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ASIA PACIFIC

Food Standards Australia New Zealand CEO year in review

2025-12-05

As 2025 draws to a close, I reflect with pride on the progress we have made with our food regulation system partners and stakeholders to keep food safe and trusted in a rapidly evolving food system environment.

This year, following rigorous scientific assessment and extensive stakeholder consultation, we delivered a range of important food regulatory outcomes for Australia and New Zealand. We strengthened national standards for egg production and processing to ensure eggs remain a safe and trusted staple in Australian households, updated the definitions for genetically modified (GM) foods to bring the Food Standards Code into line with current science and introduced mandatory energy labelling on alcoholic beverages to support informed consumer choice.

We approved cultured quail, the first cell-cultured food in Australia and New Zealand, marking a milestone in food innovation, while advancing preparatory work on front- and back-of-pack nutrition labelling. We also continued to gather the data and evidence needed to underpin standards development through national food surveillance, including progressing the 28th Australian Total Diet Study and a national study into antimicrobial resistance in the Australian food supply.

Read More

Food Standards Australia New Zealand, 05-12-25

https://www.foodstandards.gov.au/news/ceo-year-review

Behind the numbers: what's causing harm at work

2025-12-02

What causes injuries, illnesses and fatalities in Australian workplaces? In 2025, Safe Work Australia's Data Improvement and Analysis team set out to examine the mechanisms – the actions, exposures or events – that lead to work-related harm.

Whether it's a fall from height, a vehicle incident, or body stressing, each mechanism tells a story about the nature of workplace risk. Guided by

the Australian Work Health and Safety Strategy monitoring approach, the team analysed existing datasets to uncover patterns, compare causes of serious injury claims and fatalities, and identify the most common and costly mechanisms.

These findings will help to shape evidence and data-informed policies to make Australian workplaces safer and healthier.

A closer look into fatalities and serious injury claims

The analysis began by comparing the mechanisms behind serious workers' compensation claims and fatalities. In 2023-24p1, there were 146,700 serious claims2, while 188 traumatic injury fatalities were recorded in the 2024 calendar year. The data revealed notable differences in the types of incidents driving these outcomes.

Vehicle incidents emerged as the leading cause of work-related deaths in Australia, and by a significant margin. In 2024, they accounted for 42% of all workplace fatalities and more than triple the next most deadly mechanism, falls from a height (13%). Trucks, semi-trailers and lorries featured prominently in vehicle incident fatalities, with males making up 94% of vehicle-related deaths. The data also revealed a trend that older workers had an increased fatality risk in vehicle incidents.

Read More

Safe Work Australia, 02-12-25

https://www.safeworkaustralia.gov.au/media-centre/evidence-matters/2025/behind-numbers-whats-causing-harm-work

AMERICA

New York's Climate Law Experiences Another Delay

2025-11-25

ALBANY, N.Y. — Today, the Hochul administration filed an appeal of the Albany Supreme Court's decision that the New York Department of Environmental Conservation (DEC) violated the law by failing to promulgate regulations that ensure compliance with the state's emissions limits by the statutory deadline of January 1, 2024.

This appeal pauses the deadline of February 6, 2026 that was set by the court for DEC to issue regulations and will likely move the timeline to much later in the year.

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"This delay has already caused communities to miss out on at least $3 billion in investments to expand access to cleaner, cheaper energy today, including over $1 billion that could have directly lowered energy bills," said Kate Courtin, Senior Manager of State Climate Policy & Strategy at EDF. "There is robust evidence that, by moving forward with a well-designed Clean Air Initiative, Governor Hochul would cut costs for working families in New York while significantly cutting pollution.

"The Hochul administration is rejecting an opportunity to slash pollution, shield families from rising energy costs and push back against federal rollbacks that would stick New Yorkers with dirty, expensive energy sources."

Read More

EDF, 25-11-25

https://www.edf.org/media/new-yorks-climate-law-experiences-another-delay

New Jersey Settlement: Protecting Residents and Their Environment

2025-11-24

Environmental Defense Fund (EDF) joined PSE&G, New Jersey Ratepayer Counsel, and New Jersey Board of Public Utilities (BPU) staff in a settlement approved last week that protects New Jersey residents and our environment. EDF supports the settlement and applauds the BPU for approving it in full.

"New Jersey's gas customers win with this settlement," said Curt Stokes, Director and Senior Attorney at Environmental Defense Fund. "It significantly cuts costs for customers by scaling back PSE&G's originally proposed increases to infrastructure spending and removes a proposal to charge ratepayers for unproductive renewable natural gas and hydrogen projects."

A recent study, commissioned by EDF and conducted by the think tank Switchbox, shows that blending green hydrogen into New Jersey's natural gas system as proposed by PSE&G in its original filing would be far less efficient than directly electrifying homes and using efficient, affordable, and reliable heat pumps.

Read More

EDF, 24-11-25

https://www.edf.org/media/new-jersey-settlement-protecting-residents-and-their-environment

Risk management scope for triphenyl phosphate (TPHP) and tris(2-butoxethyl) phosphate (TBOEP)

2025-11-21

Summary of proposed risk management

This risk management scope outlines the risk management options under consideration for TPHP and TBOEP. It is proposed to conclude that these substances are harmful to human health under a human health risk characterization. The proposed risk management options under consideration for human health are being considered in addition to the risk management options under consideration to address the risks to the environment of the aryl organophosphates subgroup (which includes TPHP), as outlined in the November 2021 Risk Management Scope for TPHP, BPDP, BDMEPPP, IDDP, IPPP and TEP.

For the purposes of paragraph 77(1)(a) of the Canadian Environmental Protection Act, 1999 (CEPA), the Government of Canada proposes to recommend that TPHP and TBOEP be added to Part 2 of Schedule 1 to CEPAFootnote1. As a result, the Government of Canada is considering the following new risk management actions:

- Regulatory and/or non-regulatory actions to reduce dermal exposure to TPHP of adults from certain lubricants and greases
- Regulatory and/or non-regulatory actions to reduce prolonged dermal exposure to TPHP of people of all ages from products made with polymeric foams (such as certain mattresses and upholstered furniture)
- Regulatory and/or non-regulatory actions to reduce prolonged dermal exposure to TPHP of infants and children up to 13 years of age from the foam in certain infant and child restraint systems
- Regulatory and/or non-regulatory actions to reduce prolonged dermal exposure of people of all ages to TBOEP in products made with polymeric foams (such as certain mattresses and upholstered furniture)
- Regulatory and/or non-regulatory actions to reduce prolonged dermal exposure of infants and children up to 13 years of age to TBOEP in the foam of certain infant and child restraint systems

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The Government of Canada is also considering other risk management actions, as follows:

- Listing TPHP as a prohibited or restricted ingredient on the Cosmetic Ingredient HotlistFootnote2 to help reduce dermal exposure to TPHP of people 4 years of age and older from certain nail care products

To inform risk management decision-making, information on the following topics should be provided (ideally on or before January 21, 2026) to the contact details identified in section 8 of this document:

- Anticipated economic impacts if the import/export and/or use of TPHP and/or TBOEP are prohibited or restricted in Canada
- Ongoing or anticipated changes in use of the above flame retardants, whether in response to:
- Shifts to alternative substances (please provide commercial name), alternative systems and approaches
- Market forces
- Changes in performance-based flammability requirements and/or standards; and/or
- Other reasons (please provide information on these reasons)

Read More

Government of Canada, 21-11-25

https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/risk-management-scope-triphenyl-phosphate-tris-2-butoxethyl-phosphate.html

EUROPE

The Circulation Room – a reflection on ultra-fast fashion and sharing

2025-11-26

We live in a world where everything has to be fast. Cars, the internet, even reading—speed-reading courses are more popular than ever (not to mention one-minute fairy tales for children). But nothing moves faster than fashion. It seems that when it comes to getting dressed, people are constantly racing against time.

Once, fast fashion was the problem. Today, it's ultra-fast fashion—a beast of an entirely new scale. France, for instance, differentiates the two by

production speed: fast fashion brands release about 1,000 new items a day, while ultra-fast fashion companies push out up to 12,000.

The result? A dizzying flood of clothes that no one really needs.

The numbers tell a stark story. Every year, the global fashion industry produces between 100 and 150 billion garments, and around 120 million tons of those end up in landfills or are incinerated. We already have enough clothes on this planet to dress ourselves, our children, and our grandchildren, yet production keeps accelerating.

Behind this endless stream of cheap clothes lies an uncomfortable truth. The average price of clothing has plummeted over the past 30 years, while production has skyrocketed. Clothes are cheaper than ever. So cheap that we no longer think twice before buying, or before throwing them away. But the real price is paid elsewhere: in developing countries, where garment workers often earn far below a living wage and work under harsh, unsafe conditions.

Fashion is now one of the world's most polluting industries, responsible for about 10% of global carbon emissions. It consumes vast amounts of water, chemicals, and energy, and pollutes rivers and ecosystems in the process. Yet, we rarely think about who made our clothes—or what happened to them before they ended up on a hanger.

Read More

Zero Waste Europe, 26-11-25

https://zerowasteeurope.eu/2025/11/the-circulation-room-a-reflection-on-ultra-fast-fashion-and-sharing/

What you need to know about e-waste, and how communities across Europe are taking action

2025-11-26

E-waste is the EU's fastest-growing waste stream, rising by around 2% every year. In 2022, Europeans bought 14.4 million tonnes of electrical and electronic equipment, yet only 5 million tonnes of WEEE (Waste Electrical and Electronic Equipment) were officially collected, about 11.2 kg per person. Nearly half of all e-waste slips through formal systems, and only around 40% is properly recycled.

Read the factsheet about the overview of WEEE within the EU framework.

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Why e-waste matters

WEEE includes everything from fridges and TVs to laptops, routers, toys, and small household gadgets. These items contain hazardous substances that can contaminate soil, water, and air if improperly handled. At the same time, they hold valuable and critical raw materials essential to Europe's digital infrastructure, climate technologies, and green transition.

Recovering these materials through reuse, repair, and high-quality recycling reduces environmental impact and strengthens Europe's strategic autonomy.

Communities leading the way

Across Europe, people are showing that practical, community-based solutions already exist. The European Week for Waste Reduction (EWWR) brings together public authorities, NGOs, schools, businesses, and citizens to promote real-world actions that cut waste. This year's focus on e-waste highlights how local initiatives can deliver measurable impact.

Read More

Zero Waste Europe, 26-11-25

https://zerowasteeurope.eu/2025/11/what-you-need-to-know-about-e-waste-and-how-communities-across-europe-are-taking-action/

Spotlight: New report shines light on industry actors attempting to remove EU water protections

2025-11-24

A new report, "Industry's role in water resilience: How some lead – and others wreck", has lifted the lid on how little some of Europe's most powerful industry groups care about the rules that protect people and nature from one of the biggest threats of our time: pollution and destruction of nature. The findings reveal attempts by parts of the agriculture, energy, mining, and chemical sectors to weaken the EU's cornerstone water protection law, the Water Framework Directive (WFD), under the guise of "simplification" and "competitiveness."

Despite depending on clean and abundant water for their own operations, these lobbies are pressuring the European Commission (EC) to use the upcoming Environmental "Omnibus" Package – the EC's proposal to deregulate (rip up) environmental laws – to roll back fundamental WFD safeguards. Their demands include scrapping the "one-out, all-out"

principle, watering down the ban on destroying nature, and postponing the 2027 deadline to restore Europe's rivers, lakes, and aquifers to good health. All despite the fact that the WFD was given a clean bill of health, declared as "fit for purpose" by the Commission's own fitness check, only in 2019.

If granted, these changes would open the floodgates to further pollution and nature destruction, threatening not only ecosystems and wildlife, but also vital sources of drinking water – endangering the health of millions of people across Europe, while at the same time undermining the EU's new Water Resilience Strategy and Europe's climate goals.

The report shows how industrial agriculture seeks to dodge vitally needed pollution controls, extractive industries want freer permits for new mines, and energy giants are pushing to redefine pollution standards, all while claiming to act in the name of green growth. All in the name of short-term profits.

Read More

EEB, 24-11-25

https://eeb.org/en/spotlight-new-report-shines-light-on-industry-actors-attempting-to-remove-eu-water-protections/

Legislative and guidance proposals for the Control of Asbestos Regulations 2012

2025-11-10

The Health and Safety Executive (HSE) undertakes a wide range of regulatory functions fundamental to enabling a safe and healthy workplace. We are dedicated to protecting people and places and helping everyone lead safer and healthier lives. Our role goes beyond worker protection to include public assurance. We work to ensure people feel safe where they live, where they work and, in their environment.

Great Britain (GB) has one of the best workplace health and safety performances in the world and achieves some of the lowest rates of occupational injury and fatality in Europe.

HSE's work supports innovation, productivity and economic growth in GB and businesses that adopt effective, proportionate health and safety practices increase productivity and employee engagement. HSE's strategy - Protecting people and places: HSE strategy 2022 to 2032 – also commits HSE to enabling industry to reduce workplace ill health.

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This consultative document is issued by HSE in compliance with its duty to consult under section 50(3) of the Health and Safety at Work etc. Act 1974 and in line with the Government's Consultation Principles for consulting with stakeholders.

The consultation aims to seek stakeholders views on regulatory and non-regulatory proposals:

Regulatory

1. To amend the Control of Asbestos Regulations 2012 and associated guidance to ensure the independence and impartiality of roles in the four-stage clearance process to minimise the risk of exposure from asbestos to workers and building users after the removal of asbestos

Read More

HSE, 10-11-25

https://consultations.hse.gov.uk/hse/proposals-control-of-asbestos-regs-2012/

Revision of EU legislation on drug precursors: Implementation take-aways

2025-12-03

The main objective of European Union regulation of drug precursors is to strike a balance between preserving the legitimate interests of businesses that commercialise chemical substances for licit economic activities, and the need for controls to prevent their diversion to illicit narcotic drugs production. However, measures to control the trade in drug precursors only partially prevent their illicit use. Despite reforms to apply controls to new substances more rapidly, criminal networks have demonstrated their ability to circumvent the rules by using unscheduled (see below) and ever-emerging substances to further produce narcotic drugs and psychoactive substances. They also seize opportunities provided by new global trade modus operandi via postal or online platforms. The inclusion of substances submitted to strict control on a list is no longer sufficient; drug precursor regulations have become only one of the tools available to prevent, reduce and eventually end their misuse. The need to revise the drug precursors regulations as envisaged in the European Commission's 2025 work programme is not put into question; however, the revision needs to be understood and conceived within the broader policy framework on the fight against drugs trafficking and be supported by operational measures,

such as innovative technologies to detect drug precursors within the EU and across its borders. The Commission is expected to publish the new proposal on 3 December 2025.

Read More

European Parliament, 03-12-25

https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2025)774691

INTERNATIONAL

World's biggest chemicals group to exit PFAS 'forever chemicals'

2025-11-26

PRESS RELEASE: BASF will phase out PFAS by 2028. This decision signals a new trend among chemical giants to phase out "forever chemicals" amid mounting investor concerns over safety and the environment.

The world's largest chemicals group, BASF, will phase out PFAS by 2028, ChemSec can reveal, as it joins a raft of major companies turning their back on controversial "forever chemicals."

According to the ChemScore index, published yesterday, one-third of major chemicals manufacturers say they intend to exit highly persistent chemicals, the toxic group to which PFAS belong.

"Considering the need to maintain high safety and environmental standards, BASF calls for substituting the use of PFAS in industrial equipment," BASF said in a statement.

The German conglomerate, with sales of €65 billion last year, said it will phase out products (excluding crop protection) formulated with PFAS, opting instead to provide innovative alternatives to customers.

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BASF says it adopted this position in May 2023. Although the company does not provide a clear exit date, its sustainability manual indicates the phase-out must take place within five years, or by 2028.

Read More

Chemsec, 26-11-25

https://chemsec.org/worlds-biggest-chemicals-group-to-exit-pfas-forever-chemicals/

Global Environment Outlook 7 Launch

2025-12-05

The Global Environment Outlook is UNEP's flagship environmental assessment. GEO-7, the product of 287 multi-disciplinary scientists from 82 countries, is the most comprehensive scientific assessment of the global environment ever carried out. GEO-7, the product of 287 multi-disciplinary scientists from 82 countries, is the most comprehensive scientific environmental assessment ever carried out. It focuses on how to tackle the global environmental crises the world is currently facing. The report shows how investing in a stable climate and healthy nature can deliver higher GDP, fewer deaths, and less poverty. It assesses two main themes: the impacts of the interlinked global environmental crises of climate change, biodiversity loss and land degradation, and pollution and waste; and how these crises can be addressed through systems transformations. GEO-7 draws on a diversity of world views and knowledge from many different sources including the natural, social and behavioural sciences, modelling, economics, as well as Indigenous Knowledge and Local Knowledges.

Read More

UNEP, 05-12-25

https://www.unep.org/events/publication-launch/global-environment-outlook-7-launch

REACH Update

DEC. 12, 2025

Video tutorials help navigate ECHA CHEM

2025-12-03

Have a look at the first two video tutorials on our new chemicals database ECHA CHEM.

These tutorials show how to navigate REACH registrations, search for analytical and ecotoxicological information in them and interpret key study data.

The first two videos are part of a series of short tutorials – more will come soon.

Read More

ECHA, 03-12-25

Video tutorials help navigate ECHA CHEM

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Janet's Corner

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Who am I?

2025-12-12

I am a pale blue, radioactive noble gas produced from the decay of radium.

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

I am a pale blue, radioactive noble gas produced from the decay of radium.

.

Chlordane

2025-12-12

USES [2,3]

Chlordane was used as a pesticide in the United States from 1948 to 1988. In 1988, all approved uses of chlordane in the United States were cancelled. From 1983 to 1988, chlordane's only approved use was to control termites in homes. The pesticide was applied underground around the foundation of homes. Before 1978, chlordane was also used as a pesticide on agricultural crops, lawns, and gardens and as a fumigating agent. In 1978, EPA cancelled the use of chlordane on food crops and phased out other above ground uses over the following 5 years. Chlordane still can be legally manufactured in the United States, but it can only be sold to or used by foreign countries. Although chlordane can be used to control fire ants in the United States, no products are currently registered for this use.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Before 1988, exposure to chlordane may have occurred in the workplace; persons involved in the manufacture, formulation, or application of chlordane, such as farmers, lawn-care workers, and pest-control workers may have been exposed.
- Studies on chlordane levels in indoor air reported levels ranging from < 1 to 610,000 nanograms per cubic metre (ng/m3).
- Currently, exposure to chlordane appears to be highest for those persons living in homes that were treated for termites with chlordane. Chlordane may be found in the air in these homes for many years after treatment.
- Additional exposure to chlordane may occur from digging in soil around the foundation of homes where chlordane was applied. Mean residue levels in soil around 30 homes treated with chlordane ranged from 22 to 2,540 parts per million (ppm).
- Exposure to chlordane may also occur from eating chlordane-contaminated food. Chlordane remains in the food supply today because much of the farmland in the United States was treated with chlordane in the 1960s and 1970s, and it remains in the soil for over 20 years.

Chlordane, is an organochlorine compound with the molecular formula C10H6Cl8, used as a pesticide in the United States from 1948 to 1988. Chlordane does not dissolve in water. Therefore, before it can be used as a spray, it must be placed in water with emulsifiers (soap-like substances), which results in a milky-looking mixture. [1,2]

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- Chlordane has been listed as a pollutant of concern to EPA's Great Waters Program due to its persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment.

Routes of Exposure

One of the most common ways phenanthrene can enter your body is through breathing contaminated air. It can get into your lungs when you breathe it. If you work in a hazardous waste site where PAHs are disposed, you are likely to breathe phenanthrene and other PAHs. If you eat or drink food and water that are contaminated with PAHs, you could be exposed. Exposure can also occur if your skin comes into contact with contaminated soil or products like heavy oils, coal tar, roofing tar or creosote where PAHs have been found. Creosote is an oily liquid found in coal tar and is used to preserve wood. Once in your body, the PAHs can spread and target fat tissues. Target organs include kidneys, liver and fat. However, in just a matter of days, the PAHs will leave your body through urine and faeces.

HEALTH EFFECTS [4]

Acute Health Effects

The main routes of exposure to chlordane are:

- inhalation,
- skin absorption,
- ingestion,
- skin and/or eye contact

Carcinogenicity

- An occupational study investigating men with non-Hodgkin's lymphoma found that the odds of chlordane use as an insecticide were significantly greater among cases than among controls.
- Two other epidemiological studies did not find an association between chlordane exposure and leukaemia or multiple myeloma.
- Animal studies have reported liver cancer in mice and male rats exposed to chlordane via ingestion.
- EPA considers chlordane to be a probable human carcinogen and has classified it as a Group B2 carcinogen.

Other Effects

- Chronic exposure of humans to chlordane by inhalation results primarily in effects on the nervous system.
- Animal studies have reported effects on the liver, kidney, blood, thyroid, and respiratory and nervous systems from chronic exposure to chlordane via inhalation.
- The Reference Concentration (RfC) for chlordane is 0.0007 milligrams per cubic metre (mg/m3) based on liver effects in rats.
- The Reference Dose (RfD) for chlordane is 0.0005 milligrams per kilogram body weight per day (mg/kg/d) based on liver necrosis in mice.

SAFETY

First Aid Measures [5]

- **Inhalation:** No specific intervention is indicated as the compound is not likely to be hazardous by inhalation. Remove victim to fresh air immediately. Keep affected person warm and at rest.
- **Skin Contact:** The compound is hazardous by skin contact. Remove contaminated clothing and shoes immediately. Wash affected area with mild soap or detergent for at least 15 minutes or until no evidence of chemical remains. In case of chemical burns, cover area with sterile, dry dressing. Bandage securely, but not too tightly. Get medical attention, immediately.
- **Eye Contact:** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Eyelids may be lifted occasionally, until no evidence of chemical remains. Call a physician.
- **Ingestion:** The compound is toxic by ingestion. Do not use gastric lavage or emesis. Affected person must drink 100 fold of water or milk to dilute acid. Call a physician immediately.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling chlordane:

- Respiratory Protection: None required.
- Protective Gloves: Are highly recommended.
- Eye Protection: Safety glasses with side shields are required.

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- Other Protective Equipment: Lab coat or other long – sleeved garment is required.

REGULATION

United States

- **EPA:** The Environmental Protection Agency guidelines for drinking water suggest that no more than 60 ppb chlordane should be present in drinking water that children consume for no longer than 10 days. Drinking water should contain no more than 0.5 ppb for children or 2 ppb for adults if they drink the water for longer periods. All use of chlordane were cancelled on food crops, effective March 1978. Until 1988, EPA permitted chlordane use for termite control or dipping the roots or tops of nonfood plants. On April 14, 1988, however, EPA stopped all sales and commercial use of chlordane. Federal regulations limit the amount of chlordane that factories can release into wastewater. The EPA requires industry to report releases or spills of 1 pound or more. A temporary guideline of the National Research Council indicated that 0.005 mg/m^3 should be the maximum amount allowed in the air of military housing.
- **FDA:** The Food and Drug Administration has established that the levels of chlordane and its breakdown products in most fruits and vegetables should not be greater than 300 ppb and in animal fat and fish should not be greater than 100 ppb.
- **OSHA:** The Occupational Safety and Health Administration regulates chlordane levels in the workplace. The maximum allowable level in workplace air is 0.5 mg/m^3 for a person who is exposed for 8 hours per workday and 40 hours per workweek.
- **NIOSH:** The National Institute for Occupational Health and Safety also recommends an exposure limit of 5 mg/m^3 for a person exposed to chlordane in the workplace for 8 hours per workday and 40 hours per workweek.

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Femtosecond laser technique captures elusive atomic oxygen in water

2025-12-14

A never-before-seen image of individual oxygen atoms dissolved in water has been captured.

Scientists used an advanced laser technique called femtosecond two-photon absorption laser-induced fluorescence (fs-TALIF) to directly see and image ground-state oxygen atoms in water. To their surprise, the oxygen atoms remained stable for tens of microseconds and traveled several hundred micrometers into the liquid—a behavior that defied existing scientific assumptions about oxygen in liquid environments.

These findings, published in Nature Communications, might enable researchers to explore innovative ways to tap into the distinctive chemistry of atomic oxygen.

With its powerful oxidative abilities, atomic oxygen (O) holds potential for applications across medicine, fundamental research, and industrial chemistry. However, many emerging applications of atomic oxygen depend on the atoms reacting in aqueous environments and understanding how oxygen atoms behave in such conditions has long been a challenge for scientists. Questions about their reaction rates and how they move from gas into liquid have remained unanswered as measuring oxygen concentrations in liquids is extremely difficult.

Measuring oxygen with a laser

Previous studies attempted to quantify oxygen atoms dissolved in water using chemical probes. They remained unsuccessful because the probes would often either degrade due to strong oxidizing tendencies or undergo chemical reactions to form reactive oxygen species (ROS).

Researchers now had two tasks: measure the concentration of oxygen atoms solvated in water and develop a tool that can selectively detect and measure oxygen atoms with precision, without destroying itself or disturbing the liquid with oxygen.

Two-photon absorption laser-induced fluorescence (TALIF), an optical technique already used to quantify reactive atomic species in gases, emerged as a potential candidate.

TALIF works by using a precisely tuned laser to excite the atoms being measured. Instead of absorbing a single photon, each atom absorbs two

photons at the same time, and the combined energy of these photons lifts the atom into a higher, excited state.

As the atom returns to its lower-energy state, it releases the excess energy as fluorescence—emission of light—which an instrument can detect. The amount of light emitted during the process helps researchers calculate the concentration of specific species in a sample.

Previous attempts to use TALIF to measure atomic oxygen in water have failed because the liquid quickly quenches the excited atoms, reducing the signal below detectability.

The researchers in this study addressed this issue and obtained a detectable signal by using an ultrafast femtosecond laser, which delivered enough energy to excite the oxygen atoms quickly and make them fluoresce before the surrounding water molecules could quench them.

This setup allowed them to point a very precisely tuned to 225.7 nm femtosecond laser onto the surface of water that was enriched with atomic oxygen via a plasma jet. As the excited oxygen atoms returned to their normal state, they emitted fluorescence at 844.6 nm, which was captured by a sensitive camera.

To determine the actual concentration of oxygen atoms in water, the researchers compared the measured fluorescence to a calibrated xenon signal and used computer simulations to estimate the frequency with which excited oxygen atoms collided with water molecules, thereby quenching their fluorescence. Together, these results provided a dissolved oxygen density on the order of 1016 cm−3 near the water surface.

They also observed that oxygen atoms survived far longer and traveled deeper than expected. The researchers emphasize that these surprising findings highlight the need to rethink and update existing models of how oxygen atoms behave in liquids.

Phys Org, 14 December 2025

https://phys.org

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Health Impacts of "Forever Chemicals" Linked to Billions in Economic Losses

2025-12-09

The negative health impacts from contamination by so called "forever chemicals" in drinking water costs the contiguous U.S. at least $8 billion a year in social costs, a University of Arizona-led study has found.

The study, published in the Proceedings of the National Academy of Sciences, builds on previous research into how PFAS – per- and polyfluoroalkyl substances – can negatively impact health when the chemicals contaminate drinking water. The research team studied all births in New Hampshire from 2010-2019, focusing on mothers living near PFAS-contaminated sites.

The research shows that mothers receiving water from wells that are "downstream" (in groundwater terms) of PFAS-contaminated sites, as opposed to comparable mothers receiving water from "upstream" wells, had higher first-year infant mortality, more preterm births (including more births before even 28 weeks), and more births with infants weighing less than 5.5 pounds (including more births with weights less than even 2.2 pounds). These findings build on earlier laboratory and public health research but offer new evidence from real-world exposure across a large population.

Extrapolating to the contiguous U.S., PFAS contamination imposes costs of at least $8 billion on the babies born each year, which encompasses medical care, long-term health impacts and reduced lifetime earnings. The results indicate that the potential health benefits of PFAS cleanup and regulation may be substantial.

"If we compare costs we're finding versus the cost of cleaning up PFAS, the answers are obvious," said study coauthor Derek Lemoine, a professor of economics and director of graduate studies in the U of A Eller College of Management. "Removing PFAS from drinking water not only results in drastically improved health outcomes. It also produces a significant long-term economic benefit."

Lemoine and fellow Eller economics professor Ashley Langer collaborated on the research with Bo Guo, an associate professor of hydrology and atmospheric sciences, in the College of Science, after meeting at an event hosted by the Arizona Institute for Resilience to foster collaborative research across disparate fields of study. Lemoine and Langer took an immediate interest in Guo's years-long research into PFAS, while Guo

was fascinated by the economists' research into long-term health and economic impacts.

Eller economics alumnus Robert Baluja and former AIR-funded postdoctoral researcher Wesley Howden also contributed to the study.

PFAS were originally developed to make protective coatings for goods to resist heat, oil and water, and are used in a range of products and in firefighting activities. They earned the label "forever chemicals" because they take much longer to break down naturally in the environment. Researchers have long suspected that exposure to PFAS poses health risks, especially to infants, who can suffer from low birth weight or even die from PFAS exposure via their pregnant mothers. But prior work had not found a way to make PFAS exposure effectively random.

"We found really substantial impacts on infant health, which expanded on what others before us had found," Langer said. "What we then do is calculate how these negative birth outcomes follow these children throughout their lives. The numbers we found represent the lowest end of the economic impact – we suspect it is even more."

The U of A study focuses on two "long-chain" PFAS – PFOA and PFOS – that are no longer manufactured in the U.S. but remain in soils and therefore are still percolating into groundwater.

"Whatever PFAS we see in groundwater is only a tiny fraction of the PFAS that has been dumped in the environment," Guo said. "The majority of PFAS is still in the soil and migrating downward."

The authors highlight opportunities for future research, including understanding the effects of newer PFAS and the role of long-term exposure. They also note that activated carbon filters, whether used by water utilities or installed in homes, can remove these long-chain PFAS from drinking water.

"These chemicals may be everywhere, but we still find that drinking water matters for pregnant women. Installing and maintaining home water filters could be prudent for them," Lemoine said.

Technology Networks, 9 December 2025

https://technologynetworks.com

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High-energy photons drive conversion of greenhouse gases into high-value chemicals, no catalyst needed

2025-12-14

Scientists have found a way to turn carbon dioxide and methane, the two most notorious greenhouse gases, into useful chemicals without any expensive catalysts, using only light.

A team of researchers from China discovered that high-energy photons with a wavelength of 185 nm generated by a specialized 28-W ultraviolet light source could directly break the strong chemical bonds in methane and carbon dioxide. This allowed them to transform the gases into chemicals such as water-gas (CO/H2) and ethane (C2H6) under ambient conditions and even in oxygen-free outer-space-like conditions.

The findings were published in Nature Photonics.

Climate impact and the need for solutions

Carbon dioxide and methane together fuel nearly 84% of today's global temperature rise, making them the two most influential drivers of climate change. Beyond heating the planet, carbon dioxide is the leading cause of ocean acidification, a process that is slowly altering ocean chemistry and threatening marine ecosystems worldwide.

To tackle these growing threats, scientists are working on solutions that go beyond simply cutting emissions at the source. They are seeking out ways to capture the gases already in the atmosphere and alter them into valuable products, trying to build a circular economy where waste becomes a resource.

However, converting carbon dioxide and methane into other molecules is difficult due to their chemically stubborn nature. Methane's strong C–H bonds and carbon dioxide's stable C=O bond make them chemically inert, thereby requiring additional steps to effect any chemical transformation.

Conventional methods often rely on expensive metal catalysts and require extreme conditions, with temperatures above 700 °C and high pressures, to overcome these barriers, which makes the process both energy-intensive and costly.

How the light-driven process works

The researchers in this study found that a very specific wavelength of light could deliver the exact energy needed to break the molecules' bonds.

They began by building a quartz reactor chamber filled with a mixture of 99.9% pure carbon dioxide and methane. The chamber was then illuminated with multiple types of light under low pressure and a controlled temperature of 25°C. High-energy photons at a precise wavelength of 185 nm from a 28-W ultraviolet light source, together with a booster light source at 200–1,100 nm, could activate the stubborn gas molecules and kickstart the conversion process.

Gas analysis results revealed that the light-driven reactions produced carbon monoxide, hydrogen and ethane; the production rates were 3.1 mmol m-3 h-1, 1.93 mmol m-3 h-1, and 2.53 mmol m-3 h-1, respectively. A series of trials showed that adding water to the mixture and removing atmospheric oxygen improved the yields. When the researchers simulated space-like conditions by flushing the reaction chamber with argon gas, they achieved a total gas conversion of 1.51% within 24 hours.

The researchers acknowledge that the yield is low at this stage but believe that these findings demonstrate a powerful new approach for turning two greenhouse gases into valuable products using only light and ambient conditions, with no catalysts or extreme energy demands.

The findings underscore the increasing value of biomass-derived materials in energy conversion applications. Combining renewable carbon supports with carefully designed metal oxide interfaces aligns with global efforts to create low cost and environmentally friendly clean energy technologies.

The researchers note that this method could be adapted to different metal combinations and catalytic reactions, opening new opportunities for designing next generation electrocatalysts based on abundant natural resources.

Phys Org, 14 December 2025

https://phys.org

Plastic can be programmed to have a lifespan of days, months or years

2025-11-28

Chemical additions to plastic that mimic natural polymers like DNA can create materials that break down in days, months or years rather than littering the environment for centuries. Researchers hope their new technique will lead to plastic products that serve their purpose and then safely self-destruct.

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In 2022, more than a quarter of a billion tonnes of plastic was discarded globally, and only 14 per cent was recycled – the rest was either burned or buried. The promise of a practical, biodegradable plastic has been around for at least 35 years, and there have been efforts to make such materials using everything from bamboo to seaweed. But, in truth, many such materials are difficult to compost and their producers make unrealistic claims.

Now, Yuwei Gu and his colleagues at Rutgers, The State University of New Jersey, are developing a technique to create plastics with finely-tuned lifespans that could quickly break down either in compost or in the natural environment.

Gu wondered why natural, long-stranded polymers like DNA and RNA can break down relatively quickly, but synthetic ones, such as plastics, can't, and if there was a way to replicate their process.

Natural polymers contain chemical structures called neighbouring groups that aid in deconstruction. These structures power internal reactions called nucleophilic attacks that sever the bonds in polymer chains – something that requires a great deal of energy with normal plastics.

Gu and his team created artificial chemical structures that mimic these neighbouring groups, and added them when making new plastics. They found that the resulting material could break down easily and that by altering the structure of the additions, they could fine-tune how long the material remained intact before deconstructing.

After the plastic breaks down, the long polymer chains are converted into small fragments, which Gu hopes will either be used to make new plastics or will safely dissolve into the environment.

"This strategy works best for plastics that benefit from controlled degradation over days to months, so we see strong potential for applications like food packaging and other short-lived consumer materials," says Gu. "At the moment, it is less suited for plastics that must remain stable for decades before breaking down – such as construction materials or long-term structural components."

But there are several problems to solve before this type of plastic can be used commercially. The liquid left over after the plastics deconstruct is made up of fragments of polymer chains, and further tests are needed to ensure that this soup of parts isn't toxic and can therefore be safely released into nature.

Also, ultraviolet light is currently needed to initiate the deconstruction, although ambient sunlight is sufficient. So until the group finds ways to create materials that can break down in the dark, any plastic that is buried or otherwise covered up will remain in the environment almost indefinitely.

New Scientist, 28 November 2025

https://newscientist.com

Inorganic homologous series forms solids with predictable structures

2025-12-11

An unusual new 'homologous series' of barium compounds forms a potentially infinite sequence of related structures with predictable unit cells. The US team behind this discovery says that understanding such structure–composition relationships could improve the ability of machine learning models to discover new inorganic materials.

Homologous series are commonly seen in organic chemistry, where sequences of compounds with repeating units can be described by a general formula – famous examples include straight chain alkanes and alkenes. Similar sequences can exist in solid-state inorganic materials, although they are less widespread. Examples include non-stoichiometric titanium oxides and the 2D halide perovskites used in solar cells.

In the new work, inorganic chemist Mercouri Kanatzidis of Northwestern University in Illinois and his colleagues found that a series of barium compounds form closely related solid structures that vary in a predictable way when a single parameter is changed. 'That means if you have one member and you know you're in a sequence, you know what the next member is going to be,' says Kanatzidis.

The researchers started with barium antimony telluride ($BaSbTe_3$). They then substituted increasing proportions of the tellurium with its fellow group 16 element sulfur. The sulfur and tellurium atoms would intuitively have been expected to disperse randomly around the anionic sites, forming a solid solution. However, the researchers showed theoretically that the sulfur, being more electronegative, preferentially incorporates at more electron-rich sites in the crystal lattice. This causes second-order effects on the structure, with the telluride anions becoming increasingly electron-poor as the proportion of sulfur increases. 'A solid solution doesn't happen,' says Kanatzidis. 'Instead the material responds by finding

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another way to order the tellurium and sulfur, forming another member of the homology. That's the part that's just out of this world.'

Establishing chemical principles

The researchers synthesised ten members of the homologous series, with ever-increasing structural complexity. The final member, $BaSbSTe_2$, contains an instability in its electronic structure called a charge density wave. At high temperatures or low pressures, such charge density wave materials often show superconductivity. The researchers now intend to use the results to try to predict new types of superconductors rationally – something not presently possible.

Kanatzidis and his team also point out that while machine learning is increasingly being used to design new chemical structures, these techniques are best at predicting materials within established structure types. As a result, these tools have been more successful in areas like organic chemistry, where more 'extensive sets of chemical principles have been established', whereas they have struggled to find truly novel solid-state materials. Kanatzidis says that findings like the new phase homology will provide useful training data for machine learning, enhancing its predictive power.

Materials chemist Leslie Schoop from Princeton University in New Jersey describes the work as 'very solid', and adds that researchers will need to examine the new materials for 'any relevant properties that are worth pursuing in detail'. Schoop, who has previously expressed concern about autonomous materials discovery methods, also believes that relationships like those uncovered by Kanatzidis' team could help to improve AI's ability to tackle challenges in inorganic chemistry. 'We need to start implementing this kind of thinking that actually leads to new material discoveries into AI algorithms,' she says.

Chemistry World, 11 December 2025

https://chemistryworld.com

Freezing salty water reveals dynamic brine migration and evolving ice patterns

2025-12-13

Imagine holding a narrow tube filled with salty water and watching it begin to freeze from one end. You might expect the ice to advance steadily

and push the salt aside in a simple and predictable way. Yet the scene that unfolded was unexpectedly vivid.

Based on X-ray computed tomography (Micro-CT), our study, published in the Journal of Fluid Mechanics, realized the 4D (3D + time) dynamic observation and modeling of the whole process of ice crystal growth and salt exclusion.

Real-time imaging of the freezing process

When we monitored brine as it froze, the microstructure evolved far more dynamically than expected. Immediately after nucleation, ice crystals (dark areas) formed rapidly and trapped brine (bright areas) within a porous network. As freezing progressed, this network reorganized into striped patterns that moved either downward or upward depending on boundary conditions.

During downward freezing, dense brine collected into central columns, which gradually sank as they accumulated salt from adjacent regions. In upward freezing, brine instead migrated toward the periphery, forming skirt-like structures. These motions show how temperature gradients and gravity jointly drive salt redistribution in the early stages of freezing.

Although the distinct freezing paths experienced, the final steady state of ice and brine structure in downward freezing and upward freezing tended to coincide after about 24 h of freezing.

Evolution of freezing processes in spatiotemporal scales

By comparing temperature evolution, ice volume fraction and brine distribution, we found that salt exclusion follows three distinct stages.

The first stage lasts only seconds. Ice crystals nucleate rapidly, and neither heat nor salt has time to migrate. The second stage begins as the temperature field stabilizes. Brine is expelled through a combination of expansion during solidification and, in downward freezing, convection driven by density differences. In the third stage, diffusion becomes the dominant mechanism. Brine pockets migrate slowly toward the warm end, and a cleaner ice layer gradually develops near the cold boundary.

Tracking brine migration patterns

A range of unique salt morphologies, such as brine streaks, columns, skirts, pockets, and relatively pure ice, also occur during freezing. We traced the migration of these key features from tens of minutes to hours during freezing: inclined stripes formed in the initial stage (point A) followed by

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gradual transformation into vertically aligned brine bands (point B), while scattered isolated brine pockets (point C) migrated slowly and remained in porous ice. At the same time, the relatively pure ice boundary (point D) continues to push toward the warm end. As the freezing process advances, these brine features are gradually expelled from the ice.

The overall migration rate follows the following order: (A) > (B) > (C) > (D). Compared with the theoretical calculation results of the saltwater bag migration theory dominated by diffusion (gray line), the experimental results of (B) and (C) are roughly parallel to the theoretical calculation values, indicating that diffusion is the dominant factor; the migration rate of (A) (purple line) is significantly faster soon after nucleation but then gradually converges to the predicted trend.

Potential impact

Taken together, these results show that microscopic salt exclusion is neither uniform nor monotonic. Instead, it proceeds through rapid rearrangements, convective movements and slow diffusive transport, leaving behind long-lived brine pockets. Understanding these dynamics helps clarify how natural sea ice becomes relatively fresh and how freezing can be optimized for desalination, materials processing and cryogenic applications.

This story is part of Science X Dialog, where researchers can report findings from their published research articles. Visit this page for information about Science X Dialog and how to participate.

Dr. Liang Lei has been working on pore and particle scale processes within porous media. His group conducts thermal-hydraulic-chemical-mechanical coupled experiments to explore mass and energy transfer in porous media (single- and multi- phase flow) and phase change (dissolution, precipitation, dissociation, freezing, melting and etc.) at multiple scales. He has several contributions to the field of natural gas hydrate and permafrost.

Phys Org, 13 December 2025

https://phys.org

This artificial leaf turns pollution into power

2025-10-02

Now, a team led by the University of Cambridge is exploring innovative approaches that could eventually "de-fossilize" this vital industry.

Their breakthrough involves a hybrid device that brings together light-absorbing organic polymers and bacterial enzymes to transform sunlight, water, and carbon dioxide into formate, a clean fuel that can power additional chemical reactions.

This "semi-artificial leaf" replicates photosynthesis, the natural process plants use to turn sunlight into energy, and operates entirely on its own power. Unlike previous designs that relied on toxic or unstable light absorbers, this new biohybrid model uses non-toxic materials, runs more efficiently, and remains stable without extra additives.

In laboratory tests, the team successfully used sunlight to convert carbon dioxide into formate and then applied it directly in a "domino" reaction to synthesize a valuable compound used in pharmaceuticals, achieving both high yield and purity.

According to findings published in Joule, this marks the first instance where organic semiconductors have served as the light-capturing component in such a biohybrid system, paving the way for a new generation of eco-friendly artificial leaves.

The chemical industry remains a cornerstone of the global economy, producing a vast range of goods—from medicines and fertilizers to plastics, paints, electronics, cleaning agents, and toiletries.

"If we're going to build a circular, sustainable economy, the chemical industry is a big, complex problem that we must address," said Professor Erwin Reisner from Cambridge's Yusuf Hamied Department of Chemistry, who led the research. "We've got to come up with ways to de-fossilize this important sector, which produces so many important products we all need. It's a huge opportunity if we can get it right."

Reisner's research group specializes in the development of artificial leaves, which turn sunlight into carbon-based fuels and chemicals without relying on fossil fuels. But many of their earlier designs depend on synthetic catalysts or inorganic semiconductors, which either degrade quickly, waste much of the solar spectrum, or contain toxic elements such as lead.

"If we can remove the toxic components and start using organic elements, we end up with a clean chemical reaction and a single end product, without any unwanted side reactions," said co-first author Dr. Celine Yeung, who completed the research as part of her PhD work in Reisner's lab. "This device combines the best of both worlds – organic semiconductors

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are tuneable and non-toxic, while biocatalysts are highly selective and efficient."

The new device integrates organic semiconductors with enzymes from sulfate-reducing bacteria, splitting water into hydrogen and oxygen or converting carbon dioxide into formate.

The researchers have also addressed a long-standing challenge: most systems require chemical additives, known as buffers, to keep the enzymes running. These can break down quickly and limit stability. By embedding a helper enzyme, carbonic anhydrase, into a porous titania structure, the researchers enabled the system to work in a simple bicarbonate solution — similar to sparkling water — without unsustainable additives.

"It's like a big puzzle," said co-first author Dr. Yongpeng Liu, a postdoctoral researcher in Reisner's lab. "We have all these different components that we've been trying to bring together for a single purpose. It took us a long time to figure out how this specific enzyme is immobilized on an electrode, but we're now starting to see the fruits from these efforts."

"By really studying how the enzyme works, we were able to precisely design the materials that make up the different layers of our sandwich-like device," said Yeung. "This design made the parts work together more effectively, from the tiny nanoscale up to the full artificial leaf."

Tests showed the artificial leaf produced high currents and achieved near-perfect efficiency in directing electrons into fuel-making reactions. The device successfully ran for over 24 hours: more than twice as long as previous designs.

The researchers are hoping to further develop their designs to extend the lifespan of the device and adapt it so it can produce different types of chemical products.

"We've shown it's possible to create solar-powered devices that are not only efficient and durable but also free from toxic or unsustainable components," said Reisner. "This could be a fundamental platform for producing green fuels and chemicals in future – it's a real opportunity to do some exciting and important chemistry."

The research was supported in part by the Singapore Agency for Science, Technology and Research (A*STAR), the European Research Council, the Swiss National Science Foundation, the Royal Academy of Engineering, and UK Research and Innovation (UKRI). Erwin Reisner is a Fellow of St

John's College, Cambridge. Celine Yeung is a Member of Downing College, Cambridge.

Science Daily, 2 November 2025

https://sciencedaily.com

Inorganic homologous series forms solids with predictable structures

2025-12-11

An unusual new 'homologous series' of barium compounds forms a potentially infinite sequence of related structures with predictable unit cells. The US team behind this discovery says that understanding such structure–composition relationships could improve the ability of machine learning models to discover new inorganic materials.

Homologous series are commonly seen in organic chemistry, where sequences of compounds with repeating units can be described by a general formula – famous examples include straight chain alkanes and alkenes. Similar sequences can exist in solid-state inorganic materials, although they are less widespread. Examples include non-stoichiometric titanium oxides and the 2D halide perovskites used in solar cells.

In the new work, inorganic chemist Mercouri Kanatzidis of Northwestern University in Illinois and his colleagues found that a series of barium compounds form closely related solid structures that vary in a predictable way when a single parameter is changed. 'That means if you have one member and you know you're in a sequence, you know what the next member is going to be,' says Kanatzidis.

The researchers started with barium antimony telluride (BaSbTe3). They then substituted increasing proportions of the tellurium with its fellow group 16 element sulfur. The sulfur and tellurium atoms would intuitively have been expected to disperse randomly around the anionic sites, forming a solid solution. However, the researchers showed theoretically that the sulfur, being more electronegative, preferentially incorporates at more electron-rich sites in the crystal lattice. This causes second-order effects on the structure, with the telluride anions becoming increasingly electron-poor as the proportion of sulfur increases. 'A solid solution doesn't happen,' says Kanatzidis. 'Instead the material responds by finding another way to order the tellurium and sulfur, forming another member of the homology. That's the part that's just out of this world.'

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Chemistry World, 11 December 2025

https://chemistryworld.com

Paper mill waste could unlock cheaper clean energy

2025-12-11

The study, published in Biochar X, reports that the catalyst reaches a low overpotential of 250 mV at 10 mA cm^2 and remains highly stable for more than 50 hours when operating at elevated current density. These performance levels point to a viable, low cost alternative to the precious metal catalysts typically used in large-scale water splitting.

"Oxygen evolution is one of the biggest barriers to efficient hydrogen production," said corresponding author Yanlin Qin of the Guangdong

University of Technology. "Our work shows that a catalyst made from lignin, a low-value byproduct of the paper and biorefinery industries, can deliver high activity and exceptional durability. This provides a greener and more economical route to large-scale hydrogen generation."

Transforming Lignin Into a Functional Carbon Framework

Lignin is one of the most abundant natural polymers, yet it is often burned for minimal energy return. In this work, the team converted lignin into carbon fibers using electrospinning and thermal treatment. These fibers serve as a conductive and supportive framework for the metal oxide particles. The resulting catalyst, known as NiO/Fe3O4@LCFs, contains nitrogen-doped carbon fibers that offer fast charge transport, high surface area, and strong structural stability.

Microscopy revealed that the nickel and iron oxides form a nanoscale heterojunction within the carbon fiber structure. This interface plays a central role in the oxygen evolution reaction by helping intermediate molecules bind and detach at optimal rates. Pairing these metal oxides with a conductive carbon network improves electron movement and prevents the particles from clumping together, which is a frequent issue in conventional base metal catalysts.

Verified Activity Through Advanced Testing

Electrochemical measurements showed that the material performs better than catalysts containing only one metal, especially under the high current conditions needed for real world electrolysis systems. The catalyst also exhibits a Tafel slope of 138 mV per decade, indicating more rapid reaction kinetics. Additional evidence from in situ Raman spectroscopy and density functional theory calculations supports the proposed mechanism, confirming that the engineered interface efficiently drives oxygen evolution.

Scalable Design Using Widely Available Biomass

"Our goal was to develop a catalyst that not only performs well but is scalable and rooted in sustainable materials," said co-corresponding author Xueqing Qiu. "Because lignin is produced in huge quantities worldwide, the approach offers a realistic path toward greener industrial hydrogen production technologies."

Science Daily, 11 December 2025

https://sciencedaily.com

How Microplastics Trigger Inflammation in the Brain

2025-12-08

Microplastics could be fuelling neurodegenerative diseases like Alzheimer's and Parkinson's, with a new study highlighting five ways microplastics can trigger inflammation and damage in the brain.

More than 57 million people live with dementia, and cases of Alzheimer's and Parkinson's are projected to rise sharply. The possibility that microplastics could aggravate or accelerate these brain diseases is a major public health concern.

Pharmaceutical scientist Associate Professor Kamal Dua, from the University of Technology Sydney, said it is estimated that adults are consuming 250 grams of microplastics every year – enough to cover a dinner plate.

"We ingest microplastics from a wide range of sources including contaminated seafood, salt, processed foods, tea bags, plastic chopping boards, drinks in plastic bottles and food grown in contaminated soil, as well as plastic fibres from carpets, dust and synthetic clothing."

"Common plastics include polyethylene, polypropylene, polystyrene and polyethylene terephthalate or PET. The majority of these microplastics are cleared from our bodies, however studies show they do accumulate in our organs, including our brains."

The systematic review, recently published in Molecular and Cellular Biochemistry, was an international collaboration led by researchers from the University of Technology Sydney and Auburn University in the US.

The researchers highlighted five main pathways through which microplastics can cause harm to the brain, including triggering immune cell activity, generating oxidative stress, disrupting the blood–brain barrier, impairing mitochondria and damaging neurons.

"Microplastics actually weaken the blood–brain barrier, making it leaky. Once that happens, immune cells and inflammatory molecules are activated, which then causes even more damage to the barrier's cells," said Associate Professor Dua.

"The body treats microplastics as foreign intruders, which prompts the brain's immune cells to attack them. When the brain is stressed by factors like toxins or environmental pollutants this also causes oxidative stress," he said.

Microplastics cause oxidative stress in two main ways: they increase the amount of "reactive oxygen species" or unstable molecules that can damage cells, and they weaken the body's antioxidant systems, which normally help keep those molecules in check.

"Microplastics also interfere with the way mitochondria produce energy, reducing the supply of ATP, or adenosine triphosphate, which is the fuel cells need to function. This energy shortfall weakens neuron activity and can ultimately damage brain cells," said Associate Professor Dua.

"All these pathways interact with each other to increase damage in the brain."

The paper also explores specific ways in which microplastics could contribute to Alzheimer's, including triggering increased buildup of beta-amyloid and tau; and in Parkinson's through aggregation of α-Synuclein and damage to dopaminergic neurons.

First author UTS Master of Pharmacy student Alexander Chi Wang Siu is a currently working in the lab of Professor Murali Dhanasekaran at Auburn University, in collaboration with Associate Professor Dua, Dr Keshav Raj Paudel and Distinguished Professor Brian Oliver from UTS, to better understand how microplastics affect brain cell function.

Previous UTS research has examined how microplastics are inhaled and where they are deposited in the lungs. Dr Paudel, a visiting scholar in the UTS Faculty of Engineering, is also currently investigating the impact of microplastic inhalation on lung health.

While evidence suggests microplastics could worsen diseases like Alzheimer's and Parkinson's, the authors emphasise that more research is needed to prove a direct link. However, they recommend taking steps to reduce microplastic exposure.

"We need to change our habits and use less plastic. Steer clear of plastic containers and plastic cutting boards, don't use the dryer, choose natural fibres instead of synthetic ones and eat less processed and packaged foods," said Dr Paudel.

The researchers hope the current findings will help shape environmental policies to cut plastic production, improve waste management and reduce

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long-term public health risks posed by this ubiquitous environmental pollutant.

Technology Networks, 8 December 2025

https://technologynetworks.com

Used cooking oil yields super strong glue and recyclable plastics

2025-12-10

Plastics are made from crude oil and petroleum by-products, so a team of scientists decided to explore if they could turn waste cooking oil into a useful plastic material, and they succeeded.

The researchers converted waste cooking oil (WCO) into chemically recyclable polyesters—a type of synthetic plastic—that can serve as an alternative to the widely used fossil-fuel-based polyethylene (PE). This pursuit also resulted in a powerful adhesive that bonded stainless steel plates so strongly that it was able to pull a four-door sedan up a slight hill, as per the findings published in the Journal of the American Chemical Society.

Slippery to sticky

Polyethylene is the most widely produced plastic in the world because its hydrocarbon backbone makes it highly resistant to degradation. However, the same property that makes it useful also contributes to environmental pollution. Since PE-based products—such as plastic bags, food containers, and plumbing pipes—are non-degradable and not easily recycled, they often end up adding to the heaps of plastic in landfills and have even made an appearance in the Great Pacific Garbage Patch.

Over the years, scientists have made several attempts to develop materials that could replace PE, but its high performance and low-cost production have made the switch difficult. For any alternative to be truly viable, the starting material has to be cheap and eco-friendly and result in a final product that remains strong, versatile, and durable. Most PE alternatives fail to meet this checklist.

With sustainability in mind, one material gaining attention in this field is waste cooking oil. Each year, the world produces approximately 3.7 billion gallons of it, a largely untapped resource that could serve as a sustainable feedstock for plastic production if used appropriately.

In this study, the researchers first converted waste cooking oil unsaturated fatty acids into a long-chain C19-diester using a palladium catalyst, which was then reduced to form a long-chain diol. The resulting diol formed the main linear-chain structure required to mimic polyethylene (PE). Glycerol, another major component of waste cooking oil, was turned into branched 1,3-diols.

By polymerizing the branched and linear building blocks, the researchers designed a series of new polyesters (P1–P7) to mimic the properties of polyethylene. Their tests revealed that the polyesters matched or sometimes even surpassed low-density PE in both flexibility and strength.

Unlike PE, which is difficult to recycle, the new polymers/plastics could be readily broken down with chemical reagents, recycled, mixed with conventional plastics, and rebuilt into new plastics under mild conditions. The polymers made from branched diols showed strong adhesive performance across a wide range of surfaces, even outperforming commercial adhesives.

The researchers note that these findings establish the potential of waste cooking oil as a viable feedstock for plastic production. It also demonstrates a robust waste-to-materials strategy that aligns with circular-economy principles and highlights the potential of biomass to advance sustainable plastics innovation.

Phys Org, 10 December 2025

https://phys.org

Plastic can be programmed to have a lifespan of days, months or years

2025-11-28

Chemical additions to plastic that mimic natural polymers like DNA can create materials that break down in days, months or years rather than littering the environment for centuries. Researchers hope their new technique will lead to plastic products that serve their purpose and then safely self-destruct.

In 2022, more than a quarter of a billion tonnes of plastic was discarded globally, and only 14 per cent was recycled – the rest was either burned or buried. The promise of a practical, biodegradable plastic has been around for at least 35 years, and there have been efforts to make such materials using everything from bamboo to seaweed. But, in truth, many such

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materials are difficult to compost and their producers make unrealistic claims.

Now, Yuwei Gu and his colleagues at Rutgers, The State University of New Jersey, are developing a technique to create plastics with finely-tuned lifespans that could quickly break down either in compost or in the natural environment.

Gu wondered why natural, long-stranded polymers like DNA and RNA can break down relatively quickly, but synthetic ones, such as plastics, can't, and if there was a way to replicate their process.

Natural polymers contain chemical structures called neighbouring groups that aid in deconstruction. These structures power internal reactions called nucleophilic attacks that sever the bonds in polymer chains – something that requires a great deal of energy with normal plastics.

Gu and his team created artificial chemical structures that mimic these neighbouring groups, and added them when making new plastics. They found that the resulting material could break down easily and that by altering the structure of the additions, they could fine-tune how long the material remained intact before deconstructing.

After the plastic breaks down, the long polymer chains are converted into small fragments, which Gu hopes will either be used to make new plastics or will safely dissolve into the environment.

"This strategy works best for plastics that benefit from controlled degradation over days to months, so we see strong potential for applications like food packaging and other short-lived consumer materials," says Gu. "At the moment, it is less suited for plastics that must remain stable for decades before breaking down – such as construction materials or long-term structural components."

But there are several problems to solve before this type of plastic can be used commercially. The liquid left over after the plastics deconstruct is made up of fragments of polymer chains, and further tests are needed to ensure that this soup of parts isn't toxic and can therefore be safely released into nature.

Also, ultraviolet light is currently needed to initiate the deconstruction, although ambient sunlight is sufficient. So until the group finds ways to create materials that can break down in the dark, any plastic that is

buried or otherwise covered up will remain in the environment almost indefinitely.

New Scientist, 28 November 2025

https://newscientist.com

Scientists are turning Earth into a giant detector for hidden forces shaping our Universe

2025-12-06

This approach lays the groundwork for a global and interplanetary sensing system that could reveal hidden particles and forces.

Understanding SQUIRE and Its Space-Based Quantum Strategy

Exotic-boson-mediated interactions fall into 16 categories. Of these, 15 depend on particle spin and 10 depend on relative velocity. These interactions can produce small shifts in atomic energy levels, and quantum spin sensors detect those shifts as pseudomagnetic fields. The SQUIRE mission intends to place such sensors on space platforms, including the China Space Station, to look for pseudomagnetic fields generated by exotic interactions between the sensors and Earth's geoelectrons. By combining space access with quantum precision tools, SQUIRE avoids a major limitation of ground experiments, which struggle to increase both relative velocity and the total number of polarized spins at the same time.

Why Low Earth Orbit Greatly Improves Sensitivity

Several features of the orbital environment provide strong advantages.

1. The China Space Station travels in low Earth orbit at 7.67 km/s relative to Earth, nearly the first cosmic velocity and about 400 times faster than typical moving sources used in laboratory tests.
2. Earth acts as an enormous natural source of polarized spins. Unpaired geoelectrons within the mantle and crust, aligned by the geomagnetic field, supply roughly 1042 polarized electrons, exceeding the capabilities of SmCo5 laboratory spin sources by approximately 1017.
3. Orbital motion turns exotic interaction signatures into periodic signals. For the China Space Station (orbital period ~1.5 hours), this produces modulation near 0.189 mHz, a region with lower intrinsic noise than DC measurement bands.

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Projected Performance Gains in Orbit

With these space-enabled benefits, the SQUIRE concept allows exotic field amplitudes to reach up to 20 pT even under strict current limits on coupling constants. This is dramatically higher than the best terrestrial detection threshold of 0.015 pT. For velocity-dependent interactions with force ranges $>10^6$ m, the projected sensitivity improves by 6 to 7 orders of magnitude.

Building a Space-Ready Quantum Spin Sensor

Developing the prototype quantum sensor is essential for putting SQUIRE into operation. The instrument must remain extremely sensitive and stable over long periods while operating in a challenging orbital environment. In space, spin sensors encounter three dominant sources of interference: variations in the geomagnetic field, mechanical vibrations of the spacecraft, and cosmic radiation.

Reducing Noise and Increasing Stability

To overcome these challenges, the SQUIRE team created a prototype using three major innovations.

4. Dual Noble-Gas Spin Sensor: The device uses 129Xe and 131Xe isotopes with opposite gyromagnetic ratios, which allows it to cancel shared magnetic noise while remaining responsive to SSVI signals. This approach provides 104-fold noise suppression. With multilayer magnetic shielding, geomagnetic disturbances fall to the sub-femtotesla level.
5. Vibration Compensation Technology: A fiber-optic gyroscope tracks spacecraft vibrations and enables active correction, bringing vibration noise to roughly 0.65 fT.
6. Radiation-Hardened Architecture: A 0.5 cm aluminum enclosure and triple modular redundancy in its control electronics protect the system from cosmic rays. The design can continue functioning even if two of the three modules fail, reducing radiation-related interruptions to fewer than one per day.

On-Orbit Sensitivity and Scientific Readiness

By combining these technologies, the prototype achieves a single-shot sensitivity of 4.3 fT @ 1165 s, which is well matched to detecting SSVI signals that follow the 1.5-hour orbital period. This capability establishes a strong technological basis for precision dark matter searches conducted directly in orbit.

Expanding Toward a Space-Ground Quantum Sensing Network

Quantum spin sensors aboard the China Space Station can do far more than search for exotic interactions. SQUIRE proposes a "space-ground integrated" quantum sensing network that links orbital detectors with those on Earth, enabling far greater sensitivity across many dark matter models and other beyond-Standard-Model possibilities. These include additional exotic interactions, Axion halos, and CPT violation studies.

Science Daily, 6 December 2025

https://sciencedaily.com

Oxygen scavenger doubles biosensor accuracy for medical and agricultural uses

2025-12-10

Biosensors are helping people with chronic conditions worldwide live better lives. However, their measurement accuracy has often been relatively low, limiting the range of possible applications. Researchers at the Technical University of Munich (TUM) have now discovered a way to boost the accuracy of common oxidase biosensors from 50% to 99%, paving the way for new uses.

Biosensors make it possible for people with diabetes to self-monitor blood glucose and adjust insulin as needed, quickly and without the need for a lab. Biosensors are also used in other areas, but many promising applications require greater precision. For example, measuring creatinine levels, an important indicator of kidney function, has been too inaccurate. As a result, the full potential of biosensors remains untapped.

Nicolas Plumeré, Professor of Electrobiotechnology at TUM, Huijie Zhang, former researcher at his professorship and now Professor of New Energy at Nanjing University of Science and Technology in China, and Mohamed Saadeldin, a TUM doctoral student, set out to change that. In a lab study, the accuracy of oxidase biosensors for glucose, lactate, and creatinine was increased from approximately 50% to 99%—without the need for prior calibration. Lactate, for instance, is measured when monitoring critically ill patients.

According to the team, this breakthrough opens up entirely new fields of application. Their findings were published in Science Advances.

Oxygen scavenger tidies up inside the sensor

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The previous lack of accuracy stems from the way these sensors operate. They use oxidases—enzymes that convert substances like glucose into gluconolactone and electrons. The electrons are transferred to electrodes built into the sensor, generating an electrical current. The higher the concentration of a substance, the stronger the current displayed.

The problem: Oxidases don't just transfer electrons to the electrode—they also transfer them to oxygen in the environment. These "lost" electrons don't contribute to the current, weakening the signal and causing the measured concentration to appear lower than it really is.

To solve this, the researchers developed an oxygen scavenger: an alcohol oxidase that consumes excess oxygen by converting it into water. Crucially, this alcohol oxidase does not react with the actual target substances—glucose, creatinine, or lactate. After this "clean-up," only minimal oxygen remains, allowing the primary oxidase to transfer nearly all its electrons to the sensor.

From health care to agriculture

"We see a wide range of new and expanded applications and the potential to eliminate some lab tests in the future," says Plumeré. "In personalized medicine, these biosensors could help calibrate wearable devices, providing more reliable health data, detecting problems early, and supporting accurate medication dosing. There's also potential in AI-driven health care, which depends on large datasets that improved biosensors could help generate."

Plumeré also sees opportunities beyond medicine and is already working on practical applications. Building on the LiveSen-MAP research project, his team developed a test based on the same principle to measure nitrogen content in wheat plants. This enables on-site adjustments to fertilization, preventing over-fertilization. For farmers, that means lower costs and reduced environmental impact.

Phys Org, 10 December 2025

https://phys.org

After 50 Years, MIT Chemists Finally Synthesize Elusive Anti-Cancer Compound

2025-12-09

MIT chemists have, for the first time, successfully created in the laboratory a fungal molecule called verticillin A. This compound was first discovered

more than 50 years ago and has been recognized for its potential as an anticancer agent.

Although verticillin A differs from some related molecules by only a small number of atoms, its complex structure made it much more challenging to synthesize than those similar compounds.

"We have a much better appreciation for how those subtle structural changes can significantly increase the synthetic challenge," says Mohammad Movassaghi, an MIT professor of chemistry. "Now we have the technology where we can not only access them for the first time, more than 50 years after they were isolated, but also we can make many designed variants, which can enable further detailed studies."

In experiments with human cancer cells, one modified form of verticillin A showed strong activity against a rare pediatric brain tumor known as diffuse midline glioma. The researchers caution that additional testing will be necessary before its suitability for clinical use can be determined.

Movassaghi and Jun Qi, an associate professor of medicine at Dana-Farber Cancer Institute/Boston Children's Cancer and Blood Disorders Center and Harvard Medical School, are the senior authors of the study, which was published on December 2nd in the Journal of the American Chemical Society. Walker Knauss PhD '24 is the lead author of the paper. Xiuqi Wang, a medicinal chemist and chemical biologist at Dana-Farber, and Mariella Filbin, research director in the Pediatric Neurology-Oncology Program at Dana-Farber/Boston Children's Cancer and Blood Disorders Center, are also authors of the study.

A complex synthesis

Researchers first reported the isolation of verticillin A from fungi, which use it for protection against pathogens, in 1970. Verticillin A and related fungal compounds have drawn interest for their potential anticancer and antimicrobial activity, but their complexity has made them difficult to synthesize.

In 2009, Movassaghi's lab reported the synthesis of (+)-11,11′ -dideoxyverticillin A, a fungal compound similar to verticillin A. That molecule has 10 rings and eight stereogenic centers, or carbon atoms that have four different chemical groups attached to them. These groups have to be attached in a way that ensures they have the correct orientation, or stereochemistry, with respect to the rest of the molecule.

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Once that synthesis was achieved, however, synthesis of verticillin A remained challenging, even though the only difference between verticillin A and (+)-11,11′ -dideoxyverticillin A is the presence of two oxygen atoms.

"Those two oxygens greatly limit the window of opportunity that you have in terms of doing chemical transformations," Movassaghi says. "It makes the compound so much more fragile, so much more sensitive, so that even though we had had years of methodological advances, the compound continued to pose a challenge for us."

Both of the verticillin A compounds consist of two identical fragments that must be joined together to form a molecule called a dimer. To create (+)-11,11′ -dideoxyverticillin A, the researchers had performed the dimerization reaction near the end of the synthesis, then added four critical carbon-sulfur bonds.

Yet when trying to synthesize verticillin A, the researchers found that waiting to add those carbon-sulfur bonds at the end did not result in the correct stereochemistry. As a result, the researchers had to rethink their approach and ended up creating a very different synthetic sequence.

"What we learned was the timing of the events is absolutely critical. We had to significantly change the order of the bond-forming events," Movassaghi says.

The verticillin A synthesis begins with an amino acid derivative known as beta-hydroxytryptophan, and then step-by-step, the researchers add a variety of chemical functional groups, including alcohols, ketones, and amides, in a way that ensures the correct stereochemistry.

A functional group containing two carbon-sulfur bonds and a disulfide bond were introduced early on, to help control the stereochemistry of the molecule, but the sensitive disulfides had to be "masked" and protected as a pair of sulfides to prevent them from breakdown under subsequent chemical reactions. The disulfide-containing groups were then regenerated after the dimerization reaction.

"This particular dimerization really stands out in terms of the complexity of the substrates that we're bringing together, which have such a dense array of functional groups and stereochemistry," Movassaghi says.

The overall synthesis requires 16 steps from the beta-hydroxytryptophan starting material to verticillin A.

Killing cancer cells

Once the researchers had successfully completed the synthesis, they were also able to tweak it to generate derivates of verticillin A. Researchers at Dana-Farber then tested these compounds against several types of diffuse midline glioma (DMG), a rare brain tumor that has few treatment options.

The researchers found that the DMG cell lines most susceptible to these compounds were those that have high levels of a protein called EZHIP. This protein, which plays a role in the methylation of DNA, has been previously identified as a potential drug target for DMG.

"Identifying the potential targets of these compounds will play a critical role in further understanding their mechanism of action, and more importantly, will help optimize the compounds from the Movassaghi lab to be more target specific for novel therapy development," Qi says.

The verticillin derivatives appear to interact with EZHIP in a way that increases DNA methylation, which induces the cancer cells to under programmed cell death. The compounds that were most successful at killing these cells were N-sulfonylated (+)-11,11′ -dideoxyverticillin A and N-sulfonylated verticillin A. N-sulfonylation — the addition of a functional group containing sulfur and oxygen — makes the molecules more stable.

"The natural product itself is not the most potent, but it's the natural product synthesis that brought us to a point where we can make these derivatives and study them," Movassaghi says.

The Dana-Farber team is now working on further validating the mechanism of action of the verticillin derivatives, and they also hope to begin testing the compounds in animal models of pediatric brain cancers.

"Natural compounds have been valuable resources for drug discovery, and we will fully evaluate the therapeutic potential of these molecules by integrating our expertise in chemistry, chemical biology, cancer biology, and patient care. We have also profiled our lead molecules in more than 800 cancer cell lines, and will be able to understand their functions more broadly in other cancers," Qi says.

Sci Tech Daily, 9 Decemeber 2025

https://scitechdaily.com

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Lining pipes with lab-grown diamonds can keep them squeaky clean

2025-12-27

Industrial pipes carrying water or chemicals invariably get gunked up as deposits accumulate on their internal surfaces. That slows flow, and slowly damages the equipment, leading to the need for periodic maintenance and higher operational costs.

There are many ways to tackle this, including water softeners, chemical-based scale inhibitors that aim to prevent mineral buildup, and using specialized pipe materials and pipe lining. But they all come with one drawback or another. Now, researchers at Rice University in Houston, Texas, have hit upon a more effective solution to resisting scale formation: coatings made with lab-grown diamonds.

The material scientists note their chosen coating material can stay clean without regular intervention. Their work builds on previous studies which found that diamond, besides being incredibly hard and chemically stable, can also stave off bacterial growth.

To evaluate this, the team first grew diamond films through a process called microwave plasma chemical vapor deposition, or MPCVD, which you can see demonstrated in the video clip below. MPCVD is the most common method for making synthetic diamonds.

For this film coating, methane and hydrogen gases were fed into a reactor chamber that contained silicon wafers spin-coated with a nanodiamond solution. High-power microwave radiation energized the atoms of the gases into a hot plasma state, which freed up carbon atoms to settle on the wafers, and linked into the diamond structure over the course of several hours. The film was also terminated with different gases to achieve subtle changes to its surface, and test how they'd perform.

Samples of the film were then immersed in a supersaturated calcium sulfate solution for 20 hours at room temperature, to allow the mineral scale to deposit. The nitrogen-terminated diamond film accumulated more than an order of magnitude less scale than the other versions of film terminated with oxygen, hydrogen or fluorine. Plus, the buildup appeared only in scattered crystal clusters, as opposed to dense layers that would be hard to break down and remove.

When this approach was applied to boron-doped diamonds electrodes, the buildup was approximately seven times lower compared to untreated electrodes.

"These findings identify vapor-grown, cost-effective, polycrystalline diamond films as a powerful, long-lasting anti-scaling material with broad potential across water desalination, energy systems and other industries where mineral buildup is a problem," said Pulickel Ajayan, professor of materials science and nanoengineering at Rice University and an author of the study that appeared in ACS Nano earlier this month.

Ajayan and his team have been involved in work on diamond films before, including in a study from earlier this year that showed its potential in enabling the production of faster and more efficient electronics and quantum computing components.

The researchers' finding could see diamond coatings being applied not only to industrial pipes in the future, but it could also find use in water desalination, oil and gas production, and power generation equipment.

New Atlas, 27 November 2025

https://newatlas.com

Eco-friendly, photo-switchable smart adhesives use biomass-derived materials

2025-12-10

Conventional petroleum-based adhesives rely heavily on the petrochemical industry and pose environmental risks due to harmful emissions and limited reusability. In a new study, researchers developed a novel photo-switchable smart adhesive based on materials derived from rose oil. It is both eco-friendly and highly reusable, while exhibiting great adhesion to a variety of surfaces. This innovative adhesive paves the way for more sustainable and smart material technologies.

Adhesives are essential in various industries, including aerospace, electronics, construction, marine, automotive, and biomedical fields. As these fields continue to advance, the demand for high-performance, multifunctional adhesives is also growing. However, such widespread use has also highlighted their environmental issues.

Conventional adhesives, while effective and economical, release petroleum-based chemicals that are harmful to soil and water quality. Their production also contributes to environmental pollution, and the

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adhesives themselves are difficult to recycle or dispose of. Developing reusable and more eco-friendly alternatives is therefore becoming increasingly important.

At the same time, there is a growing demand for advanced adhesives with diverse functionalities. For example, stimuli-responsive adhesives that can vary their adhesive strength based on external stimuli are attracting significant attention. Among them, photo-responsive adhesives are especially attractive, as they allow localized wireless control of adhesion through light while also possessing non-invasive properties.

To meet both performance and sustainability goals, a research team led by Professor Kwang-Un Jeong, along with Ph.D. Student Mr. Mintaek Oh from the Department of Nano Convergence Engineering at Jeonbuk National University, South Korea, has developed a novel eco-friendly, photo-switchable smart adhesive.

"We synthesized a tetrahydrogeraniol-based monomer, a derivative of rose oil, and successfully fabricated an eco-friendly adhesive containing 95% of it," explains Prof. Jeong. "The final adhesive, incorporating a small amount of a functional monomer that responds to light and adheres strongly to various substrates, exhibits high-responsive adhesion, allowing quantitative control of its bonding strength. It is eco-friendly, cost-effective, versatile, and reusable."

Their study was published in the Chemical Engineering Journal on September 15, 2025.

To fabricate the adhesive, the researchers first synthesized two key components: an acid azobenzene-based methacrylate monomer (AAMM) and a biomass-based tetrahydrogeraniol methacrylate monomer (TGMM). AAMM consists of azobenzene, carboxylic acid, and methacrylate. Azobenzene derivatives are well known for their reversible photo-switchable behavior, making them ideal for light-responsive systems. The carboxylic groups can form strong hydrogen bonds with a variety of substrates, facilitating strong adhesion.

TGMM, made from rose-oil-derived tetrahydrogeraniol, contributes to biodegradability and sustainability. It also helps maintain the balance between flexibility and mechanical stability in the adhesive. By copolymerizing AAMM and TGMM through their methacrylate groups, the researchers successfully created a new eco-friendly and photo-switchable adhesive, termed the T/A adhesive.

During testing, the optimized T/A adhesive demonstrated excellent photo-switchable adhesion, with strong adhesion to a wide range of substrates, including metals, plastics, rubber, glass, cork, and paper. When exposed to ultraviolet light, the adhesive becomes more liquid-like, and its adhesion strength decreases. After subsequent exposure to visible light, it returns to its original adhesion strength and becomes more solid-like again, thus demonstrating fully reversible, light-controlled adhesion.

In addition to light, adhesion strength can also be switched using heat and chemical treatments. Specifically, increasing temperature beyond 500°C significantly reduces adhesion strength, which can then be restored by cooling. Similarly, the adhesive can be dissolved by solvents like chloroform and recovered when the solvent evaporates. The researchers also found that the reused T/A adhesives in all three processes were able to retain more than 90% of their original adhesive strength across repeated usage cycles.

The researchers further demonstrated a smart UV sensor built using the new adhesive and a spring-based mechanism that can serve as a UV-light sensitive switch in electrical circuits. In this device, the T/A adhesive holds the spring to maintain an open circuit. When exposed to UV-light, its adhesion strength reduces, causing the spring to close the circuit.

"Our smart, reusable adhesive is promising for a wide range of practical applications," remarks Oh. "It can play a valuable role in environmental monitoring, smart electronics, and adaptive assembly systems, where controllable and reusable adhesion is critical. It could also enable reusable light-responsive smart packaging, wearable devices with detachable sensors, and reconfigurable robotic components."

Overall, by replacing petroleum-based adhesives with biomass-derived alternatives, this research paves the way for more sustainable and smart adhesive technologies.

Provided by Jeonbuk National University

Phys Org, 10 December 2025

https://phys.org

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Scientists Identify the Recipe for Stabilizing Atomically Thin Metals

2025-12-09

Metallenes possess exceptional properties that make them highly attractive for future applications in advanced electronics, high-efficiency energy storage, sensors, and catalysis. However, their tendency to collapse due to metallic bonding has made their synthesis difficult, often requiring confinement within the pores of template materials as small patches.

"The aim of our researcher group was to use a large-scale computational approach to conduct a systematic, microscopic analysis of metallene interfaces to discover the fundamental design principles for greater stability," explains the team leader, Professor Pekka Koskinen from the University of Jyväskylä.

Geometry determines the stability of metal parts

To tackle this challenge, researchers used a powerful computational approach that combined quantum-mechanical modeling with advanced universal machine learning. This allowed them to analyze the stability and properties of 1080 different graphene-metallene interfaces.

"We found that interface stability depends on maintaining smooth, well-aligned geometries. Such clean edges provide strong resistance to defects and mechanical strain, whereas irregular boundaries promote destabilization," says postdoctoral researcher Mohammad Bagheri from University of Jyväskylä, who conducted the theoretical simulations.

Machine learning speeds up the design of new materials

The researchers also found that metallenes made from transition metals form the most robust interfaces overall. Moreover, the research validates the use of machine-learning models for accurately predicting atomic-level interface behavior, establishing a powerful new tool to accelerate the design and screening of novel materials.

"This systematic understanding provides useful geometric and elemental rule-of-thumb requirements for stability. This way, the research offers a guideline to accelerate the synthesis of more robust, larger-scale metallene structures," says Koskinen.

This knowledge is a critical breakthrough needed to move metallenes out of the research lab and into practical, high-performance devices. This

study marks a vital step toward enabling metallenes for applications in high-tech fields like electronics, energy conversion and biomedicine.

The results were published in the journal Nanoscale and featured in the 2025 Nanoscale HOT Article Collection.

website, date

https://website

"Self-densified" wood could give metal a run for its money

2025-03-25

While sustainably-grown wood can be an economical and eco-friendly building material, its relatively low tensile strength limits its potential applications. That could soon change, however, thanks to a new self-densifying technique for creating super-strong wood.

Individual wood fibers are made up mainly of cellulose, along with a binder material known as lignin. This mixture forms the wall of what is essentially a long hollow tube – the fiber – which runs lengthwise within the larger piece of wood. The hollow space inside the tube is called the lumen, and it is what limits wood's strength.

A team from China's Nanjing University recently set out to address that shortcoming, by developing the new process.

It begins by boiling a block of wood in a mixture of sodium hydroxide (lye) and sodium sulfite, removing some of the lignin. That block is then immersed in a heated blend of lithium chloride salt and a solvent known as dimethylacetamide. This causes the cellulose (and remaining lignin) to swell, expanding inwards to fill the lumen.

In a final step, the processed wood is left to air-dry at room temperature for 10 hours. As it does so, it uniformly shrinks inwards from all sides, but maintains its original length.

The resulting material is claimed to exhibit "ultra-high" tensile strength, flexural strength, and impact toughness – much more so than natural wood. It even surpasses wood which has been compressed by traditional methods, in which the fibers are just mechanically flattened in one direction.

(NOTE: OPEN YOUR WEB BROWSER AND CLICK ON HEADING TO LINK TO SECTION)

CHEMICAL EFFECTS

Is Reproductive Toxicity of Bisphenols an Adverse Outcome from Insulin Homeostasis Disruption in Fish?

Impacts of the 2024 flash flood on water quality, pathogenic bacteria and organic contaminant risks in the Albufera wetland (Valencia, Spain)

Toxicity comparison of avermectins, chlorantraniliprole and deltamethrin on Procambarus clarkii: Histopathology, apoptosis, antioxidation, transcriptome response and intestinal microflora

Comparing the toxicity of nitrate between different species of subterranean Niphargus amphipods

ENVIRONMENTAL RESEARCH

Air pollution exposure modes, smoking and genetic risk with chronic respiratory diseases: a prospective study

PHARMACEUTICAL/TOXICOLOGY

Long-term ozone exposure and attention-deficit/hyperactivity disorder symptoms in school-aged children: Findings from a large multi-city study in China

OCCUPATIONAL

Occupational exposure to phthalate esters and systemic clinical changes in municipal sanitation workers: Human Biomonitoring and Network Analysis approach

Micronucleus frequency in buccal cells increases with urinary titanium concentrations and oxidative stress biomarkers among subway workers

Changes in lung function and fractional exhaled nitric oxide across wildfire seasons in the wildland firefighter exposure and health effect (WFFEHE) study

The Impact of a Blue-Blocking Filter Over One Eye on Health and Performance Outcomes and Its Implications for Night Workers