through mating, gestation and weaning of their pups (F1 generation). At weaning, pups are selected and assigned to cohorts of animals for reproductive/developmental toxicity testing (cohort 1), developmental neurotoxicity testing (cohort 2) and developmental immunotoxicity testing (cohort 3). The F1 offspring receive further treatment with the test substance from weaning to adulthood. Clinical observations and pathology examinations are performed on all animals for signs of toxicity, with special emphasis on the integrity and performance of the male and female reproductive systems and the health, growth, development and function of the offspring. Part of cohort 1 (cohort 1B) may be extended to include an F2 generation; in this case, procedures for F1 animals will be similar to those for the P animals.

ECHA to consult on PFAS draft opinion in spring 2026

2025-09-15

The European Chemicals Agency plans to launch a consultation on the draft opinion of its Committee for Socio-Economic Analysis (SEAC) on the proposed EU-wide restriction of per- and polyfluoroalkyl substances (PFAS) following the Committee's meeting in March 2026.

Helsinki, 15 September 2025 – The SEAC draft opinion on the PFAS restriction proposal will cover the evaluation of the socio-economic aspects, including the availability of alternative substances and technologies. SEAC intends to agree its draft opinion at its meeting, which is provisionally scheduled for the first half of March 2026. The consultation will begin shortly after this meeting and remain open for 60 days, during which stakeholders can provide feedback.

Survey structure

The consultation will use a structured survey format, inviting participants to respond to questions on the potential impacts of restricting the use of PFAS across various sectors. Participants will also be asked to provide specific information about the availability and feasibility of alternatives to these widely used chemicals. Any information marked as confidential will be treated appropriately. Information on the risks associated with PFAS will not be considered, as these are evaluated in a separate opinion by the Committee for Risk Assessment (RAC).

All feedback will be entered directly into the question fields for each survey topic to streamline the processing of information. Attachments cannot be submitted as part of the consultation.

The consultation is open to all interested parties, including industry representatives, non-governmental organisations, researchers and members of the public. Stakeholders are encouraged to prepare in advance and to participate in this consultation to ensure that SEAC's final opinion on the restriction proposal is scientifically robust and fit for purpose.

To support interested parties in preparing for the consultation, ECHA will hold an online information session on 30 October 2025. More details about this event will be provided on ECHA's website. Consultation guidelines will also be published to help stakeholders submit relevant information that can be considered by the Committee when finalising its opinion.

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ECHA will confirm the exact starting date of the consultation in March 2026.

Next steps

After reviewing the consultation feedback, SEAC is expected to adopt its final opinion by the end of 2026. This adoption will conclude ECHA's committees' scientific evaluation of the proposed restriction as announced on 27 August 2025.

Background

The proposal to restrict PFAS in the EU/EEA was prepared by authorities in Denmark, Germany, the Netherlands, Norway and Sweden. It was submitted to ECHA on 13 January 2023. It aims to reduce PFAS emissions into the environment and make products and processes safer for people. The six-month consultation ran from 22 March to 25 September 2023. Currently, ECHA's scientific committees, comprised of independent experts from EU Member States, are evaluating the proposal.

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

Read More

ECHA, 15-09-25

https://echa.europa.eu/-/echa-to-consult-on-pfas-draft-opinion-in-spring-2026

ECHA CHEM now includes regulatory data on chemicals

2025-09-16

The third expansion of ECHA's new chemicals database, ECHA CHEM, incorporates overviews of different regulatory activities by authorities and the resulting outcomes.

Helsinki, 16 September 2025 – The regulatory data includes information from various pieces of legislation under ECHA's remit. Visibility of authorities' regulatory activities on specific chemicals and resulting actions help stakeholders to effectively participate in the decision-making process via consultations, and comply with the laws concerning the chemicals they use.

Peter van der Zandt, Director of Risk Management, said:

"Transparency and predictability of the EU's regulatory activities are a cornerstone of well-functioning chemicals regulation. We have now made this regulatory information available in a consistent manner and in a more user-friendly format, allowing all impacted and interested parties to follow the authorities' ongoing work."

In this release, ECHA CHEM incorporates regulatory processes and lists from four chemicals regulations and directives:

REACH Regulation:

- The list of substances restricted under REACH and the restriction process;
- The Authorisation List and ECHA's recommendations for including substances in the Authorisation List;
- Substances of very high concern (SVHC) and the Candidate List;
- Dossier and substance evaluation;

Drinking Water Directive (DWD):

- European positive lists (EUPL);
  Classification, Labelling and Packaging Regulation (CLP):
- Annex VI - the list of substances with EU harmonised classification and labelling (CLH) and the CLH process;
  Persistent Organic Pollutants (POPs) Regulation:
- The lists of substances subject to POPs Regulation and substances proposed as POPs.

These lists will, except for the new DWD European positive lists, also continue to be available under the Search for chemicals section on ECHA's website. However, as ECHA CHEM continues to expand with more data sets, the old Search for chemicals pages will be gradually decommissioned.

Background

ECHA maintains the largest chemicals database in the European Union (EU), combining industry-submitted data with information generated in the EU's regulatory processes. ECHA CHEM is the solution to share the growing amount of information hosted by the Agency with the public.

On ECHA CHEM you can now find information of substances' regulatory activities, the Classification and Labelling Inventory as well as the over 100 000 REACH registrations that companies have submitted to ECHA.

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Read More

ECHA, 16-09-25

https://echa.europa.eu/-/echa-chem-now-includes-regulatory-data-on-chemicals

Janet's Corner

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Who am I?

2025-09-26

I am the eighth element on the periodic table. I'm a nonmetal and a crucial component of the air you breathe, making up about 21% of Earth's atmosphere. I'm highly reactive and support combustion, meaning things burn much more readily in my presence. You need me to live, and I'm often found in compounds with silicon in the Earth's crust.

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

I am the eighth element on the periodic table.

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Hazard Alert

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Fluorine

2025-09-26

[1,2]

USES [2,3]

Fluorine is used in the petrochemical industry, aluminium manufacturing, in dye and ceramics, for etching glass and enamel, as flux for smelting and in agricultural chemicals. Atomic fluorine and molecular fluorine are used for plasma etching in semiconductor manufacturing, flat panel display production and MEMs fabrication. Fluorine is indirectly used in the production of low friction plastics such as teflon and in halons such as freon, in the production of uranium. Fluorochlorohydrocarbons are used extensively in air conditioning and in refrigeration.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- The general population can be exposed to fluorine in contaminated air, food, drinking water and soil.
- People living in communities with fluoridated water or high levels of naturally occurring fluoride may be exposed to higher levels.
- People who work or live near industries where fluorine-containing substances are used may be exposed to higher levels.

Routes of Exposure

Main routes of exposure to fluorine are:

- Inhalation;
- Skin contact;
- Eye contact

HEALTH EFFECTS [4]

Acute Health Effects

Fluorine is an extremely strong irritant to all tissues it comes in contact with. It can cause injury ranging from mild irritation to caustic burns depending on the concentration of the gas at the time of exposure. It is a very severe irritant of the lungs, mucous membranes, skin and eyes. The reaction of this gas with moisture produces hydrofluoric acid. Thermal

Fluorine is a chemical element with symbol F and atomic number 9.

burns have been reported when fluorine gas comes in contact with the skin due to the violent reaction between the skin and the gas. Direct contact with liquid fluorine can cause frostbite. The lungs appear to be the most affected tissue. Respiratory tract irritation may progress to pulmonary oedema.

SAFETY

First Aid Measures [5]

- **Inhalation:** Remove victim to uncontaminated area wearing self-contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.
- **Skin/Eye Contact:** Remove contaminated clothing. Drench affected area with water for at least 15 minutes. In case of skin contact, wearing rubber gloves rub 2.5% calcium gluconate gel continuously into the affected area for 1.5 hours or until further medical care is available. Immediately flush eyes thoroughly with water for at least 15 minutes. Alternatively irrigate eyes intermittently for 20 minutes with an aqueous Calcium gluconate 1% solution if available. Obtain medical assistance.
- **Ingestion:** Ingestion is not considered a potential route of exposure.
- Delayed adverse effects possible. Prolonged exposure to small concentrations may result in pulmonary oedema. May cause severe chemical burns to skin and cornea. Treat with a corticosteroid spray as soon as possible after inhalation.
- Obtain medical assistance.

Workplace Controls & Practices [4]

- A risk assessment should be conducted and documented in each work area to assess the risks related to the use of the product.
- Fluorine should be handled in a closed system and under strictly controlled conditions.
- Keep concentrations well below occupational exposure limits.
- Consider work permit system e.g. for maintenance activities. Preferably use permanent leak-tight connections (eg. welded pipes).
- Systems under pressure should be regularly checked for leakages.
- Provide adequate general or local ventilation.
- Gas detectors should be used when toxic quantities may be released.

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- Gas detectors should be used when quantities of oxidising gases may be released.

Personal Protective Equipment [5]

The following personal protective equipment should be used when handling fluorine:

Eye and face protection:

- Wear goggles and a face-shield when transfilling or breaking transfer connections;
- Wear eye protection to EN 166 when using gases;
- Full-face mask recommended

Hand protection:

- Wear working gloves and safety shoes while handling containers.
- Chemically resistant gloves complying with EN 374 should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
- Material: Neoprene

Body protection:

- Keep suitable chemically resistant protective clothing readily available for emergency use.
- Personal protective equipment for the body should be selected based on the task being performed and the risks involved.

Other protection:

- Wear working gloves and safety shoes while handling containers.

Respiratory protection:

- Keep self-contained breathing apparatus readily available for emergency use.
- Use SCBA in the event of high concentrations,
- The selection of the Respiratory Protective Device (RPD) must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected RPD.
- When allowed by a risk assessment, Respiratory Protective Equipment (RPE) may be used.

REGULATION

United States

OSHA: The United States Occupational Safety & Health Administration has set the following Permissible Exposure Limit (PEL) for fluorine:

- **General Industry:** 29 CFR 1910.1000 Table Z-1 - 0.1 ppm, 0.2 mg/m3 TWA
- **Construction Industry:** 29 CFR 1926.55 Appendix A - 0.1 ppm, 0.2 mg/m3 TWA
- **Maritime:** 29 CFR 1915.1000 Table Z-Shipyards - 0.1 ppm, 0.2 mg/m3 TWA

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for fluorine of 1 ppm, 1.6 mg/m3 TWA; 2 ppm, 3.1 mg/m3 STEL

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for fluorine of 0.1 ppm, 0.2 mg/m3 TWA

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4. http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=211&tid=38
5. https://www.boconline.co.uk/internet.lg.lg.gbr/en/images/sg-057-fluorine-v1.2410_39632.pdf
6. https://www.osha.gov/dts/chemicalsampling/data/CH_242400.html
7. http://www.safeworkaustralia.gov.au/sites/swa/about/Publications/Documents/772/Workplace-exposure-standards-for-airborne-contaminants.docx

Scientists Transform Plastic Waste Into Efficient CO2 Capture Materials

2025-09-08

As CO2 concentrations in the atmosphere keep rising regardless of years of political intentions to limit emissions, the world's oceans are drowning in plastics, which threatens marine environments and ecosystems.

The key global problems are often interconnected, and typically, the solution to one problem creates another one while the clock keeps ticking. But what if we could solve several problems at the same time?

It's almost too good to be true, but a new cutting-edge invention promises to do just that. Researchers at the University of Copenhagen have developed a method where one man's trash really does become another man's "treasure", when decomposed PET plastic becomes the main ingredient in efficient and sustainable CO2 capture.

We know the material from plastic bottles, textiles, and many other uses: PET plastic is one of the most widely used types of plastic in the world, but when it has served its purpose, it becomes a pressing global environmental issue. This is because it ends up in landfills in many parts of the world, where it breaks down into polluting microplastics that spread to the air, soil and groundwater. A large portion also end up in the oceans.

"The beauty of this method is that we solve a problem without creating a new one. By turning waste into a raw material that can actively reduce greenhouse gases, we make an environmental issue part of the solution to the climate crisis," says Margarita Poderyte from the Department of Chemistry at the University of Copenhagen, lead author of the research paper disclosing the invention.

The solution is a potential win-win on a global scale, where plastic waste not only does not end up in nature but also becomes an active player in climate mitigation.

With the new chemical technology, researchers can transform PET plastic waste that is overlooked by recyclers into a primary resource in a new form of CO2 sorbent they have developed. The process 'upcycles' it to a new material the researchers have named BAETA, which can absorb CO2 out of the atmosphere so efficiently that it easily compares with existing carbon capture technologies.

Sustainable, flexible and scalable

The BAETA material has a powdery structure that can be pelletized, and a chemically 'upgraded' surface, which enables it to very effectively bind and chemically capture CO2. Once saturated, CO2 can be released through a heating process allowing the CO2 to be concentrated, collected and stored or converted into a sustainable resource. In practice, the researchers expect the technology to be first installed on industrial plants with exhausts from chimneys passing through BAETA units to cleanse them of CO2.

The research paper is published in Science Advances journal, which describes the chemical process behind the invention. The process is gentle compared to existing technologies and, at the same time, well-suited for industrial scaling.

"The main ingredient is plastic waste that would otherwise have an unsustainable afterlife, and the synthesis we use, where the chemical transformation takes place, is gentler than other materials for CO2 capture because we can make the synthesis in ambient temperatures. It also has the advantage that the technology can be scaled up more easily," Margarita Poderyte says.

She is seconded by co-author and Associate Professor at the Department of Chemistry, Jiwoong Lee, who highlights the material's flexibility also.

"One of the impressive things about this material is that it stays effective for a long time. And flexible. It works efficiently from normal room temperature up to about 150 degrees Celsius, making it very useful. With this kind of tolerance to high temperatures, the material can be used at the end of industrial plants where the exhausts are typically hot," Jiwoong Lee says.

From laboratory to innovation at the end of the chimney

With a potentially revolutionary idea, a proven method and an effective finished product, the researchers are now ready for the next step.

"We see great potential for this material, not just in the lab, but in real-life industrial carbon capture plants. The next big step is scaling up to produce the material in tonnes, and we're already working to attract investments and make our invention a financially sustainable business venture," Margaryte Poderyte says.

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The technical challenges do not worry the researchers. Instead, the decisive challenge, they say, is to persuade decision-makers to make the necessary investments. If they succeed in that, the invention could ultimately lead to significant changes.

A sea of cheap plastic

Large amounts of PET plastic accumulate in our oceans, damaging ecosystems and breaking down into microplastics, the consequences of which are yet unknown. That sort of plastic is very well suited for the technology.

"If we can get our hands on the highly decomposed PET plastic floating in the world's oceans, it will be a valuable resource for us as it's so well suited for upcycling with our method," Margarita Poderyte says.

The researchers hope that their invention can help to fundamentally change the way we see climate and environmental issues as separate problems.

"We're not talking about stand-alone issues, nor will the solutions be. Our material can create a very concrete economic incentive to cleanse the oceans of plastic," Jiwoong Lee says.

Technology Networks, 8 September 2025

https://technologynetworks.com

Magnesium, the microbiome, and reducing the risk of colon cancer

2025-09-21

A new clinical trial suggests magnesium supplements may boost gut bacteria that help block the development of colon cancer – but only for some people, depending on their genes and sex.

An increase in the use of colonoscopies as a surveillance tool has reduced the incidence of colorectal cancer. However, despite this, it remains the third most common cancer globally, and the second leading cause of cancer-related deaths worldwide.

New research led by the Vanderbilt University Medical Center (VUMC) has demonstrated, by way of a clinical trial, that magnesium supplements increase gut bacteria that can inhibit the growth of colorectal cancer.

"Our previous study showed magnesium supplementation increased blood levels of vitamin D when vitamin D levels were low," said Qi Dai, MD, PhD, professor of medicine at VUMC and the study's corresponding author. "The current study reveals that magnesium supplementation also increases the gut microbes which have been shown to synthesize vitamin D in the gut without sunlight and locally inhibit colorectal cancer development."

Sunlight is the body's main source of vitamin D, which is essential for strong bones and overall health. Previous studies have found a link between vitamin D deficiency and colorectal cancer. In the current study, which was a double-blind randomized controlled trial, the researchers recruited 240 participants with a history of colorectal polyps, a risk factor for colorectal cancer. People were randomly assigned to take either personalized magnesium supplements or a placebo for 12 weeks. The dose of oral magnesium (magnesium glycinate) given was based on participants' calcium-to-magnesium intake ratio, which is generally considered to be around 2:1 calcium to magnesium on a weight basis.

The researchers collected stool samples, rectal swabs, rectal tissue, and blood samples before and after the intervention. They looked at two gut bacteria – Carnobacterium maltaromaticum and Faecalibacterium prausnitzii – that have previously been shown in mice to help produce vitamin D in the gut and reduce cancer development. They also tested whether genetic differences in the TRPM7 gene, which is important for magnesium regulation in the body, changed the effects of supplementation. TRPM7 can be thought of like a "magnesium gate" in the cells. If the gate isn't working properly, magnesium levels in the body and in the gut may not be well-regulated.

Before discussing what the researchers found, it's necessary to talk briefly first about genetic variations. Here, the researchers were on the lookout for what's called a "missense variant." The genetic code in DNA is written in "letters", and sometimes a single letter changes, which is called a variant (or mutation). A missense variant means that this tiny DNA change swaps one amino acid building block for another. In TRPM7, the study looked at a missense variant where the protein's 1482nd position changes from one amino acid (threonine) to another (isoleucine). This is a bit like swapping one piece in a lock-and-key system: the protein still works, but maybe not as smoothly.

What the researchers found was that people without the TRPM7 missense variant (normal TRPM7) responded well to magnesium. It increased the

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abundance of C. maltaromaticum and, to a lesser degree, F. prausnitzii. This increase was strongest in women, suggesting that hormones like estrogen might play a role. In participants with the TRPM7 missense variant (Thr1482Ile), magnesium sometimes had the opposite effect, reducing these bacteria. The extra bacteria didn't explain increases in vitamin D, though, which suggested that magnesium works on vitamin D metabolism both directly and through the microbiome, but via separate mechanisms.

Exploratory follow-up colonoscopies found that in rectal tissue biopsies, people with the highest levels of F. prausnitzii had about a 2.8-fold (nearly three times) higher risk of developing new polyps compared to those with the lowest levels. This association was statistically significant. Whereas, higher levels of C. maltaromaticum were linked to approximately an 85% lower risk of developing serrated polyps, which are less common than conventional polyps but are associated with an increased risk of colorectal cancer and may progress faster when they do become cancerous. However, this result was only "marginally significant," so it should be seen as suggestive rather than conclusive. In stool samples, neither bacterium showed a clear or consistent link with polyp risk.

The study had limitations. The increase in F. prausnitzii did not remain statistically significant after correcting for multiple comparisons, so results should be interpreted cautiously. The study didn't identify which strains of bacteria were responsible, and effects may vary by strain. Microbial changes were measured in relative abundance (percent of total bacteria), which may shift even if absolute numbers of bacteria don't. Participants were mostly older, White, and from a single geographic area (Tennessee, US), so results may not generalize widely. Finally, the trial was relatively short (12 weeks), so long-term effects are unknown.

Nonetheless, the research suggests that magnesium supplementation may help to prevent colorectal cancer, especially in women and in people without certain TRPM7 genetic variants. This suggests a possible "precision nutrition" strategy, where genetic testing could guide who benefits most from taking magnesium. However, m ore research is needed before this can be turned into clinical advice.

The study was published in The American Journal of Clinical Nutrition.

New Atlas, 21 September 2025

https://newatlas.com

Catalyst evolution reveals the unsung heroes in industrial ammonia production

2025-09-22

Researchers at the Fritz Haber Institute of the Max Planck Society, in collaboration with the Max Planck Institute of Chemical Energy Conversion and Clariant have unveiled new insights into the complex catalyst systems used in industrial ammonia production. By examining the structural evolution of these catalysts, the study highlights the critical role of promoters in enhancing performance and stability.

The Haber-Bosch process, a cornerstone of industrial ammonia production, has remained largely unchanged for over a century. However, researchers at the Departments of Inorganic Chemistry and Interface Science of the Fritz Haber Institute, the Max Planck Institute for Chemical Energy Conversion, and Clariant have made significant strides in the mechanistic understanding of the highly complex industrial catalyst that drives this process.

By using advanced characterization techniques like operando scanning electron microscopy and near-ambient pressure X-ray photoelectron spectroscopy, the team has decoded the complex interactions within multi-promoted ammonia synthesis catalysts.

Prof. Thomas Lunkenbein, the corresponding author, stated, "Our research provides a deeper understanding of the catalyst's inner workings, revealing how promoters and structural transformations contribute to its efficiency and stability. This knowledge is crucial for developing next-generation catalysts that are both more effective and sustainable."

The findings are published in the journal Nature Communications.

The study reveals that the activation phase is crucial for forming the active catalyst configuration. During this phase, the interplay of various promoter phases facilitates the transformation of the catalyst's structure into a porous entity with a special surface coverage paving the way for its enhanced performance and longevity.

Promoters: The unsung heroes

Promoters, including potassium, calcium, and aluminum oxides, are vital in stabilizing the catalyst's structure and boosting its activity. These elements work together to create cement-like phases—an important ingredient for robust and efficient catalyst capable of sustaining ammonia synthesis over extended periods. In addition, ammonia K—a special form of highly

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dispersed K+ species—was found to be the pacemaker of the catalytic reaction.

The research highlights the importance of the catalyst's hierarchical porous structure, which is stabilized by mineral phases. This architecture not only enhances the catalyst's durability but also its resistance to deactivation, ensuring consistent performance in industrial settings.

This study sheds light on the intricate dynamics of ammonia synthesis catalysts, offering valuable insights that could pave the way for future innovations in industrial chemistry, including the strong need to consider the dynamic nature of active catalytic surfaces while at work.

By understanding the role of promoters and the critical role of the activation process, researchers can develop more efficient and sustainable catalysts for ammonia production. We acknowledge the expertise and input of Prof. Dr. Robert Schlögl, who, together with a team of excellent scientists, led to this important scientific contribution.

Phys Org, 22 September 2025

https://phys.org

Scientists Create a Biodegradable Plastic Stronger Than PET

2025-09-04

The PET-alternative PDCA is biodegradable and has superior physical properties. A Kobe University team of bioengineers engineered E. coli bacteria to produce the compound from glucose at unprecedented levels and without byproducts — and opened up a realm of possibilities for the future of bioengineering.

The durability of plastics is both the reason why they have become so wide-spread and why they pose environmental problems. In addition, they are mainly sourced from petroleum, making them non-renewable and contingent on geopolitics. Research groups worldwide work on both biodegradable and bio-sourced alternatives, but there often are issues with yield, purity and — as a result — associated production cost.

Kobe University bioengineer TANAKA Tsutomu says: "Most biomass-based production strategies focus on molecules consisting of carbon, oxygen and hydrogen. However, there are highly promising compounds for high-performance plastics PDCA, which stands for pyridinedicarboxylic acid, is such a candidate. It is biodegradable, and materials incorporating this

show physical properties comparable to or even surpassing those of PET, which is widely used in containers and textiles. "Our group approached the challenge from a new angle: We aimed to harness cellular metabolism to assimilate nitrogen and build the compound from start to finish," says Tanaka.

In the journal Metabolic Engineering, the Kobe University group now published that they achieved the production of PDCA in bioreactors at concentrations more than seven-fold higher than previously reported. Tanaka explains, "The significance of our work lies in demonstrating that metabolic reactions can be used to incorporate nitrogen without producing unwanted byproducts, thereby enabling the clean and efficient synthesis of the target compound."

The group, however, did have some stubborn problems to solve along the way. The most stubborn of these came when they discovered a bottleneck where one of the enzymes they had introduced produced the highly reactive compound hydrogen peroxide, H2O2. The compound then attacked the enzyme that produced it, thereby deactivating it.

"Through refining the culture conditions, in particular by adding a compound that can scavenge H2O2, we could finally overcome the issue, although this addition may present new economic and logistical challenges for large-scale production," says Tanaka.

The bioengineers already have plans on how to improve the production going forward, with every problem pointing the way to its solution. Looking at the future, Tanaka says: "The ability to obtain sufficient quantities in bioreactors lays the groundwork for the next steps toward practical implementation. More generally, though, our achievement in incorporating enzymes from nitrogen metabolism broadens the spectrum of molecules accessible through microbial synthesis, thus enhancing the potential of bio-manufacturing even further. "that include other elements such as nitrogen, but there are no efficient bioproduction strategies. And purely chemical reactions inevitably generate unwanted byproducts."

Technology Networks, 4 September 2025

https://technologynetworks.com

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Scientists crack the explosive secret of how diamonds reach the surface

2025-9-24

If you've ever held or beheld a diamond, there's a good chance it came from a kimberlite. Over 70% of the world's diamonds are mined from these unique volcanic structures. Yet despite decades of study, scientists are still working to understand how exactly kimberlites erupt from deep in Earth's mantle to the surface.

Kimberlites -- carrot-shaped volcanic pipes that erupt from mantle depths greater than 150 km -- have long fascinated geologists as windows into the deep Earth. Their mantle-derived melt ascends rapidly through the mantle and crust, with some estimates suggesting ascent rates of up to 80 miles per hour before kimberlites erupt violently at the surface. Along the way, the magma captures xenoliths and xenocrysts, fragments of the rocks encountered on its path.

"They're very interesting and still very enigmatic rocks," despite being well-studied, says Ana Anzulović, a doctoral research fellow at the University of Oslo's Centre for Planetary Habitability.

In a study published this month in the journal Geology, Anzulović and colleagues from the University of Oslo have taken a major step toward solving the puzzle. By modelling how volatile compounds like carbon dioxide and water influence the buoyancy of proto-kimberlite melt relative to surrounding materials, they quantified for the first time what it takes to erupt a kimberlite.

Diamonds make it to the surface in kimberlites because their rapid ascent prevents them from reverting to graphite, which is more stable at shallow pressures and temperatures. But the composition of the kimberlite's original melt -- and how it rises so fast -- has remained mysterious.

"They start off as something that we cannot measure directly," says Anzulović. "So we don't know what a proto-kimberlite, or parental, melt would be like. We know approximately but everything we know basically comes from the very altered rocks that get emplaced."

To constrain the composition of these parental melts, the team focused on the Jericho kimberlite, which erupted into the Slave craton of far northwest Canada. Using chemical modelling, they tested different original mixtures of carbon dioxide and water.

"Our idea was, well, let's try to create a chemical model of a kimberlite, then vary CO2 and H2O," says Anzulović. "Think of it as trying to sample a kimberlite as it ascends at different pressure and temperature points."

The researchers used molecular dynamics software to simulate atomic forces and track how atoms in a kimberlite melt move under varying depths. From these calculations, they determined the density of the melt at different conditions and whether it remained buoyant enough to rise.

"The most important takeaway from this study is that we managed to constrain the amount of CO2 that you need in the Jericho kimberlite to successfully ascend through the Slave craton," Anzulović says. "Our most volatile-rich composition can carry up to 44% of mantle peridotite, for example, to the surface, which is really an impressive number for such a low viscosity melt."

The study also shows how volatiles play distinct roles. Water increases diffusivity, keeping the melt fluid and mobile. Carbon dioxide helps structure the melt at high pressures but, near the surface, it degasses and drives the eruption upward. For the first time, researchers demonstrated that the Jericho kimberlite needs at least 8.2% CO2 to erupt; without it, diamonds would remain locked in the mantle.

"I was actually pretty surprised that I can take such a small scale system and actually observe, 'Okay, if I don't put any carbon in, this melt will be denser than the craton, so this will not erupt,'" says Anzulović. "It's great that modeling kimberlite chemistry can have implications for such a large-scale process."

Science Daily, 24 September 2025

https://sciencedaily.com

AI lab assistant predicts material properties in seconds

2025-09-22

A Johns Hopkins University engineer has developed a specialized AI tool that could do for materials scientists what ChatGPT has done for coders and writers. The new system, called ChatGPT Materials Explorer, or CME, could speed the discovery of everything from advanced batteries to tougher alloys, according to findings published in Integrating Materials and Manufacturing Innovation.

"ChatGPT Materials Explorer is like having a specialized research assistant who is trained specifically to dig through huge databases, predict how a

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material or materials will behave without physical testing, sort through scientific papers to find studies relevant to your projects, and even analyze work and assist with scientific writing," says CME inventor Kamal Choudhary, a professor of materials science and engineering at the university's Whiting School of Engineering.

The tool's key innovation is its access to real scientific data and physics-based models, enabling it to give accurate answers to questions posed by materials scientists. Choudhary's experiences with ChatGPT inspired its creation.

"I work on a lot of superconductors, which are materials that conduct electricity without any resistance," says Choudhary, who also holds a joint appointment in the Department of Electrical and Computer Engineering. "I would ask ChatGPT, 'Can you design a superconductor with a particular composition and show me the crystal structure?' It gave me a very generic response, which turned out to be the wrong answer."

What Choudhary was experiencing are called hallucinations—when ChatGPT presents false information as factual, a not uncommon occurrence. Some experts estimate that ChatGPT has a hallucination rate of between 10% and 39%.

"Hallucinations happen because ChatGPT isn't trained to understand facts," Choudhary says. "If it can't find the exact answer based on the data it's pulling from, it will say something that sounds plausible. Data sources like Wikipedia or The New York Times don't often include current facts and research about materials science and can lead to incorrect answers. CME pulls its information from materials science databases, so its answers can be trusted by materials scientists."

Choudhary developed his specialized language model with the ChatGPT builder feature, which enables users to create custom GPTs tailored to their needs. He started by telling the AI broadly what he wanted it to do and setting parameters for its functions. Then he configured it, connecting the AI to the databases and instructing it on what kinds of answers it can give.

"These databases are how ChatGPT gets its information, so plugging in databases that are relevant to the field is crucial to getting the correct output from the chatbot," Choudhary says. "Before, I would ask regular ChatGPT for the molecular structure notation of ibuprofen, and it would give an incorrect or generic response. With CME, I'll get the right answer to this and many other materials science questions."

The databases, including the National Institute of Science and Technology–Joint Automated Repository for Various Integrated Simulations (NIST-JARVIS), the National Institutes of Health-Chemistry Agent Connecting Tool Usage to Science (NIH-CACTUS), and Materials Project, consistently update CME with the most recent materials science findings, he says.

"Materials Explorer is correct because these databases are automatically updated with new papers; it runs itself and pulls from the newest journals," Choudhary says.

To test its resistance to hallucinations, Choudhary compared CME to ChatGPT 4 and ChemCrow, an AI agent geared to solve chemistry-related tasks. From asking the molecular formula for aspirin to interpreting phase diagrams, CME got all eight answers correct, whereas the other models gave only five accurate responses.

Choudhary is now working to develop the platform further by adding advanced materials modeling tools, automated literature reviews, and more. He is also developing an open-source platform which is available at AtomGPT.org. Contrary to the closed-source model of CME, which doesn't enable users to edit the code that Choudhary established, Atom GPT allows select users to change the code and improve its ability to answer materials science questions.

"The ultimate goal is to make ChatGPT Materials Explorer the one-stop research assistant that can help materials scientists with computer simulations, data analysis, and other methods that advance the field," Choudhary says. "What started as a fun project on the weekends has turned into something that could be a useful career resource for materials scientists."

Phys Org, 22 September 2025

https://phys.org

Cement-like building material doubles up as an electrolyte in rechargeable battery

2025-05-08

Researchers in France and Spain have developed a cement-like material from a geopolymer and shown how it can simultaneously serve as a solid electrolyte in a rechargeable electrochemical energy storage system. 'This is more than a battery,' says Vadim Kovrugin, who carried out the work at

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the University of Bordeaux and the University of the Basque Country. 'It is a new material concept, where infrastructure does not merely stand still but can actively contribute to the energy ecosystem.'

Previous research into construction materials with integrated energy storage has focused on storing waste heat energy in Portland cement. Storing energy electrochemically, rather than thermally is much more efficient, so a few studies have explored using traditional cement or concrete mixtures as battery components.

The issue with cement, however, is that producing it generates significant carbon dioxide emissions. Kovrugin and colleagues have therefore been investigating the electrochemical properties of more sustainable building binders.

Here they used a synthetic aluminosilicate called metakaolin that's made by heating the clay mineral kaolinite. Metakaolin has high mechanical strength and durability, as well as good ionic conductivity. Mixing metakaolin with an activation solution formed a paste into which the team embedded zinc and manganese dioxide electrodes to create a battery with a classic probe-style configuration.

In previous studies into cement-based batteries, the alkaline conditions of such materials can see them react with zinc to form calcium zincate. The mildly acidic metakaolin electrolyte in Kovrugin and colleagues' battery, however, allows zinc to remain in its ionic form. This makes the system rechargeable via a reversible plating and stripping process.

'The use of metakaolin-based geopolymers as a solid electrolyte for energy storage is a great advancement, and it is exciting to see the dual functionality of this material in energy storage and construction. As we transition to renewable energy, the need for efficient and integrated energy storage solutions becomes more urgent, making this research particularly timely,' remarks Damian Stefaniuk, from the Massachusetts Institute of Technology in the US, who was part of a team that created a supercapacitor out of cement in 2023.

Durability is a key challenge when incorporating batteries into permanent structures and Stefaniuk explains 'one of the functions – energy storage – may degrade much sooner due to the chemical reactions present in batteries'.

Hydrogen evolution is a well-known stumbling-block in zinc battery development and in the metakaolin-based system it generates

hexahydrated zinc sulfate. This side product could compromise the interface between the negative electrode and electrolyte, and lead to cracks in the geopolymer material. The team therefore suggests that using a modular design, where battery components are structured in accessible layers or compartments, could make this less of an issue by allowing components to be maintained or replaced without compromising the structural integrity of any construction.

Another key consideration in the geopolymer material's durability is its hydration and drying behaviour. There was heavy water loss in the batteries after 40 days of curing, by which time the electrochemical stability had decreased. This implies hydration levels are important for maintaining sufficient conductivity. However, increasing the water content could potentially affect the material's mechanical integrity. The geopolymer formulation and curing processes will need to be optimised, but further work on this could help to make the material more suitable for real structures.

Despite the challenges involved in embedding energy storage functionality into structural materials, Kovrugin notes that 'with each step forward, we move closer to a future where walls and bridges are not just passive structures, but active elements capable of storing energy and monitoring their own health – for example, by detecting the appearance of cracks or other signs of structural degradation.'

Correction: This article was updated on 9 May to clarify Kovrugin's role in the project

Chemistry World, 8 May 2025

https://chemistryworld.com

Extra-hard hexagonal diamonds can now be grown in a lab

2025-07-30

A harder form of diamond that has eluded scientists for decades can now be synthesised in the laboratory, and could be used to make extremely tough cutting and drilling tools.

Diamonds as we know them have a cubic arrangement of atoms in their crystalline structure. But for at least 60 years, we have been aware of another form – hexagonal diamond – that is much tougher, thanks to its crystals having no uniform shear lines along which breaks can propagate.

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Natural hexagonal diamond occurs in meteorites, where it is known by the mineral name lonsdaleite, but only in mixtures with cubic diamond. Previous attempts to synthesise hexagonal diamonds have yielded only tiny traces that are similarly impure.

Now, Ho-Kwang Mao at the Center for High Pressure Science and Technology Advanced Research in Beijing and his colleagues have succeeded in creating a relatively large sample of hexagonal diamond that is 1 millimetre in diameter and 70 micrometres thick, with purity close to 100 per cent.

While normal diamond has been synthesised for some time, the researchers explored a range of pressures and temperatures to find a sweet spot in which hexagonal diamonds were produced. This ended up being 1400°C at 20 gigapascals – 200,000 times the atmospheric pressure on Earth.

Such a material has never been made before, so it will need to be thoroughly studied to determine its properties, says Mao. "It's incredibly valuable," he says. "But once we know how to make it, anyone can produce it. So then the important thing is to get a patent and find a way to make it less expensive."

Hexagonal diamonds are predicted to be about 60 per cent harder than regular diamonds based on their structure. Cubic diamond has a hardness of around 115 gigapascals when measured in a Vickers hardness test. The hexagonal diamond created by Mao and his team measures 120 gigapascals, but they believe they can improve this significantly as they develop their technique further.

If hexagonal diamond can be synthesised with sufficient thicknesses, it could be used to make harder and more resilient tools for a range of uses in industry, such as drilling for geothermal energy, says James Elliott at the University of Cambridge. "Obviously, the deeper you go, the hotter it gets, [and] it could enable them to go deeper underground."

New Scientist, 30 July 2025

https://newscientist.com

Chemists create light-switchable magnets that remain active for hours

2025-09-19

A research team from the University of Chemistry and Technology, Prague (UCT Prague) and the Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences (IOCB Prague) has created and described a new type of photoswitch. The molecule, a thienyl-based acylhydrazone, undergoes an unprecedented "closed-to-open-shell" transformation, where light converts it into a stable diradical.

While previously published lifetimes of such triplet states are a few milliseconds, this new molecule's switched state has a half-life of over six hours. This revolutionary innovation opens the way for optimizing catalytic processes, developing new data storage and spintronic devices, and targeted elimination of antibiotic-resistant pathogens. The work is published in the Journal of Materials Chemistry C.

Photoswitches are molecules that change between two states under the influence of light. This new switch is unique because it transitions from a stable, non-magnetic (closed-shell) state to an exceptionally long-lived magnetic (open-shell triplet) state. In this triplet state, two electrons have parallel spins, making the molecule paramagnetic and highly reactive. This state is crucial for many photochemical processes, including the generation of reactive oxygen species.

"While it is previously known and described in literature that, in molecules, this state lasts on the order of nano- to milliseconds, in the case of our switch, it persists for tens of hours, which is extraordinary," explains the head of the research, Petr Kovaříček from UCT Prague, adding that his doctoral student, Martin Šetek, made a fundamental contribution to the result. Additionally, the team could not have succeeded without the expert skills of Dana Nachtigalová and Ján Tarábek from IOCB Prague.

The innovation has several immediate applications. In catalysis, the team demonstrated that the photoswitched form acts as a potent radical initiator, successfully driving the radical bromination of toluene. For data storage and spintronics, the molecule forms a complete write-read-erase system.

"The triplet state is paramagnetic, which allows information to be 'written' with light, 'read' magnetically," states Dr. Kovaříček. The scientific paper further reveals a crucial third step: The information can be completely and instantly erased by an electrical impulse.

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"Such a long-living triplet state is truly surprising. For a long time I did not even consider it possible and rejected this explanation," he says, explaining why the article is the result of three years of intensive experimental work. "To convince editors and reviewers of this was also a colossal task."

The team's most promising application is the photodynamic inactivation of pathogens. "Our new molecules can, after being irradiated with light, generate reactive oxygen species, so-called ROS, which effectively destroy a range of antibiotic-resistant fungi and bacteria, including golden staph (Staphylococcus aureus) and selected pathogens from the WHO list," says Dr. Kovaříček.

"ROS are extremely effective—they eliminate more than 99.99% of cells, but only where we shine the light. This is key for the safety of the medical application, which of course must be verified in further studies."

A major advantage of the newly synthesized molecules is their exceptionally low cost and simple production—on a laboratory scale, one kilogram costs approximately 1,000 Czech crowns (about $43 USD).

The idea for medical use was a serendipitous discovery. A bachelor's student testing the molecules in a biological setting found that they destroyed the sample's DNA with astonishing efficiency, revealing a powerful new weapon against microorganisms. In collaboration with Dr. Lencová from the Department of Biochemistry and Microbiology, the teams are already preparing a new project to pursue this goal.

Phys Org, 19 September 2025

https://phys.org

Sun-powered device extracts lithium without wrecking the environment

2025-09-05

The mining of lithium for batteries – the key to the electric vehicle revolution and levelling out the power supplied by renewables – is environmentally damaging. But an experimental sun-powered method that produces fresh water as well as lithium could make it more sustainable.

Today, most lithium is obtained from underground brine reservoirs in the Andes. The brine is concentrated by letting it evaporate in open-air ponds for months, and the subsequent extraction of lithium carbonate from the concentrated brine requires large quantities of fresh water. What's more,

as the brine is pumped out of the reservoirs, fresh water in the rocks above may flow down to replace it, causing the water table to fall. In other words, mining has a major impact on the water supply.

Many groups are working on direct lithium extraction methods that don't require open-air evaporation. One such approach, developed by Yu Tang at Lanzhou University in China and her colleagues, would also produce freshwater that could be used or to be pumped back underground.

The team based their technique on a form of manganese oxide that has two key properties. Firstly, it converts a lot of the sunlight falling on it into heat. Secondly, it can selectively bind to lithium ions.

In their design, a thin layer of brine or seawater flows down a sun-facing layer of manganese oxide. As the sun warms the material, the water evaporates and the lithium ions bind to the oxide. Once the layer is saturated, the ions can be removed using an acidic solution, and the material can be reused.

Because the process takes place inside a sealed system, the water that evaporates condenses out and can be harvested. The team has tested a small prototype over five cycles of lithium adsorption and release, and the harvested water met the drinking standards of the World Health Organization.

"It is very clever," says Ugo Bardi at the University of Florence in Italy. In principle, it could provide a more sustainable source of lithium, he says.

"The paper looks credible," says Bardi. "The potential problem I can see is the stability of the material: for how many cycles can it be used in real-world conditions?"

New Scientist, 5 September 2025

https://newscientist.com

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Sponge-Like Gold Nanoparticles Could Upgrade Ovarian Cancer Diagnostics

2025-09-10

A gilt-edged project led by University of Queensland PhD student Javeria Bashir has produced specially crafted gold nanoparticles that can highlight cancer markers in samples like urine, saliva or blood.

Ms Bashir said she hoped to use her gold nanoparticles to help improve survival rates for a cancer that is considered particularly deadly.

"Ovarian cancer rarely shows clear symptoms in its early stages, and diagnosis is often complex, Ms Bashir said. Sponge-like gold particles could be used to triage women with suspected ovarian cancer more accurately than current diagnostic tools.

"Current approaches make it difficult to accurately triage and identify women with ovarian cancer compared to those with benign conditions, often requiring painful and invasive procedures such as tissue biopsy."

Gold-enhanced light sensors

Guided by experts from UQ's School of Mechanical and Mining Engineering - in collaboration with the Australian Institute for Bioengineering and Nanotechnology (AIBN), UQ Centre for Clinical Research (UQCCR), and UQ Centre for Extracellular Vesicle Nanomedicine - Ms Bashir sought to improve cancer diagnostics by using the unique biosensing capabilities of sponge-like mesoporous gold nanoparticles.

Working at scales of a billionth of a metre, Ms Bashir was able to boost the sensitivity of gold-enhanced light sensors using a technique called Surface-Enhanced Raman Scattering (SERS).

"SERS platforms are already highly sensitive and can detect biomarkers at the nanoscale," Ms Bashir said.

"Using mesoporous gold nanoparticles increased that sensitivity even further compared to nonporous, or commercially available nanoparticles."

"Essentially, the gold particles act like tiny light amplifiers, creating hotspots that reveal even the faintest traces of cancer."

Ms Bashir said the gold could be embedded in the diagnostic process with a small tube to hold the patient sample and a handheld Raman spectrophotometer.

This combination has already been used to outperform current blood tests, achieving 82 per cent sensitivity in confirming ovarian cancer and 98 per cent specificity in ruling it out.

Helping women in remote communities

Ms Bashir said the portability, simplicity, and affordability of this sensor technology would be particularly beneficial for women in remote or under-resourced regions.

"This project demonstrates how mesoporous nanotechnologies can help us transform disease monitoring and pave the way for personalised treatment strategies," Ms Bashir said.

"Devices like this are moving closer and closer to everyday use."

Technology Networks, 10 September 2025

https://technologynetworks.com

Solar fuel conundrum in iron-based systems nears solution

2025-09-23

Solar energy stored in the form of fuel is something scientists hope could partially replace fossil fuels in the future. Researchers at Lund University in Sweden may have solved a long-standing problem that has hindered the development of sustainable solar fuels. If solar energy can be used more efficiently using iron-based systems, this could pave the way for cheaper solar fuels.

"We can now see previously hidden mechanisms that would allow iron-based molecules to transfer charge more efficiently to acceptor molecules. This could effectively remove one of the biggest obstacles to producing solar fuels using common metals," says Petter Persson, a chemistry researcher at Lund University and an author of the study published in the Journal of the American Chemical Society.

An intense search for new ways to produce environmentally friendly fuels is underway. These could help phase out the fossil fuels that currently dominate global energy. One promising strategy is to develop catalysts that utilize solar energy to produce fuels such as green hydrogen.

In recent years, significant progress has been made in this area, including the development of solar-powered catalysts based on iron and other

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common elements. Despite these achievements, the conversion of energy from solar to fuel has proved too inefficient in iron-based systems.

To produce solar fuels such as green hydrogen, the light-absorbing molecules must transfer electrical charge to an acceptor molecule. If the transfer does not work well, much of the energy is lost before it can be stored in the solar fuel. Although iron is inexpensive and environmentally friendly, this problem has made it difficult to make iron-based systems work as efficiently as more expensive systems based on rare earth metals.

Using advanced calculations, the researchers have now been able to analyze the process at the molecular level. The study shows that much of the energy is lost because the acceptor molecules often stick to the catalysts before the charge has time to transfer.

However, the researchers discovered unexpected mechanisms whereby acceptor molecules can enlist the help of neighboring molecules to complete the charge transfer. This can significantly reduce energy losses and increase efficiency in iron-based solar energy systems.

"It was surprising that the surroundings play such a crucial role. Our simulations show several unexpected ways in which the interaction with neighboring molecules can facilitate the formation of energy-rich products," says Persson.

This is an important step towards viable solar fuel production with common metals. The study shows how the crucial first step of charge separation can be optimized, but further steps are necessary before the process can lead to finished solar fuels.

"The study provides new insights into how solar energy can be converted more efficiently using common metals such as iron. In the long run, this can contribute to the development of cheaper and more sustainable solar fuels—an important piece of the puzzle in the global energy transition," concludes Persson.

Phys Org, 23 September 2025

https://phys.org

The shocking reason Arctic rivers are turning rusty orange

2025-09-22

Ice can dissolve iron minerals more effectively than liquid water, according to a new study from Umeå University. The discovery could help explain why many Arctic rivers are now turning rusty orange as permafrost thaws in a warming climate.

The study, recently published in the scientific journal PNAS, shows that ice at minus ten degrees Celsius releases more iron from common minerals than liquid water at four degrees Celsius. This challenges the long-held belief that frozen environments slow down chemical reactions.

"It may sound counterintuitive, but ice is not a passive frozen block," says Jean-François Boily, Professor at Umeå University and co-author of the study. "Freezing creates microscopic pockets of liquid water between ice crystals. These act like chemical reactors, where compounds become concentrated and extremely acidic. This means they can react with iron minerals even at temperatures as low as minus 30 degrees Celsius."

To understand the process, the researchers studied goethite - a widespread iron oxide mineral - together with a naturally occurring organic acid, using advanced microscopy and experiments.

They discovered that repeated freeze-thaw cycles make iron dissolve more efficiently. As the ice freezes and thaws, organic compounds that were previously trapped in the ice are released, fuelling further chemical reactions. Salinity also plays a crucial role: fresh and brackish water increase dissolution, while seawater can suppress it.

The findings apply mainly to acidic environments, such as mine drainage sites, frozen dust in the atmosphere, acid sulfate soils along the Baltic Sea coast, or in any acidic frozen environment where iron minerals interact with organics. The next step is to find out if the same is true for all iron-bearing ice. This is what ongoing research in the Boily laboratory will soon reveal.

"As the climate warms, freeze-thaw cycles become more frequent," says Angelo Pio Sebaaly, doctoral student and first author of the study. "Each cycle releases iron from soils and permafrost into the water. This can affect water quality and aquatic ecosystems across vast areas."

The findings show that ice is not a passive storage medium, but an active player. As freezing and thawing increase in polar and mountain regions,

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for the impact on ecosystems. and the natural cycling of elements could be significant.

Science Daily, 22 September 2025

https://sciencedaily.com

Cannabis Use Quadruples Diabetes Risk, Study of 4 Million Adults Finds

2025-09-20

Cannabis use may come with an unexpected cost: a nearly fourfold rise in diabetes risk.

The finding, drawn from millions of health records, challenges assumptions about the drug's effects and underscores the need for closer medical monitoring.

Cannabis Use and Diabetes Risk

Cannabis use has been associated with nearly a fourfold increase in the likelihood of developing diabetes, according to an analysis of health data from more than 4 million adults. The findings are being presented at this year's Annual Meeting of The European Association for the Study of Diabetes (EASD) in Vienna, Austria.

Worldwide, cannabis use continues to rise, with an estimated 219 million people (4.3% of the global adult population) reported as users in 2021. Despite widespread consumption, the long-term effects of this on metabolism remain poorly understood. Some earlier research has suggested potential benefits, including anti-inflammatory properties and support for weight management. Others, however, have pointed to concerns about how cannabis might affect glucose regulation and insulin resistance, and the scale of the potential diabetes risk has remained uncertain.

Large-Scale Real-World Data Analysis

To provide stronger evidence, Dr. Ibrahim Kamel of Boston Medical Center in Massachusetts, USA, and his team reviewed electronic health records collected from 54 healthcare institutions within the TriNetX Research Network, which includes sites across the USA and Europe. Their analysis identified 96,795 outpatients (aged 18 to 50 years, 52.5% female) with cannabis-related diagnoses between 2010 and 2018. These diagnoses

ranged from occasional use to dependence and also included cases involving intoxication or withdrawal.

For comparison, the researchers matched this group with 4,160,998 individuals with no history of substance use or major chronic disease, aligning them by age, sex, and baseline health conditions. All participants were then tracked over a five-year period.

Nearly Fourfold Risk After Adjustments

After controlling HDL and LDL cholesterol, uncontrolled high blood pressure, atherosclerotic cardiovascular disease, cocaine use, alcohol use and several other lifestyle risk factors, the researchers found that new cases of diabetes were significantly higher in the cannabis group (1,937; 2.2%) compared to the healthy group (518; 0.6%), with statistical analysis showing cannabis users at nearly four times the risk of developing diabetes compared to non-users.

While the authors note that more research is needed to fully explain the association between cannabis and diabetes, it may come down to insulin resistance and unhealthy dietary behaviors. Nevertheless, the study's results have immediate implications for metabolic monitoring practices and public health messaging.

Public Health Implications and Warnings

"As cannabis becomes more widely available and socially accepted, and legalized in various jurisdictions, it is essential to understand its potential health risks," said lead author Dr. Kamel. "These new sights from reliable real-world evidence highlight the importance of integrating diabetes risk awareness into substance use disorder treatment and counseling, as well as the need for healthcare professionals to routinely talk to patients about cannabis use so that they can understand their overall diabetes risk and potential need for metabolic monitoring."

Unanswered Questions and Study Limitations

The authors note that more research is needed on the long-term endocrine effects of cannabis use and whether diabetes risks are limited to inhaled products or other forms of cannabis, such as edibles.

Despite the important findings, this is a retrospective study and cannot prove that cannabis use causes diabetes, and the authors cannot rule out the possibility that other unmeasured factors may have influenced the results despite efforts to reduce confounding bias via propensity

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score matching. This study has limitations due to a lack of detailed cannabis consumption data and potential misclassification. The authors acknowledge that inherent limitations of real-world data often result from inconsistent patient reporting in electronic medical records. They also note that there is a risk of bias because of imprecise measures of cannabis exposure and the reliance on participants to accurately report any cannabis use, even when they lived in places where the drug is illegal.

Meeting: Annual Meeting of the European Association for the Study of Diabetes (EASD)

Sci Tech Daily, 20 Sepetember 2025

https://scitechdaily.com

New Polymer Paves the Way for Recyclable Water-Based Batteries

2025-09-05

The new electrode material can be broken down into its raw components under mild conditions.

Aqueous batteries have been around for centuries. They are safe and relatively low-cost, but their adoption in new energy storage systems - such as grid storage and electric vehicles - has been limited.

One major reason is material compatibility: many electrode materials do not perform well in aqueous electrolytes. For organic redox polymers in particular, hydrophobicity has been a barrier. Like other polymer materials, they also present challenges when it comes to decomposition and recycling.

One major reason is material compatibility: many electrode materials do not perform well in aqueous electrolytes. For organic redox polymers in particular, hydrophobicity has been a barrier. Like other polymer materials, they also present challenges when it comes to decomposition and recycling.

Now, a research team from Tohoku University, working in collaboration with Nitto Boseki Co., Ltd., has developed a new organic redox polymer that addresses these long-standing challenges.

To overcome the hurdles, the team introduced p-dihydroxybenzene - an organic molecule with high charge storage capacity - into a polyamine, which is water-soluble due to its positive charge. This was achieved

through a simple condensation reaction. The resulting polymer retains high hydrophilicity, can be used as an electrode-active material at room temperature (25°C), and can be broken down into its raw components under mild conditions at temperatures below 100°C.

"This study provides a design strategy for making hydrophobic redox molecules compatible with aqueous systems," said Kouki Oka, associate professor at Institute of Multidisciplinary Research for Advanced Materials, Tohoku University. "By combining high charge storage capacity with recyclability, we can open new directions for sustainable battery research."

The findings highlight two key benefits. First, the use of water-based electrolytes avoids the risk of fire associated with conventional flammable solvents. Second, because the new polymers are made from abundant elements and can be easily decomposed, they may help reduce resource consumption and plastic pollution.

"Our next step is to evaluate durability and other performance factors to understand the full potential of this material for real-world applications," added Oka.

Technology Networks, 5 September 2025

https://technologynetworks.com

One-pot atom swap chemistry allows direct indole-to-benzimidazole conversion

2025-09-23

Single-atom swaps are rare because strong bonds in molecular frameworks are difficult to break selectively. But Bill Morandi's group at ETH Zürich in Switzerland has reported a carbon-to-nitrogen swap in N-alkyl indoles, directly converting them into the corresponding benzimidazoles. This one-pot reaction uses simple, commercially available reagents with no need for metal catalysts or protecting groups.

Morandi's group is a pioneer of skeletal-editing, remodelling molecules on an atomic level to access new areas of chemical space. The latest work demonstrates that complex, drug-like molecules can be transformed in a single synthetic step, something that would be valuable to the pharmaceutical and agrichemical industry.

The reaction itself is elegant in its design. It proceeds via a carefully orchestrated sequence: oxidative cleavage to the Witkop intermediate, followed by amide formation and Hofmann-type rearrangement. The

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sequence is mediated by commercially available reagents, including ammonium carbamate, which serves as the nitrogen source, and phenyliodine(III) diacetate (PIDA). Specificity stems from the selective formation and reactivity of the Witkop intermediate, which guides the transformation with minimum side reactions.

'The operationally simple reaction setup gives access to complex benzimidazoles within 30 minutes,' explains Ann-Sophie Paschke, a member of the team. By replacing a single atom in the indole scaffold, a common motif that appears in bioactive molecules, the physiochemical properties of the molecule can be altered and new target binding sites could be introduced. 'With our approach, native indoles from commercial suppliers or existing libraries can be directly subjected to the reaction conditions,' adds Paschke.

Unlike traditional approaches for molecular diversification, which often rely on peripheral functionalisation, this approach modifies the core skeleton. No additional functionalisation of the parent indole is required, enabling the use of existing compound libraries. However, single atom swaps typically require the installation of specific functional groups, such as azides or N-oxides, limiting the applicability in late-stage diversification.

The group highlighted this late-stage versatility by applying the reaction to 15 drug-like indoles, 'highlighting its potential as a useful addition to the medicinal chemistry toolbox' of molecular editing. Among them, a 5-HT1C antagonist analogue was transformed into benzimidazole, demonstrating the reaction's compatibility with sensitive functional groups such as urea. A phosphatidylinositol-3 kinase inhibitor also underwent the swap to its benzimidazole derivative with minimal disruption to the sulfonamide's functionality. These examples highlight the method's versatility and relevance to real-world drug scaffolds.

Other groups have reported promising strategies for single-atom exchange reactions that expand the toolbox of late-stage editing methodologies. For instance, in morphine, replacing an oxygen in the core E-ring with carbon produced an analogue that retained painkilling activity while reducing side effects, illustrating how precise atomic edits can tune biological function.

Alec Christian, associate principal scientist at Merck, believes this new methodology is 'unique and is adding to the toolbox', and says that, 'one of the most impactful aspects of this work is its ability to adjust the electronics of molecules, which can directly influence their biological

activity'. He adds that, 'it's rare to have a method that allows a controlled nitrogen insertion at a late stage, directly on complex scaffolds'.

Armido Studer, an organic chemist at the University of Münster, comments that 'the beauty of this method lies in combining well-known reactions in a single step, directly converting indoles into benzimidazoles without pre-functionalisation'. 'Indoles are a common scaffold in biologically active molecules,' he adds, 'modifying them through single-atom swaps can rapidly generate analogues for drug discovery'. Studer also notes that the technique could 'expand structural libraries, explore new analogues and even inspire applications beyond pharmaceuticals, such as in materials science'. Work on related C-to-N atom swaps in indoles and benzofurans has also been explored by Studer's group using a two-step process, offering a flexible route to new heterocyclic scaffolds.2

Looking ahead, Paschke says, 'we aim to develop further methods to access various heterocycles to facilitate rapid synthesis of novel or hard-to-access scaffolds and to ultimately support the discovery of new bioactive compounds'.

Chemistry World, 23 September 2025

https://chemistryworld.com

Innovative porous material enables efficient xylene separation at room temperature

2025-09-23

UNIST and Hanyang University researchers have developed a novel porous material capable of high-purity separation of xylene isomers at room temperature. This breakthrough promises to significantly reduce energy consumption and process complexity in petrochemical refining.

Their findings were published in the online version of Angewandte Chemie International Edition.

Xylene, a key raw material used in plastic bottles, synthetic fibers, and fragrances, exists as three isomers—ortho-, meta-, and para-xylene—each with distinct applications. These isomers, along with ethylbenzene, are typically produced as a mixture in petrochemical processes, requiring energy-intensive separation steps under high temperature and pressure.

The research team successfully developed a porous metal–organic framework (MOF) that selectively captures and separates these isomers under ambient conditions.

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Unlike conventional MOFs, which feature open channels on multiple sides, this innovative design has blocked side pores and open vertical channels. This structure was achieved by incorporating a large organic molecule called DABCO into a nickel-based framework.

This configuration functions as a molecular sieve: the bent shape of ortho-xylene is effectively filtered out at the entry point, while the elongated para-xylene and ethylbenzene molecules can pass through and be adsorbed within the internal pores.

This specially designed MOF demonstrated up to 268 times higher selectivity for ortho-xylene compared to existing materials, with performance maintained over multiple reuse cycles. Such high selectivity at room temperature represents a significant advancement over traditional high-temperature separation methods.

Professor Lah explained, "Our new material can spontaneously separate specific xylene isomers at ambient conditions, overcoming the limitations of high-temperature, high-pressure processes. This innovation could lead to more energy-efficient and environmentally friendly petrochemical separation techniques, contributing to sustainable industrial practices."

The research was conducted by Seonghwan Lee, Amitosh Sharma, and Jae Hyeok Lee, who served as first authors.

Phys Org, 23 Sepetember 2025

https://phys.org

America is throwing away the minerals that could power its future

2025-09-18

All the critical minerals the U.S. needs annually for energy, defense and technology applications are already being mined at existing U.S. facilities, according to a new analysis published recently in the journal Science.

The catch? These minerals, such as cobalt, lithium, gallium and rare earth elements like neodymium and yttrium, are currently being discarded as tailings of other mineral streams like gold and zinc, said Elizabeth Holley, associate professor of mining engineering at Colorado School of Mines and lead author of the new paper.

"The challenge lies in recovery," Holley said. "It's like getting salt out of bread dough - we need to do a lot more research, development and policy to make the recovery of these critical minerals economically feasible."

To conduct the analysis, Holley and her team built a database of annual production from federally permitted metal mines in the U.S. They used a statistical resampling technique to pair these data with the geochemical concentrations of critical minerals in ores, recently compiled by the U.S. Geological Survey, Geoscience Australia and the Geologic Survey of Canada.

Using this approach, Holley's team was able to estimate the quantities of critical minerals being mined and processed every year at U.S. metal mines but not being recovered. Instead, these valuable minerals are ending up as discarded tailings that must be stored and monitored to prevent environmental contamination.

"This is a brand-new view of 'low hanging fruit' - we show where each critical mineral exists and the sites at which even 1 percent recovery of a particular critical mineral could make a huge difference, in many cases dramatically reducing or even eliminating the need to import that mineral," Holley said.

The analysis in Science looks at a total of 70 elements used in applications ranging from consumer electronics like cell phones to medical devices to satellites to renewable energy to fighter jets and shows that unrecovered byproducts from other U.S. mines could meet the demand for all but two - platinum and palladium.

Among the elements included in the analysis are:

- **Cobalt (Co):** The lustrous bluish-gray metal, a key component in electric car batteries, is a byproduct of nickel and copper mining. Recovering less than 10 percent of the cobalt currently being mined and processed but not recovered would be more than enough to fuel the entire U.S. battery market.
- **Germanium (Ge):** The brittle silvery-white semi-metal used for electronics and infrared optics, including sensors on missiles and defense satellites, is present in zinc and molybdenum mines. If the U.S. recovered less than 1 percent of the germanium currently mined and processed but not recovered from U.S. mines, it would not have to import any germanium to meet industry needs.

The benefits of enhanced recovery are not only economic and geopolitical but also environmental, Holley said - recovering these critical minerals instead of sending them to tailings piles would reduce the environmental impact of mine waste and open more opportunities for reuse in construction and other industries.

"Now that we know which sites are low-hanging fruit, we need to conduct detailed analyses of the minerals in which these chemical elements reside and then test the technologies suitable for recovery of those elements from those specific minerals," Holley said. "We also need policies that incentivize mine operators to incorporate additional processing infrastructure. Although these elements are needed, their market value may not be sufficient to motivate operators to invest in new equipment and processes without the right policies in place."

Co-authors on the paper are Karlie Hadden, PhD candidate in geology; Dorit Hammerling, associate professor of applied mathematics and statistics; Rod Eggert, research professor of economics and business; Erik Spiller, research professor of mining engineering; and Priscilla Nelson, professor of mining engineering.

Science Daily, 18 September 2025

https://sciencedaily.com

MXene-supported ruthenium catalyst accelerates upcycling of plastics

2025-09-22

Plastics are valued for their durability, but that quality also makes them difficult to break down. Tiny pieces of debris known as microplastics persist in soil, water and air and threaten ecosystems and human health.

Traditional recycling reprocesses plastics to make new products, but each time this is done, the material becomes lower in quality due to contamination and degradation of the polymers in plastics. Moreover, recycling alone cannot keep pace with the growing volume of global plastic waste.

Now, a University of Delaware-led research team has developed a new type of catalyst that enhances conversion of plastic waste into liquid fuels more quickly and with fewer undesired byproducts than current methods. Featured on the cover of the Chem Catalysis, the pilot-stage work helps pave the way toward energy-efficient methods for plastic upcycling, reducing plastic pollution and promoting sustainable fuel production.

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"Instead of letting plastics pile up as waste, upcycling treats them like solid fuels that can be transformed into useful liquid fuels and chemicals, offering a faster, more efficient and environmentally friendly solution," said senior author Dongxia Liu, the Robert K. Grasseli Professor of Chemical and Biomolecular Engineering at UD's College of Engineering.

One promising upcycling approach is hydrogenolysis, which uses hydrogen gas and a catalyst to convert the polymers in plastics into liquid fuels for transportation and industrial use. However, conventional catalysts have limited efficiency because bulky polymer molecules have a hard time interacting with the active sites of the catalyst where the reaction takes place.

To address this, the researchers transformed MXenes (pronounced max-eens), a type of nanomaterial, into mesoporous MXenes, a form with larger, more open pores that had not previously been used for plastic upcycling.

"MXenes form two-dimensional layers, like the pages of a book. These stacked layers in the closed book make it difficult for molten plastic to move through easily, limiting contact with the catalyst," explained first author Ali Kamali, a doctoral candidate in the Department of Chemical and Biomolecular Engineering.

"To improve the design, we inserted silica pillars to open up the space between MXene layers, allowing the polymers and intermediate compounds that form during the reaction to flow more easily."

They tested their mesoporous MXene-supported ruthenium catalyst with low-density polyethylene (LDPE), a plastic often used in shopping bags and plastic films. In a small pressurized reactor, the team combined LDPE with the catalyst and hydrogen gas and heated the mixture, melting the plastic into a thick syrup.

Their catalyst achieved reaction rates nearly two times faster than those previously reported for LDPE hydrogenolysis. The catalyst also displayed high selectivity, allowing for targeted production of liquid fuels while minimizing undesired byproducts like the greenhouse gas methane. The researchers attribute this selectivity to stabilization of ruthenium nanoparticles in the mesoporous space between MXene layers.

"We were able to produce a material that not only speeds the conversion but also improves the quality of the fuel products. This advance highlights the potential of nanostructured mesoporous catalysts to enhance plastic upcycling," Liu said.

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Looking ahead, the research team plans to further refine the catalyst and to develop a broader library of MXene-based catalysts for use with different types of plastics. Ultimately, they hope to collaborate with industry partners to turn plastic waste from a problem into a resource, converting it into fuels and chemicals that not only help the environment but also bring economic value to local communities.

Phys Org, 22 September 2025

https://phys.org

Ozempic killer? New drug reprograms metabolism for lasting weight loss

2025-09-21

While Ozempic and other drugs like it have proven effective in helping people lose weight, many gain it back when the injections stop. A new drug targets weight loss differently, leading to a more permanent fat-shedding solution.

While their formulations are all slightly different, drugs like Trulicity, Ozempic, and Wegovy are all Glucagon-like peptide-1 (GLP-1) receptor agonists. These drugs work, in part, by slowing the emptying of stomach contents and increasing a sense of fullness. The problem, however, is that when you stop taking the drug, the feelings of fullness fade, and weight gain can return.

At this year's meeting of the European Association for the Study of Diabetes in Vienna, Austria, researchers from Resalis Therapeutics, a biotech company in Turin, Italy, just announced a weight-loss drug that works differently. The drug, which is called RES-010, works by employing an antisense oligonucleotide, a synthetic bit of genetic material that blocks the action of an RNA molecule known as miR-22. It is now in phase 1 clinical trials in humans.

According to the researchers, miR-22 acts as a "master controller" of multiple processes related to obesity. These include the body's fat-metabolizing process, the creation and regulation of mitochondria, and the way in which the body's fat functions and is organized (a process known as adipose tissue remodeling). When a weekly injection of the drug was given to mice over the course of five months, they lost 12% more weight than untreated mice.

Getting to the root cause

Significantly, both groups of mice ate the same amount of calories, indicating that RES-010 changed the body's metabolism, rather than causing the mice to simply eat less. Basically, it was able to treat the root cause of obesity.

"RES-010 works by reprogramming how cells handle fat and energy," said study co-author Riccardo Panella, Resalis' co-founder and CEO. "Rather than reducing appetite, it changes the way in which the body uses fats, boosts the production and activity of mitochondria, the 'batteries' that power cells, and helps convert white fat, which stores energy, into brown fat, which burns it. Because it acts on these fundamental pathways, weight regain is less likely."

Another benefit of RES-010 is that the animal tests revealed that it was able to target fat cells only, while sparing lean tissue. This is a major difference from GLP-1 receptor agonists, which can cause the body to cannibalize lean mass, including muscle and bone. The tests revealed that non-human primates (NHPs) given RES-010 lost 15% of their fat and only 1% of their lean mass over 10 weeks. NHPs put on semaglutide (the drug marketed as Ozempic) alone, they lost 16% of their fat mass, but also 8% of their lean mass.

"Lean mass, especially skeletal muscle, is central to strength, stamina and blood sugar regulation, and so its loss is potentially harmful," says Panella.

As part of the study, when the animals were taken off semaglutide, the regained weight. When they were given both semaglutide and RES-010, however, the weight loss remained permanent, even after both drugs were stopped.

The new phase 1 clinical trial has been underway in the Netherlands since November 2024. The results are expected to be reported in early 2026.

New Atlas, 21 September 2025

https://newatlas.com

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Unveiling chemical space, scaffold diversity, critical structural features of pesticides: A comprehensive QSAR, qRASAR, machine learning studies to predict pesticides toxicity

Evaluation of the pollution pressures posed by groups of chemicals on British riverine invertebrate populations

Oxidative potential and cellular toxicity of carbonaceous aerosols undergoing aging in an atmospheric simulation chamber

ENVIRONMENTAL RESEARCH

Assessment of potentially toxic elements (PTEs) in surface and groundwater of volcanic and granite regions of Hainan Island, China: Pollution status, sources, and health risk evaluation

Degradation of PVDF in photocatalytic membranes in gaseous environments

Degradation of PVDF in photocatalytic membranes in gaseous environments

PHARMACEUTICAL/TOXICOLOGY

Environmental cadmium exposure promotes lung cancer via DHX34: A molecular toxicology perspective

Dysregulation of Immune Checkpoint LAG3 in Mice Exposed to Silica

Oral exposure to tire rubber-derived contaminant 6PPD and 6PPD-quinone induces intestinal toxicity in mice

Oral exposure to tire rubber-derived contaminant 6PPD and 6PPD-quinone induces intestinal toxicity in mice

OCCUPATIONAL

Associations of ambient exposure to benzene, toluene, ethylbenzene, and xylene with daily mortality: a multicountry time-series study in 757 global locations