CHEMWATCH

Bulletin Board

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(click on page numbers for links)

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ASIA PACIFIC

WHS prosecutions

2025-07-16

Safe Work Australia has updated the WHS prosecutions dashboard to reflect the latest publicly available data from 2024. We have also enhanced the dashboard functionality by adding the ability to filter the data by industry.

The new data is available to explore on our interactive data website, Our Data. Your Stories.

The prosecutions dashboard provides national information on criminal prosecutions for breaching WHS laws or regulations since 1 January 2020. Developed in response to the 2018 Senate inquiry report They never came home – the framework surrounding the prevention, investigation and prosecution of industrial deaths in Australia, the prosecutions data can help inform decision-making to improve WHS outcomes.

Key findings and insights from the 2024 WHS prosecutions dashboard include:

- 317 prosecutions were recorded, reflecting a continued yearly increase.
- The top 3 industries involved in WHS prosecutions cases were:
- Construction (47%)
- Manufacturing (21%), and
- Transport, postal & warehousing (5%).
- 16% of prosecutions cases involved a fatal injury and 49% involved a serious injury.
- 97% of prosecutions cases resulted in a financial penalty.
- The average financial penalty per case decreased since 2023, averaging $116,979 compared to $138,724 in 2023.
- Read More

Safe Work Australia, 16-07-25

https://data.safeworkaustralia.gov.au/interactive-data/topic/whs-prosecutions

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AMERICA

National Emission Standards for Hazardous Air Pollutants: Integrated Iron and Steel Manufacturing Facilities Technology Review: Interim Final Rule

2025-07-03

Environmental Protection Agency

- 40 CFR Part 63
- [EPA-HQ-OAR-2002-0083; FRL-5919.4-03-OAR]

AGENCY:

Environmental Protection Agency (EPA).

ACTION:

Interim final rule; request for comment.

SUMMARY:

The U.S. Environmental Protection Agency (EPA) is taking interim final action on the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Integrated Iron and Steel Manufacturing Facilities to revise certain compliance deadlines for standards finalized in 2024. Specifically, the EPA is revising certain compliance deadlines in the 2024 rule to April 3, 2027, in light of serious concerns that facilities will be unable to comply with the relevant requirements by the existing deadlines.

DATES:

This interim final rule is effective on July 2, 2025. Comments on this rule must be received on or before August 1, 2025.

ADDRESSES:

You may send comments, identified by Docket ID No. EPA-HQ-OAR-2002-0083 by any of the following methods:

- **Federal eRulemaking Portal:** https://www.regulations.gov (our preferred method). Follow the online instructions for submitting comments.
- **Email:** a-and-r-docket@epa.gov. Include Docket ID No. EPA-HQ-OAR-2002-0083 in the subject line of the message.

- **Fax:** (202) 566-9744. Attention Docket ID No. EPA-HQ-OAR-2002-0083.
- **Mail:** U.S. Environmental Protection Agency, EPA Docket Center, Docket ID No. EPA-HQ-OAR-2002-0083, Mail Code 28221T, 1200 Pennsylvania Avenue NW, Washington, DC 20460.
- **Hand/Courier Delivery:** EPA Docket Center, WJC West Building, Room 3334, 1301 Constitution Avenue NW, Washington, DC 20004. The Docket Center's hours of operation are 8:30 a.m.-4:30 p.m., Monday-Friday (except Federal Holidays).

Read More

US EPA, 03-07-25

https://www.federalregister.gov/documents/2025/07/03/2025-12407/national-emission-standards-for-hazardous-air-pollutants-integrated-iron-and-steel-manufacturing

EPA Withdraws Proposed SNURs for 18 Chemicals Made from Plastic Waste-Based Feedstocks

2025-07-11

On July 9, 2025, the U.S. Environmental Protection Agency (EPA) withdrew proposed significant new use rules (SNUR) under the Toxic Substances Control Act (TSCA) for 18 chemical substances that were the subject of premanufacture notices (PMN) and a subsequent TSCA Order. 90 Fed. Reg. 30216. EPA states that it is withdrawing the proposed SNURs because it withdrew the 2022 TSCA Order that was the basis of the rules on December 18, 2024. As reported in our April 17, 2023, blog item, in April 2023, Cherokee Concerned Citizens, a community group in Pascagoula, Mississippi, filed suit in the U.S. Court of Appeals for the District of Columbia Circuit for review of the 2022 TSCA Order. Cherokee Concerned Citizens v. EPA (No. 23-1096). Earthjustice's April 7, 2023, press release states that EPA approved the new chemicals to make fuels "despite finding that the resulting air pollution would pose a cancer risk 250,000 times greater than what the agency typically considers unreasonable."

Read More

B&C, 11-07-25

https://www.lawbc.com/epa-withdraws-proposed-snurs-for-18-chemicals-made-from-plastic-waste-based-feedstocks/

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EPA Finalizes TSCA Risk Evaluation for 1,1-Dichloroethane

2025-06-20

Today, the U.S. Environmental Protection Agency (EPA) released its final risk evaluation for 1,1-dichloroethane conducted under the Toxic Substances Control Act (TSCA). EPA determined that 1,1-dichloroethane presents an unreasonable risk of injury to human health driven by three conditions of use (COUs). EPA did not identify exposures to the general population, or to the environment, associated with COUs of 1,1-dichlorethane as significantly contributing to the unreasonable risk. EPA transmitted the notice of availability of this final risk evaluation to the Federal Register on June 17, 2025, pursuant to the terms of the Consent Decree the agency entered into in Community In-Power and Development Association, Inc. et al v. EPA, no. 1:23-cv-02715-DLF, a case in the United States District Court for the District of Columbia.

1,1-Dichlorethane is primarily used as an industrial and commercial solvent and to make many different substances, including other chlorinated solvents (e.g., 1,1,1-trichloroethane) that have broad industrial applications. It is also used in relatively small amounts for laboratory research.

1,1-Dichloroethane Final Risk Evaluation

EPA determined that 1,1-dichloroethane presents an unreasonable risk of injury to human health driven by identified risk to workers from three COUs. The other five COUs that EPA examined do not significantly contribute to the unreasonable risk determination for 1,1-dichloroethane.

Read More

US EPA, 20-06-25

https://www.epa.gov/chemicals-under-tsca/epa-finalizes-tsca-risk-evaluation-11-dichloroethane

EUROPE

Banning Pesticides with PFAS Active Ingredients

2025-07-07

The Danish Environmental Protection Agency has decided to recall 23 pesticides containing PFAS active ingredients.

The decision was made following an assessment of new information from the Geological Survey of Denmark and Greenland (GEUS), which shows that the substances break down into the health-hazardous trifluoroacetic acid (TFA). TFA leaches into groundwater in concentrations above the EU's limit value, posing a risk to both the environment and public health.

"We must protect our precious drinking water, and we have a duty to intervene when we see that the use of certain pesticides poses a risk to nature and human health. Therefore, the Danish Environmental Protection Agency is now prohibiting 23 pesticides with proven problematic PFAS active substances," said Minister of the Environment, Magnus Heunicke, in connection with the decision.

The ban applies to pesticides containing five of the seven PFAS active substances examined in the current report by GEUS. A sixth substance, flonicamid, is also under consideration based on information from an ongoing reassessment in the EU. These pesticides are estimated to have accounted for about 28% of the total pesticide burden in Denmark in 2023.

Read More

Copenhagen Star, 07-07-25

https://www.cphstar.dk/2025/07/07/banning-pesticides-with-pfas-active-ingredients/

First results from the second national campaign on air quality in homes (CNL2)

2025-07-10

The Indoor Environment Quality Observatory (OQEI), run by the Scientific and Technical Centre for Building (CSTB) and the French Agency for Food, Environmental and Occupational Health & Safety (ANSES), is presenting

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the first results from the Second National Housing Campaign (CNL2), which has documented changes in air quality in French homes since the previous campaign (2003-2005). More than 170 pollutants were measured. This first report from the CNL2 covers results relating to volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), nitrogen dioxide (NO2), fine particulate matter (PM2.5) and radon. The results of this study, which was carried out by the CSTB, have been validated by the OQEI's Scientific Board.

Read More

ANSES, 10-07-25

https://www.anses.fr/en/content/first-results-second-national-campaign-air-quality-homes-cnl2

European Commission Unveils Intermediate Climate Target Proposal alongside a Communication on the CID, Charting a New Path Towards 2040 and beyond.

2025-07-03

On 2 July, the European Commission tabled its long-awaited proposal to amend the EU Climate Law, putting forward a new, legally binding intermediate climate target of a 90% reduction in net greenhouse gas (GHG) emissions by 2040, compared to 1990 levels.

The newly proposed 2040 target marks a significant milestone in the EU's climate trajectory, ensuring continuity and momentum toward the Union's 2050 goal. The Commission's move signals predictability and stability to European businesses and investors, reaffirming the EU's long-term commitment to becoming the world's first climate-neutral continent.

The Commission has proposed amendments to the European Climate Law aimed at establishing the right enabling environment to achieve the 2040 climate target, in line with a pragmatic and flexible approach. In particular, when designing future legislation to meet the proposed 2040 target, the Commission will consider, among other factors:

- A limited role for high-quality international credits starting from 2036, capped at 3% of 1990 net emissions, in accordance with Article 6 of the Paris Agreement.
- The use of domestic permanent removals in the EU Emissions Trading System (EU ETS) to address residual emissions from hard-to-abate sectors.

- Greater cross-sectoral flexibility to help achieve the target in a cost-effective way.

The Commission's proposal for the 2040 climate target will now move forward to the European Parliament and the Council for negotiation and adoption under the ordinary legislative procedure.

The interim target is also aligned with and supported by a policy ecosystem that the Commission is designing to balance its sustainability objectives with the need to preserve the competitiveness of the European Industries.

Read More

Global CCS Institute, 03-07-25

https://www.globalccsinstitute.com/news-media/latest-news/ec2040targetproposal/

The European PET Bottle Platform (EPBP) introduces the PET Circularity Test — a pioneering tool that simulates multiple recycling loops

2025-07-15

The European PET Bottle Platform (EPBP), a leading industry initiative dedicated to advancing the circular economy within the PET bottle value chain, is pleased to announce the launch of its Circularity Test Protocol. This new protocol marks a pivotal milestone in supporting the PET value chain efforts toward sustainable development and resource efficiency.

Meeting ambitious environmental goals

The launch of the Circularity Test Protocol provides industry stakeholders with a powerful tool to meet ambitious environmental targets. EPBP's Design for Recyclability Test Protocol already aligns with the EU's Packaging and Packaging Waste Regulation (PPWR) and the Circularity Test Protocol can be seen as the next evolution towards true circularity.

"With this new protocol, EPBP reinforces its commitment to fostering sustainable packaging innovations that embody true circularity," said Antoon Spiessens, co-chair of EPBP representing UNESDA.

"This protocol offers industry stakeholders a reliable framework to assess and improve the circularity of PET bottles during their R&D phase," said John McClelland, co-chair of EPBP representing PETCORE EUROPE.

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Read More

PETnology, 15-07-25

https://www.petnology.com/online/news-detail/the-european-pet-bottle-platform-epbp-introduces-the-pet-circularity-test-a-pioneering-tool-that-simulates-multiple-recycling-loops

Green-listing certain waste for the purposes of shipments to recovery between Member States

2025-07-02

About this initiative

Summary

This initiative implements the new Waste Shipments Regulation and complements the objectives of the future Circular Economy Act.

It will consider certain waste as green-listed and may also introduce contamination thresholds so that other types of waste can be green-listed.

The initiative will be preceded by a consultation process to gather input from a wide range of stakeholders on waste streams to be addressed.

Topic

Environment

Type of act

Delegated regulation

Expert group

E03343

Public consultation

Feedback: Open

Consultation period

02 July 2025 - 31 October 2025 (midnight Brussels time)

The Commission would like to hear your views.

This public consultation is open. Your input will be taken into account as we further develop and fine-tune this initiative. We will summarise the

input we receive in a synopsis report, explaining how we have taken it into account. Feedback received will be published on this site and therefore must adhere to the feedback rules.

Go to consultation

Read More

European Commission, 02-07-25

https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14712-Green-listing-certain-waste-for-the-purposes-of-shipments-to-recovery-between-Member-States_en

Norway will implement EU rules to reduce deforestation

2025-07-07

Preserving rainforests and other tropical forests is crucial to reduce climate change and halt loss of biodiversity. The Norwegian Government will implement parts of the EU Deforestation Regulation. This regulation introduces new requirements for products with a high risk of contributing to deforestation, such as wood, coffee, cocoa, rubber, and oil palm.

The Government has decided that Norway will incorporate the EU Deforestation Regulation into the EEA Agreement. For other products with a high risk for deforestation, such as beef and soya, the Government will explore national regulations.

'Deforestation is a major global issue and converting forests into agricultural land accounts for nearly 90 percent of global deforestation. Consumers should be confident that the products they buy do not contribute to deforestation of important areas for the world's nature and climate. This is why the Government will impose requirements on high-risk products such as wood, coffee, and cocoa', said Minister of Climate and Environment Andreas Bjelland Eriksen.

Read More

Government.no, 07-07-25

https://www.regjeringen.no/en/aktuelt/norge-vil-gjennomfore-eu-regler-for-redusert-avskoging/id3111376/

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GB maximum residue level (MRL) amendments adopted May to June 2025

2025-07-16

The GB MRL Statutory Register has recently been amended and new statutory levels have been set.

To meet the requirements of international trade, and to accommodate a new authorisation of a plant protection product in GB, new MRLs have been set in the GB MRL Statutory Registerfor the following active/commodity combinations. The dates the new MRLs came into force are also detailed:

- Acetamiprid/strawberries

28 May 2025

- Potassium phosphonates/mangoes

28 May 2025

- Oxathiapiprolin/ grapes, garlic, onions, shallots, tomatoes, sweet peppers/bell peppers, aubergines/eggplants, okra/lady's fingers, cucumbers, gherkins, courgettes, melons, pumpkins, watermelons, broccoli, cauliflower, head cabbage, lettuces and salads plants, spinaches and similar leaves, peas (with and without pods), leeks, ginseng

20 June 2025

The evaluation reports, reasoned opinions and decision documents supporting the new MRLsare available on the HSE website.

Read More

HSE, 16-07-25

https://www.hse.gov.uk/pesticides/mrls/gb-pubs-spreadsheet.htm

EU Omnibus Act: Financial gains, consumer safety and CMRs spark debate

2025-07-16

The European Commission (EC) has unveiled a simplification package of chemical regulations in the Omnibus Act, arguing it would save the industry hundreds of millions in annual costs. However, the move sparked concerns from green lawmakers who accuse the EC of siding with the industry and sacrificing consumer safety.

The changes apply to Classification, Labeling, and Packaging (CLP) and chemical regulations. They aim to simplify chemical labels for cosmetic products, which the Commission argues does not compromise on safety.

Meanwhile, an EU document, which leaked before the announcement, outlines plans for carcinogenic, mutagenic, or reprotoxic (CMR) substances. According to the document, CMR substances may be re-evaluated for use in cosmetics due to the current high burden of legislation on the industry.

Read More

Personal Care Insights, 16-07-25

https://www.personalcareinsights.com/news/eu-omnibus-chemicals-consumer-risk.html

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ECHA and EU-OSHA strengthen cooperation on chemical safety

2025-06-19

The European Chemicals Agency (ECHA) and the European Agency for Safety and Health at Work (EU-OSHA) have signed an updated cooperation agreement to enhance the health and safety of workers.

Helsinki, 19 June 2025 – The two agencies will work together to protect workers through cooperation on regulatory science, provision of policy support and collaborating on stakeholder engagement. They will exchange information and consult each other on topics related to EU chemicals laws and protection of workers' health and safety. The collaboration will cover hazard and risk assessment of chemical substances used at the workplace, definition of exposure limits, safety data and best practice for risk mitigation, as well as joint publications and communication.

Dr Sharon McGuinness, ECHA's Executive Director, says:

"Increased cooperation between our agencies will help to further improve the health and safety of workers in Europe, for example, by increasing knowledge about cancer-causing substances and reducing workers' exposure to chemicals of very high concern. We look forward to our continued collaboration with EU-OSHA."

EU-OSHA Executive Director William Cockburn supports this view:

"Our renewed collaboration with ECHA reflects a shared determination to turn knowledge into action for safer and healthier workplaces. Through our joint commitment, we are raising awareness on emerging workplace risks and driving prevention efforts across Europe. This partnership also builds on EU-OSHA's research into workers' exposure to cancer risk factors, ensuring that our research-based knowledge leads to practical improvements in occupational safety and health."

The Memorandum of Understanding was signed today at EU-OSHA's Management Board meeting.

Read More

ECHA, 19-06-25

https://www.echa.europa.eu/-/echa-and-eu-osha-strengthen-cooperation-on-chemical-safety-1

Janet's Corner

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Who Am I?

2025-07-25

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

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

I am element number 14.

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Hazard Alert

JUL. 25, 2025

1,1-dichloroethylene

2025-07-25

USES [2,3]

1,1-Dichloroethylene is used to make certain plastics, such as flexible films like food wrap, and in packaging materials. It is also used to make flame retardant coatings for fibre and carpet backings, and in piping, coating for steel pipes, and in adhesive applications.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Workers may be exposed in industries that make or use 1,1-dichloroethylene.
- Food that is wrapped in plastic wrap may contain very low levels of 1,1-dichloroethylene. The government controls these levels to prevent harm to your health.
- A small percentage (3%) of the drinking water supplies may contain very low levels of 1,1-dichloroethylene.
- Air near factories that make or use 1,1-dichloroethylene and air near hazardous waste sites may contain low levels of it.

Routes of Exposure

The main routes of exposure to 1,1-dichloroethylene are:

- Inhalation,
- Skin absorption,
- Ingestion, and
- Skin and/or eye contact

HEALTH EFFECTS [4]

Acute Health Effects

- Studies in humans indicate that relatively high concentrations of inhaled 1,1-dichloroethylene can induce adverse neurological effects including central nervous system(CNS) depression and symptoms of inebriation, convulsions, spasms, and unconsciousness, and respiratory effects, such as inflammation of mucous membranes.

1,1-dichloroethylene, also called 1,1-Dichloroethene, vinylidene chloride or 1,1-DCE, is an organochloride with the molecular formula C2H2Cl2.

- Acute animal tests in rats have shown 1,1-dichloroethylene to have high toxicity from oral exposure and moderate toxicity from inhalation exposure.

Carcinogenicity

- No relationship between the occurrence of cancer in humans and occupational exposure to 1,1-dichloroethylene has been demonstrated. However, only three studies are available and these studies are limited by small population sizes and short observation periods.
- One study showed an increase in kidney and mammary tumours in mice exposed to 1,1-dichloroethylene via inhalation, while a drinking water study showed an increase in adrenal tumours in male rats.
- A study by the National Toxicology Program (NTP) did not show an increase in tumours in rats and mice exposed to 1,1-dichloroethylene via gavage (experimentally placing the chemical in the animal's stomachs).
- EPA has calculated an oral cancer slope factor of 0.6 (mg/kg/d)-1.

Other Effects

- No studies were located regarding developmental or reproductive effects in humans.
- Birth defects were noted in the offspring of pregnant rats and mice that had been exposed to 1,1-dichloroethylene in air. In this study, maternal toxicity was observed at developmentally toxic concentrations.

SAFETY

First Aid Measures [5]

- **Eye Contact:** check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention if irritation occurs.
- **Skin Contact:** In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

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- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
- **Serious Inhalation:** Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek medical attention.
- **Ingestion:** If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Personal Protective Equipment [4]

The following personal protective equipment is recommended when handling 1,1-dichloroethylene:

- Safety glasses;
- Lab coat;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves.

Personal Protection in Case of a Large Spill:

- Splash goggles;
- Full suit;
- Vapour respirator;
- Boots;
- Gloves;
- A self-contained breathing apparatus should be used to avoid inhalation of the product.
- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION

United States

OSHA: The Occupational Safety and Health Administration has set an occupational exposure limit of 1 ppm for 1,1-dichloroethylene in workplace air for an 8-hour workday, 40-hour workweek.

NIOSH: The National Institute for Occupational Safety and Health currently recommends that workers breathe as little 1,1-dichloroethylene as possible.

EPA: The Environmental Protection Agency has set a limit in drinking water of 0.007 parts of 1,1-dichloroethylene per million parts of drinking water (0.007 ppm). EPA requires that discharges or spills into the environment of 5,000 pounds or more of 1,1-dichloroethylene be reported.

REFERENCES

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3. http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=721&tid=130
4. http://www.cdc.gov/niosh/npg/npgd0661.html
5. http://www.epa.gov/ttnatw01/hlthef/di-ethyl.html
6. http://www.sciencelab.com/msds.php?msdsId=9925419
7. http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/772/Workplace-exposure-standards-airborne-contaminants.pdf

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Common amino acid found to speed up skin wound healing

2025-07-19

When the skin is injured, a stem cell's survival instincts kick in. New research reveals that a simple amino acid, serine, helps push stem cells to abandon hair growth in favor of wound healing, opening the door to new therapies for chronic wounds.

Hair follicle stem cells (HFSCs) are continuously self-renewing cells responsible for two important bodily functions: maintaining hair's growth cycles through the regeneration of hair follicles, and tissue regeneration in the skin to aid wound healing.

New research led by Rockefeller University, New York, has explored how a non-essential amino acid, serine, influences the behavior of HFSCs and discovered that when serine levels are low, the cells prioritize wound healing over hair growth.

"Serine deprivation triggers a highly sensitive cellular 'dial' that fine tunes the cell's fate – towards skin and away from hair," said lead author Jesse Novak, a current MD-PhD student at Weill Cornell Medicine's Tri-Institutional Program and former PhD student at Rockefeller's Laboratory of Mammalian Cell Biology and Development. "Our findings suggest that we might be able to speed up the healing of skin wounds by manipulating serine levels through diet or medications."

As a non-essential amino acid, humans can produce serine themselves, but it is also found in food like meat, poultry, fish, soybeans, nuts, and dairy products. Serine functions as a building block for proteins, is involved in cell proliferation, and various metabolic pathways.

The researchers found that in mice fed a diet low in serine and glycine, another amino acid, HFSCs delayed hair growth and accelerated wound repair, specifically the process of re-epithelialization or restoring the skin barrier. Although serine is classed as a non-essential amino acid, HFSCs struggled if they couldn't both make and absorb it from external (i.e., dietary) sources.

The researchers identified the integrated stress response (ISR) as the internal cellular program that triggers this shift in HFSC function in response to stress, such as injury or serine deprivation. ISR was activated in HFSCs under serine deprivation, which pushed the cells to become more like epidermal stem cells, which help to rebuild skin, rather than pursuing their typical hair-growing role.

"Most skin wounds that we get are from abrasions, which destroy the upper part of the skin," Novak said. "That area is home to a pool of stem cells that normally takes charge in wound repair. But when these cells are destroyed, it forces hair follicle stem cells to take the lead in repair. Knowing that, we thought that tracking these skin cells through wound healing presented a very good model for testing if and how metabolites are regulating this process overall."

The ISR can be thought of like a volume dial. If stress levels are high, such as with an injury or when serine levels are low, the ISR shifts HFSCs away from making hair toward repairing skin. The researchers found that boosting ISR activity in mice using a pharmaceutical agent that mimicked the effects of serine deprivation improved wound healing at the expense of hair regeneration. Conversely, inhibiting activity by blocking ISR sensor proteins reversed these skin-related effects, confirming the central role the ISR has in this process. Similar ISR signatures were found in human skin models at the edge of healing wounds, suggesting the mechanism is evolutionarily conserved, meaning it has remained unchanged across different species over long periods.

"No one likes to lose hair, but when it comes down to survival in stressful times, repairing the epidermis takes precedence," said Elaine Fuchs, PhD, head of Rockefeller University's Mammalian Cell and Biology and Development lab and the study's corresponding author. "A missing patch of hair isn't a threat to an animal, but an unhealed wound is."

The researchers tested whether administering a large dose of serine supercharged hair regeneration. Unfortunately for hair loss sufferers, it didn't. When mice were fed six times the normal amount of serine, their serine levels increased by only 50%. It turns out that the body keeps a tight check on the amino acid.

"However, we did see that if we prevented a stem cell from making its own serine and replenishing its losses through a high-serine diet, we were able to partially rescue hair regeneration," said Novak.

The researchers' discovery has some obvious real-world implications, especially in relation to wound healing. Targeting the ISR, through diet or drugs, it may be possible to speed up healing in burn injuries or chronic wounds in people with diabetes. Additionally, understanding the ISR's role may offer ways of preserving hair regeneration, particularly in stress-related or injury-induced hair loss. However, because cancer cells can also exploit stress response pathways like the ISR, careful control of any future therapies will be critical.

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The researchers will continue exploring the potential of serine to speed up wound healing, and plan to test other amino acids to see if they have similar properties.

"Overall, the ability of stem cells to make cell fate decisions based on the levels of stress they experience is likely to have broad implications for how tissue organize their regenerative capacities in times when resources are scarce," said Fuchs.

The study was published in the journal Cell Metabolism.

New Atlas, 19 July 2025

https://newatlas.com

Long-Term Exposure to Air Pollution Tied to Brain Tumors

2025-07-10

Traffic-related air pollution may increase the risk of developing meningioma, a common noncancerous brain tumor.

People exposed to higher levels of air pollution may be more likely to develop meningioma, a typically noncancerous brain tumor, according to a large study published July 9, 2025, in Neurology®Clinical Practice, an official journal of the American Academy of Neurology. This common type of brain tumor forms in the lining of the brain and spinal cord. The findings do not prove that air pollution causes meningioma; they only show a link between the two.

The study analyzed several air pollutants, including those commonly linked to traffic—such as nitrogen dioxide and ultrafine particles—which are especially concentrated in urban environments.

"Various types of air pollution have been shown to have negative effects on health, and ultrafine particles are small enough to cross the blood-brain barrier and may directly affect brain tissue,' said study author Ulla Hvidtfeldt, PhD, of the Danish Cancer Institute in Copenhagen. "Our study suggests that long-term exposure to air pollution from traffic and other sources may play a role in the development of meningioma and adds to the growing body of evidence that air pollution can affect the brain—not just the heart and lungs."

The study included nearly 4 million adults in Denmark with an average age of 35 who were followed over a 21-year period. During that time, 16,596

people developed a tumor of the central nervous system, including 4,645 who developed meningioma.

Researchers used address histories and advanced modeling to estimate long-term exposure to air pollution.

They calculated 10-year average exposure to the following: ultrafine particles with particles less than 0.1 micrometers in diameter; fine particulate matter, also called PM2.5, with particles that are 2.5 micrometers in diameter or less; nitrogen dioxide, a gas mostly from traffic emissions; and elemental carbon, a marker of diesel pollution.

Researchers then compared people with the lowest exposure to those with the highest by dividing people into three groups for each pollutant.

For example, for ultrafine particles, people in the lowest group had an average 10-year exposure of 11,041 particles per centimeter cubed (cm3) compared to people with the highest exposure of 21,715 particles/cm3. In these groups, 0.06% of people in the group with the lowest exposure developed meningiomas compared to 0.20% of people with the highest exposure.

After adjusting for factors like age, sex, education level and neighborhood socioeconomic status, researchers found that people with higher exposure to air pollutants had a greater risk of developing meningioma:

- 10% higher risk for ultrafine particles for every increase of 5,747 particles/cm3
- 21% higher risk for fine particulate matter for every increase of 4.0 micrograms per meter cubed (µg/m3)
- 12% higher risk for nitrogen dioxide for every 8.3 µg/m3
- 3% higher risk for elemental carbon for every 0.4 µg/m3
- The study did not find strong links between these pollutants and more aggressive brain tumors, such as gliomas.

"While research on the health effects of ultrafine particles is still in its early stages, these findings point to a possible link between traffic-related ultrafine particle exposure and the development of meningioma," Hvidtfeldt said. "More research is needed to confirm these results, but if cleaning up our air can help lower the risk of brain tumors, that could make a real difference for public health."

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A limitation of the study is that pollution exposure was based on outdoor air quality near people's homes, so it doesn't capture all sources of personal exposure—like workplace air or time spent indoors.

Technology Networks, 10 July 2025

https://technologynetworks.com

Researchers Crack One of Aromatic Chemistry's Toughest Challenges

2025-07-23

The method has applications in organic chemistry, particularly within the pharmaceutical industry.

A team of scientists has developed an electrochemical technique that enables precise, para-position single-carbon insertion into polysubstituted pyrroles. This advancement holds significant promise for synthetic organic chemistry, particularly in the development of pharmaceutical compounds.

Their work was recently published in the Journal of the American Chemical Society.

"We set out to address the longstanding challenge of achieving single-carbon insertion into aromatic rings with precise positional control," said Mahito Atobe, Professor, Faculty of Engineering, Yokohama National University.

Chemical transformations that alter aromatic rings are fundamental to creating pharmaceuticals and advanced materials. However, introducing a single carbon atom at a specific site, especially at the para position, has been extremely difficult to achieve. The para position refers to the specific arrangement of atoms in a molecule, where substituents (atoms that replace a hydrogen atom) are located opposite each other on an aromatic ring.

In this method, a single carbon atom is added directly into the molecular framework. This can extend a carbon chain or increase the size of a ring structure by one carbon atom, offering a powerful new tool for molecular design.

Introducing a Novel Electrochemical Strategy

"Our goal was to develop a new, electrochemically driven method that enables this transformation selectively and efficiently, while gaining

mechanistic insights into how the electronic structure of the substrate controls the insertion position," said Atobe. This study presents a novel concept for single-carbon insertion chemistry and expands a researcher's chemical toolbox for synthesizing polysubstituted (hetero)aromatic compounds. Polysubstituted pyrroles are organic compounds that have a pyrrole ring and multiple substituents are joined to it. These compounds play a crucial role in diverse fields, such as natural products, pharmaceuticals, and functional materials. They hold particular interest for pharmaceuticals, where they are fundamental to many approved drugs.

"We discovered an electrochemical method that enables highly selective para-position single-carbon insertion into polysubstituted pyrroles—an unprecedented transformation," said Naoki Shida, Associate Professor, Faculty of Engineering, Yokohama National University. This reaction is enabled with distonic radical cation intermediates and is governed by the electronic properties of nitrogen-protecting groups. "Our findings establish a new strategy for site-selective molecular editing of aromatic rings, expanding the toolkit for synthetic organic chemistry," said Shida.

Mechanism and Proof of Concept

The team demonstrated the electrochemical ring expansion reaction using α-H diazo esters as a carbynyl anion equivalent. This approach allowed efficient single-carbon insertion into a range of polysubstituted pyrroles, affording structurally diverse pyridine derivatives. They controlled the insertion position through electronic perturbation by the N-protecting group (PG), and achieved unprecedented para-selective insertion by introducing an electron-withdrawing protecting group to the pyrrole derivatives.

The team used in-situ spectroscopy and theoretical calculations to support the reaction mechanism involving a distonic radical cation intermediate. The spectroscopy and calculations suggest distonic radical cation intermediates are involved, facilitating carbon-atom migration on the aromatic ring and enabling insertion at different positions.

Approved drugs like Netupitant, Esomeprazole, Pyridoxine, and Opicapone contain benzene and pyridine rings with more than three substituents. These drugs are important medications for wide-ranging health challenges, such as Parkinson's disease, stomach ulcers, or the control of chemotherapy-induced nausea. To synthesize these compounds, researchers have used multiple methods, such as coupling reactions, carbon-hydrogen functionalization, and cyclization reactions.

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Single-carbon insertion is yet another approach scientists have used to modify polysubstituted (hetero)aromatic compounds. The single-carbon insertion approach significantly alters the structure of the parent skeletons. But up to this point in time, controlling the insertion position had been a significant challenge for researchers. The team's novel electrochemical method introduces a new concept for single-carbon insertion chemistry.

Looking to the Future

Looking ahead, the team's next step is to expand the scope of this reaction to a broader range of heteroaromatic compounds and complex molecules, including pharmaceutical intermediates.

"We also aim to integrate this methodology into flow electrolysis systems to improve scalability and efficiency. Ultimately, our goal is to establish a general platform for precise molecular editing of aromatic frameworks using electricity as a clean and controllable driving force," said Atobe.

Sci Tech Daily, 23 July 2025

https://scitechdaily.com

Electron beam irradiation decomposes Teflon-like fluoroplastics efficiently

2025-07-24

Plastics like Teflon are famously durable—and infamously difficult to recycle. But a breakthrough from researchers at the National Institutes for Quantum Science and Technology (QST) may offer a powerful new solution.

The team, led by Senior Principal Researcher Dr. Akira Idesaki, has developed a technique using electron beam (EB) irradiation to break down polytetrafluoroethylene (PTFE) into gaseous products, effectively transforming a solid, heat-resistant fluoropolymer into useful chemical components. Their results are published in the journal Radiation Physics and Chemistry.

"By applying heat during irradiation, we were able to reduce the energy required to decompose PTFE by 50% compared to traditional methods," said Dr. Idesaki. "This makes large-scale recycling of fluoropolymers much more viable."

PTFE—best known by the trade name Teflon—is widely used in electronics, medical devices, and nonstick cookware. Its resistance to heat and chemicals comes from its strong carbon-fluorine bonds, which also make it a member of the environmentally persistent family of substances known as PFAS, which are informally called "forever chemicals."

Traditional methods for decomposing PTFE, such as pyrolysis, require extremely high temperatures (600-1,000 °C) and massive energy input. The QST team demonstrated that heating PTFE to 370 °C and irradiating it with an EB in the air allowed them to convert 100% of the plastic into gas.

Gases from solids: The chemistry of breakdown

The key to the method is combining heat with radiation. When PTFE powder was irradiated with a dose of 5 MGy at 30 °C, only 10% decomposed. But at 270 °C, that number rose to 86%. At 370 °C, full decomposition was achieved.

The main gases released during the process were oxidized fluorocarbons—chemical compounds that contain both fluorine and oxygen, and perfluoroalkanes—compounds containing fluorine and carbon. The research team identified them using gas chromatography and mass spectrometry. These gases could be collected and reused as raw materials in chemical industries, helping to support a more sustainable, circular use of resources.

Structural transformation and crystallinity

The researchers also found that heating PTFE during EB irradiation caused changes in its internal structure. The small crystal units inside the material became larger, which suggests that the material underwent a reorganization. Infrared and X-ray analysis showed that most of the oxidized chemicals were removed, meaning the PTFE was efficiently broken down into gas.

"High-temperature irradiation not only enhances decomposition but also changes the internal structure of PTFE," noted the first-author Dr. Hao Yu, a researcher at QST. "This helps explain why the process becomes more energy-efficient as the temperature rises."

Toward industrial application

Based on their data, the researchers estimate that this new approach could cut the energy cost of PTFE recycling from approximately 2.8–4 MWh per ton—typical for pyrolysis (high temperature)—by 50% using EB

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irradiation. This level of efficiency could make it commercially attractive for industries that generate PTFE waste.

"We hope this technology will contribute to the safer, cleaner, and more cost-effective recycling of high-performance plastics," said co-author Dr. Yasunari Maekawa, who led the research project.

Phys Org, 24 July 2025

https://phys.org

Microplastics Can Cause Lung Cell Malignancy

2025-07-16

Although the respiratory system is one of the main entry points for microplastics and nanoplastics (MNPs) from the air into the body, little is known about the effects of these tiny particles on the lungs. Researchers at MedUni Vienna have now demonstrated for the first time that MNPs can trigger malignant changes in lung cells that are associated with the development of cancer. The findings were published in the Journal of Hazardous Materials and once again underline the urgent need for action to reduce plastic waste.

As part of the study, the research team led by Karin Schelch, Balazs Döme and Büsra Ernhofer (all from the Department of Thoracic Surgery and the Comprehensive Cancer Centre at MedUni Vienna) investigated how polystyrene micro- and nanoplastics (PS-MNPs) interact with different types of lung cells. Polystyrene is a plastic widely used in everyday objects, including food packaging and disposable items such as yoghurt pots and coffee-to-go cups. The surprising result of the research: healthy (non-malignant) lung cells absorb particularly small particles (0.00025 millimetres) of PS-MNPs significantly more than malignant cancer cells – and react with biological changes that once again highlight the health risks posed by MNPs.

Specifically, after contact with the particles, the healthy cells showed increased cell migration, DNA damage, oxidative stress and the activation of signalling pathways that promote cell growth and survival – all processes that are considered early indicators of cancer development. "Particularly striking was the reduced ability of healthy cells to repair DNA damage and the simultaneous activation of certain signalling pathways that normally promote cell growth," said study leader Karin Schelch, providing details.

Long-term effects still unclear

While lung cancer cells remained relatively unaffected under the same conditions, even short-term exposure to MNPs could be enough to influence healthy lung cells in a direction associated with malignant changes. According to the latest research findings, the cells' defence mechanisms were also triggered under the influence of polystyrene particles. "We observed the activation of antioxidant defence systems – an indication that the cells are actively defending themselves against the stress caused by plastic particles," explains first author Büsra Ernhofer.

The lungs are considered one of the main routes of exposure to airborne microplastics. However, little was known about how these particles interact with lung tissue cells. "The data now available provide initial indications that healthy lung cells in particular react in a way that gives cause for concern," says co-study leader Balazs Döme. This opens up new questions about the possible link between plastic pollution, chronic lung disease and cancer development – and underscores both the need for interdisciplinary research at the interface between environmental medicine and cancer biology and the need for action to reduce plastic waste. In addition, the long-term effects of MNP exposure on the lungs remain unclear and, according to the research team, need to be investigated urgently.

Technology Networks, 16 July 2025

https://technologynetworks.com

One amino acid triggers weight loss that doesn't rely on eating less

2025-07-12

Cutting a single amino acid from the diet caused rapid, drastic weight loss in mice by converting white fat into calorie-burning brown fat. The study reveals a powerful new mechanism for weight loss that doesn't rely on eating less and moving more.

When we think of "body fat," we're most likely thinking of white fat, which stores energy from the food we eat and builds up when we take in more calories than we burn. White fat has been linked to health problems like heart disease and diabetes. Brown fat, on the other hand, is much more beneficial. It burns energy instead of storing it, producing heat to keep our bodies warm in a process called thermogenesis.

Scientists are especially interested in brown fat because increasing its activity, or converting white fat into brown-like fat, could help people burn

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more calories and improve overall health. A new study has found that reducing the amino acid cysteine triggers the transition of white fat cells to brown fat cells and can lead to significant weight loss.

"In addition to the dramatic weight loss and increase in fat burning resulting from the removal of cysteine, … [t]hese results suggest future weight management strategies that might not rely exclusively on reducing caloric intake," said study co-author Krisztian Stadler, PhD, a professor at the Pennington Biomedical Research Center (PBRC), affiliated with Louisiana State University.

Cysteine is a "proteinogenic" amino acid, meaning it's involved in making proteins, in addition to diverse metabolic functions. The body can produce cysteine, making it a non-essential amino acid (essential amino acids have to be obtained through diet). In the present study, the researchers explored how cysteine affected metabolism, fat tissue behavior, and body weight by examining how cysteine influences metabolic changes seen in both humans and mice.

They looked at evidence obtained from the CALERIE-II trial, a two-year randomized controlled trial investigating the effects of long-term calorie restriction in healthy, non-obese adults. As part of the trial, participants reduced their calorie intake by an average of 14% over two years. The researchers found that the reduced caloric intake led to a drop in cysteine levels and changes in metabolic pathways related to cysteine and the essential amino acid methionine.

Mice that had been genetically engineered to lack the enzyme CTH that helps produce cysteine from methionine were fed a cysteine-free diet. The mice experienced rapid and drastic weight loss, losing around 25% to 30% of their body weight within one week, primarily due to fat loss. Reintroducing cysteine to the animals' diet reversed the weight loss, showing the effect was specifically due to cysteine deprivation. The researchers noted that cysteine deficiency caused white fat tissue to convert into brown-like fat, a process known as "browning." This transition increased energy expenditure and fat burning without requiring changes in food intake or activity levels.

The researchers then examined the impact of cysteine deficiency on diet-induced obesity. When obese mice that had been fed a high-fat diet for 12 weeks were switched to a low-cysteine diet, they lost approximately 30% of their body weight in a week despite maintaining a high calorie intake. The animals also had improved blood sugar control, increased energy

expenditure, and reduced inflammation in fat tissue. Analysis of the mice's fat tissue revealed browning.

"Reverse translation of human caloric restriction trial identified a new player in energy metabolism," said co-author Eric Ravussin, PhD, who holds the Douglas L Gordon Chair in Diabetes and Metabolism at PBRC and oversees its Human Translational Physiology Laboratory. "Systemic cysteine depletion in mice causes weight loss with increased fat utilization and browning of adipocytes [fat cells]."

Interestingly, the fat tissue browning response observed by the researchers didn't rely on UCP1, a common thermogenic protein, suggesting a new, independent mechanism. Instead, the effect required noradrenaline signaling through part of the sympathetic nervous system, which is primarily responsible for the body's fight-or-flight response. Noradrenaline, a hormone and neurotransmitter that's also known as norepinephrine, plays a key role in this response.

The study has some limitations. The mouse models used were genetically modified, which is understandable, but which may not reflect human metabolism. The severity of weight loss in mice was extreme and potentially lethal, making it non-translatable as-is to humans. The exact UCP1-independent thermogenesis pathway remains unknown. It's not yet known how safe or effective cysteine manipulation would be in humans. The study doesn't address the long-term effects or sustainability of cysteine depletion.

Nevertheless, its findings suggest that cysteine plays a key role in regulating energy metabolism and fat storage. It highlights a potential new drug target for obesity treatment, particularly by mimicking the effects of cysteine depletion without actually depleting cysteine, which could be dangerous. The bottom line is that the study provides further support for the notion that the amino acid composition, not just calories, can influence healthspan and weight regulation.

The study was published in the journal Nature Metabolism.

New Atlas, 12 July 2025

https://newatlas.com

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Blocking Vitamin D Gene Kills Cancer Cells Without Harming Others

2025-07-18

Vitamin D is not only an essential nutrient, but also the precursor of the hormone calcitriol, indispensable for health: it regulates the uptake of phosphate and calcium necessary for bones by the intestines, as well as cell growth and the proper function of muscles, nerve cells, and the immune system.

Now, researchers have shown for the first time in Frontiers in Endocrinology that a particular gene, called SDR42E1, is crucial for taking up vitamin D from the gut and further metabolizing it – a discovery with many possible applications in precision medicine, including cancer therapy.

"Here we show that blocking or inhibiting SDR42E1 may selectively stop the growth of cancer cells," said Dr Georges Nemer, a professor and associate dean for research at the University of College of Health and Life Sciences at Hamad Bin Khalifa University in Qatar, and the study's corresponding author.

Faulty copy

Nemer and colleagues were inspired by earlier research that had found a specific mutation in the SDR42E1 gene on chromosome 16 to be associated with vitamin D deficiency. The mutation caused the protein to be cut short, rendering it inactive.

The researchers used CRISPR/Cas9 gene editing to transform the active form of SDR42E1 in a line of cells from a patient with colorectal cancer, called HCT116, into its inactive form. In HCT116 cells, the expression of SDR42E1 is usually abundant, suggesting that the protein is essential for their survival.

Once the faulty SDR42E1 copy had been introduced, the viability of the cancer cells plummeted by 53%. No fewer than 4,663 'downstream' genes changed their expression levels, suggesting that SDR42E1 is a crucial molecular switch in many reactions necessary for the health of cells. Many of these genes are normally involved in cancer-related cell signaling and the absorption and metabolism of cholesterol-like molecules – consistent with the central role of SDR42E1 in calcitriol synthesis.

These results suggest that inhibiting the gene can selectively kill cancer cells, while leaving neighboring cells unharmed.

Cuts two ways

"Our results open new potential avenues in precision oncology, though clinical translation still requires considerable validation and long-term development," said Dr Nagham Nafiz Hendi, a professor at Middle East University in Amman, Jordan, and the study's first author.

But starving selected cells of vitamin D is not the only possible application that immediately sprang to the mind of the researchers. The present results suggest that SDR42E1 cuts two ways: artificially 'dialing up' levels of SDR42E1 in local tissues through gene technology might likewise be beneficial, leveraging the many known health effects of calcitriol.

"Because SDR42E1 is involved in vitamin D metabolism, we could also target it in any of the many diseases where vitamin D plays a regulatory role," said Nemer.

"For example, nutrition studies have indicated that the hormone can lower the risk of cancer, kidney disease, and autoimmune and metabolic disorders."

"But such broader applications must be done with caution, as long-term effects of SDR42E1 on vitamin D balance remain to be fully understood," warned Hendi.

Technology Networks, 18 July 2025

https://technologynetworks.com

Curved molecules store sunlight as chemical energy and release heat on demand

2025-07-24

Curved molecules that absorb sunlight, store the energy, and re-release it as heat are pushing the boundaries in solar thermal storage technology.

In a recent study published in the journal Chem, researchers revealed curved anthracene derivatives—organic molecules found in coal tar—that undergo structural changes upon absorbing sunlight and, when triggered to return to their original shape, release the stored solar energy as heat.

The anthracene systems, derived from a by-product of the fossil fuel industry, exhibited high energy storage densities, making them promising solvent-free alternatives to traditional thermal energy storage systems.

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Molecular solar thermal (or MOST) energy storage works on the principle of storing energy in chemical bonds. It relies on specially designed photosensitive molecules that undergo reversible structural change known as Dewar isomerization. When exposed to light, the molecules shift from a stable form to a high-energy form, and in the process, they trap solar energy in strained chemical structures.

MOST material can keep the energy locked in for long periods of time and the energy can be released if and when required by simply triggering the system with either heat, light of a specific wavelength or a catalyst.

Sunlight is a cocktail of light with different wavelengths, and existing MOST systems miss harnessing a major portion of it as they tend to only absorb ultraviolet (UV) light, leaving visible light untapped. They also require dilute organic solvents to operate, which leads to low gravimetric energy densities (energy stored per unit mass).

These new curved anthracene systems, designed by the researchers, not only absorb visible light but are also solvent-free, and experienced more than 28 cycles with minimal fatigue.

The researchers chose anthracene—an organic molecule made up of three benzene rings fused in a linear arrangement—as the starting molecule. They designed four distinct derivatives by introducing different bulky groups at the 9-position of the anthracene to ensure that the molecule attains a bent structure, as regular anthracene tends to form a dimer upon absorbing energy rather than forming an isomer. The formation of isomers is crucial to the process of energy storage and subsequent release.

The designed systems exhibited efficient Dewar isomerization upon visible-light absorption, achieving high energy storage densities of up to 170 kJ/mol and 0.65 MJ/kg, values comparable to those of popular materials on the market. The anthracene systems, which were in the liquid phase, required no solvent for operation, which maximized the usable energy.

One of the systems underwent 28 cycles of photo-induced Dewar isomerization and thermally triggered reversion with minimal decline in absorbance values and no significant degradation. All four systems were able to recharge themselves under simulated sunlight within 6–8 hours, ready to release thermal energy when required.

The researchers note that this study demonstrated the potential of fully carbon-based systems to store substantial amounts of solar energy,

marking a significant step toward practical and scalable solar thermal energy storage.

Phys Org, 24 July 2025

https://phys.org

Morphine analogues kill pain with fewer negative side effects

2025-07-18

A single atom swap in the core structure of morphine has created an analogue with the opioid's signature painkilling activity but without the problematic side effects. The O-to-CH2 exchange removed a key hydrogen-bonding interaction in the binding pocket, activating the receptor to dull pain while suppressing the secondary pathways responsible for addiction and respiratory depression. This pharmacological profile of what has been dubbed carbamorphine suggests similar core modifications could help to design safer opioids, say the team behind the work.

The analgesic activity of morphine has been exploited by humans for thousands of years and opioids are still some of the most prescribed medicines today. 'Morphine is an agonist of the μ-opioid receptor, which means that it activates the receptor, recruits proteins, and ultimately reduces the transmission of pain signals [and] leads to the production of dopamine in the brain,' explains Richmond Sarpong, a synthetic chemist at the University of California Berkeley. However, concomitant activation of other pathways – such as the recruitment of beta-arrestin 2 proteins, which mediate tolerance and dependence – also induces worrying side effects including reduced respiratory activity and addictive behaviours.

Peripheral modifications to morphine's structure can modulate this activity – doubly acetylated heroin is significantly more addictive, while n-allylated nalorphine acts as an antagonist to reverse the effects of overdose. However, the influence of changes to the core pentacyclic framework remain unknown.

Modelling studies have previously identified a hydrogen-bonding interaction between the furan E-ring oxygen and a tyrosine residue in the receptor and, for Sarpong, this posed a tantalising question. 'I wondered what would happen if one removed [that] bond,' he says. 'We decided [to swap] the E-ring oxygen for another atom that will not hydrogen bond. We settled on carbon and so we decided to install a methylene group.'

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Rebuilding morphine

A single atom skeletal edit directly to the morphine framework is currently beyond the scope of chemistry. However, armed with the synthetic logic developed during previous successful syntheses (notably the cephanolide family in 2022), the team devised an efficient 15-step route to the carba-analogue, employing an intramolecular cycloaddition to form the pentacyclic core. The racemic product was readily separated into its component enantiomers using chiral chromatography and the sequence also provided easy access to carbacodeine and carbanalorphine for future biological studies. 'Overall, our synthesis compares favourably (from a step count perspective) with existing syntheses of morphine,' Sarpong says. 'Importantly, our synthesis is scalable to allow us to access hundreds of milligrams in one pass.'

The team then began to explore the analogues' pharmacological activity. Intriguingly, unlike morphine for which only the (-)-enantiomer is active, both (+)- and (-)-carbamorphine demonstrated good binding affinity with the μ-opioid receptor in cell assays and comparable, though slightly reduced, potency at therapeutic doses. Most notably, when trialled in mice, (+)-carbamorphine did not reduce breathing rate or create addictive behaviour patterns, addressing two of the most concerning side effects of morphine use.

These promising preliminary results suggest core atom modifications could become an important tool in the design of safer and more specific opioid medications but carbamorphine itself is still a long way from clinical trials. 'To even start to consider this possibility, we will need to develop a shorter synthesis to make larger quantities of these materials. In addition, we will need even more rigorous in vitro and in vivo assays, not only on carbamorphine and carbanalorphine, but also on their metabolites, which would need to be fully characterised,' explains Sarpong.

Twisted tale

Focusing instead on the underlying mechanism behind carbamorphine's contrasting biological profile, they conducted docking and simulation studies to model the binding behaviour. These computations revealed that (+)-carbamorphine occupies the same binding pocket as (-)-morphine but is significantly twisted relative to the natural compound. This rotation reduces the number of interactions with the receptor and induces a steric clash with key residues on the opposite side of pocket, which the team propose may explain (+)-carbamorphine's moderate potency and suppression of side effects.

'There's a lot of exciting data in this paper and, because they have such detailed docking and proposed binding models, I think they're in a really good spot to think about further optimising these compounds to increase potency and selectivity,' says Joshua Pierce, a synthetic chemist at North Carolina State University. 'I think it would be interesting to couple this modification with some of the known derivatives of morphine to see whether it could be further enhanced and differentiated from these compounds.'

For both Sarpong and Pierce it is this conceptual approach, rather than the analogue compounds themselves, which marks the most significant advance at this stage. 'We have demonstrated that making single core atom changes to the morphine framework leads to a novel (and unanticipated) biological profile and so as a community, we should be looking to make more of these types of changes to molecules and not just focusing on the periphery of compounds,' says Sarpong.

While we are continuing to explore the effects of these modifications on morphine, developing synthetic methods to streamline this process is equally important, he adds. 'We would like to be able to make single-atom changes directly on the core of compounds like morphine. Access to this type of technology would allow us to swap out the E-ring oxygen for not only carbon, but nitrogen, sulfur, silicon, etc.'

Chemistry World, 18 July 2025

https://chemistryworld.com

Clues for dinosaurs' diets found in the chemistry of their fossil teeth

2025-07-24

You are what you eat, it turns out—even if your last meal was 150 million years ago.

While the grub itself may be long gone, a record of dinosaurs' favorite foods has been stowed away in their ancient tooth enamel over the last eon. When researchers at The University of Texas at Austin took a close look, they discovered that some dinosaurs were discerning eaters, with different species preferring different plant parts.

Tooth enamel contains calcium isotopes that reflect the range of foods the dinosaurs ate; different types of plants have different chemical signatures, and discrete parts of trees—from buds to bark—can also have unique

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signatures. According to the study's lead author Liam Norris, the results help explain how so many behemoth creatures all lived together in the same area at the same time.

"The ecosystem that I studied has been a mystery for a long time because it has these giant herbivores all coexisting," said Norris, a recent doctoral graduate at UT's Jackson School of Geosciences. "The idea is that they were all eating different things, and now we have found proof of that."

The findings are published in Palaeogeography, Palaeoclimatology, Palaeoecology.

Norris inspected teeth from four dinosaur species and one crocodyliform, both herbivores and carnivores, that roamed the Western U.S. during the Late Jurassic. The plant-eaters are the long-necked Camarasaurus; the short-armed Camptosaurus; and the trunk-legged Diplodocus. The meat-eaters are the bipedal Allosaurus and the comparatively small, crocodile-like Eutretauranosuchus. The bones and teeth of these ancient creatures were all found in the Carnegie Quarry deposit in northeast Utah, which is thought to have formed during an extreme drought in as little as six months to a few thousand years.

"We were very lucky to be able to study fossils of dinosaurs that lived together and were all rapidly preserved in a single deposit," said Rowan Martindale, an associate professor at the Jackson School's Department of Earth and Planetary Sciences. "The Jurassic tomb preserved a unique paleontological gem and these skeletons are beautifully displayed at Dinosaur National Monument."

Norris, who now works at the Texas Science & Natural History Museum, studied teeth from 17 individual animals across these five species. The specimens were loaned by the Utah Field House of Natural History State Park Museum or accessed in the field at Dinosaur National Monument. He shaved off a dusting of their enamel, which he took back to the Jackson School for calcium isotope analysis. Jackson School Professor John Lassiter and Radiogenic Isotope Laboratory Manager Aaron Satkoski, both co-authors on the paper, helped to analyze and interpret these data.

Previously, scientists believed that large herbivorous dinosaurs coexisted by munching on different levels of the tree canopy according to height. However, Norris's research shows that plant height wasn't the only factor driving the differentiation of their diets—instead, it was specific plant parts.

For example, Norris found that the Camptosaurus was a rather discerning eater, preferring softer, more nutritious plant parts such as leaves and buds. The Camarasaurus ate mostly conifers, with a preference for woody plant tissues. The Diplodocus ate more of a mixed diet that included soft ferns and horsetail plants lower to the ground, as well as tougher plant parts.

"This differentiation in diet makes sense with what we see from the morphology of these animals: the different heights, the different snout shapes. Then, we bring in this geochemical data, which is a very concrete piece of evidence to add to that pot," Norris said.

This research also provides interesting food for thought for a theory about long-necked dinosaurs having flexible necks that could be used to reach many areas of vegetation without having to expend the energy to move the rest of their bodies. This research, which shows that the dinosaurs ate from different levels of the tree canopy, furthers that line of thinking.

The carnivores in the study—the Allosaurus and Eutretauranosuchus—had an overlap in calcium isotope values, which could mean that they ate some of the same things. However, the results also showed that the Eutretauranosuchus is more likely to have eaten fish, while the Allosaurus primarily ate herbivorous dinosaurs—possibly including the three other dinosaur species mentioned in this study.

For this ancient ecosystem to have supported so many enormous dinosaurs with such specific dietary proclivities helps to paint a picture of the vegetation and plant productivity of the time.

"It's really just more proof that this ecosystem was as spectacular as we thought it was," Norris said.

Henry Fricke of Colorado College also co-authored the study.

Technology Networks, 24 July 2025

https://technologynetworks.com

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A Safer, Eco-Friendly Polymer for Implantable Medical Devices

2025-07-02

Every year, millions of patients receive medical devices inserted or implanted in the cardiovascular system: arterial and venous catheters, cardiac devices, pacemaker leads, artificial hearts, vascular prostheses, etc. These devices, often made from polyurethane (PU), perform vital functions, but are not without defects. PU production relies on toxic chemicals called isocyanates, and PU is also partly responsible for serious complications in patients, such as blood clots and infections.

Faced with these limitations, a team from the GIGA (Cardiology Laboratory) and the CESAM (Centre de recherche sur les macromolécules - CERM) at the University of Liège has come up with a promising alternative: PHOx, a thermoplastic elastomer without isocyanate PU (NIPU), which is therefore less toxic to produce and much better tolerated by the human body.

"PHOx (Poly Hydroxy-Oxazolidone) is a flexible, transformable plastic that can be moulded, pressed, spun into fibres or 3D printed," explain Anna Pierrard, chemist, and Christine Jérôme, Director of CERM. It can thus be used to produce a variety of personalised medical devices. Better still, its manufacture is based on 'greener' raw materials, derived in particular from carbon dioxide, reducing the environmental impact of the process.

"Extensive laboratory tests have shown that PHOx outperforms PU in several key respects," enthuse Sofia Melo, bioengineer, and Cécile Oury, FNRS Research Director and Head of the Cardiology Laboratory at the GIGA. PHOx is more compatible with blood. In particular, it reduces the adhesion of platelets (essential cells in the formation of blood clots) and the activation of coagulation, limiting the risks of clot formation. It is also thought to inhibit the adhesion of bacteria such as staphylococcus aureus, which is often implicated in implant infections. No toxicity was observed, either for human cells or during implantation, and the material did not cause excessive inflammation, degradation or rejection.

3D printable implants

Another major advantage of PHOx is that it can be easily 3D printed. "This means that we could eventually produce custom-made devices for each patient, reducing waste and at lower cost," explains Patrizio Lancellotti, Head of Cardiology at Liège University Hospital." Tailor-made implants,

heart valves adapted to the anatomy of each individual: the applications are numerous.

Thanks to its mechanical (flexibility, strength) and biological (biocompatibility, compatibility with blood, stability) properties, PHOx could well replace PUs in many medical applications. This is a major step towards medical devices that are safer for patients, more environmentally friendly, and potentially more economical thanks to customised manufacturing and reduced healthcare costs associated with fewer complications.

The researchers stress that this is the first time that a NIPU (non-isocyanate polyurethane) material has demonstrated such performance in critical medical applications.

This major advance has been published in the scientific journal Advanced Healthcare Materials, and an international patent application (WO2025082761) has already been filed.

Technology Networks, 2 July 2025

https://technologynetworks.com

Belly fat-melting jab is now one step away from FDA approval

2025-07-19

What if you could inject a drug into a "problem area" – like abdominal fat – that could kill off fat cells and reduce fat stores in that localized spot? That's what a novel drug from Taiwan's Caliway Pharmaceuticals offers, the world's very first injection that triggers programmed fat-cell death in a targeted area, like the belly or the thighs.

Known as CBL-514, this small-molecule drug induces adipocyte apoptosis, which kills fat cells rather than starves them, meaning different regions of subcutaneous fat stores can be rapidly reduced in just a few weeks after a single dose. It's currently being tested for three uses: Non-surgical fat reduction, Dercum's disease – which causes painful fatty tumors to build up around the body, and cellulite.

"Administered via subcutaneous injection, CBL-514 has demonstrated a favorable safety and tolerability profile, enabling significant localized fat reduction without surgery and delivering results comparable to liposuction," Caliway has stated.

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While it's being investigated for various applications, the leading one – and the one expected to be on the market first – is for the non-surgical reduction of problematic abdominal fat.

CBL-514 has completed two successful Phase 2b studies (CBL-0204 and CBL-0205) and is about to undertake two pivotal global Phase 3 clinical trials in the second half of 2025.

In the most recent CBL-0205 Phase 2b trial, 75% saw their abdominal fat reduce by at least one grade on the Abdominal Fat Rating Scale (AFRS) four weeks after the initial single shot. This meant it passed its efficacy endpoint to satisfy the US Food and Drug Administration (FDA), which it had already demonstrated (along with safety and tolerability) in the previous 2b trial.

Right now, the only drug approved for localized fat redution is ATX-101 – or deoxycholic acid injection – which has been effective in reducing adipose stores in small areas but comes with serious side effects including skin necrosis, ulceration, nerve injury and infections. CBL-514 hasn't caused any of these issues even with multiple doses across much larger areas of the body.

In the last trial, more than 75% of participants reached their target fat volume loss after one or two injections, and the mean fat loss was more than double this. It closely mirrored the results from the initial Phase 2b trial, with results released in December 2024 detailing how 76.7% of its 107 participants who received the treatment improved by at least one grade on the five-grade AFRS. Three quarters of those participants only needed a single shot for this.

"CBL-514, a first-in-class small-molecule drug, is a lipolysis injectable that can induce adipocyte apoptosis and lipolysis to reduce subcutaneous adiposity in treatment areas without causing any systematic side effects on the central nervous system, cardiovascular system, and respiratory system," the company noted. "Caliway's preclinical studies have shown that CBL-514 upregulates the apoptosis mediators caspase 3 and Bax/Bcl-2 ratio and then induces adipocyte apoptosis in vivo and in vitro."

While it has obvious aesthetic application – non-surgical body-sculpting – the first-in-class drug stands to have broader benefits. Abdominal fat, particularly in midlife and later in life, has been implicated in a number of serious conditions including chronic pain, stroke and cardiovascular disease. While CBL-514 doesn't specifically target the deeper visceral fat in the region, it can reduce subcutaneous fat by more than 25%, which

reduces chronic disease risk and positively impacts hard-to-treat visceral fat.

A safe, localized, non-surgical fat-loss treatment has so far eluded scientists.

Back in 2023, the FDA approved CBL-514 as an Investigational New Drug (IND). A year later, it received European Medicines Agency (EMA) approval, being granted Orphan Drug Designation status for the treatment of Dercum's disease.

In May, the company got the seal of approval to move on to its final clinical trial stage; the first Phase 3 trial will take place in the US and Canada, and a second in the US, Canada and Australia – both are in the recruitment stage now. The first Phase 3 cohort will feature around 300 participants across close to 30 clinical sites in North America.

"We are pleased to have reached alignment with the FDA on both study design and indication," said Vivian Ling, Chief Executive Officer of Caliway. "The Agency agrees that the 'reduction of abdominal subcutaneous fat' as the proposed indication reinforces our confidence in CBL-514's differentiated value, and its potential to redefine standards in aesthetic medicine."

If it delivers in these larger trials, it could be on the market within 12 months.

The results of the most recent Phase 2b clinical trial was published in the Aesthetic Surgery Journal.

New Atlas, 19 July 2025

https://newatlas.com

Common sweetener found to significantly and immediately boost heart attack and stroke risk

2025-07-18

Sugar-free treats have taken over the shelves. You've probably seen erythritol listed on sodas, protein bars, and even toothpaste. It's everywhere. Almost zero calories, no sugar spikes, and perfect for keto diets. Sounds like a win, but maybe not.

A new study from the University of Colorado Boulder has cracked open a side of erythritol that few expected. It's not about weight gain or tooth

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decay. It's about what this sweetener does to your brain's blood vessels that may elevate the risk of a stroke.

"Our study adds to the evidence suggesting that non-nutritive sweeteners that have generally been purported to be safe, may not come without negative health consequences," said Professor Christopher DeSouza, who led the study.

Understanding artificial sweeteners

Artificial sweeteners like erythritol have become go-to sugar substitutes for people looking to cut calories or manage blood sugar.

Erythritol, in particular, is a sugar alcohol found naturally in some fruits but is typically produced in bulk from corn or wheat starch.

It tastes sweet like sugar but has almost zero calories and doesn't spike blood glucose, making it popular among those with diabetes or on keto diets.

Unlike some other sugar alcohols, erythritol usually causes fewer digestive issues because your body absorbs most of it before it reaches the colon.

That said, it's not without controversy. Some recent studies, including this one, have raised concerns about potential links between high erythritol levels and cardiovascular issues like heart attack and stroke.

Sweetener changes brain cells

The researchers did not yet test this in people. They went straight to the cells that line your brain's blood vessels. These cells regulate blood flow, keep inflammation in check, and help prevent clots.

The cells were exposed to erythritol for just three hours. The amount used was equal to what you would get from one sugar-free drink. That was all it took to cause noticeable changes.

The cells got stressed. They flooded with free radicals, also called reactive oxygen species or ROS. These unstable molecules damage proteins, DNA, and cell membranes. In response, antioxidant defenses went up, but not enough.

It was like the cells knew they were under attack and tried, unsuccessfully, to defend themselves.

Blood vessels started misbehaving

That same short exposure changed how the cells produced nitric oxide, a molecule that helps blood vessels relax. Less nitric oxide means tighter vessels. That's bad news when your brain needs steady blood flow.

The total amount of the enzyme that makes nitric oxide didn't change much, but its function tanked. It stopped doing its job well.

Erythritol messed with the enzyme's activation at two specific sites. One turned down, one cranked up. The result was about 20 percent less nitric oxide production. This sets the stage for constricted vessels.

Sweetener makes brain vessels tighten

The same cells started pumping out more endothelin-1, a protein that tells blood vessels to tighten up. Compared to normal cells, the erythritol-exposed ones had a 30 percent increase in ET-1. They also had more of its precursor, Big ET-1.

That's a double whammy. First, blood vessels lose their ability to widen. Then, they get signals to squeeze even more.

"Big picture, if your vessels are more constricted and your ability to break down blood clots is lowered, your risk of stroke goes up," said first author Auburn Berry. "Our research demonstrates not only that, but how erythritol has the potential to increase stroke risk."

Clots don't stand a chance

Blood clots are tricky. You want your body to stop bleeding when you get a cut. But you also want it to break down unnecessary clots inside vessels. One of the body's tools for that is tissue-type plasminogen activator, or t-PA.

In this study, the researchers added thrombin, which mimics a clotting signal. Normally, that should have made the cells release more t-PA. In untreated cells, that's exactly what happened. A nice 25 percent boost.

In erythritol-treated cells? Nothing. The response was completely muted. Clots form and cells don't react. That's the formula for a stroke.

One study tracked over 4,000 people in the U.S. and Europe. The research team found that those with high blood levels of erythritol had more strokes and heart attacks within three years. This happened across both sexes and regardless of other health issues.

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The Colorado team didn't just observe changes. They showed exactly how the sweetener weakens brain vessel cells in ways that match the stroke patterns found in people.

Sweeteners may harm blood vessels

DeSouza and his team exposed real human brain vessel cells to a typical drink-size dose of erythritol. Many people consume several such servings a day. And unlike some substances, erythritol crosses into the brain.

The study wasn't designed to track long-term effects, but it does raise a concern. What happens when those cells face erythritol not just for three hours, but every day?

"Given the epidemiological study that inspired our work, and now our cellular findings, we believe it would be prudent for people to monitor their consumption of non-nutrient-sweeteners such as this one," said DeSouza.

The study is published in the Journal of Applied Physiology.

Earth, 18 July 2025

https://earth.com

Novel material efficiently removes 'forever chemicals'

2025-07-23

University of Utah researchers have developed a material that addresses an urgent environmental challenge: the real-time detection and efficient removal of perfluorooctanoic acid (PFOA), a toxic and persistent member of the PFAS "forever chemicals" family, from contaminated water.

In an industry-funded study published in the Journal of Materials Chemistry C, Ling Zang, professor in the College of Engineering's Department of Materials Science and Engineering, and his research team introduced a dual-functional metal-organic framework (MOF) known as UiO-66-N$(CH_3)_3$, a zirconium-based material known for its thermal and chemical stability.

This new MOF demonstrates exceptional capabilities in both PFOA adsorption and fluorescence-based detection; the MOF literally lights up when it binds to the pollutant, making it easier to quantify the scale of the problem and the rate and efficiency of remediation. The MOF also exhibits excellent reusability, as tested through repeated adsorption–desorption

cycles. After each adsorption, the material could be readily regenerated by simple washing.

"This MOF represents a major leap forward for PFAS remediation," said Rana Dalapati, the study's lead author and postdoctoral researcher in the Zang Research Group. "Its ability to both selectively capture and sensitively detect PFOA in real time makes it a versatile and practical solution for water treatment and environmental monitoring."

This work builds on past research from the Zang lab that created a porous material that fluoresces in the presence of PFAS.

A prominent subset of this group of fluorine-based compounds, PFOA is a synthetic chemical with water and stain-resistant properties and has commonly been used in non-stick cookware, firefighting foam and other products. The material, which does not break down in the environment, has leached into groundwater, raising public health concerns.

Detecting and mitigating PFOA and other PFAS contamination has become a priority for many environmental quality agencies, and Zang's breakthroughs could help.

UiO-66-N$(CH_3)_3$ features fluorescent tags that turn on once PFOA is captured inside the MOF's molecular cage.

Zang's team constructed their MOF by modifying another widely studied metal-organic framework, known as UiO-66-NH_2, a material recognized for its high porosity and potential in water treatment applications. However, when applied to removal of PFOA, the adsorption capacity of UiO-66-NH_2 is limited due to weak binding interactions.

To address this limitation, the researchers incorporated quaternary ammonium groups that enhance electrostatic interactions with PFOA, resulting in a 3.4-fold increase in adsorption capacity compared to the parent UiO-66-NH_2 framework. These cationic groups also work synergistically with the MOF's metal-binding sites, achieving high selectivity and efficiency in contaminant capture.

The success of this approach underscores the power of post-synthetic modification in MOF design, opening the door to the development of next-generation multifunctional materials with tailored performance for specific environmental contaminants.

Key technological breakthroughs

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- **Record-High Adsorption Capacity:** UiO-66-N$(CH_3)_3$ achieves a maximum PFOA adsorption capacity of 1178 mg/g, as determined by Langmuir isotherm modeling, far surpassing conventional sorbents such as activated carbon and unmodified MOFs. This sets a new benchmark for PFOA uptake in the field.
- **Ultra-Fast Removal Performance:** Thanks to its highly porous, interconnected structure, the MOF removes nearly 100% of PFOA from 50 ppb aqueous solutions within 5 minutes. This sort of rapid treatment is crucial for real-world applications.
- **High Selectivity and Salt Tolerance:** The MOF exhibits strong selectivity for PFOA even in the presence of other PFAS compounds, salts, and natural organic matter, ensuring reliable performance in complex environmental conditions.
- **Robust Reusability:** The material maintains over 93% adsorption capacity after five regeneration cycles, making it both cost-effective and environmentally sustainable.
- **Integrated Fluorescent Sensing for Real-Time Monitoring:** Beyond removal, UiO-66-N$(CH_3)_3$ functions as a highly sensitive "turn-on" fluorescent sensor for PFOA using an indicator displacement assay (IDA). This enables real-time, on-site quantification of PFOA concentrations, offering a user-friendly and rapid alternative to traditional lab-based techniques.

Phys Org, 23 July 2025

https://phys.org

New Compound Defies Fundamental Principle of Organometallic Chemistry

2025-07-08

For over a century, the well-known 18-electron rule has guided the field of organometallic chemistry. Now, researchers at Okinawa Institute of Science and Technology (OIST) have successfully synthesized a novel organometallic compound that challenges this longstanding principle. They have created a stable 20-electron derivative of ferrocene, an iron-based metal-organic complex, which could lead to exciting possibilities in chemical science.

"For many transition metal complexes, they are most stable when surrounded by 18 formal valence electrons. This is a chemical rule of thumb on which many key discoveries in catalysis and materials science are based," said Dr. Satoshi Takebayashi, lead author of the paper published

in Nature Communications, in collaboration with scientists from Germany, Russia, and Japan. Ferrocene is a classic example that embodies this rule. "We have now shown for the first time that it is possible to synthesize a stable 20-electron ferrocene derivative," he added.

This breakthrough improves our understanding of the structure and stability of metallocenes, a class of compounds known for their characteristic "sandwich" structure, in which a metal atom sits between two organic rings.

Rebuilding our conceptual understanding

First synthesized in 1951, ferrocene revolutionized chemistry with its unexpected stability and unique structure, eventually earning its discoverers the 1973 Nobel Prize in Chemistry. In many ways, ferrocene opened a new chapter in our understanding of metal–organic bonding and launched the modern field of organometallic chemistry, which continues to inspire generations of scientists to explore metal–organic compounds.

This new study builds on that foundation. By designing a novel ligand system, the team was able to stabilize a ferrocene derivative with 20 valence electrons, coordination chemistry that was previously considered improbable. "Moreover, the additional two valence electrons induced an unconventional redox property that holds potential for future applications," Dr. Takebayashi noted.

This is important because even though ferrocene is already used in reactions involving electron transfer, known as redox reactions, it has traditionally been limited to a narrow range of oxidation states. By enabling access to new oxidation states through the formation of an Fe–N bond in this derivative, it expands the ways in which ferrocene can gain or lose electrons. As a result, it could become even more useful as a catalyst or functional material across a variety of fields, from energy storage to chemical manufacturing.

Understanding how to break and rebuild the rules of chemical stability enables researchers to design molecules with tailor-made properties. These insights could inspire new research aimed at advancing sustainable chemistry, including the development of green catalysts and next-generation materials.

A platform for future innovation

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Ferrocene derivatives have already made their way into various technologies, from solar cells and pharmaceuticals to medical devices and advanced catalysts. By expanding the conceptual toolkit available to chemists, this latest breakthrough could help build on and diversify these applications while inspiring entirely new ones.

The Organometallic Chemistry Group at OIST focuses on uncovering the fundamental principles that govern metal-organic interactions and applying them to real-world challenges. The team has a special interest in unconventional compounds that defy standard chemical rules, such as the 20-electron ferrocene derivative reported in this study.

Technology Networks, 8 July 2025

https://technologynetworks.com

Molecule activated by cobalt targets DNA three-way junctions linked to cancer

2025-07-23

During DNA replication, the classic double helix can temporarily rearrange into an alternative structure known as a DNA three-way junction (3WJ). These configurations form a well-defined central cavity capable of hosting molecules with specific shapes and properties. Because of their role in cellular processes linked to cancer, 3WJs are gaining attention as promising molecular targets for next-generation therapeutic approaches.

Now, a research team at CiQUS has designed a new molecule that self-assembles into fibrous materials, remaining inactive until exposed to cobalt ions. Upon stimulation, the molecule undergoes a structural transformation into a well-defined 3D arrangement that fits precisely into the central cavity of the DNA junction. Led by CiQUS group leader and USC Professor Miguel Vázquez López, the study introduces a new paradigm in selective recognition of noncanonical DNA structures from dormant molecular precursors.

The research, featured this week on the cover of Journal of the American Chemical Society, was carried out at the CiQUS laboratories—an institution recognized as a CIGUS center of excellence by the Xunta de Galicia.

At the heart of this system is a small peptide-based molecule called BTMA-1, which spontaneously self-organizes under physiological conditions into supramolecular helical fibers. When exposed to metal ions such as

cobalt, these fibers disassemble and generate biologically active peptide helicates—molecular complexes capable of selectively binding to DNA three-way junctions. This controlled transformation represents a key advance toward the development of responsive functional materials that can be activated by external stimuli to carry out specific biological tasks.

One of the most innovative aspects of the study is the behavior of these helical fibers as inactive precursors: stable, temporary assemblies that release the active helicate units only upon chemical activation. This dynamic behavior, previously unobserved in such supramolecular polymers, opens new opportunities to design molecular systems capable of storing their biological function until needed—an idea with broad implications in complex cellular environments.

Although its biomedical applications remain at an early stage, this research lays the groundwork for a new molecular strategy that is both adaptable and environmentally responsive. In the future, such systems could offer spatiotemporal control over DNA recognition in targeted anticancer therapies.

The findings broaden the landscape at the interface between chemical biology and molecular materials, and reinforce the potential of supramolecular chemistry as a powerful tool for designing programmable molecular systems.

The study also involved researchers from the Center for Research in Nanomaterials and Biomedicine (CINBIO) at the University of Vigo.

Phys Org, 23 July 2025

https://phys.org

This AI-powered lab runs itself—and discovers new materials 10x faster

2025-07-14

Self-driving laboratories are robotic platforms that combine machine learning and automation with chemical and materials sciences to discover materials more quickly. The automated process allows machine-learning algorithms to make use of data from each experiment when predicting which experiment to conduct next to achieve whatever goal was programmed into the system.

"Imagine if scientists could discover breakthrough materials for clean energy, new electronics, or sustainable chemicals in days instead of years,

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using just a fraction of the materials and generating far less waste than the status quo," says Milad Abolhasani, corresponding author of a paper on the work and ALCOA Professor of Chemical and Biomolecular Engineering at North Carolina State University. "This work brings that future one step closer."

Until now, self-driving labs utilizing continuous flow reactors have relied on steady-state flow experiments. In these experiments, different precursors are mixed together and chemical reactions take place, while continuously flowing in a microchannel. The resulting product is then characterized by a suite of sensors once the reaction is complete.

"This established approach to self-driving labs has had a dramatic impact on materials discovery," Abolhasani says. "It allows us to identify promising material candidates for specific applications in a few months or weeks, rather than years, while reducing both costs and the environmental impact of the work. However, there was still room for improvement."

Steady-state flow experiments require the self-driving lab to wait for the chemical reaction to take place before characterizing the resulting material. That means the system sits idle while the reactions take place, which can take up to an hour per experiment.

"We've now created a self-driving lab that makes use of dynamic flow experiments, where chemical mixtures are continuously varied through the system and are monitored in real time," Abolhasani says. "In other words, rather than running separate samples through the system and testing them one at a time after reaching steady-state, we've created a system that essentially never stops running. The sample is moving continuously through the system and, because the system never stops characterizing the sample, we can capture data on what is taking place in the sample every half second.

"For example, instead of having one data point about what the experiment produces after 10 seconds of reaction time, we have 20 data points - one after 0.5 seconds of reaction time, one after 1 second of reaction time, and so on. It's like switching from a single snapshot to a full movie of the reaction as it happens. Instead of waiting around for each experiment to finish, our system is always running, always learning."

Collecting this much additional data has a big impact on the performance of the self-driving lab.

"The most important part of any self-driving lab is the machine-learning algorithm the system uses to predict which experiment it should conduct next," Abolhasani says. "This streaming-data approach allows the self-driving lab's machine-learning brain to make smarter, faster decisions, honing in on optimal materials and processes in a fraction of the time. That's because the more high-quality experimental data the algorithm receives, the more accurate its predictions become, and the faster it can solve a problem. This has the added benefit of reducing the amount of chemicals needed to arrive at a solution."

In this work, the researchers found the self-driving lab that incorporated a dynamic flow system generated at least 10 times more data than self-driving labs that used steady-state flow experiments over the same period of time, and was able to identify the best material candidates on the very first try after training.

"This breakthrough isn't just about speed," Abolhasani says. "By reducing the number of experiments needed, the system dramatically cuts down on chemical use and waste, advancing more sustainable research practices.

"The future of materials discovery is not just about how fast we can go, it's also about how responsibly we get there," Abolhasani says. "Our approach means fewer chemicals, less waste, and faster solutions for society's toughest challenges."

The paper, "Flow-Driven Data Intensification to Accelerate Autonomous Materials Discovery," will be published July 14 in the journal Nature Chemical Engineering. Co-lead authors of the paper are Fernando Delgado-Licona, a Ph.D. student at NC State; Abdulrahman Alsaiari, a master's student at NC State; and Hannah Dickerson, a former undergraduate at NC State. The paper was co-authored by Philip Klem, an undergraduate at NC State; Arup Ghorai, a former postdoctoral researcher at NC State; Richard Canty and Jeffrey Bennett, current postdoctoral researchers at NC State; Pragyan Jha, Nikolai Mukhin, Junbin Li and Sina Sadeghi, Ph.D. students at NC State; Fazel Bateni, a former Ph.D. student at NC State; and Enrique A. López-Guajardo of Tecnologico de Monterrey.

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Science Daily, 14 July 2025

https://sciencedaily.com

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Researchers Crack One of Aromatic Chemistry's Toughest Challenges

2025-07-23

The method has applications in organic chemistry, particularly within the pharmaceutical industry.

A team of scientists has developed an electrochemical technique that enables precise, para-position single-carbon insertion into polysubstituted pyrroles. This advancement holds significant promise for synthetic organic chemistry, particularly in the development of pharmaceutical compounds.

Their work was recently published in the Journal of the American Chemical Society.

"We set out to address the longstanding challenge of achieving single-carbon insertion into aromatic rings with precise positional control," said Mahito Atobe, Professor, Faculty of Engineering, Yokohama National University.

Chemical transformations that alter aromatic rings are fundamental to creating pharmaceuticals and advanced materials. However, introducing a single carbon atom at a specific site, especially at the para position, has been extremely difficult to achieve. The para position refers to the specific arrangement of atoms in a molecule, where substituents (atoms that replace a hydrogen atom) are located opposite each other on an aromatic ring.

In this method, a single carbon atom is added directly into the molecular framework. This can extend a carbon chain or increase the size of a ring structure by one carbon atom, offering a powerful new tool for molecular design.

Introducing a Novel Electrochemical Strategy

"Our goal was to develop a new, electrochemically driven method that enables this transformation selectively and efficiently, while gaining mechanistic insights into how the electronic structure of the substrate controls the insertion position," said Atobe. This study presents a novel concept for single-carbon insertion chemistry and expands a researcher's chemical toolbox for synthesizing polysubstituted (hetero)aromatic compounds. Polysubstituted pyrroles are organic compounds that have a pyrrole ring and multiple substituents are joined to it. These compounds play a crucial role in diverse fields, such as natural products,

pharmaceuticals, and functional materials. They hold particular interest for pharmaceuticals, where they are fundamental to many approved drugs.

"We discovered an electrochemical method that enables highly selective para-position single-carbon insertion into polysubstituted pyrroles—an unprecedented transformation," said Naoki Shida, Associate Professor, Faculty of Engineering, Yokohama National University. This reaction is enabled with distonic radical cation intermediates and is governed by the electronic properties of nitrogen-protecting groups. "Our findings establish a new strategy for site-selective molecular editing of aromatic rings, expanding the toolkit for synthetic organic chemistry," said Shida.

Mechanism and Proof of Concept

The team demonstrated the electrochemical ring expansion reaction using α-H diazo esters as a carbynyl anion equivalent. This approach allowed efficient single-carbon insertion into a range of polysubstituted pyrroles, affording structurally diverse pyridine derivatives. They controlled the insertion position through electronic perturbation by the N-protecting group (PG), and achieved unprecedented para-selective insertion by introducing an electron-withdrawing protecting group to the pyrrole derivatives.

The team used in-situ spectroscopy and theoretical calculations to support the reaction mechanism involving a distonic radical cation intermediate. The spectroscopy and calculations suggest distonic radical cation intermediates are involved, facilitating carbon-atom migration on the aromatic ring and enabling insertion at different positions.

Approved drugs like Netupitant, Esomeprazole, Pyridoxine, and Opicapone contain benzene and pyridine rings with more than three substituents. These drugs are important medications for wide-ranging health challenges, such as Parkinson's disease, stomach ulcers, or the control of chemotherapy-induced nausea. To synthesize these compounds, researchers have used multiple methods, such as coupling reactions, carbon-hydrogen functionalization, and cyclization reactions.

Single-carbon insertion is yet another approach scientists have used to modify polysubstituted (hetero)aromatic compounds. The single-carbon insertion approach significantly alters the structure of the parent skeletons. But up to this point in time, controlling the insertion position had been a significant challenge for researchers. The team's novel electrochemical method introduces a new concept for single-carbon insertion chemistry.

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Looking to the Future

Looking ahead, the team's next step is to expand the scope of this reaction to a broader range of heteroaromatic compounds and complex molecules, including pharmaceutical intermediates.

"We also aim to integrate this methodology into flow electrolysis systems to improve scalability and efficiency. Ultimately, our goal is to establish a general platform for precise molecular editing of aromatic frameworks using electricity as a clean and controllable driving force," said Atobe.

Sci Tech Daily, 23 July 2025

https://scitechdaily.com

Green ammonia revolution: New electrolyte strategy boosts sustainable fertilizer production

2025-07-23

A joint international research team has, for the first time, revealed the crucial link between the structure of the solid electrolyte interphase (SEI) and the efficiency of lithium-mediated nitrogen reduction to ammonia, a promising eco-friendly approach to fertilizer production.

Using in situ spectroscopy, the team directly observed the previously poorly understood SEI formation process, revealing that the ethanol-to-water ratio in the electrolyte significantly impacts ammonia conversion efficiency. This discovery opens a new avenue for sustainable fertilizer production by reducing reliance on fossil fuels and lowering greenhouse gas emissions. The study is published in Energy & Environmental Science.

Ammonia, a key component of fertilizers, is currently produced globally in large-scale plants using the Haber-Bosch process. This process, however, requires substantial energy input and relies heavily on fossil fuels, contributing significantly to CO2 emissions and global warming.

Consequently, there is growing interest in developing smaller-scale, environmentally friendly ammonia production methods. The lithium-mediated nitrogen reduction reaction, the focus of this study, represents one such promising alternative.

This breakthrough developed by researchers from SANNKEN at the University of Osaka and Imperial College London provides a new paradigm for SEI design. By tailoring the electrolyte composition, it becomes possible to engineer SEIs with specific properties, optimizing ammonia

production and reducing reliance on fossil fuels. This could revolutionize fertilizer production, significantly decreasing its environmental footprint.

"Clean electrochemical ammonia synthesis is a key process for achieving carbon neutrality," explains Dr. Yu Katayama at the University of Osaka, the lead corresponding author of the study. "Our research demonstrates that even subtle changes in the electrolyte composition significantly affect the SEI structure and reaction efficiency. This is the first step toward designing ideal SEIs as reaction sites. We aim to achieve clean ammonia synthesis by tuning the electrolyte to form SEIs conducive to the reaction."

Phys Org, 23 July 2025

https://phys.org

Concrete that lasts centuries and captures carbon? AI just made it possible

2025-07-23

Now, researchers at the USC Viterbi School of Engineering have developed a revolutionary AI model that can simulate the behavior of billions of atoms simultaneously, opening new possibilities for materials design and discovery at unprecedented scales.

The current state of the world's climate is a dire one. Brutal droughts, evaporating glaciers, and more disastrous hurricanes, rainstorms and wildfires devastate us each year. A major contributor to global warming is the constant emission of carbon dioxide into the atmosphere.

Aiichiro Nakano, a USC Viterbi professor of computer science, physics and astronomy, and quantitative and computational biology, was contemplating these issues after the January wildfires in Los Angeles. So, he reached out to longtime partner Ken-Ichi Nomura, a USC Viterbi professor of chemical engineering and materials science practice, with whom he's collaborated for over 20 years.

Discussing these issues together helped spark their new project: Allegro-FM, an artificial intelligence-driven simulation model. Allegro-FM has made a startling theoretical discovery: it is possible to recapture carbon dioxide emitted in the process of making concrete and place it back into the concrete that it helped produce.

"You can just put the CO2 inside the concrete, and then that makes a carbon-neutral concrete," Nakano said.

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Nakano and Nomura, along with Priya Vashishta, a USC Viterbi professor of chemical engineering and materials science, and Rajiv Kalia, a USC professor of physics and astronomy, have been doing research on what they call "CO2 sequestration," or the process of recapturing carbon dioxide and storing it, a challenging process.

By simulating billions of atoms simultaneously, Allegro-FM can test different concrete chemistries virtually before expensive real-world experiments. This could accelerate the development of concrete that acts as a carbon sink rather than just a carbon source -- concrete production currently accounts for about 8% of global CO2 emissions.

The breakthrough lies in the model's scalability. While existing molecular simulation methods are limited to systems with thousands or millions of atoms, Allegro-FM demonstrated 97.5% efficiency when simulating over four billion atoms on the Aurora supercomputer at Argonne National Laboratory.

This represents computational capabilities roughly 1,000 times larger than conventional approaches.

The model also covers 89 chemical elements and can predict molecular behavior for applications ranging from cement chemistry to carbon storage.

"Concrete is also a very complex material. It consists of many elements and different phases and interfaces. So, traditionally, we didn't have a way to simulate phenomena involving concrete material. But now we can use this Allegro-FM to simulate mechanical properties [and] structural properties," Nomura said.

Concrete is a fire-resistant material, making it an ideal building choice in the wake of the January wildfires. But concrete production is also a huge emitter of carbon dioxide, a particularly concerning environmental problem in a city like Los Angeles. In their simulations, Allegro-FM has been shown to be carbon neutral, making it a better choice than other concrete.

This breakthrough doesn't only solve one problem. Modern concrete only lasts about 100 years on average, whereas ancient Roman concrete has lasted for over 2,000 years. But the recapture of CO2 can help this as well.

"If you put in the CO2, the so-called 'carbonate layer,' it becomes more robust," Nakano said.

In other words, Allegro-FM can simulate a carbon-neutral concrete that could also last much longer than the 100 years concrete typically lasts nowadays. Now it's just a matter of building it.

Behind the scenes

The professors led the development of Allegro-FM with an appreciation for how AI has been an accelerator of their complex work. Normally, to simulate the behavior of atoms, the professors would need a precise series of mathematical formulas -- or, as Nomura called them, "profound, deep quantum mechanics phenomena."

But the last two years have changed the way the two research.

"Now, because of this machine-learning AI breakthrough, instead of deriving all these quantum mechanics from scratch, researchers are taking [the] approach of generating a training set and then letting the machine learning model run," Nomura said. This makes the professors' process much faster as well as more efficient in its technology use.

Allegro-FM can accurately predict "interaction functions" between atoms -- in other words, how atoms react and interact with each other. Normally, these interaction functions would require lots of individual simulations.

But this new model changes that. Originally, there were different equations for individual elements within the periodic table, with several unique functions for these elements. With the help of AI and machine-learning, though, we can now potentially simulate these interaction functions with nearly the entire periodic table at the same time, without the requirement for separate formulas.

"The traditional approach is to simulate a certain set of materials. So, you can simulate, let's say, silica glass, but you cannot simulate [that] with, let's say, a drug molecule," Nomura said.

This new system is also a lot more efficient on the technology side, with AI models making lots of precise calculations that used to be done by a large supercomputer, simplifying tasks and freeing up that supercomputer's resources for more advanced research.

"[The AI can] achieve quantum mechanical accuracy with much, much smaller computing resources," Nakano said.

Nomura and Nakano say their work is far from over.

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"We will certainly continue this concrete study research, making more complex geometries and surfaces," Nomura said.

This research was published recently in The Journal of Physical Chemistry Letters and was featured as the journal's cover image.

Science Daily, 23 July 2025

https://sciencedaily.com

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