CHEMWATCH

Bulletin Board

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ASIA PACIFIC

Amendments to the APVMA MRL Standard

2025-05-13

The Australian Pesticides and Veterinary Medicines Authority (APVMA) approves maximum residue limits (MRLs) of agricultural and veterinary chemicals in agricultural produce, particularly produce entering the food chain. The MRLs

approved by the APVMA are associated with a regulatory decision to register a product, grant a permit approval, or as an outcome from a review decision and are set out in the Agricultural and Veterinary Chemicals (MRL Standard for

Residues of Chemical Products) Instrument 2023. The MRL Standard lists MRLs of substances that may arise from the approved use of agricultural and veterinary chemical products containing those substances on commodities used for

human consumption as well as livestock feeds. The MRL Standard also provides the relevant residue definitions to which these MRLs apply. There may be situations where the residue definition for monitoring and enforcement is different to the definition used for dietary risk assessment purposes.

MRLs are set at levels which are not likely to be exceeded if the agricultural or veterinary chemicals are used in accordance with approved label instructions. In considering MRLs and variation to MRLs, the APVMA takes into account studies on chemistry, metabolism, analytical methodology, residues, toxicology, good agricultural practice and dietary exposure. In approving MRLs, the APVMA is satisfied, from dietary exposure assessment, that the levels set are not an undue hazard to human health.

The APVMA has amended the MRL Standard and the changes will take effect the day after the instrument is registered.

Details of the amendment can be found in the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Amendment Instrument (No. 2) 2025.

The amendments will be incorporated into the compilation of the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023.

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The MRL Standard is accessible via the Federal Register of Legislation website.

Read More

APVMA, 13-05-25

https://www.apvma.gov.au/sites/default/files/2025-05/Gazette%20No%2010%2C%20Tuesday%2013%20May%202025.pdf

Proposal to amend Schedule 20 in the Australian New Zealand Food Standards Code

2025-05-13

In the previous notice on page 18 of APVMA Gazette No. 10, the APVMA gazetted amendments which it has approved to vary maximum residue limits (MRLs) for substances contained in agricultural and veterinary chemical products as set out in the APVMA's MRL Standard.

Under section 82 of the Food Standards Australia New Zealand Act 1991, the APVMA is proposing to incorporate those variations (Agricultural and Veterinary Chemicals Code (MRL Standard) Amendment Instrument 2025 (No. 2)) to MRLs into Schedule 20 – Maximum residue limits in the Australia New Zealand Food Standards Code.

MRLs contained in Schedule 20 provide the limits for residues of agricultural and veterinary chemicals that may legitimately occur in foods. By this means Schedule 20 permits the sale of treated foods and protects public health and safety by minimising residues in foods consistent with the effective control of pests and diseases. The APVMA and Food Standards Australia New Zealand (FSANZ) are satisfied, based on dietary exposure assessments and current health standards, that the proposed limits are not harmful to public health.

Read More

APVMA, 13-05-25

https://www.apvma.gov.au/sites/default/files/2025-05/Gazette%20No%2010%2C%20Tuesday%2013%20May%202025.pdf

List of new chemical assessment statements

2025-05-05

Reference Number	Chemical name or AICIS approved chemical name (AACN)	End use or generalised end use
CA09793 - Assessment Statement - 26 June 2024 [pdf] [465 KB]		Chemical used in oil and gas production
CA09912 - Assessment Statement - 26 June 2024 [pdf] [465 KB]	Hexaoxadocosane-1-sulfonic acid,	Chemical used in oil and gas production
CA09913 - Assessment Statement - 26 June 2024 [pdf] [465 KB]	Tetraoxapentadecane-1-sulfonic acid,	Chemical used in oil and gas production

Read More

AICIS, 05-05-25

https://www.industrialchemicals.gov.au/news-and-notices/new-chemical-assessment-statements-5-may-2025

AMERICA

EPA Releases U.S. Greenhouse Gas Inventory in Response to EDF FOIA Request

2025-05-08

The Environmental Protection Agency has released the latest U.S. Greenhouse Gas Inventory in response to a Freedom of Information Act (FOIA) request from Environmental Defense Fund.

The U.S. Greenhouse Gas Inventory provides critical, commonsense information about the pollution that causes climate change, fuels extreme weather events, and harms people in communities across the country. EPA compiles the inventory every year, but this year the Trump EPA failed to release it to the public.

"EPA has reliably released the U.S. Greenhouse Gas Inventory over the past three decades, under Presidential administrations of both parties," said Erin Murphy, EDF Director and Senior Attorney. "The Trump administration's decision to withhold this vital information left people in

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the dark about the sources of pollution while they're experiencing the harms of a changing climate. Fortunately, public access to these important documents has now been restored."

EDF submitted a FOIA request in April for records related to the U.S. Greenhouse Gas Inventory. We have posted the records we received – which include the Executive Summary, full U.S. Greenhouse Gas Inventory Report, and extensive underlying information – on our website. Our initial examination of the data finds that the report is highly detailed and transparent.

The U.S. Greenhouse Gas Inventory ensures the public has transparent information about the country's largest sources of climate pollution, which enables policymakers and companies to pursue commonsense solutions to reduce that pollution. In addition, as a party to the UN Framework Convention on Climate Change the United States is obligated to submit a national greenhouse gas emissions inventory report by April 15th each year but failed to fulfill that obligation this year.

Read More

EDF, 08-05-25

https://www.edf.org/media/epa-releases-us-greenhouse-gas-inventory-response-edf-foia-request

EPA Draft Proposals Would Repeal Modern Limits on Mercury and Air Toxics for Coal Plants, Carbon Pollution Standards

2025-05-03

"Today, the Trump administration posted two EPA proposals under final White House review that would repeal protections against air pollution. One is theMercury and Air Toxics Update Rule which limits pollution that causes brain damage in babies, cancer, and heart and lung diseases, and applies to coal-burning power plants. The second is the 'carbon pollution standards,' which may refer to limits on power plant pollution that causes climate change and the resulting severe heat waves, storms, fires and floods – although unlike other formal proposals, this one does not list the full name or describe the scope of the standard it is referring to.

"Power plants are one of the largest industrial sources of mercury, arsenic, chromium and climate pollution. Clean affordable solutions are available

to address this harmful pollution – and those solutions create high quality jobs in the U.S.

"The lack of transparency about the scope of the proposal to repeal carbon pollution standards means the Trump administration's action could impact other industrial sources of carbon pollution or could implicate the foundational determination that climate pollution endangers the health of the American people. (In contrast, the Biden administration listed much more information about the carbon pollution standards for power plantswhen they were announced, as is common for government regulatory actions.)

Read More

EDF, 03-05-25

https://www.edf.org/media/epa-draft-proposals-would-repeal-modern-limits-mercury-and-air-toxics-coal-plants-carbon

EPA Announces It Will Keep Maximum Contaminant Levels for PFOA, PFOS

2025-05-14

U.S. Environmental Protection Agency (EPA) Administrator Lee Zeldin announced the agency will keep the current National Primary Drinking Water Regulations (NPDWR) for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), which set nationwide limits for these "forever chemicals" in drinking water. The agency is committed to addressing Per- and Polyfluoroalkyl substances (PFAS) in drinking water while following the law and ensuring that regulatory compliance is achievable for drinking water systems.

"The work to protect Americans from PFAS in drinking water started under the first Trump Administration and will continue under my leadership," said EPA Administrator Zeldin. "We are on a path to uphold the agency's nationwide standards to protect Americans from PFOA and PFOS in their water. At the same time, we will work to provide common-sense flexibility in the form of additional time for compliance. This will support water systems across the country, including small systems in rural communities, as they work to address these contaminants. EPA will also continue to use its regulatory and enforcement tools to hold polluters accountable."

As part of this action, EPA is announcing its intent to extend compliance deadlines for PFOA and PFOS, establish a federal exemption framework,

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and initiate enhanced outreach to water systems, especially in rural and small communities, through EPA's new PFAS OUTreach Initiative (PFAS OUT). This action would help address the most significant compliance challenges EPA has heard from public water systems, members of Congress, and other stakeholders, while supporting actions to protect the American people from certain PFAS in drinking water.

Paired with effluent limitations guidelines (ELGs) for PFAS and other tools to ensure that polluters are held responsible, EPA's actions are designed to reduce the burden on drinking water systems and the cost of water bills, all while continuing to protect public health and ensure that the agency is following the law in establishing impactful regulations such as these.

EPA is also announcing its intent to rescind the regulations and reconsider the regulatory determinations for PFHxS, PFNA, HFPO-DA (commonly known as GenX), and the Hazard Index mixture of these three plus PFBS to ensure that the determinations and any resulting drinking water regulation follow the legal process laid out in the Safe Drinking Water Act.

Read More

US EPA, 14-05-25

https://www.epa.gov/newsreleases/epa-announces-it-will-keep-maximum-contaminant-levels-pfoa-pfos

EUROPE

UK and Norway accelerate clean energy opportunities

2025-05-08

On a visit to Oslo this week, Energy Secretary Ed Miliband secured a Green Industrial Partnership with Norwegian counterparts Ministers Terje Aasland and Cecilie Myrseth and met with Norway's Prime Minister Jonas Gahr Støre.

The Energy Secretary also met a number of energy companies to deepen bilateral relationships and make the case for clean energy investment in Britain. Norway is a crucial ally in securing our energy security, which in turn will deliver clean, secure and cheaper power for British families, whilst securing new clean energy manufacturing jobs through the Plan for Change.

The ambitious partnership enhances the UK and Norway's longstanding collaboration on energy and is one of the key deliverables of Prime Minister Keir Starmer's and Norwegian Prime Minister Støre's over-arching Strategic Partnership.

It focuses on key areas that support the development of renewables. These include offshore wind and grid development, collaboration on the protection of UK and Norwegian offshore infrastructure and reducing barriers to develop a North Sea hub for the cross-border storage of carbon dioxide.

This builds on the government's aim for the North Sea to be at the heart of Britain's clean energy future and to drive economic growth.

Read More

Gov.uk, 08-05-25

https://www.gov.uk/government/news/uk-and-norway-accelerate-clean-energy-opportunities

Amid political backlash, the European Parliament calls for action on chemical water pollution, including pesticides

2025-05-07

Today, the European Parliament adopted its own-initiative report on the upcoming EU Water Resilience Strategy, signalling the need for stronger efforts to tackle water pollution, including that from pesticides. While the report falls short on the ambition needed to confront Europe's water crisis, PAN Europe welcomes key provisions calling for increased pesticide monitoring, better enforcement of the Pesticide Regulation, and financial aid for farmers transitioning to low-input and organic farming practices.

The report also highlights growing concern over PFAS contamination, including trifluoroacetic acid (TFA) - a highly persistent and potentially reprotoxic breakdown product of many PFAS, including PFAS pesticides. TFA has been detected in surface and drinking water all across Europe. Scientific evidence indicates that the use of PFAS pesticides is one of the main sources of water pollution.

PAN Europe urges the Commission to propose a robust strategy to force the implementation of current EU legislation and oblige Member States to truly eliminate the use of pesticides, and support farmers in this transition.

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"The Water Resilience Strategy must deliver real change by tackling pollution at its source," said Manon Rouby, Policy Officer at PAN Europe. "The European Commission must adopt measures that go beyond the Parliament's recommendations. That means banning PFAS pesticides, establishing pesticide-free zones around water resources across Europe and supporting farmers to eliminate their overall dependency on pesticides."

"We are facing a pollution crisis, and pesticide-dependent agriculture is one of the main drivers. It is the duty of our legislators to put in place measures to phase out the use of pesticides to ensure clean and safe water for Europeans, ecosystems, and future generations," she adds.

Read More

Pesticide Action Network Europe, 07-05-25

https://www.pan-europe.info/press-releases/2025/05/amid-political-backlash-european-parliament-calls-action-chemical-water

INTERNATIONAL

Policy Brief: Potential for reducing the health burden of air pollution from residential wood combustion in the Nordic countries

2025-05-05

This report examines the impact of air pollution from residential wood combustion on health in the Nordic countries.Residential wood combustion is a major contributor to premature deaths and health issues. The number of premature deaths is expected to decrease from 1,600 in 2019 to 1,200 by 2030, with health costs dropping from EUR 3.2 bn. to EUR 2.5 bn. This improvement is due to fewer and newer, less polluting appliances, and better energy efficiency in homes.Two additional scenarios for 2030 reflecting national differences were evaluated. Technology Scenario: Faster replacement of old appliances, reducing premature deaths by 190 and health costs by EUR 390 mil.Zone-Based Scenario: Bans in densely populated areas, reducing premature deaths by 240 and health costs by EUR 510 mil.Mitigation in densely populated areas offers greater health benefits than national-level efforts.

Read More

Nordic Cooperation, 05-05-25

https://www.norden.org/en/publication/policy-brief-potential-reducing-health-burden-air-pollution-residential-wood-combustion

ASHRAE Updates Refrigerant Designations and Safety Classifications

2025-05-09

The May 2025 UNEP/ASHRAE factsheet outlines new refrigerant numbers and safety classifications under ANSI/ASHRAE Standards 34 and 15, including flammability, toxicity, and GWP data.

ASHRAE has released an updated refrigerant factsheet in collaboration with UNEP, detailing newly designated refrigerants and their safety classifications under Standard 34. The document includes refrigerants assigned an R-number from 2010 onward and presents critical data such as global warming potential (GWP), boiling points, and chemical compositions. These updates aim to provide HVACR professionals with standardized references for emerging refrigerants.

ASHRAE Standard 34 designates refrigerants with an R- followed by a number and categorizes them by toxicity and flammability. For example, "A1" indicates low toxicity and no flame propagation, while "A2L" represents lower toxicity with mild flammability. Zeotropic blends are numbered in the R-4xxx range and azeotropes in the R-5xxx series.

New refrigerants include compounds such as R-1233zd(E) (A1, GWP 1, boiling point 64.6°F / 18.1°C) and R-1336mzz(Z) (A1, GWP 2, boiling point 91.4°F / 33.4°C), along with low-GWP blends like R-444A (A2L, GWP 89) and R-451A (A2L, GWP 133). The list also highlights flammable natural refrigerant mixtures such as R-441A (A3, GWP 5) and R-477A (A3), supporting the industry's transition to environmentally safer options.

Standard 15 complements Standard 34 by setting safety guidelines for system design to protect people and property. It addresses risks such as pressure rupture, refrigerant leakage, and toxic exposure, especially in poorly ventilated areas.

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Read More

Refindustry, 09-05-25

https://refindustry.com/news/market-news/ashrae-updates-refrigerant-designations-and-safety-classifications/

Toxic Pesticide Chlorpyrifos and Large Chemical Group Set for Global Bans

2025-05-02

Stockholm Convention lists chlorpyrifos and long-chain PFCAs for global elimination

Geneva-Today, the Stockholm Convention Conference of Parties (COP) agreed that the toxic pesticide chlorpyrifos and the group of long-chain perfluorocarboxylic acids (LC-PFCAs) meet the Convention criteria as persistent organic pollutants (POPs) and added them to the list of globally banned substances. IPEN welcomed the movement as an important step for global health and praised the increasing drive to list groups of chemicals that have similar harmful properties – rather than listing chemicals one at a time, a time-consuming process that can leave people and the environment at risk.

While IPEN welcomed the Convention's decision, the global network also warned that the extensive exemptions granted for continued use of chlorpyrifos will create ongoing and avoidable risks, as alternatives for these toxic substances are available and should be adopted. In particular, broad exemptions for the chlorpyrifos listing will result in ongoing threats to children's health, as the pesticide is known to harm children's developing brains.

"The COP took an important step today toward protecting human health and the environment from chemicals linked to serious health conditions and threats to biodiversity," said Dr. Sara Brosché, a Science Advisor with IPEN. "But we are disappointed that financial interests caused unnecessary and dangerous exemptions that will lead to ongoing toxic exposures."

Pamela Miller, Co-chair of IPEN and Executive Director of Alaska Community Action on Toxics added, "We should not allow continued uses of the most dangerous chemicals known. The work of the Convention and its expert committee has been undermined this week with the extensive number of exemptions introduced. Science must be the foundation of the Convention's decisions, which must meet the Convention's intent to

protect the health of women, children, workers, Indigenous peoples, and future generations."

The COP is still discussing the listing of the toxic plastic chemical group medium-chain chlorinated paraffins (MCCPs), as recommended by the expert review committee. That decision is expected over the next few days.

Read More

IPEN, 02-05-25

https://ipen.org/news/toxic-pesticide-chlorpyrifos-and-large-chemical-group-set-global-bans

Consultations on applications for authorisation

2025-05-14

We have launched consultations on ten applications for authorisation covering ten uses of Chromium trioxide (EC 215-607-8):

- for chrome plating of different parts and substrates in the sanitary, automotive, rubber, plastic, paper, hydraulic, pharmaceutical, automotive, food, and building sectors;
- for etching and pre-treatment of parts used in the cosmetic, hydro-sanitary, and perfumery sectors; and
- in primers and slurry coating operations in the aerospace and defence sectors.

More information about the uses applied for is available on our website. Have your say through an online webform until 9 July 2025.

Read More

ECHA, 14-05-25

https://echa.europa.eu/applications-for-authorisation-consultation

Updated catalogue of borderline cases between articles and substances/mixtures

2025-05-14

This catalogue contains borderline cases between articles and substances/mixtures assessed in accordance with the Guidance on requirements for substances in articles under the REACH Regulation. It helps the user to determine if an object is an article according to REACH.

The cases assessed are based on questions received by national helpdesks and ECHA.

Read More

ECHA, 14-05-25

https://echa.europa.eu/documents/10162/17240/borderline_cases_substances_articles_catalogue_en.pdf

Janet's Corner

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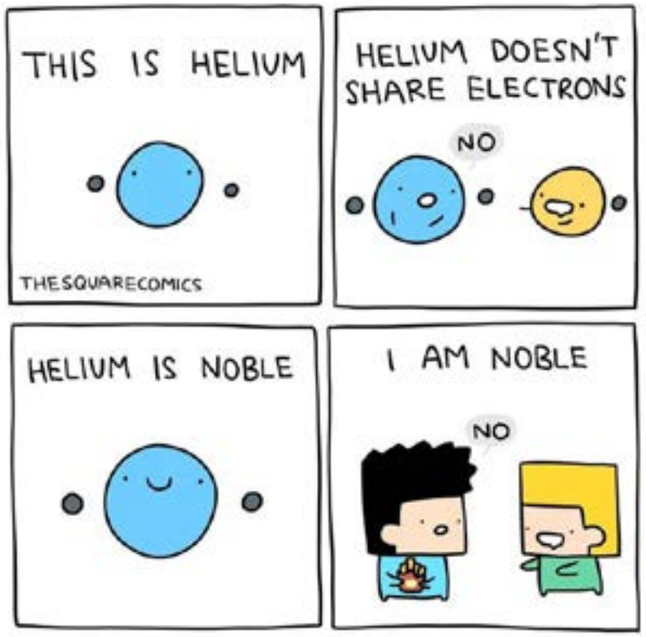
I am Helium

2025-05-23



https://www.instagram.com/p/B0gG710HZ-W/?igshid=1ozjmhtmk78v4&epik=dj0yJnU9X3NnNlBvNWgzMnBUcWFDMHdncXBRWlNUbmlDNmp1U3QmcD0wJm49QlJiUjBpb2cxazdzUFB1NUJJYXYxUSZ0PUFBQUFBR2d2MXI3

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Toluene diisocyanate

2025-05-23

USES [2,3]

TDI is used primarily to manufacture flexible polyurethane foams for use in furniture, bedding, and automotive and airline seats. Other, smaller uses are for polyurethane elastomers (for automobile bumper covers, industrial rollers, sport soles and boots, and mechanical goods) and coatings (for automotive refinishing, wood finishes, and high-performance anti-corrosion coatings). Toluene diisocyanate–based rigid polyurethane foam is used in household refrigerators and for residential sheathing or commercial roofing in board or laminate form. "Pour-in-place" or "spray-in" rigid foam is used as insulation for truck trailers, railroad freight cars, and cargo containers. Polyurethane-modified alkyds contain approximately 6% to 7% isocyanate, mostly toluene diisocyanates, and are used as coating materials, such as floor finishes, wood finishes, and paints. Moisture-curing coatings are used as wood and concrete sealants and floor finishes. Aircraft, truck, and passenger-car coatings often are composed of toluene diisocyanate prepolymer systems. Castable urethane elastomers are used in applications requiring strength, flexibility, and shock absorption, and are resistant to oil, solvents, and ultraviolet radiation. They are used in adhesive and sealant compounds and in automobile parts, shoe soles, rollerskate wheels, pond liners, and blood bags. They are also used in oil fields and mines. Certain elastomer products are produced from the pure 2,4 isomer rather than the 80:20 mixture.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- **Industry sources:** Industrial emissions to air (especially companies producing the materials listed above) or spills.
- **Diffuse sources:** Emission to air (by outgassing) from products containing TDI.
- **Natural sources:** There are no known or expected natural sources of TDI emissions.
- **Transport sources:** No significant mobile emission sources.
- **Consumer products:** Polyurethane coatings, cement sealers, polyurethane mastic sealants, and polyurethane cushions and pads.

Toluene diisocyanate (TDI) is an organic compound with the formula CH3C6H3(NCO)2. Two of the six possible isomers are commercially important: 2,4-TDI (CAS: 584-84-9) and 2,6-TDI (CAS: 91-08-7). They are combustible when exposed to heat or flame and darken when exposed to sunlight (IARC 1999, HSDB 2009). [1,2]

Very low emissions of TDI have been infrequently detected from cushions.

Routes of Exposure

The main routes of exposure to TDI are inhalation, ingestion, skin and/or eye contact.

HEALTH EFFECTS [4]

Acute Health Effects

Acute exposure to high levels of 2,4-toluene diisocyanate in humans, via inhalation, results in severe irritation of the skin, eyes, and nose, and causes nausea and vomiting. Acute animal tests in rats have shown 2,4-toluene diisocyanate to have moderate to extreme acute toxicity from inhalation exposure and low acute toxicity from oral exposure.

Carcinogenicity

Information is not adequate to determine the carcinogenic effects of 2,4-toluene diisocyanate in humans. Three epidemiology studies did not find an increased occurrence of cancer among exposed workers. Animal studies have reported significantly increased incidences of tumours of the pancreas, liver, and mammary glands from exposure to 2,4-toluene diisocyanate via gavage. Animal studies, via inhalation, did not report an increased incidence of tumours. A study by the National Toxicology Program (NTP) on a mixture of toluene 2,4- and 2,6-diisocyanate administered by gavage showed an increase in tumours of subcutaneous tissues in male and female rats, the pancreas in male rats, mammary gland and liver in female rats, and liver and circulatory system in female mice. EPA has not classified 2,4-toluene diisocyanate for carcinogenicity. IARC has classified 2,4-toluene diisocyanate as a Group 2B, possible human carcinogen.

Other Effects

Chronic inhalation exposure to 2,4-toluene diisocyanate in workers has caused significant decreases in lung function, an asthma-like reaction characterised by wheezing, dyspnea, and bronchial constriction. Animal studies have reported irritation of respiratory tissues, bronchopneumonia, and weight loss from chronic exposure to 2,4-toluene diisocyanate. EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for 2,4-toluene diisocyanate. However, EPA has established an RfC

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of 0.00007 milligrams per cubic metre (mg/m3) for the mixture of toluene 2,4- and 2,6-diisocyanate based on respiratory effects in humans.

SAFETY

First Aid Measures [5]

- **Eye contact:** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Use lukewarm water if possible. Use fingers to ensure that eyelids are separated and that the eye is being irrigated. Then remove contact lenses, if easily removable, and continue eye irrigation for not less than 15 minutes. Get medical attention.
- **Skin contact:** Immediately remove contaminated clothing and shoes. Wash off with soap and water. Use lukewarm water if possible. Wash contaminated clothing before re-use. For severe exposures, immediately get under safety shower and begin rinsing. Get medical attention if irritation develops.
- **Inhalation:** Move to an area free from further exposure. Get medical attention immediately. Administer oxygen or artificial respiration as needed. Asthmatic symptoms may develop and may be immediate or delayed up to several hours. Extreme asthmatic reactions can be life threatening.
- **Ingestion:** Do NOT induce vomiting. Wash mouth out with water. Do not give anything by mouth to an unconscious person. Get medical attention.
- **Notes to physician:** Eyes: Stain for evidence of corneal injury. If cornea is burned, instil antibiotic/steroid preparation as needed. Workplace vapours could produce reversible corneal epithelial oedema impairing vision. Skin: This compound is a skin sensitiser. Treat symptomatically as for contact dermatitis or thermal burn. Ingestion: Treat symptomatically. There is no specific antidote. Inducing vomiting is contraindicated because of the irritating nature of the compound. Inhalation: Treatment is essentially symptomatic. An individual having a dermal or pulmonary sensitisation reaction to this material should be removed from further exposure to any diisocyanate.

Workplace Controls & Practices [4]

Local exhaust should be used to maintain levels below the threshold values whenever diisocyanate is handled, processed, or spray-applied. At normal room temperatures (70 F) TDI levels quickly exceed the TLV or PEL

unless properly ventilated. Standard reference sources regarding industrial ventilation should be consulted for guidance about adequate ventilation. To ensure that published exposure limits have not been exceeded, monitoring for airborne diisocyanate should become part of the overall employee exposure characterisation program.

Personal Protective Equipment [5]

- **Respiratory protection:** At normal room temperatures, airborne TDI can exceed limits; therefore, in inadequately ventilated environments, respiratory protection must be worn. The type of respiratory protection selected must comply with the requirements set forth in OSHA's Respiratory Protection Standard (29 CFR1910.134). The type of respiratory protection available includes (1) an atmosphere-supplying respirator such as a self-contained breathing apparatus (SCBA) or a supplied air respirator (SAR) in the positive pressure or continuous flow mode, or (2) an air-purifying respirator (APR). If an APR is selected then (a) the cartridge must be equipped with an end-of-service life indicator (ESLI) certified by NIOSH, or (b) a change out schedule, based on objective information or data that will ensure that the cartridges are changed out before the end of their service life, must be developed and implemented. Furthermore, if an APR is selected, the airborne diisocyanate concentration must be no greater than 10 times the TLV or PEL. An organic vapour (OV) cartridge is recommended for APR use.
- **Hand protection:** Gloves should be worn. Nitrile rubber showed excellent resistance. Butyl rubber, neoprene, and PVC are also effective.
- **Eye protection:** When directly handling liquid product, eye protection is required. Examples of eye protection include a chemical safety goggle, or chemical safety goggle in combination with a full-face shield when there is a greater risk of splash.
- **Skin and body protection:** Avoid all skin contact. Depending on the conditions of use, cover as much of the exposed skin area as possible with appropriate clothing to prevent skin contact.

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REGULATION

United States

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA Permissible Exposure Limit (PEL) - General Industry See 29 CFR 1910.1000 Table Z-1	0.02 ppm (0.14 mg/m^3) Ceiling	HE9	Allergic sensitisation of respiratory tract; asthma
OSHA PEL - Construction Industry See 29 CFR 1926.55 Appendix A	0.02 ppm (0.14 mg/m^3) Ceiling	HE9	Allergic sensitisation of respiratory tract; asthma
OSHA PEL - Shipyard Employment See 29 CFR 1915.1000 Table Z-Shipyards	0.02 ppm (0.14 mg/m^3) Ceiling	HE9	Allergic sensitisation of respiratory tract; asthma
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) See Appendix A	Lowest Feasible Concentration Ca	HE2	Carcinogenicity (pancreas, liver, skin, mammary glands, and circulatory system)
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2004)*	0.005 ppm (0.036 mg/m^3) TWA 0.02 ppm (0.14 mg/m^3) STEL A4; SEN	HE9	Allergic sensitisation of respiratory tract; asthma
		HE11	Bronchitis, pneumonitis, pulmonary oedema
		HE14	Eye, mucous membrane, and respiratory irritation

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
CAL/OSHA PELs	0.005 ppm (0.04 mg/m³) TWA 0.02 ppm Ceiling 0.02 ppm (0.15 mg/m³) STEL	HE9	Allergic sensitisation of respiratory tract; asthma
		HE11	Bronchitis, pneumonitis, pulmonary oedema
		HE14	Eye, mucous membrane, and respiratory irritation

References

1. http://en.wikipedia.org/wiki/Toluene_diisocyanate
2. http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/Toluenediisocyanates.pdf
3. http://www.npi.gov.au/resource/toluene-24-diisocyanate
4. http://www.cdc.gov/niosh/npg/npgd0621.html
5. http://www.epa.gov/ttn/atw/hlthef/toluene2.html
6. http://www.bayermaterialsciencenafta.com/resources/d/document.cfm?Mode=view&f=C9612D22-DE8F-5A78-FE9F7C556AAD37FF&d=1B32DE24-C1A8-38D9-2944243B3F24CE54
7. https://www.osha.gov/dts/chemicalsampling/data/CH_272400.html

New innovation destroys 90% of toxic 'forever chemicals' in water

2025-05-19

New research is opening the door to a simpler, cheaper way to destroy harmful chemicals that threaten water quality and public health. Scientists studying per- and polyfluoroalkyl substances, or PFAS, are making progress in turning these toxic materials into harmless compounds using tools that are widely available and affordable.

PFAS, often called "forever chemicals," are found in thousands of everyday products—from non-stick pans and waterproof clothing to firefighting foams and food wrappers. These chemicals don't break down easily. They stay in the environment and the human body for decades, building up over time. Scientists link PFAS exposure to serious health problems, including increased cancer risk, lower fertility, and developmental delays in children.

New findings now show that it's possible to break PFAS down using a simple mixture of heat and granular activated carbon, or GAC. This marks a major step forward in dealing with chemicals that many believed could never be destroyed.

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Heat and Carbon: A Powerful Combo

A team from the University of Missouri has discovered that heating PFAS with GAC—an inexpensive, coal- or wood-based material often used in water filters—can break down over 90% of the chemicals. Unlike previous methods, which needed extremely high heat, high pressure, or costly solvents, this new method works at just 572 degrees Fahrenheit and normal pressure. That's a temperature that a regular furnace can reach.

"You don't need organic solvent or really high temperatures," said Feng "Frank" Xiao, a professor who led the research. "Just heat the PFAS with granular activated carbon."

In the study, the team tested five types of long-chain PFAS. These included three that are now regulated under federal water safety laws, one cationic compound, and a compound with 10 carbon atoms. The results showed that combining GAC with moderate heat caused the PFAS to break down into simple, non-toxic forms of fluorine.

Brighter Side News, 19 May 2025

https://thebrighterside.news

A new complexity in protein chemistry: Algorithm uncovers overlooked chemical linkages

2025-05-20

Proteins are among the most studied molecules in biology, yet new research from the University of Göttingen shows they can still hold surprising secrets. Researchers have discovered previously undetected chemical bonds within archived protein structures, revealing an unexpected complexity in protein chemistry.

These newly identified nitrogen-oxygen-sulfur (NOS) linkages broaden our understanding of how proteins respond to oxidative stress, a condition where harmful oxygen-based molecules build up and can damage proteins, DNA, and other essential parts of the cell. The new findings are published in Communications Chemistry.

The research team systematically re-analyzed over 86,000 high-resolution protein structures from the Protein Data Bank, a global public repository of protein structures, using a new algorithm that they developed inhouse called SimplifiedBondfinder. This pipeline combines machine learning, quantum mechanical modeling, and structural refinement methods to reveal subtle chemical bonds that were missed by conventional analyses

Unexpectedly, NOS linkages were not restricted to previously known amino acid pairs but were also discovered between the amino acid pairs arginine-cysteine and glycine-cysteine. NOS linkages were first discovered by research led by Professor Kai Tittmann at Göttingen University.

"Our work shows that the Protein Data Bank still holds hidden chemistry," said Dr. Sophia Bazzi at Göttingen University's Institute of Physical Chemistry, who led the study. "By developing new digital tools and

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revisiting existing data, we uncovered chemical interactions that had remained unnoticed for decades."

These NOS bonds act as molecular switches, stabilizing proteins under oxidative stress and potentially influencing a whole range of biological processes. "Our approach has much wider implications," Bazzi adds. "It can uncover overlooked chemical bonds, leading to improved protein models and advancing protein engineering, drug design, and synthetic biology."

Phys Org, 20 May 2025

https://phys.org

Breakthrough Alzheimer's blood test has been approved for the US

2025-05-20

The very first blood test for Alzheimer's disease detection has been green-lit by the US Food and Drug Administration (FDA), providing a simpler and less invasive method for early diagnosis and speedier intervention. It's a milestone moment for medical science.

While finding a cure remains elusive, we're edging closer to more impactful interventions that can slow cognitive decline. The blood test, known as the Lumipulse G pTau217/ß-Amyloid 1-42 Plasma Ratio screening, aims to identify the early accumulation of amyloid plaques in people aged 55 years or older, who show early signs of the disease.

"Alzheimer's disease impacts too many people, more than breast cancer and prostate cancer combined," said FDA Commissioner Martin A. Makary. "Knowing that 10% of people aged 65 and older have Alzheimer's, and that by 2050 that number is expected to double, I am hopeful that new medical products such as this one will help patients."

While the scientific community has debated the significance of focusing on amyloid plaques, it's nonetheless one of the leading biomarkers of Alzheimer's disease (AD) progression. Traditionally, amyloid positron emission tomography (PET) brain scans have been used to identify their existence, but it's a costly, specialized process and has other downsides such a radiation exposure.

The Lumipulse G pTau217/ß-Amyloid 1-42 Plasma Ratio test, made by the Tokyo-based in-vitro diagnostics company Fujirebio Diagnostics, measures two proteins, pTau217 and β-amyloid 1-42, found in plasma. A numerical

ratio from the results can then determine the presence of absence of plaques in the brain.

Besides PET scans, the only similar diagnostic tool involves cerebrospinal fluid (CSF) analysis, which requires challenging and invasive lumbar punctures, or spinal taps. The new blood test requires just a single sample, is quick to process and is expected to be more accessible than these other methods currently available.

The race to get blood tests to market has been under way for several years, which we have covered here, here and here, to name a few developments. But Fujirebio Diagnostics has crossed the line first. However, we don't expect it to be on its own for long. Scientists are also hoping to have testing available for those who show no symptoms.

"Nearly seven million Americans are living with Alzheimer's disease and this number is projected to rise to nearly 13 million," said Center for Devices and Radiological Health Director Michelle Tarver in response to the FDA news. "Today's clearance is an important step for Alzheimer's disease diagnosis, making it easier and potentially more accessible for US patients earlier in the disease."

The approval comes after a clinical trial that saw 91.7% of positive tests using the Lumipulse G pTau217/ß-Amyloid 1-42 Plasma Ratio screening method revealing the presence of amyloid plaques, confirmed by PET or CSF test. And 97.3% of those who returned negative results via the blood test, were also cleared through further investigation.

While not 100% foolproof, there were no other health risks identified besides a small chance of false positive/false negative results. However, the FDA states that the Lumipulse test is not intended to be used as a stand-alone diagnostic tool but used as part of the process that reduces the frontline use of more invasive and time-consuming methods of detection.

"The lack of effective, accessible and minimally invasive diagnostics for AD contributes to its late diagnosis and inadequate treatment," says Monte Wiltse, President and CEO at Fujirebio Diagnostics. "The Lumipulse G pTau 217/ β-Amyloid 1-42 Plasma Ratio test will go a long way to assist physicians and patients to obtain an AD diagnosis in early stages of the disease, when interventions are more effective.

"As part of our worldwide commitment to improve the diagnosis and treatment of AD, Fujirebio is developing additional assays, which will

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increase the availability of diagnostic tools and expand the foundation for early, more effective treatment," Wiltse added.

New Atlas, 20 May 2025

https://newatlas.com

Chemists develop new approach to synthesizing air-stable four-membered boracycles

2025-05-19

Boracycles are important functional scaffolds, finding increasing applications in catalysis, synthesis, materials science, and pharmaceuticals. However, current studies predominantly focus on three-, five-, and six-membered boracycles, leaving four-membered boracycles largely unexplored.

A research team led by Prof. Quan Yangjian and Prof. Lin Zhenyang from the Department of Chemistry at the Hong Kong University of Science and Technology (HKUST), in collaboration with Prof. Lyu Hairong from The Chinese University of Hong Kong (CUHK), has made a breakthrough in developing an efficient synthetic approach to four-membered boracycles. This advancement enables the facile synthesis of other previously inaccessible boracycles, which may lead to valuable applications.

The paper is published in the journal Nature Chemistry.

As important structural elements, boracycles demonstrate unique application value in the fields of medicinal chemistry and functional materials. Among them, five-membered and six-membered boron heterocycles have been widely applied in bioactive molecules and optoelectronic materials.

The lack of efficient and versatile synthetic methods has limited the investigation into the properties and applications of four-membered boracycles. Due to their inherent ring strain, four-membered boracycles are expected to serve as valuable synthons with versatile reactivities and functionalities.

In this recent research, the team developed a novel and efficient synthetic approach to four-membered boracycles, made possible by unlocking boron-carbon diradical (BCDR) chemistry. The triplet energy transfer catalysis creates air-stable benzoboretenes through the intramolecular coupling of BCDR.

Notably, a balance between the stability and reactivity of four-membered boracycles has been achieved for the first time, enabling the facile synthesis of previously inaccessible boracycles. These new boracycles are expected to have valuable applications in boron pharmaceuticals and molecular functional materials.

"More importantly, the concept and strategy of balancing the reactivity and stability of strained boracycles will not only facilitate the development of boracycle synthons but also broaden curiosity-driven research into application-oriented investigations, attracting researchers from diverse fields," Prof. Quan added.

Phys Org, 19 May 2025

https://phys.org

Cobalt catalyst rivals platinum in key industrial reaction

2025-05-20

Propane dehydrogenation is a key industrial route to producing propylene without relying on oil. However, its current production processes rely heavily on precious-metal catalysts such as Pt-based materials. Developing efficient alternatives using Earth-abundant metals has remained a challenge.

In a study published in Nature Catalysis, Prof. Xiao Jianping's group from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences, and collaborators, have developed a high-performance cobaltosilicate zeolite catalyst (CoS-1) via a hydrothermal synthesis method.

The catalyst has solely tetrahedral cobalt sites and none of the unstable cobalt species, achieving a propylene productivity as high as 9.7 kgC3= kgcat−1 h−1, surpassing that of an industrial PtSn/Al2O3 catalyst.

The synthesis method involved a gel composed of cobalt salts, tetraethyl orthosilicate, tetrapropylammonium hydroxide (TPAOH), urea, and water, followed by crystallization at 180°C. After calcination to remove the organic template and triple nitric acid washing at 80°C to eliminate excess cobalt species, the resulting CoS-1 catalyst contained only tetrahedral cobalt sites without unstable Co species.

Through density functional theory calculations and ab initio molecular dynamics simulations, researchers studied the stability of different active

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centers and uncovered the mechanism behind the high performance of the CoS-1 catalyst.

They revealed that the flexible zeolite framework obviously lowered the dehydrogenation barriers at isolated cobalt sites due to entropic effects, resulting in a lower barrier of propane dehydrogenation than a Pt3Sn alloy.

Microkinetic simulations further showed that while CoS-1 had a lower dehydrogenation barrier, its overall reaction rate at initial conversions was slightly lower than that of Pt3Sn, due to reduced propane concentration at isolated Co sites—an effect of entropy loss during diffusion into the zeolite channels.

The CoS-1 developed in this study exhibits excellent long-time stability. Researchers have proven that this can be attributed to the non-bonding adsorption of propylene within the zeolite, which enables rapid product desorption and reduces coke formation.

Phys Org, 20 May 2025

https://phys.org

Personal space chemistry suppressed by perfume and body lotion indoors

2025-05-21

In 2022 a team led by the Max Planck Institute for Chemistry discovered that high levels of OH radicals can be generated indoors, simply due to the presence of people and ozone. This means: People generate their own oxidation field and change the indoor air chemistry around them within their own personal space. Now, in a follow-up study again in cooperation with an international research team, they found that commonly applied personal care products substantially suppress a human's production of OH radicals. These findings have implications for the indoor chemistry, the air quality of occupied spaces, and human health, since many of the chemicals in our immediate vicinity are transformed by this field.

- People indoors generate an oxidation field consisting of hydroxyl radicals (OH). The oxidation field is generated by the reaction of ozone with oils and fats on our skin
- Researchers now have found that the application of personal care products, such as fragrances and body lotions, suppresses the human oxidation field.

- Body lotion hinders the generation of a key OH precursor by acting as a physical barrier between air ozone and skin squalene.
- A large amount of ethanol solvent in fragrances acts as a OH sink which leads to a reduction of the human generated OH field.
- **Used methods:** a multiphase chemical kinetic model and a computational fluid dynamics model to demonstrate how the concentrations of the reactive components develop in the indoor environment.

The indoor environment contains multiple sources of chemical compounds. These include continuous emissions from housing materials such as furniture, floors and furnishings, but also periodic intense emissions from human activities such as cooking, smoking, and cleaning. Outdoor air chemicals can also enter indoor environments through infiltration and ventilation. Ozone (O3) from outdoors can react with compounds indoors to create a complex chemical cocktail within the indoor living space. Since people spend up to 90 percent of their time indoors, exposure to this diverse array of chemical compounds over extended periods is cause for concern, particularly as the human-health impacts of many such chemicals remain poorly understood.

On the basis of their findings in 2022, Jonathan Williams' research group from the Max Planck Institute for Chemistry had a closer look on how the human oxidation field might be influenced by personal care products. "Given that the human oxidation field influences the chemical composition of air in the breathing zone and close to the skin, it affects our intake of chemicals, which in turn impacts human health. It is therefore of interest to examine how personal care products can influence the strength and spatial extent of the self-generated OH-field," explains Jonathan Williams.

The experimental measurements made by the Max Planck team were supported by Manabu Shiraiwa and his team at the University of California (Irvine, USA) and Donghyun Rim's group from the Pennsylvania State University.

"Our team took a unique approach to simulate concentrations of chemical compounds near humans in the indoor environment," said Shiraiwa. "We developed a state-of-the-art chemical model that can simulate reactions of ozone with human skin and clothing that can lead to the formation of semi-volatile organic compounds."

"We applied a three-dimensional computational fluid dynamics model to simulate the evolution of the oxidation field around human occupants,"

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said Rim. "This integrated modeling approach highlights the impact of personal care products on the human oxidation field."

Personal care products affect the human oxidation field

First, the researchers examined how the application of body lotion impacts the chemistry in the periphery of the persons tested. Then they investigated, how perfume applied to the skin affects the chemical composition of the indoor air. For both cases Williams and his team saw that the OH concentration around the volunteers decreased. This means: It decreased compared to the standard case without cosmetics, where ozone reacts on human skin to form gas phase products that react again in the air with ozone to make OH.

Concerning the perfume, the researchers explain the OH decrease with the primary perfume component ethanol: it reacts with OH, using it up, as ethanol does not produce OH when reacting with ozone.

"Regarding body lotion, we can explain the decline in two ways. One is that phenoxyethanol -- a chemical in the body lotion -- reacts with OH but does not generate OH with ozone. This is the same as the perfume with ethanol. The second explanation is simply that the body lotion gets in the way of ozone reacting with squalene on the skin," states atmospheric chemist Jonathan Williams.

"The application of a fragrance and a lotion together showed that fragrances impact the OH reactivity and concentration over shorter time periods, whereas lotions show more persistent effects, consistent with the rate of emissions of organic compounds from these personal care products," sums up Nora Zannoni, first author of the study published in the research magazine Science Advances. She is currently employed at the Institute of Atmospheric Sciences and Climate in Bologna, Italy.

Implications for indoor chemistry

While thousands of different fragrances and lotions exist on the market, there are some general conclusions valid for any product that the international research team draws based on their tests:

Following the new findings of this study, an applied fragrance indoors would be expected to suppress the personal human oxidation field. In contrast with fragrances, lotions have more variable compositions. Despite their variable composition, they expect most lotions to suppress the human oxidation field due to a combination of dilution of skin oil constituents and reduced interaction between O3 and the

skin. Additionally, marketed lotions contain preservatives acting as antimicrobial agents. Widely used is phenoxyethanol which further contributes to suppressing the human oxidation field by reacting with the OH radicals as experimentally demonstrated in this study.

"If we buy a sofa from major furniture company, it is tested for harmful emissions before being put on sale. However, when we sit on the sofa, we naturally transform some of these emissions because of the oxidation field we generate. This can create many additional compounds in our breathing zone whose properties are not well known or studied. Interestingly body lotion and perfume both seem to dampen down this effect," says Jonathan Williams.

These findings are part of the project ICHEAR (Indoor Chemical Human Emissions and Reactivity Project) which brought together a group of collaborating international scientists from Denmark (DTU), USA (Rutgers University), and Germany (MPI). The modelling was part of the MOCCIE project based in University of California Irvine and the Pennsylvania State University. Both projects were funded by grants from the A. P. Sloan foundation.

Additional information

Experimental setup in a climate chamber

The experiments were conducted at the Technical University of Denmark (DTU) in Copenhagen in 2021. Four test subjects stayed in a special climate-controlled chamber under standardized conditions. Ozone was added to the chamber air inflow in a quantity that was not harmful for humans but representative of the higher range of indoor levels. The team determined the OH concentrations indirectly by quantifying the individual OH sources and the overall loss rate of OH. The OH field was only generated when ozone was present.

By combining air measurements from within the chamber with model simulations, they calculated the effect of the lotion and fragrance on the human oxidation field.

Science Daily, 21 May 2025

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Eco-Friendly Alchemy: Turning Waste Into Silver Using Everyday Oils

2025-05-18

Silver is becoming harder to mine, but researchers in Finland have found a creative and eco-friendly way to recover it from waste using common fatty acids and hydrogen peroxide.

These mild, green solvents not only dissolve silver efficiently but also allow for easy recycling of the acids themselves.

The Urgent Need for Silver Recycling

Recycling silver from electronic and industrial waste is becoming more crucial than ever. As demand for this precious metal grows and natural sources become harder to mine, scientists are racing to develop cleaner, smarter ways to recover it.

"Recycling silver from waste materials is becoming increasingly important for securing the supply of this precious metal. It is highly desirable to design new sustainable separation and recycling strategies to replace current processes that strain the environment," says Postdoctoral Researcher Anže Zupanc from the University of Helsinki and the University of Birmingham.

Right now, less than 20% of silver produced each year gets recycled, even though the global push for renewable energy is generating more silver-containing waste. Silver plays a key role in technologies like solar panels, but silver ore is becoming scarcer. Over the last 25 years, the price of silver has increased sixfold, making effective recycling not just necessary, but economically attractive.

Now, researchers from the University of Helsinki and the University of Jyväskylä have introduced a breakthrough recycling technique, recently published in the Chemical Engineering Journal.

Why Does Metal Dissolve in Fats?

To extract silver safely, the team turned to common fatty acids, such as oleic, linoleic, and linolenic acids. When combined with a 30% solution of hydrogen peroxide, a powerful yet eco-friendly oxidant, these natural oils were able to dissolve silver under mild conditions. In this system, the fatty acids didn't just act as a liquid medium—they also helped stabilize the dissolved silver ions.

"Computational chemistry enabled us to understand the solubility of metals by investigating the effect of solvents on the thermodynamics of dissolution," says Professor Karoliina Honkala from the University of Jyväskylä.

Recovering Pure Silver from the Solution

The results made it possible to explain whether the insolubility of metals is caused by surface passivation or a thermodynamic barrier. Adding ethyl acetate to the silver–fatty acid solution enabled the separation of silver as silver carboxylates from the unreacted fatty acids, which can be recycled. The silver carboxylates were in turn reduced to metallic silver in a light-assisted reduction reactor, an efficient and safe method for separating silver.

"The goal of our research is to develop metal recycling techniques from multi-metal substrates using strategies that are inexpensive, sustainable, and selective by design," says Professor Timo Repo from the University of Helsinki.

Fatty Acids: The Green Advantage

Using fatty acids as solvents has many benefits over using traditional mineral acids and aqueous solutions. In addition to originating in waste material, they are biocompatible, biodegradable, low in acid, and non-volatile. This makes them safe and non-corrosive compared with other acids and organic solvents, enabling recycling and reuse.

Since fatty acids are not water-based, metal compounds can be separated from unreacted reaction mixtures by using ethyl acetate and other antisolvents. This allows for both straightforward metal recovery and the recycling of fatty acids. In addition, the possibility of using 30% aqueous hydrogen peroxide as a green oxidant under mild conditions enables urban mining, that is, separating, for example, silver from keyboards with waste silver plating.

Sci Tech Daily, 18 May 2025

https://scitechdaily.com

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Berries just the beginning for biodegradable plastic

2025-05-15

University of Queensland researchers have developed a biodegradable plastic to set a new sustainability standard for mass-produced food packaging such as fruit punnets.

The research is published in Composites Part A: Applied Science and Manufacturing.

Fermented from bacteria and strengthened with Australian wood fibers, the novel biocomposite was produced by Ph.D. candidate Vincent Mathel and Dr. Luigi Vandi at UQ's School of Mechanical and Mining Engineering as a commercial alternative to petrol-based plastics.

Mr. Mathel said the biocomposite has been successfully tested as a strawberry punnet that biodegrades completely in soil, fresh water, the ocean, and in compost.

"This is a new material that carries all the sustainability benefits of a bio-sourced product while having the same properties as mass-produced plastic packaging and containers," Mr. Mathel said.

"It was also important to us to make a biocomposite that maximizes Australian resources to have the added environmental benefit that it does not need to be imported from overseas."

Mr. Mathel and Dr. Vandi spent three years perfecting their biocomposite within UQ's Center for Advanced Materials Processing and Manufacturing (AMPAM), backed by an assortment of industry collaborators and an Advance Queensland Industry Research Fellowship.

The team created the material by blending bacteria-produced biodegradable polyesters known as polyhydroxyalkanoates (PHAs) with wood fibers taken from Radiata Pine sawdust.

Mr. Mathel said the team selected wood as the "biofiller" to flesh out the plastic because it was abundant, low in cost, and could enhance the end-of-life standard for biodegradable and compostable products.

"The thing many people don't realize is that bioplastics are not always bio-based and not always biodegradable—there is a lot of greenwashing," Dr. Vandi said.

"If you are striving for complete sustainability and add natural ingredients to the mix, you can impact the physical qualities of the bioplastic, and its suitability for everyday use.

"Getting the balance right is very important."

The team then turned to its biotech partners, Uluu, and Brisbane-based injection molding firm SDI Plastics to help with a manufacturing run of 200 strawberry punnets.

Kulbir Dhanda, who was based at SDI Plastics, was integral to the process.

The Queensland Strawberry Growers Association and Mandy Schultz from LuvaBerry Farm were also enlisted to ensure the new biocomposite met end-user requirements for a product that typically has a very high packaging-to-fruit ratio.

"Punnets are pretty bad from a sustainability perspective, but they are the only way to effectively ship and sell strawberries without ruining the fruit," Dr. Vandi said.

"We've shown we can make a product that could potentially replace the 580 million or so plastic punnets every year."

Mr. Mathel said the team was now compiling data on the end-of-life composting of their packaging in collaboration with Phoenix Power Recyclers led by senior environmental scientist Dr. Deepak Ipe and general manager Chris Alexander.

Eventually Dr. Mathel envisages the biocomposite will be used for a range of food packaging and other rigid plastic applications and is looking for financial backing to establish manufacturing.

"The ultimate goal is to phase out petrol-based plastics," Dr. Mathel said.

"But bioplastics will play a crucial role as a solution when plastics are unavoidable, especially for short-term applications."

phys.org, 15 May 2025

https://phys.org

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Cerium Glows Yellow: Chemists Teach Rare Earth Elements New Tricks

2025-05-19

Scientists have developed a method to alter the color and brightness of rare earth element luminescence by changing their chemical environment, enabling the design of advanced light-emitting materials.

Researchers at HSE University and the Institute of Petrochemical Synthesis of the Russian Academy of Sciences have discovered a method to control both the color and brightness of light emitted by rare earth elements. Typically, the luminescence of these elements is highly predictable. For example, cerium ions usually emit light in the ultraviolet range.

However, the scientists demonstrated that this emission can be altered. By creating a specific chemical environment, they caused a cerium ion to emit a yellow glow instead of its usual ultraviolet light. These findings could lead to the development of advanced light sources, display technologies, and laser systems. The study was published in Optical Materials.

Rare earth elements are important in microelectronics, LEDs, and fluorescent materials because they can emit light in precisely defined colors. This ability results from the behavior of their electrons when they absorb and release energy.

When an atom absorbs energy from a source such as light or an electric current, one of its electrons can move to a higher energy level. This excited state is unstable. After a short time, the electron returns to its original energy level and releases the excess energy in the form of light. This process is known as luminescence.

Orbital Transitions and Their Typical Stability

In rare earth elements, the glow results from electron transitions between 4f orbitals—regions around the atomic nucleus where electrons can reside. Typically, the energy of these transitions is fixed, meaning the color of the glow remains constant: cerium emits invisible ultraviolet light, while terbium emits green.

The 4f orbitals are situated deep within the atom and interact minimally with the surrounding environment. In contrast, the 5d orbitals are sensitive to external influences but generally do not contribute to the luminescence of lanthanides due to their excessively high energy.

However, scientists from HSE University and the Institute of Petrochemical Synthesis of the Russian Academy of Sciences have demonstrated that the color of the radiation can be altered by adjusting the chemical environment of the metals. They synthesised cerium, praseodymium, and terbium complexes using organic ligands—molecules that surround metal ions. These ligands shape the geometry of the complex and influence its properties. In all cases, three cyclopentadienyl anions were symmetrically arranged around the metal.

These anions consist of regular pentagons of carbon atoms, to which large organic fragments are attached, providing the required structure for the complex. This environment generates a specific electrostatic field around the ion, which alters the energy of the 5d orbitals and, consequently, affects the luminescence spectrum.

Unveiling the Mechanism Behind the Change

"Previously, a change in the color of the glow had been observed, but the underlying mechanism was not understood. Now, in collaboration with our physicist colleagues, we have been able to understand the mechanism behind this effect. We deliberately designed compounds with an electronic structure that is atypical for lanthanides. Rather than focusing on a single example, we synthesised a series of compounds from cerium to terbium to observe how their properties change and to identify common patterns," comments Daniil Bardonov, a master's student at the HSE Faculty of Chemistry.

In conventional compounds, cerium emits ultraviolet light with wavelengths between 300 and 400 nanometres. In the new complexes, its emission shifted to the red range, reaching up to 655 nanometres. This indicates that the energy gap between the 4f and 5d levels has decreased. A similar rearrangement of electronic levels was observed in the other lanthanides studied, also resulting in changes to their luminescence.

"To understand how this process works, it's important to first grasp the mechanism of energy transfer. Typically, a ligand molecule absorbs ultraviolet light, enters an excited state, and then transfers this energy to the metal atom, causing it to emit light," explains Dmitrii Roitershtein, Academic Supervisor of the Chemistry of Molecular Systems and Materials Programme and co-author of the paper. "However, in the new compounds, the process occurred differently: energy was transferred not directly to the 4f electrons, but via an intermediate 5d state."

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The researchers believe that being able to predict the luminescence spectrum will make it possible to design materials with desired properties more efficiently by eliminating the need for time-consuming trial and error. This could facilitate the creation of new and advanced light sources.

"We were able to demonstrate exactly how the environment of an atom influences its electronic transitions and lanthanide luminescence," says Fyodor Chernenkiy, a bachelor's student at the HSE Faculty of Chemistry. "We can now intentionally select the structure of compounds to control luminescence and produce materials with specific optical properties."

Sci Tech Daily, 19 May 2025

https://scitechdaily.com

Extreme weather cycles change underwater light at Lake Tahoe

2025-05-21

Lake Tahoe is experiencing large-scale shifts in ultraviolet radiation (UV) as climate change intensifies wet and dry extremes in the region. That is according to a study led by the University of California, Davis' Tahoe Environmental Research Center and co-leading collaborator Miami University in Ohio.

For the study, published in ASLO, the journal of the Association for the Sciences of Limnology and Oceanography, scientists analyzed an 18-year record of underwater irradiance at Lake Tahoe, which is renowned for its clear blue waters. They found up to a 100-fold difference in UV radiation between a wet and dry year.

These large fluctuations were associated with wet and dry extremes in the local climate, which caused variations in particulate matter and colored dissolved organic matter in the lake.

UV radiation penetrates most deeply in clear water bodies, such as alpine or polar lakes, so the research carries implications for those water bodies. In less transparent lakes, UV radiation may reach only a few inches into the water. In clear systems like Lake Tahoe, it can reach dozens of feet down.

"In a wet year, UV radiation penetrates shallower," said lead author Shohei Watanabe, an associate project scientist with UC Davis Tahoe Environmental Research Center. "In a drought year, more UV radiation is slicing through the water. It's a bit like reducing the lake's 'sunscreen,' making it susceptible to severe sunburn."

The role of UV radiation

UV radiationhas wide-ranging effects on aquatic ecosystems. It affects the carbon cycle and behavior of fish and zooplankton. It can suppress photosynthesis, which forms the basis of the lake ecosystem. Understanding how it is changing can help natural resource managers and others anticipate changes while building lake resilience.

In revealing the close tie between UV radiation changes and wet-dry cycles, the study also suggests that monitoring underwater radiation can help serve as a sentinel for climate-driven disturbances in lakes.

Long-term monitoring

Long-term observation of underwater UV radiation in lakes is rare. UC Davis researchers have been continuously monitoring Lake Tahoe since 1968. Specialized equipment to measure underwater UV radiation was introduced as a part of a collaborative research project with Miami University in Ohio in 2006. Since then, UV monitoring has been integrated into the long-term monitoring program. This study analyzed 18 years of that data through 2023.

"To understand what's really happening in nature, the long-term data set is quite important," Watanabe said. "One or two years of data couldn't reveal this kind of huge fluctuation related to climatic perturbations."

The study's coauthors include Erin Overholt and Craig Williamson of Miami University in Ohio, Geoffrey Schladow of UC Davis, and Warwick Vincent of Laval University in Canada. It received funding from the National Science Foundation and philanthropic gifts to UC Davis TERC.

Science Daily, 21 May 2025

https://sciencedaily.com

Portable device captures airborne molecules for noninvasive disease detection

2025-05-21

If you've ever sat waiting at the doctor's office to give a blood sample, you might have wished there was a way to find the same information without needles. But for all the medical breakthroughs of the 20th century, the best way to detect molecules has remained through liquids, such as blood.

New research from the University of Chicago, however, could someday put a pause on pinpricks.

A group of scientists announced they have created a small, portable device that can collect and detect airborne molecules—a breakthrough that holds promise for many areas of medicine and public health.

The researchers envision the device, nicknamed ABLE, could detect airborne viruses or bacteria in hospital or public spaces, improve neonatal care or allow people with diabetes to read glucose levels from their breath. The entire device is just four by eight inches across.

"This project is among the most exciting endeavors we've pursued," said UChicago Prof. Bozhi Tian, one of the senior authors on the paper. "There are so many potential applications. We're delighted to see it come to fruition."

The study is published in Nature Chemical Engineering.

For decades, our ability to detect molecules in air has lagged behind our ability to detect the same ones in a liquid. Hence the blood tests at the doctor's office, and the pinpricks people with diabetes often undergo daily. Even the home COVID tests you may have taken all involve adding droplets of liquid.

"We can use cell phones to take pictures or record audio, but we don't have similar technology to see the air chemistry," said Jingcheng Ma, the first author of the study, who was formerly a postdoctoral researcher at UChicago and is now assistant professor at the University of Notre Dame. Part of the trouble is dilution.

In air, the particles you're looking for—such as a few viruses floating around—might be as few as one in a trillion. That's a tall task for a detector, and until now it has required large, expensive equipment.

A team of UChicago scientists set out to solve that problem by finding a way to turn air into liquid, making it easier to read. The team designed a multipart system. First, a pump sucks in the air for the reading.

Next, a humidifier adds water vapor, and a miniature cooling system lowers the temperature. This causes the air to condense into droplets—with any relevant particles suspended inside. The droplets slide down a specially designed ultra-slick surface and collect into a small reservoir.

From there, detectors can easily pick up the concentrations of molecules in the liquid, using pre-existing and readily available equipment for liquid detection. As they put together the device, they weren't sure whether they would be able to capture some types of molecules that evaporate easily, known as "volatile" molecules.

For one early proof of concept, Ma used a cup of coffee as a test. He blew a puff of vaporized coffee into the system to see if it could be successfully collected and detected. When the liquid condensed out, he didn't even need to run tests to know it had worked—the distinct aroma of coffee emanated from the liquid.

In further tests, they found they could successfully detect glucose levels from breath, detect airborne E. coli and pick up markers of inflammation from the cages of mice with poor microbiome gut health. They named the system ABLE, for Airborne Biomarker Localization Engine.

The initial inspiration for the study, Tian said, was a trip he made years ago to the Stephen Family Neonatal Intensive Care Unit at UChicago's Comer Children's Hospital as a part of his ongoing work with the Center for the Science of Early Trajectories. The center founder, Prof. Erika Claud, wished there was a way to run tests on her tiny patients without drawing blood or other invasive methods.

Claud, who is the Section Chief of Neonatology and the Stephen Family Professor in Pediatrics, now hopes to be able to put this newly developed technology to use.

"Premature infants are some of the most vulnerable and fragile patients that we care for in medicine," she said. "The promise of this technology is that we will be able to non-invasively track newly identified biomarkers, to optimize care for these infants."

The researchers can also imagine many other uses. But there's a challenge—the ability to easily detect airborne molecules is so new that scientists don't even yet know what molecules they would need to look

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for. For example, the group is now collaborating with a doctor who treats inflammatory bowel disease.

It's likely you could detect markers of inflammation from the breath of patients with IBD, but they would first need to be catalogued. The team also wants to refine the design and miniaturize it further to make it wearable. Finally, Ma, a mechanical engineer who has a background in thermofluidics, is excited about the implications for revealing new principles of physics.

"This work might start many new studies on how these airborne impurities affects phase change behaviors, for example, and the new physics can be used for many applications," he said.

The researchers are working with the Polsky Center for Entrepreneurship and Innovation and the Center for the Science of Early Trajectories.

Phys Org, 21 May 2025

https://phys.org

US approves natural food dyes while pushing to phase out synthetic colours

2025-05-14

The US Food and Drug Administration (FDA) has approved three food colourings from natural sources as part of the Trump administration's campaign to eliminate artificial dyes in American foods and beverages. The agency has set a goal that by the end of 2026 companies voluntarily phase out controversial synthetic dyes from the US food system, which are restricted in other places like the UK and European nations.

On 9 May, the FDA granted three colour additive petitions that will 'expand the palette of available colours from natural sources for manufacturers to safely use in food'. The approvals are slated to take effect on 26 June.

The head of the Health and Human Services (HHS) department that oversees the FDA, Robert F Kennedy Jr, stated: 'For too long, our food system has relied on synthetic, petroleum-based dyes that offer no nutritional value and pose unnecessary health risks. We're removing these dyes and approving safe, natural alternatives – to protect families and support healthier choices.'

Galdieria extract blue, derived from the unicellular red algae Galdieria sulphuraria, has been approved for use in non-alcoholic beverages and

beverage bases, fruit drinks, fruit smoothies, yogurt drinks, and more. French biotech company Fermentalg submitted its petition to the FDA in September 2021, and this appears to be the first authorisation for the natural ingredient's use in food and beverages – it is not yet approved in the UK or EU, although petitions are pending there.

The agency has also extended approval for butterfly pea flower extract, a natural blue additive that can produce a range of blue shades as well as purples and greens. The extract is already approved in the US for use in various drinks and yoghurts, but St. Louis, US-based Sensient Colors' February 2024 petition extends that use to cereals, crackers, snacks and other drink categories. In the EU, flowers of the blue butterfly pea are regulated as 'Novel Food' and therefore can only be used as a food supplement.

Finally, calcium phosphate has been approved as a white dye for use in ready-to-eat chicken products, doughnut sugar, and various candies, under February 2023 filing from Innophos based in New Jersey, US. Calcium phosphate is approved as a food additive in the EU.

The Washington, DC-based Consumer Brands Association that represents companies manufacturing and selling consumer packaged goods is sceptical of the government's plan to remove synthetic dyes from the food supply.

'The ingredients used in America's food supply have been rigorously studied following an objective science and risk-based evaluation process and have been demonstrated to be safe,' stated Melissa Hockstad, the trade group's president and chief executive.

Similarly, the International Association of Color Manufacturers (IACM), whose members include the makers and users of natural as well as synthetic colours, emphasised that synthetic food dyes approved by the FDA continue to be used worldwide, including in Europe, and the agency is not proposing or issuing a mandatory ban on those dyes in the US.

However, proposing to reformulate such food dyes by the end of 2026 'ignores scientific evidence and underestimates the complexity of food production,' IACM stated. This process is complex and the resulting supply disruptions will limit access to familiar, affordable grocery items, the organisation warned.

Meanwhile, in January the FDA under former president Joe Biden banned the commonly used food dye erythrosine, known as Red 3, from food,

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drinks and oral medicines, citing research showing it causes cancer in male rats. Now the agency is requesting that companies remove that colouring sooner than the previously required January 2027 deadline for foods and January 2028 deadline for ingested drugs.

Chemistry World, 14 May 2025

https://chemistryworld.com

Scientists Finally Confirm "Crazy" Vitamin B1 Theory From 1958

2025-05-06

Chemists have confirmed a 67-year-old theory about vitamin B1 by stabilizing a highly reactive molecule in water, a breakthrough that was long considered impossible. This discovery not only resolves a long-standing biochemical question but also paves the way for more sustainable and efficient methods of producing pharmaceuticals.

The molecule involved is a carbene, a form of carbon atom with only six valence electrons instead of the usual eight. This electron deficiency makes carbenes extremely unstable and reactive, especially in water, where they typically break down almost immediately. However, for decades, scientists have suspected that vitamin B1, or thiamine, might form a carbene-like intermediate during essential reactions in the body.

Confirming Breslow's 1958 hypothesis

Now, for the first time, researchers have successfully created a stable carbene in water. They were able to isolate it, seal it in a container, and observe it remaining intact for several months. This achievement is detailed in a new paper published in Science Advances.

"This is the first time anyone has been able to observe a stable carbene in water," said Vincent Lavallo, a professor of chemistry at UC Riverside and corresponding author of the paper. "People thought this was a crazy idea. But it turns out, Breslow was right."

The reference is to Ronald Breslow, a Columbia University chemist who proposed in 1958 that vitamin B1 could convert into a carbene to drive biochemical transformations in the body. Breslow's idea was compelling, but carbenes were so unstable, especially in water, that no one could prove they actually existed in a biological setting.

Shielding the carbene for stability

Lavallo's team succeeded by wrapping the carbene in what he calls "a suit of armor," a molecule they synthesized in the laboratory that shields the reactive center from water and other molecules. The resulting structure is stable enough to be studied with nuclear magnetic resonance spectroscopy and x-ray crystallography, providing conclusive evidence that carbenes like this can exist in water.

"We were making these reactive molecules to explore their chemistry, not chasing a historical theory," said first author Varun Raviprolu, who completed the research as a graduate student at UCR and is now a postdoctoral researcher at UCLA. "But it turns out our work ended up confirming exactly what Breslow proposed all those years ago."

Toward greener pharmaceutical chemistry

Beyond confirming a biochemical hypothesis, the discovery has practical implications. Carbenes are often used as "ligands," or support structures, in metal-based catalysts — the chemical workhorses used to produce pharmaceuticals, fuels, and other materials. Most of these processes rely on toxic organic solvents. The researchers' method of stabilizing carbenes in water could help make those reactions cleaner, less expensive, and safer.

"Water is the ideal solvent — it's abundant, non-toxic, and environmentally friendly," Raviprolu said. "If we can get these powerful catalysts to work in water, that's a big step toward greener chemistry."

Mimicking cell chemistry in the lab

Knowing that such reactive intermediate molecules can be generated and survive in water also brings scientists one step closer to mimicking the kind of chemistry that happens naturally in cells, which are mostly made of water.

"There are other reactive intermediates we've never been able to isolate, just like this one," Lavallo said. "Using protective strategies like ours, we may finally be able to see them and learn from them."

For Lavallo, who has spent two decades designing carbenes, the moment is both professional and personal.

"Just 30 years ago, people thought these molecules couldn't even be made," he said. "Now we can bottle them in water. What Breslow said all those years ago — he was right."

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For Raviprolu, the discovery serves as a reminder to persevere in scientific research and discovery.

"Something that seems impossible today might be possible tomorrow, if we continue to invest in science," he said.

Sci Tech Daily, 6 May 2025

https://scitechdaily.com

Metal catalysts can be valuable, even when they aren't precious

2025-05-21

Transforming trash to treasure might sound like alchemy, but in some industries it's already happening. For example, furfural, an abundant plant byproduct, is regularly converted to tetrahydrofuran (THF)-based compounds that are highly valued as pharmaceutical intermediates and solvents.

This conversion process isn't easy though. An efficient conversion requires either expensive precious metal catalysts, like ruthenium and palladium, or non-precious metal catalysts that demand harsh conditions.

Now, a research team from the University of Osaka has set out to address this issue. As detailed in their study published in ACS Sustainable Chemistry & Engineering, the team sought to develop a cost-effective catalyst for furfural conversion under mild conditions.

The team previously found that nickel carbide nanoparticles, which are particles with a diameter of less than one hundred nanometers, can act as an effective catalyst in chemical conversions. In the present study, nickel carbide nanoparticles were supported on alumina to provide an effective catalyst for accessing THF compounds from furfural through hydrogenation, which involves the reaction of furfural with hydrogen molecules.

"Our catalyst readily converts furfural to the important synthetic intermediate tetrahydrofurfuryl alcohol through hydrogenation even at ambient hydrogen pressure," says lead author Taiki Kawakami. "Such high yield under mild conditions has not previously been realized using non-precious metal catalysts."

Promisingly, the nickel-based catalyst achieved 90% conversion of furfural despite the low hydrogen pressure. The catalyst was very effective under

mild conditions because of its strong ability to react with hydrogen molecules.

"The catalyst nanoparticles readily react with hydrogen to form polar hydrogen species that reduce furfural," explains senior author Tomoo Mizugaki. "In addition, the nanoparticles interact with the alumina support in a manner that further promotes furfural reduction."

The combined effects of the catalyst components led to the high-yielding synthesis of useful THF-based materials from the abundant starting material furfural under easily achievable conditions. Overall, the developed catalyst represents a major step toward the economically feasible, energy-efficient synthesis of valuable chemicals from waste biomass in biorefineries worldwide.

sPhys Org, 21 May 2025

https://phys.org

A smarter way to make sulfones: Using molecular oxygen and a functional catalyst

2025-05-09

As a recent leap in green chemistry, scientists from Japan have unveiled a new catalyst that enables high yields of sulfones using molecular oxygen -- close to room temperature. By fine-tuning the structure of oxygen vacancies in perovskite oxide catalysts, the researchers successfully reduced the reaction temperature from 80-150°C to nearly 30°C, offering improved energy efficiency. The study marks a significant milestone in advancing complex sulfide oxidation reactions, offering sustainability with excellent efficiency.

Sulfones, a class of sulfur-containing compounds, are chemically derived from the selective oxidation of sulfides. While these compounds form the core of the pharmaceuticals, solvents and polymer industries, their chemical synthesis is often hindered by high reaction temperatures and extreme reaction conditions. Additionally, these also require costly additives and harsh solvents for production. Against this backdrop, a team of researchers from Japan introduced a new catalyst design, capable of overcoming the limitations of conventional synthesis, offering higher selectivity and a better yield for sulfones.

The research team, led by Professor Keigo Kamata from Institute of Science Tokyo, Japan, utilized advanced catalyst synthesis techniques to explore

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how variations in elemental composition and crystal structure contribute to catalytic performance for sulfide oxidation at a lower temperature. Their findings were published online in Advanced Functional Materials on April 03, 2025.

"Sulfide oxidation using molecular oxygen as the oxidant is one of the most challenging reactions in organic chemistry, and the development of new solid catalysts that can facilitate this type of reaction has gained considerable attention in recent years," notes Kamata.

Addressing this demand, the researchers focused on perovskite oxide, a material widely used for catalysis. To enhance the reactivity of a specific metal-oxygen species (face-shared oxygen) in a hexagonal perovskite based on strontium (Sr), manganese (Mn) and oxygen (O) called SrMnO3, they introduced ruthenium (Ru) atoms in place of some of the Mn atoms. This subtle modification created oxygen vacancies inside the crystal, which significantly improved the catalyst's ability to transfer oxygen atoms -- an essential step in sulfide oxidation.

The result was an efficient catalyst known as SrMn1-xRuxO3, which was capable of converting sulfides to sulfones with an unprecedented selectivity of 99% at a reaction temperature as low as 30°C. This was a dramatic shift from that of conventional systems, which typically require 80-150°C for the same reaction.

Conventional reaction systems rely on large amounts of precious metals for selectivity. While the researchers did utilize Ru, they achieved greater selectivity at just 1% Ru doping, which significantly cuts down the use of precious metals. Using mechanistic studies, the researchers further uncovered the mechanism behind the remarkable catalytic performance.

"The catalysis follows a Mars-van Krevelen mechanism, in which the oxygen atoms on the crystal surface transfer to the sulfides, leaving behind oxygen vacancies. These vacancies are then filled by molecular oxygen in the atmosphere, and the cycle continues," explains Kamata.

Another striking advantage of the developed catalyst was its durability. The team confirmed that the catalyst could be reused at least five times without any significant loss of performance. Moreover, the system was applicable to a wide range of sulfide substrates, which included aromatic, aliphatic, making it highly versatile for industries.

While the present study focused only on sulfide oxidation, the implications of this work could extend to a wide range of oxidation reactions,

transforming environmental cleanup and energy conversions. The team hopes that their findings will inspire new catalyst designs that offer greater sustainability and cost-efficiency. The research also underscores the synergistic effect of multiple elements in creating sustainable materials, paving the way for greener and smarter industrial chemistry.

Science Daily, 19 May 2025

https://sciencedaily.com

Pressure and temperature record broken for sCO_2 materials testing

2025-05-20

Southwest Research Institute (SwRI) has achieved a significant milestone, reaching new temperature records for testing materials in high-pressure environments. While conducting material testing for a high-pressure, high-temperature supercritical carbon dioxide (sCO2) turbine, SwRI achieved unprecedented conditions of 1,150 degrees Celsius (2,100 degrees Fahrenheit) at 300 bar (4,350 psi). These are the highest published temperature and pressure conditions ever reached in sCO2 materials testing.

In 2020, began to design an sCO2 oxy-fuel turbine for a direct-fired sCO2 power plant. The project, led by Senior Research Engineer Michael Marshall and Institute Engineer Dr. Jeff Moore, required materials testing in extreme sCO2 environments.

"We evaluated turbine materials at constant temperatures and pressures with 100% sCO2. We assessed the performance of different materials and coatings under extreme conditions," said SwRI's Dr. Florent Bocher, who oversaw materials engineering for the project.

Previously, the highest pressure and temperature conditions reached for supercritical CO2 reported in the literature were 800 degrees Celsius at 300 bar, which SwRI aimed to exceed by 350 degrees. SwRI's oxy-fuel turbine was designed to operate at a maximum temperature of 1,150 degrees.

"During initial testing, we aimed to build a test vessel to evaluate materials at the highest temperatures and pressures based on the turbine design, which was 1,150 degrees Celsius at 300 bar," Bocher said.

"However, the mechanical properties of the vessel materials decline as temperatures rise. This makes it impossible to safely use a traditional

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high-pressure and high-temperature experimental setup design, which incorporates external heating."

To overcome this limitation, SwRI modified an autoclave, a specialized device designed to contain a high-pressure and high-temperature test environment. The researchers installed an induction coil inside the autoclave, while its exterior was actively cooled. This allows the external containment structure to stay relatively cool and hold the pressure safely while the inside of the vessel reaches the targeted high temperatures.

"The new setup allows us to reach up to 1,150 degrees Celsius at 300 bar, significantly enhancing our capability to conduct tests under extreme conditions," Bocher said. "This advancement provides additional opportunities to support testing of other types of turbine materials."

This unique capability can also test materials employed in other extreme applications, such as molten salt energy production and storage, hypersonics research and additional material testing for the Supercritical Transformational Electric Power (STEP) Demo pilot plant, a 10-megawatt supercritical carbon dioxide (sCO2) demonstration facility at SwRI.

"This is a major accomplishment. SwRI's superior capabilities push the boundaries of what's possible in this field," Bocher said. "This new capability is crucial for both current and future research areas and technologies that demand extreme testing conditions."

Phys Org, 20 May 2025

https://phys.org

Recycling Breakthrough Turns "Forever Chemicals" Into Renewable Resources

2025-05-19

Scientists at the University of Leicester have developed a technique that uses soundwaves to separate materials in fuel cells within seconds.

A new technique that uses sound waves to separate materials for recycling could help prevent harmful chemicals from leaching into the environment.

Researchers at the University of Leicester have reached a major breakthrough in fuel cell recycling by developing a method to efficiently separate valuable catalyst materials and fluorinated polymer membranes (PFAS) from catalyst-coated membranes (CCMs).

This advancement tackles significant environmental concerns related to PFAS, often called "forever chemicals," which are known to pollute drinking water and pose serious health risks. The Royal Society of Chemistry has called for government action to lower PFAS levels in UK water supplies.

Breaking down complex catalyst-coated membranes

Fuel cells and water electrolyzers, essential components of hydrogen-powered energy systems, powering cars, trains and buses, depend on CCMs containing precious platinum group metals. However, the strong adhesion between catalyst layers and PFAS membranes has made recycling difficult.

Researchers at Leicester have developed a scalable method using organic solvent soaking and water ultrasonication to effectively separate these materials, revolutionizing the recycling process.

Dr Jake Yang from the University of Leicester School of Chemistry said: "This method is simple and scalable. We can now separate PFAS membranes from precious metals without harsh chemicals—revolutionizing how we recycle fuel cells. Fuel cells have been heralded for a long time as the breakthrough technology for clean energy but the high cost of platinum group metals has been seen as a limitation. A circular economy in these metals will bring this breakthough technology one step closer to reality."

Ultrasound blade cuts recycling time to seconds

Building on this success, a follow-up study introduced a continuous delamination process, using a bespoke blade sonotrode that uses high-frequency ultrasound to split the membranes to accelerate recycling.

The process creates bubbles that collapse when subjected to high pressure, meaning the precious catalysts can be separated in seconds at room temperature. The innovative process is both sustainable and economically viable, paving the way for widespread adoption.

This groundbreaking research was carried out in collaboration with Johnson Matthey, a global leader in sustainable technologies. Industry-academia partnerships such as this underscore the importance of collective efforts in driving technological progress.

Ross Gordon, Principal Research Scientist at Johnson Matthey, said: "The development of high-intensity ultrasound to separate catalyst-loaded membranes is a game-changer in how we approach fuel cell recycling. At

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Johnson Matthey, we are proud to collaborate on pioneering solutions that accelerate the adoption of hydrogen-powered energy while making it more sustainable and economically viable."

As fuel cell demand continues to grow, this breakthrough contributes to the circular economy by enabling efficient recycling of essential clean energy components. The researchers' efforts support a greener and more affordable future for fuel cell technology while addressing pressing environmental challenges.

Sci Tech Daily, 19 May 2025

https://scitechdaily.com

Microplastics and the Invasion of Ukraine Are Affecting Bee Populations

2025-05-21

The report identifies the top 12 emerging threats that could accelerate pollinator losses within the next 5-15 years.

Warzones, microplastics and light pollution pose serious new risks to bees and other pollinators over the next decade, according to a landmark report on today's World Bee Day.

The report from Bee:wild, a new science-led global campaign to save pollinators, identifies the top 12 emerging threats that could accelerate pollinator losses within the next 5-15 years, according to ten of the world's leading experts. It also outlines steps we can take to protect them and reverse the decline.

Pollinators like bees, butterflies, some birds and bats are vital to nature and our food supply with almost 90% of flowering plants and over three-quarters of the world's staple crops depending on them. But habitat loss, pesticides, climate change and invasive species have caused their severe decline, including the extinction of some bee species.

A wave of new threats is adding further pressure, according to the report: 'Emerging Threats and Opportunities for Conservation of Global Pollinators.'

These include:

- War and conflict, such as the war in Ukraine, forcing countries to grow fewer crop types and leaving pollinators without diverse food throughout the season.
- Microplastic particles contaminating beehives across Europe, with testing from 315 honey bee colonies revealing synthetic materials like PET plastic in most hives.
- Artificial light at night reducing flower visits by nocturnal pollinators by 62% and inhibiting the crucial role moths and night insects play in pollination.
- Antibiotic pollution potentially contaminating beehives and honey, and affecting the behavior of pollinators, such as reducing their foraging and visits to flowers.
- Air pollution affecting their survival, reproduction and growth.
- Pesticide cocktails weakening pollinators who increasingly face a dangerous mix of different pesticides, particularly in developing countries.
- More frequent and larger wildfires, destroying habitats and making recovery harder.

The University of Reading's Professor Simon Potts, lead author and chair of Bee:wild's Scientific Advisory Board, says: "Identifying new threats and finding ways to protect pollinators early is key to preventing further major declines."

He continues: "By acting early, we can reduce harm and help pollinators continue their important work in nature and food production. Various conservation opportunities already exist and more are emerging. This is not just a conservation issue. Pollinators are central to our food systems, climate resilience, and economic security. Protecting pollinators means protecting ourselves."

The report also outlines some threats that unintentionally stem from climate actions, which could be improved to protect biodiversity at the same time. Planting a mix of flowering trees as well as non-flowering fast-growing trees for carbon capture would restore pollination opportunities. Avoiding pollinator-rich areas and restoring habitats after mining for car battery materials would also help reduce the impact of mining in the long-term.

These steps are among the 12 that the report outlines for pollinator protection. Ranked in order of novelty and impact, the top five are:

1. Stronger laws limiting antibiotic pollution that harms bee health

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2. Transitioning to electric vehicles to reduce air pollution affecting pollinators
3. Breeding crops with enhanced pollen and nectar for better pollinator nutrition
4. Creating flower-rich habitats within solar parks
5. Developing RNAi-based (Ribonucleic acid) treatments that target pests without harming beneficial insects

Protecting stingless bees - which are important for pollination in the tropics - by creating urban gardens, rewilding and protecting natural habitats is another solution. Using AI to help track pollinators is another opportunity.

Dr. Deepa Senapathi, Head of Department of Sustainable Land Management at the University of Reading, is co-author of the report and Vice-Chair of Bee:wild Scientific Advisory Board.

She explains: "Meaningful action to protect bees is not a "nice-to-have" future aspiration - practical solutions that we can implement now already exist and more are emerging. The most promising opportunities are ones that tackle multiple problems at once. Focused and determined action could significantly slow and even reverse pollinator decline while creating environments that benefit both nature and people."

She adds: "It will take effort from everyone to address these threats. We need to maintain, manage and improve our natural habitats to create safe spaces for pollinators. Individual actions like providing food and nesting areas in our own back gardens can help in a big way. But policy changes and individual actions must work together so everything from gardens and farms to public spaces and wider landscapes can all become pollinator-friendly habitats."

Eva Kruse, Executive Director of Bee:wild, which commissioned the report says: "We were already sounding the alarm on the decline of our pollinators, but this new report underlines that the range of threats are expanding. Rather than being filled with hopelessness, the purpose of the Bee:wild campaign is to fuel awareness, urgency and give everyone agency. There's a lot we can all do to help save our pollinators, in our homes and everyday lives. Planting flowering plants to feed them, providing outdoor shelter and considering healthier diets like plant-based as well as pesticide-free, all matter a lot."

She adds: "It's getting harder for our pollinators but we can all play a part in protecting them and building a sustainable future for all living things."

Razan Khalifa Al Mubarak, President of the International Union for Conservation of Nature (IUCN) and Board Member of nature conservation organization Re:wild - which is behind the Bee:wild campaign - provided the report's foreword.

She says: "The choices we make today will shape the future - not only for pollinators, but for all life on Earth. Together, we can ensure that these remarkable species continue their vital work, sustaining the natural world that sustains us all."

Bee:wild is a science-led, non-profit civil society movement, powered by brands, that aims to increase pollinator numbers for the benefit of more nature and human health by inspiring individual and collective action.

Bee:wild was originally initiated by PANGAIA and is now powered by a coalition of businesses and organized by Re:wild, a leading nature conservation organization focused on the most effective solution to the interconnected climate, biodiversity and human wellbeing crises; protecting and restoring the wild.

Emerging threats to pollinators (national to global) ranked from highest to lowest by novelty, then impact

6. Crop simplification due to conflicts – War and conflict affects how land is used, reducing crop variety, which could harm wild pollinators.
7. Microplastic pollution – Tiny plastic particles are everywhere and can reduce pollinator health and lifespan.
8. Poorly planned tree planting for Net Zero – Planting lots of trees can help or hurt nature, depending on the type of trees planted, and where.
9. Antibiotic pollution – Antibiotics pollute the environment and may change bee behavior.
10. Air pollution – Polluted air with gases like ozone and nitrogen oxides makes it harder for insects to survive and reproduce.
11. Increased indoor farming – Growing crops in enclosed spaces reduces natural habitats for wild pollinators and may spread disease through the introduction of managed pollinators.
12. Increased demand for mining of metals – Mining for materials like lithium and cobalt, used in batteries, damages land and water, which may harm pollinators.

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13. Pesticide cocktails – Mixing different pesticides can weaken pollinators, and their use is increasing, particularly in some regions like Africa and South America.
14. Light pollution – Bright artificial lights at night confuse pollinators like moths and can reduce pollination.
15. Heavy metal pollution – Toxic metals like cadmium and mercury can harm pollinators' health, behavior, and survival.
16. Wildfires combined with other threats – More frequent large wildfires destroy pollinator habitats, making recovery harder.
17. Regional loss of pesticide monitoring – Without proper tracking, harmful pesticides may be overused, killing pollinators and removing floral resources, as well as making pests resistant and damaging the environment.

Emerging opportunities for pollinators (national to global) ranked from highest to lowest by novelty, then impact

18. Stronger laws on antibiotic use – Better regulations could limit antibiotic pollution, especially in areas where there are no restrictions.
19. Reduced demand for fossil-fueled vehicles – Electric vehicles can reduce air pollution that can be harmful to pollinators.
20. Plant breeding for pollinators – Crops can be designed for pollinators by providing more pollen and nectar, but more research is needed to ensure safety.
21. Flower-filled solar parks – Solar farms can serve as pollinator-friendly habitats if located well and designed properly.
22. RNAi treatments for pests of pollinators – New pest control methods using RNAi technology could protect bees while reducing pesticide use.
23. AI and targeted conservation – AI can track pollinators, detect pests, and help improve conservation efforts.
24. Trade and agricultural policies promoting low-pesticide products – Regulations could encourage farming with fewer pesticides, protecting pollinators and their habitats.
25. Beekeeping legislation in conservation areas – Implementing regulations could help minimize competition between managed bees and wild pollinators for essential resources.
26. Restore full ecosystem function, not just plants – Conservation should focus on rebuilding whole ecosystems, not just planting trees.

27. Protecting stingless bees – Efforts should focus on saving native stingless bees, which play a key role in pollination in the tropics.
28. More effective global policies – International regulations and laws, like the EU Nature Restoration Regulation, support pollinator protection and create groundswell support for carbon capture and reducing carbon emissions.
29. Solutions benefiting multiple ecosystem services – Protecting pollinators can also simultaneously improve soil health, water storage, and carbon capture.

Technology Networks, 21 May 2025

https://technologynetworks.com

Experimental painkiller could outsmart opioids -- without the high

2025-05-19

An experimental drug developed at Duke University School of Medicine could offer powerful pain relief without the dangerous side effects of opioids.

The drug, called SBI-810, is part of a new generation of compounds designed to target a receptor on the nerves and spinal cord. While opioids flood multiple cellular pathways indiscriminately, SBI-810, a non-opioid treatment, takes a more focused approach, activating only a specific pain-relief pathway that avoids the euphoric "high" linked to addiction.

In tests in mice, SBI-810 worked well on its own and, when used in combination, made opioids more effective at lower doses, according to the study published May 19 in Cell.

"What makes this compound exciting is that it is both analgesic and non-opioid," said senior study author Ru-Rong Ji, PhD, an anesthesiology and neurobiology researcher who directs the Duke Anesthesiology Center for Translational Pain Medicine.

Even more encouraging: it prevented common side effects like constipation and buildup of tolerance, which often forces patients to need stronger and more frequent doses of opioids over time.

SBI-810 is in early development, but Duke researchers are aiming for human trials soon and they've locked in multiple patents for the discovery.

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There's an urgent need for pain relief alternatives. Drug overdose deaths are declining, but more than 80,000 Americans still die each year most often from opioids. Meanwhile, chronic pain affects one-third of the U.S. population.

Researchers said the drug could be a safer option for treating both short-term and chronic pain for those recovering from surgery or living with diabetic nerve pain.

SBI-810 is designed to target the brain receptor neurotensin receptor 1. Using a method known as biased agonism, it switches on a specific signal -- β-arrestin-2 -- linked to pain relief, while avoiding other signals that can cause side effects or addiction.

"The receptor is expressed on sensory neurons and the brain and spinal cord," Ji said. "It's a promising target for treating acute and chronic pain."

SBI-810 effectively relieved pain from surgical incisions, bone fractures, and nerve injuries better than some existing painkillers. When injected in mice, it reduced signs of spontaneous discomfort, such as guarding and facial grimacing.

Duke scientists compared SBI-810 to oliceridine, a newer type of opioid used in hospitals, and found SBI-810 worked better in some situations, with fewer signs of distress.

Unlike opioids like morphine, SBI-810 didn't cause tolerance after repeated use. It also outperformed gabapentin, a common drug for nerve pain, and didn't cause sedation or memory problems, which are often seen with gabapentin.

Researchers said the compound's dual action -- on both the peripheral and central nervous systems -- could offer a new kind of balance in pain medicine: powerful enough to work, yet specific enough to avoid harm.

The study was supported by the NIH and the Department of Defense.

Additional Duke authors include first authors Ran Guo and Ouyang Chen; Sangsu Bang, Sharat Chandra, Yize Li, Gang Chen, Rou-Gang Xie, Wei He, Jing Xu, Richard Zhou, Shaoyong Song, Ivan Spasojevic, Marc G. Caron, William C. Wetsel and Lawrence S. Barak.??

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Breakthrough shrinks fusion power plant and expands practicality

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Commercial fusion power plants may be cheaper and easier to build thanks to a breakthrough by TAE Technologies that allows reactors to generate their own containment fields without the need for massive magnetic coils and other systems.

Practical fusion power has been touted as only 25 years in the future ever since 1945, but there are some bright spots on the horizon that suggest that it could come to pass as soon as the next decade.

Part of the problem has been that the tokamak reactor, the front-runner design for a fusion power plant, has become a bit like that home extension that got out of hand and sucked up a lot more time and money than originally budgeted for until you wish you'd never started it in the first place.

First conceived of by Igor Tamm and Andrei Sakharov in the 1950s, tokamaks use a toroidal magnetic field to contain the hydrogen plasma to help keep it at the sun-like pressure and temperature needed to ignite fusion. The problem is that over decades of development tokamak designs have become gigantic, with huge, complicated superconducting magnetic coils to generate the containment fields along with equally complex and huge electromagnetic heating systems.

The result is that the largest tokamak weighs in at 23,000 tonnes and is still a long way from being practical.

Using a different type of fusion reaction combined with a new reactor design, TAE says that it's come up with a simpler, more efficient way to build a commercial reactor compared to a tokamak. It does this by dumping the toroidal field in favor of a linear one that is based on what is called the Field-Reversed Configuration (FRC) principle.

Essentially, FRC does away with the massive magnetic coils by making the plasma produce its own magnetic containment field. After accelerating high-energy ions of hydrogen and then giving them an electrically neutral charge, these are injected as a beam into the plasma. On colliding with the plasma, the beam particles are re-ionized, while the collision energy heats the plasma.

The clever bit is that this sets up toroidal currents in the plasma. As these intensify, the magnetic field used initially to contain the plasma inverts

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and the plasma starts generating its own containment field. This field can be configured in real-time for stability and adjusting the pressure as required.

According to TAE, an FRC reactor can produce up to 100 times more fusion power output than a tokamak based on the same magnetic field strength and plasma volume. This allows for a surprisingly simple linear reactor design that is cheaper to build and operate. Using a new neutral beam injection system, the company says that it has been able to improve on a previous experimental reactor, reducing the machine's size and complexity while slashing the costs by 50%.

In addition, FRC allows a reactor to run on proton-boron aneutronic fusion. That is, a fusion reaction that fuses a hydrogen nucleus and a boron-11 atom instead of two atoms of the hydrogen isotopes deuterium and tritium. It's called aneutronic because instead of producing a neutron, the reaction $p+{}^{11}B \rightarrow 3\alpha+8.7MeV$ produces three alpha particles (helium-4 nuclei) plus a lot of energy.

This is attractive because the fewer neutrons the less damage is done to the reactor, the energy being released as charged particles is easier to harness, less shielding is required, and boron-11 is relatively abundant and is not radioactive.

The new reactor is called Norm because it's significantly shorter than Norman, its predecessor. This is because the new FRC system allowed the engineers to dump the long quartz tubes at either end of the chamber that were used for plasma creation through supersonic collisions during plasma injection.

The data from Norm will be used to inform construction of the next reactor, Copernicus, which will lead to Da Vinci (never mind that Vinci was where Leonardo was from, not his name, but there you are), TAE's commercial prototype that is expected to enter service in the next decade.

"With Norm, we have mastered the remaining complexities of the FRC, and through its successful operation, TAE has materially de-risked Copernicus," said TAE CEO Michl Binderbauer. "The NBI-only achievement is an inflection point for TAE's fusion R&D, charting a path for streamlined devices that directly addresses the commercially critical metrics of cost, efficiency and reliability. This milestone significantly accelerates TAE's path to commercial hydrogen-boron fusion that will deliver a safe, clean and virtually limitless energy source for generations to come."

The research was published in Nature Communications.

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