CHEMWATCH

Bulletin Board

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ASIA PACIFIC

List of new chemical assessment statements published

2026-01-27

Reference number	Chemical name or AICIS approved chemical name (AACN)	End use or generalised end use
CA09906 - Assessment Statement - 12 August 2025 [pdf] [570 KB]	1,2,3-Propanetriol, homopolymer, heptanoate	Component of personal care products (cosmetics)
CA09969 - Assessment Statement - 1 October 2025 [pdf] [518 KB]	Phosphonic acid, *P*-(1,1-dimethylethyl)-, calcium salt (1:1)	Component in the production of plastic and polymer products
CA09996 - Assessment Statement - 12 December 2025 [pdf] [607 KB]	Methanaminium, 1-carboxy-*N,N,N*-trimethyl-, 2-hydroxybenzoate (1:1)	Component in non-spray skin applied personal care products (cosmetics) intended for use on face and neck only
CA10053 - Assessment Statement - 17 October 2025 [pdf] [634 KB]	Phosphorothioic triamide, *N*-propyl-	Component of fertiliser products

Read More

AICIS, 27-01-26

https://www.industrialchemicals.gov.au/news-and-notices/new-chemical-assessment-statements-published-27-january-2026

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AMERICA

PRIA 5 Training Development

2026-01-30

The U.S. Environmental Protection Agency (EPA) seeks applications from land grant colleges and universities, non-land grant colleges of agriculture, and 1994 Institutions to develop training for pesticide registrants on regulatory procedures according to the Pesticide Registration Improvement Act (PRIA). The goal is to improve the efficiency, clarity, and consistency of EPA's pesticide registration and registration review processes. In addition to developing training, the awardee will also assist EPA in determining agricultural focus areas for crop tours. The overall objectives are to improve skills, align competencies with EPA's mission, address best practices, improve processes, promote consistency, and educate stakeholders on regulatory procedures.

Read More

US EPA, 30-01-26

https://simpler.grants.gov/opportunity/74ad7de5-a0f5-463d-b337-4f037a11602c

SB 54 Plastic Pollution Prevention and Packaging Producer Responsibility Act Permanent Regulations Overview

2026-02-06

The Department of Resources Recycling and Recovery (CalRecycle) is proposing permanent regulations for Senate Bill (SB) 54.opens in a new window

SB 54 establishes the Plastic Pollution Prevention and Packaging Producer Responsibility Act, which imposes minimum content requirements for single-use packaging and single-use plastic food service ware, to be achieved through an extended producer responsibility (EPR) program.

California's landmark packaging law is the most significant overhaul of California's plastics and packaging recycling policy in history. It goes further than any other state on cutting single-use plastic at the source and represents a giant step toward a more circular economy that is essential to combat climate change.

The law establishes California's largest EPR program by regulating several thousand producers — as many as an estimated 5,741 — whereas other California EPR programs regulate fewer than 1,000 producers.

The legislation shifts the plastic pollution burden from consumers to producers, typically the companies that create — or package their products in — single-use packaging and single-use plastic food service ware. Producers must pay $5 billion over 10 years — $500 million per year beginning in 2027 — to:

- Address the environmental impacts of plastic pollution and
- Aid affected environmental justice communities most impacted by the damaging effects of single-use plastic waste.

The law requires producers to ensure that by 2032:

- 100% of single-use packaging and single-use plastic food service ware sold in the state is recyclable or compostable
- 65% of single-use plastic packaging and single-use food service ware is recycled and
- 25% reduction, compared to 2023, in the sale or distribution of single-use plastic packaging and single-use food service ware.

The law requires CalRecycle to adopt permanent regulations.

Read More

US State of California, 06-02-26

https://calrecycle.ca.gov/Laws/Rulemaking/SB54Regulations

Massachusetts Lawmakers Push Local Protections for Kids

2026-01-27

Children in the United States are surrounded all day long by toxic chemicals. Toxic chemicals are in mattresses, bedding, car seats, strollers, lotions, sunscreens, shampoos, diapers, band-aids, clothing, and toys. Meanwhile, exposure to toxic chemicals, especially in childhood, is linked to diseases that are on the rise among young people, including cancer, neurodevelopmental disorders, reproductive problems, and asthma.

Senator Jo Comerford (D-Northampton) and Representative Jim Hawkins (D-Attleboro) have filed An act relative to toxic free kids (H4357/S2660) to get the worst chemicals out of children's products.

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They are hosting a legislative briefing in collaboration with Clean Water Action this Wednesday, January 28, from 1:00 to 2:00 in Room 428 at the Massachusetts State House to give an overview of the bill and explain how it can protect children and reduce preventable illness.

Read More

Clean Water Action, 27-01-26

https://cleanwater.org/releases/massachusetts-lawmakers-push-local-protections-kids

EUROPE

PFAS Plan: building a safer future together

2026-02-03

Per- and poly-fluoroalkyl substances (PFAS), often called 'forever chemicals', represent one of the most pressing chemical challenges of our time. They are used throughout our everyday lives as their unique properties have brought significant benefits to society. They appear in non-stick frying pans in your kitchens and medical devices in our hospitals. They are used in clean energy technologies that power our industries and safety equipment that protects us from harm. Yet their persistence and widespread presence in our environment pose risks we cannot ignore.

This is an important issue for the government to address. PFAS contamination threatens public health, wildlife and the quality of our natural environment. Acting now is essential to prevent irreversible harm and to ensure that our regulatory frameworks keep pace with scientific evidence.

This plan provides a foundation for how we will act – decisively but proportionately – to manage risks. Our vision is to reduce and minimise the harmful effects of PFAS while transitioning to safer alternative substances. It reflects our commitment to protect public health and the environment while supporting innovation and economic growth.

Our approach is rooted in science and collaboration. We will strengthen understanding and awareness, tackle the sources of PFAS and how they move through the environment, and reduce ongoing exposure to the PFAS that are already out there. We will work in partnership across the UK, with devolved governments, industry, scientists, environmental groups and local communities. We will continue to lead internationally,

contributing to global efforts to phase out harmful PFAS and share best practice.

This is a long-term challenge, but through coordinated action we can ensure that we pass on to the next generations an environment that is better than the one we inherited. Together, we will protect our environment, safeguard public health, and build a cleaner, safer future.

Read More

Gov.UK, 03-02-26

https://www.gov.uk/government/publications/pfas-plan/pfas-plan-building-a-safer-future-together

PFAS in firefighting foam (FFF) restriction proposal

2026-02-06

The Health and Safety Executive (HSE), as the Agency for UK REACH, has assessed the risks linked with using per- and polyfluoroalkyl substances (PFAS) in firefighting foams (FFF). This work was carried out at the request of the Secretary of State for Environment, Food and Rural Affairs (Defra), with the agreement of the Scottish and Welsh Governments.

The assessment and a proposed restriction are set out in a detailed document called an 'Annex 15' report. The report examines the risks PFAS in FFF may pose to human health and the environment and suggests measures to reduce those risks.

We are now inviting comments on the proposed restriction on the placing on the market and use of PFAS in FFF, along with any relevant evidence or information you can provide.

Read More

UK HSE, 06-02-26

https://consultations.hse.gov.uk/crd-reach/pfas-in-firefighting-foam-fff-restriction-proposal

REFRESH project is making wind energy more circular

2026-01-28

The EU-funded REFRESH project (Smart dismantling, sorting and REcycling of glass Fibre REinforced composite from wind power Sector through

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Holistic approach) aims to build a circular and self-sustainable value chain for the glass fibre-reinforced composites used in wind turbine blades.

There are three steps to their process:

Collect information on decommissioned blades and select the most suitable recycling method, taking into account the technical parameters of the blade, logistics and the current market demand for the end products of the recycling process.

Improve existing recycling technologies. They are focusing on mechanical and thermo-chemical treatment of waste but will also explore further processing and re-use options.

Design a range of new products using the outputs of the various recycling processes.

The project is now in its fourth year and is making progress.

It has demonstrated that recycled glass fibres from old blades can be used in the manufacture of new ones.

Read More

European Union, 28-01-26

https://circulareconomy.europa.eu/platform/en/news-and-events/all-news/refresh-project-making-wind-energy-more-circular

Assessing the impact of Energy Efficiency on the EU Energy Consumption in 2010-2023

2026-01-23

This report examines the determinants of changes in primary and final energy consumption at EU27 and Member State levels over the period 2010 to 2023 to track and understand the progress towards 2030 energy efficiency targets and beyond. Energy consumption trends are driven by several factors beyond energy efficiency improvements, which can have a profound effect in the aggregate energy use, irrespective of the impact of energy efficiency policies and measures. To understand the latest energy consumption trends in the EU, the Logarithmic-Mean Divisia Index.

(LMDI) approach, a widely used Index Decomposition Analysis (IDA) method, was applied to study both aggregated and sectoral energy consumption changes at EU and Member State levels over the examined period and quantify the impact of factors such as economic activity,

demographics, productivity, lifestyle and weather changes. The results suggest significant energy efficiency gains from 2010 to 2023, without which the progress achieved towards 2030 EU energy efficiency targets would have been difficult to attain. However, any analysis for the recent years should be considered with caution as they have been significantly influenced by exceptional external factors. In 2020, the COVID-19 pandemic led to a drop in energy consumption, followed by a rebound effect once the restrictions were raised. Starting in 2022, the Russia's war of aggression against Ukraine (was preceded from and) resulted in an increase in energy prices (especially for gas) with strong interventions by the EU and Member States to limit energy consumption. With the aim to investigate the evolution of the determinant factors of energy consumption, an analysis of the energy consumption projections for selected sectors (i.e., industry, services, agriculture and residential) up to 2050 at the European level has been carried out.

Read More

European Commission, 23-01-26

https://publications.jrc.ec.europa.eu/repository/handle/JRC144708

Emerging contaminants in wastewater: The new challenge for Europe's water management

2026-01-22

Europe is undergoing a profound transformation in the way it manages water. Over the past decade, extreme droughts, increasing pressure on water resources and the need to safeguard long-term water security have pushed policymakers to update the legislative framework for wastewater treatment, water reuse and the control of emerging contaminants.

The result is a far more stringent regulatory environment—one that not only defines the quality requirements for reclaimed water but also drives systematic monitoring and mitigation of substances that, until recently, were outside the scope of routine control.

This short article by AIMPLAS looks at the Urban Wastewater Treatment Directive which covers treatments intended to remove microcontaminants, monitoring of emerging contaminants, and nutrient

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controls. It also describes what contaminants are posing a threat and why emerging contaminants matter.

Read More

European Union, 22-01-26

https://circulareconomy.europa.eu/platform/en/news-and-events/all-news/emerging-contaminants-wastewater-new-challenge-europes-water-management

INTERNATIONAL

Public warned against the use of transformer oil due to toxic chemicals that may be contained in the oils

2026-01-23

The Department of Forestry, Fisheries, and Environment (DFFE) urges the public to refrain from applying transformer oil or any other electrical equipment oil, to the body or for any other non-industrial purpose. Such oils may contain Polychlorinated Biphenyls (PCBs) – toxic chemicals that pose serious risks to human health and the environment.

PCBs are a group of man-made organic chemicals that were largely manufactured between 1929 and 1989 and were widely used as coolants in oil containing electrical equipment (such as electric transformers and capacitors), hydraulic systems, and other industrial applications. PCBs were widely used in electrical equipment by energy intensive sectors such as mining, paper and pulp, power generation and distribution (e.g. power utilities and municipalities), chemicals, etc.

During engagements with municipalities since 2024, the Department noted dangerous misconceptions in some communities, including the belief that transformer oil can be used for treating conditions such as rheumatic arthritis. This has led to requests being made to municipal officials for access to transformer oil – some of which can be contaminated with PCBs. The DFFE strongly warns against this practice and calls on municipal officials to refrain from supplying transformer oil to members of the public.

PCBs were amongst the twelve chemicals that were initially listed by the Stockholm Convention on Persistent Organic Pollutants as persistent organic pollutants (POPs). The Convention entered into force in 2004 and it obliges countries to eliminate the use of PCBs in 2025 and determined

efforts that lead to the environmentally sound management of PCB wastes (waste liquids and equipment) by 2028. Although their production was banned in many countries decades ago due to their toxic effects on human health and the environment, PCBs remain a persistent threat especially in older equipment and contaminated sites.

Read More

Republic of South Africa Department of Forestry, Fisheries and the Environment, 23-01-26

https://www.dffe.gov.za/mediarelease/publicwarnedagaintsuseoftransformeroil

New WHO Collaborating Centre established to support work on food safety and healthy diet

2026-01-28

WHO welcomes the Research Group for Risk Benefit at the DTU National Food Institute based in Kgs. Lyngby, Denmark, as the new WHO Collaborating Centre for Risk and Benefits of Foods and Diets. The group will support WHO's efforts to estimate the burden of foodborne diseases and to develop integrated risk-benefit approaches for healthier and safer food. Their contributions will help reduce avoidable disease burden due to unsafe food or unhealthy diets, and to make people healthier through evidence-based dietary recommendations adapted to regional and local contexts.

WHO collaborating centres carry out activities in support of WHO's programmes in all areas of public health. By relying on robust scientific expertise, this new Centre will support WHO's mission of supporting countries to achieve healthy, safe and sustainable diets.

Specifically, the new Centre will:

- support WHO in strengthening foodborne disease data, including maintaining and updating WHO foodborne disease estimates;
- support WHO in developing an integrated approach for risk-benefit assessment of food including nutritional, microbial and chemical contaminations, taking into account the sustainability aspects; and

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- support WHO in assisting its Member States to strengthen national data capacity with respect to foodborne diseases, source attribution, and risk-benefit assessments.

Read More

WHO, 28-01-26

https://www.who.int/news/item/28-01-2026-new-who-collaborating-centre-established-to-support-work-on-food-safety-and-healthy-diet

REACH Update

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Two hazardous chemicals added to the Candidate List

2026-02-05

The newly added substances to the Candidate List of substances of very high concern (SVHC) are:

- n-hexane (EC 203-777-6, CAS 110-54-3)
- 4,4'-[2,2,2-trifluoro-1-(trifluoromethyl)ethylidene]diphenol and its salts (EC -, CAS -).

They are used, for example, in formulation, polymer processing, coatings, cleaning agents and as process regulators and cross-linking agents respectively.

The list now contains 253 entries for chemicals that can harm people or the environment. Companies are responsible for managing the risks of these chemicals and giving customers and consumers information on their safe use.

Read More

ECHA, 05-02-26

https://echa.europa.eu/-/echa-adds-two-hazardous-chemicals-to-the-candidate-list-1

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Janet's Corner

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Who Am I?

2026-02-13

I am a silvery metal and a key component of stainless steel, prized for its strength and resistance to rust.

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

I am a silvery metal and a key component of stainless steel, prized for its strength and resistance to rust.

.

Dinitro-o-cresol

2026-02-13

Dinitro-o-cresol (DNOC) is an organic compound with the structural formula CH3C6H2(NO2)2OH. [1] DNOC is a yellow solid with no smell. The taste of DNOC is not known. It dissolves slightly in water. [1,2]

USES [2,3]

DNOC was primarily used to protect fruit trees and other food crops from insect damage. In 1991, the United States EPA cancelled DNOC's registration as a pesticide. Another less expensive chemical that is more effective in controlling pests is replacing DNOC. In the 1930s, DNOC was used in pills for reducing weight. It is no longer used for this purpose because of bad effects on health.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

People can be exposed to DNOC by breathing contaminated air, drinking contaminated water, or eating contaminated food. Other than in certain workplaces, levels of DNOC in the air have not been measured. However, the ambient level is expected to be very low. The levels of DNOC in drinking water and food also have not been detected. Certain people may be exposed to slightly higher levels of DNOC. People who live near sites containing DNOC wastes may be exposed primarily by breathing contaminated air. Children playing at or near these sites will be exposed by touching and eating soil if that soil contains DNOC. You may be exposed to DNOC if your work involves manufacturing, preparing, or using formulated DNOC products. You may be exposed if you work as a sprayer of DNOC. You also may be exposed to DNOC if your work involves incinerating waste containing DNOC or cleaning up sites contaminated with DNOC.

Routes of Exposure

The major routes of exposure to DNOC are:

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

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HEALTH EFFECTS [4]

Acute Health Effects

- Increased basal metabolic rates have resulted in humans following acute and chronic exposures to DNOC. Symptoms of toxicity from acute exposure include profuse sweating, increased pulse rate, increased respiratory rate, thirst, fatigue, lethargy, headache, nausea, appetite loss, malaise, collapse, coma and greenish-yellow pigmentation of the conjunctivae in humans. Yellow colouring of the hands, nails, and hair may also result.
- Damage to the liver, kidney, and nervous system have been reported in humans following acute exposure.
- DNOC is an uncoupler of oxidative phosphorylation, which accounts for its extreme acute toxicity.
- Dermal contact may lead to local necrosis.
- Acute animal tests in rats, mice, rabbits, and guinea pigs have demonstrated DNOC to have extreme acute toxicity from oral exposure and high acute toxicity from dermal exposure.

Carcinogenicity

- No information is available on the carcinogenic effects of DNOC in humans or animals.
- EPA has not classified DNOC for potential carcinogenicity.

Other Effects

- No information is available on the reproductive or developmental effects of DNOC in humans.
- DNOC had no teratogenic or embryotoxic effects in several animal studies, while chromosomal aberrations were reported in the foetuses of pregnant mice given DNOC by gavage.
- One animal study reported that DNOC affected spermatogenesis, while another study did not find similar results.

SAFETY

First Aid Measures [5]

- Eyes: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical aid immediately.

- Skin: In case of contact, get medical aid immediately. Immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Destroy contaminated shoes.
- Ingestion: If swallowed, get medical aid immediately. Only induce vomiting if directed to do so by medical personnel. Never give anything by mouth to an unconscious person.
- Inhalation: If inhaled, get medical aid immediately. Remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling DNOC:

- **Eyes:** Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
- **Skin:** Wear appropriate protective gloves to prevent skin exposure.
- **Clothing:** Wear appropriate protective clothing to prevent skin exposure.
- **Respirators:** A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.

REGULATION

United States

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

- General Industry: 0.2 mg/m3 (Skin)
- Construction Industry: 0.2 mg/m3 TWA (Skin)

ACGIH: The American Conference of Governmental Industrial Hygienists has established a Threshold Limit Value (TLV) for DNOC of 0.2 mg/m^3 TWA (Skin)

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for DNOC of 0.2 mg/m^3 TWA(skin)

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EPA: The Environmental Protection Agency has listed DNOC as a hazardous air pollutant. Federal regulations limit the amount of DNOC that factories can release into wastewater. EPA requires industries to report releases or spills of 10 pounds or more.

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How air pollution is rewiring gut chemistry and fuelling chronic disease

2026-02-05

After eight years of blaming herself, farmworker Shalan Chinde learned her deteriorating health was not her fault. It began with persistent acid reflux and burning in her chest. Her hands and legs would ache, and some mornings she woke up dizzy and exhausted. The bloating grew worse, followed by pounding headaches, even on days she ate simple home-cooked food.

When she finally underwent medical tests, she was diagnosed with type 2 diabetes. She was determined to find out what was behind this. 'I live a healthy lifestyle and yet my problems kept piling up each year,' says the 49-year-old. As the dosage of her medication was increased, she started tracking when her symptoms worsened. On high-pollution days, she noticed her breathlessness increased, her eyes burned, and the acid reflux returned with a painful intensity, triggering headaches that only eased with a painkiller or antacid. When she shared these observations with her doctor, he told her that air pollution was contributing to her symptoms.

For over 15 years, Chinde has been working at a sugarcane nursery in her village in Maharashtra, India. These nurseries have proliferated in the region and the piles of leftover sugar cane stalks that accumulate are frequently burned, sending out thick blankets of smoke.

Chinde's experience now echoes a growing body of international research, and in a world where the World Health Organization says 99% of people breathe unsafe air, the consequences go far beyond one village. Scientists are finding that air pollution doesn't stop at the lungs, it can travel deeper into the body and disturb the trillions of bacteria living in the gut.1 These microbes are essential for digestion, metabolism and immunity. When pollution interferes with them, it can trigger biological changes linked to diabetes, obesity, gastrointestinal diseases, cardiovascular conditions and other chronic diseases.

New pathways of harm

Chinde's story is just one window into a much larger scientific puzzle. Pinpointing air pollution's impact on the gut is tricky because there are so many variables. But a randomised trial in Uganda offers one of the clearest clues so far. Researchers replaced smoky kerosene lamps with clean solar lamps to reduce air pollution, then collected stool samples before and after the switch to analyse both bacteria and gut viruses.

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They found that the biggest changes were not to the bacteria in the gut but the viruses that infect bacteria and other microbes that live in the gut, called phages. The most substantial shift was in the gut's virome, the viral ecosystem of an organism, says Peggy Lai at Harvard Medical School, who led the Ugandan study. It showed a broad reorganisation of the phage community after air pollution exposure was reduced. After the switch to solar lamps, the team also saw a rise in helpful, fibre-loving bacteria, linked to producing butyrate, a compound known to calm inflammation. Meanwhile, bacteria associated with inflammation declined.

Women who switched to solar lamps reported fewer breathing problems, although lung function didn't change over the study period. The takeaway, Lai says, is that cleaner air can help the gut, and a healthier gut may help the lungs.

'Think of the nose and mouth as two doors leading into the same hallway,' Lai says. 'When we breathe polluted air, some of the tiniest particles don't stay in the lungs; we end up swallowing them. Once those particles reach the gut, they can irritate the gut lining, the protective inner wall of the intestines, and nudge the immune system, thereby shifting which microbes can grow. Even viruses that infect gut bacteria can reshape the microbial balance by killing some bacteria and allowing others to thrive. Together, this can reshape the balance of the gut's microbial community.'

It doesn't stop with indoor air pollution. In Italy, higher levels of traffic-related air pollution changed children's gut bacterial composition.3 Traffic pollutants, including fine particulate matter from vehicle emissions, often mixed with reactive chemicals released by traffic, trigger reactions in the body once inhaled, producing harmful molecules that can damage gut bacteria and disrupt metabolism. While the study didn't look at disease, the changes it found were similar to those previously linked to metabolic issues.

Treesa Thomas, an environmental health researcher who has published work on the link between air pollution and disruption of the gut microbiome, explains that pollutants, such as fine dust particles, can cause inflammation and stress throughout the body. Pollution can also weaken the gut's protective walls, making them 'leakier' and allowing harmful substances to slip through.

'And because the lungs, liver, brain and gut are all connected, pollution can send inflammatory signals or particles to the gut, further disturbing its ecosystem.' Moreover, pollutants like fine particulate matter, she adds,

can shift gut bacteria in ways that interfere with blood sugar regulation, potentially increasing the risk of insulin resistance and diabetes.

Over the years, many studies have tried to uncover the link between air pollution and metabolic dysfunction. For instance, in China, scientists tracked older adults' exposure to PM2.5, fine particulate matter less than 2.5µm in diameter that can easily enter the bloodstream.5 They found that higher pollution levels were linked to changes in blood chemistry and higher insulin resistance, an early warning sign for type 2 diabetes.

Worldwide, 2.1 billion people cook using inefficient stoves, leaving households exposed to dangerous levels of air pollution as clean energy sources remain out of reach. Chinde says she has cooked on a traditional stove for over three decades. Aware of the risks, she is taking measures to reduce her exposure and wears a mask whenever she enters areas with severe air pollution.

The unknown health toll

While the links between air pollution and metabolic or respiratory diseases are well established, researchers are now uncovering signs that the effects may go deeper. 'Altered gut microbes may affect brain function via the gut–brain axis, possibly influencing neurodevelopment or contributing to conditions such as anxiety or cognitive decline, though the evidence here is still early,' says Thomas. A study of over 1000 older Chinese adults found that long-term exposure to air pollution changed gut microbes in measurable ways. Higher pollution levels were linked to the loss of certain beneficial bacteria, disruptions to microbial energy-metabolism pathways and changes in blood metabolites, which, in turn, were associated with a higher risk of cognitive decline. 6

Moreover, Thomas warns that children exposed to air pollution may experience long-term disruptions in their gut microbiome, potentially increasing the risk for chronic diseases later in life.

'The firmest take-home right now is about symptoms; links to specific diseases beyond that are promising but not settled,' adds Lai.

Even as scientists continue to investigate these links, people like Malan Barwade are dealing with the consequences. For the past eight years, the 60-year-old Maharashtra resident has been struggling with serious acid reflux. She remains so worried about the headache it triggers that she always carries an antacid.

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'I eat home-cooked meals and take care of my health, yet I experience episodes of acidity,' she says, adding that it gets severe on high-pollution days. Like Chinde, she lives near a sugarcane nursery that sometimes blankets her home in smoke. 'If you look at the plants near the house, almost all of them have turned grey because of soot,' she says. With air pollution worsening her health, she was forced to quit farmwork, her only livelihood.

Protecting the gut

Avoiding exposure is rarely an option for people like Chinde and Barwade. 'We may not always be able to escape polluted air, but there are ways to safeguard or rebalance the gut,' Thomas says. High-fibre, plant-rich foods feed beneficial gut bacteria, especially the ones that produce short-chain fatty acids, which help reduce inflammation and strengthen the gut barrier. A diverse, plant-based diet can counter the damage caused by pollution. Supplements like probiotics and prebiotics may also help restore microbial diversity. While human studies are limited, she notes, they're a low-risk option worth considering.

'The solution is to reduce exposure by switching to cleaner fuels, using air purifiers or avoiding outdoor activity during high-pollution periods,' Thomas says. She adds that antioxidants, regular physical activity and stress reduction all help maintain the gut's protective lining and immune balance.

Bo-Yi Yang at Sun Yat-Sen University, China, who has looked at how being outdoors can affect people's health, says that the exact mechanisms by which green spaces influence the human microbiome remain unclear. However, he says that green spaces might alter the microbiota of the surrounding environment. 'Trees and grasses may shape the air microbiome by releasing plant particles carrying microbes, secreting volatile organic compounds and changing the microclimate that then influences airborne microbial activities.'

Evidence also suggests that residential greenspace can alter the microbiota in indoor dust, Yang notes. Exposure to greener environments may therefore increase the transfer of environmental microbes into the human body through breathing, skin contact or ingestion.

Greener areas also tend to have lower levels of air pollution, which is known to affect the diversity and abundance of microbes in the human gut. Moreover, many studies have confirmed that regular physical activity can influence intestinal microbial composition and benefit gut metabolism

and health.7 Green spaces can encourage physical activity, which itself benefits gut health and alleviates psychological stress, another factor that influences the microbiome.

However, experts say that practical steps alone aren't enough, as there is still widespread confusion about how pollution interacts with the gut. The most common belief is that pollution affects only the lungs. 'People assume the gut is protected because it's internal,' says Thomas, but inhaled pollutants can move from the lungs into the gut.

Another misconception is that the gut cannot recover once damaged. She points out that the microbiome is remarkably resilient. With a good diet and lifestyle, the gut microbiome can rebalance itself.

For Chinde, the research has offered more context rather than any direct answers. Years of illness left her searching for reasons and, while it is difficult to pinpoint a single cause, science has begun to show how environmental exposures can quietly shape health over time. Today, she tries to be more aware of the air she breathes and adjusts her routine when pollution levels rise. 'I don't know what the future holds,' she says, 'but I want to stay healthy for as long as I can.'

Chemistry World, 5 February 2026

https://chmeistryworld.com

Ammonia leaks can be spotted in under two seconds using new alveoli-inspired droplet sensor

2026-02-11

Researchers from Guangxi University, China have developed a new gas sensor that detects ammonia with a record speed of 1.4 seconds. The sensor's design mimics the structure of alveoli—the tiny air sacs in human lungs—while relying on a triboelectric nanogenerator (TENG) that converts mechanical energy into electrical energy. The sensor uses a process that is driven by A-droplets, which are tiny water droplets containing a trapped air bubble. These droplets exploit ammonia's affinity for water to rapidly capture NH_3 when it is present.

When an ammonia-laden droplet falls onto the sensor, its mechanical impact completes an electrical circuit, generating signals that are converted into accurate gas measurements at a speed that exceeds existing ammonia gas sensors.

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To take detection precision a step further, the team integrated an AI model that analyzes electrical signals and converts them into time-frequency images. After training on these images, the system classified ammonia into five concentration levels (0–200 ppm), achieving up to 98.4% detection accuracy.

The findings were published in Nature Communications.

Ammonia (NH_3), though very useful to agriculture, pharmaceuticals, and industry in general, is a colorless, pungent gas that is extremely corrosive and toxic. If a person is exposed to over 50 ppm of the gas, it can cause severe lung damage and, in extreme cases, even death.

Despite the dangers, over 182 million tons of this harmful gas are produced every year by various industrial and human activities, and 80% of it eventually finds its way into the atmosphere, making it an environmental and public health concern. A quick and reliable way to detect this colorless gas is essential to ensure the safety of both people and their surroundings.

While sensors exist that can detect ammonia, they are not fast enough to serve as truly effective monitoring tools. Most sensors in use today are solid-state, meaning they rely on solid materials to adsorb gas molecules on their surface, form chemical bonds, and then detach from the surface for the sensor to generate a reading. This entire reaction cycle creates a lag in response time, and it is crucial that this lag be as short as possible to ensure timely detection during a leak or accidental gas buildup.

Trapping ammonia in a bubble

The researchers looked to biology for inspiration and found it in the lungs' alveoli—tiny spherical air sacs that are the lungs' primary units for gas exchange. The team used a special double-needle sprayer to produce the air-cavity droplets or A-droplets, which are small water droplets with a bubble inside, that enable ammonia gas to rapidly diffuse into and dissolve in water, a mechanism clearly inspired by the lung's air sacs.

The new TENG sensor uses a dual-electrode copper setup that completes the circuit and instantly generates a signal when a droplet hits it. In this case, the A-droplets served as the moving medium that triggered the sensor.

When A-droplets capture ammonia, the gas reacts with water to form ammonium and hydroxide ions, making the droplet highly conductive. As the droplet hits the sensor surface, it completes the circuit, sending a

burst of electrons within the dual-electrode setup. However, as the droplet spreads, the ions generated by ammonia interfere with electron flow, producing a shielding effect that reduces the electrical output.

The higher the ammonia concentration, the stronger the shielding, and the lower the electrical signal. This relationship is used to determine the amount of ammonia present in under two seconds.

The raw electrical signal is converted into a digital signal and displayed in real time. An AI model then analyzes these signals as time-frequency images and identifies patterns to classify ammonia concentration levels with 98.4% accuracy.

This bioinspired hydro-electrochemical sensor, with such rapid response times, has the potential to prevent countless ammonia-related incidents once scaled for real-world use.

Phys Org, 11 February 2026

https://phys.org

Got milk? Startup develops milk-based targeted drug-delivery technology

2025-01-17

A couple of University of Nebraska professors have launched a startup company with the goal of bringing to market an innovative method for delivering drugs and other therapeutics to targeted locations in the human body. The key ingredient? Milk.

Regular old milk. Turns out it's very handy, especially in the biopharmaceutical space. New Atlas has previously reported on genetically modified cows that produce milk containing human insulin, milk produced by cows vaccinated with an HIV protein containing antibodies against the virus, and using milk nanoparticles to deliver injection-only RNA therapies orally.

Now, Janos Zempleni and Jiantao Guo, two researchers from the University of Nebraska-Lincoln, have launched a startup company, Minovacca, intending to bring to market an innovative targeted drug delivery system that uses – you guessed it – milk. The pair have committed to using their milk-based tech to treat both common and rare diseases.

"Because our technology is so versatile, we are not limited to one particular rare disease," said Zempleni, a professor of nutrition and health

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sciences. "Rare disease groups are so thankful that there is maybe a light at the end of the tunnel."

The technology relies on universal milk exosomes, nano-sized bubble-like structures released by cells that act like little messengers, carrying important materials such as proteins, fats, and genetic information. By tweaking the exosomes chemically and genetically, the researchers achieved target-specific delivery of their cargo to human cells.

Three peptides, short chains of 'mini-proteins' called amino acids, are attached to the membrane of each exosome. One directs the exosome to home in on a specific site in the body; another sends biochemical signals to immune cells telling them not to attack the exosome; and the third peptide improves the exosome's survivability once it's inside the target cell.

Ordinarily, lipids (fatty compounds) are used to attach peptides to the exosome membrane. The problem with this approach is that the lipid anchors detach when they encounter other lipophilic (lipid-loving) compounds in the body. So, the researchers tried something different. They created docking sites in a cell surface membrane protein called CD81, which is firmly anchored to the exosome. Guo used a bioorthogonal chemistry approach – bioorthogonal chemistry refers to chemical reactions that can occur inside a living system without interfering with biochemical processes – to create stable bonds between the docking sites and the peptides. In addition to improving the exosome structure's stability, this chemistry-based adjustment also makes it more uniform, which improves the commercial viability of the innovative delivery system.

"Ensuring this homogeneous structure will allow the FDA to see that the exosomes can be produced consistently from batch to batch," Guo said.

It also helps the exosome deliver its target to a specific location. Consider the chemotherapy used to treat cancer. It's administered intravenously, so it travels around the entire body and damages all fast-growing cells indiscriminately, whether they're cancerous or healthy. This widespread 'poisoning' contributes to side effects like hair loss, nausea, and a compromised immune system.

"Chemotherapy treatments kill not only cancer cells; they kill any cell that is proliferating fast," said Zempleni. "And that's something that we want to minimize with our technology."

In addition to the targeted delivery of disease-treating drugs, the technology could deliver gene editing tools and other therapeutics. The researchers are working on licensing the tech through NUtech Ventures, the nonprofit technology commercialization affiliate of the University of Nebraska. A patent has been filed.

Forming the company has been a steep learning curve for Zempleni and Guo. They plan to keep the work 'in-house,' hiring University of Nebraska students whose work will ultimately result in an Investigational New Drug (IND) Application being submitted to the FDA.

Zempleni remains determined to keep his eyes on the therapeutic prize and not be distracted by the potential for money-making.

"It might sound cheesy, but if I had a choice between making $10 million in the company or saving 10 million lives, I would go for saving the lives," he said. "I'm not into this for the money. It's about helping people."

New Atlas, 17 January 2025

https://newatlas.com

A simple chemistry trick could end forever plastic

2026-01-04

Yuwei Gu was walking through Bear Mountain State Park in New York when an unexpected sight caught his attention. Plastic bottles were scattered along the trail, with more drifting across a nearby lake. Seeing plastic waste in such a natural setting stopped the Rutgers chemist in his tracks and set his mind racing.

Gu began thinking about polymers, long chainlike molecules that make up both natural materials and modern plastics. DNA and RNA are polymers, and so are proteins and cellulose. The difference is that nature's polymers eventually break down, while synthetic plastics often remain in the environment for decades or longer.

"Biology uses polymers everywhere, such as proteins, DNA, RNA and cellulose, yet nature never faces the kind of long-term accumulation problems we see with synthetic plastics," said Gu, an assistant professor in the Department of Chemistry and Chemical Biology in the Rutgers School of Arts and Sciences.

Standing there in the woods, the reason suddenly became clear to him.

"The difference has to lie in chemistry," he said.

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Copying Nature's Built-In Exit Strategy

Gu realized that if natural polymers can perform their function and then disappear, human-made plastics might be able to do the same. He already knew that biological polymers contain small built-in chemical features that help their bonds break apart at the right moment.

"I thought, what if we copy that structural trick?" he said. "Could we make human-made plastics behave the same way?"

That question led to a breakthrough. In a study published in Nature Chemistry, Gu and his Rutgers colleagues showed that using this nature-inspired approach allows plastics to break down under everyday conditions, without requiring high heat or harsh chemicals.

"We wanted to tackle one of the biggest challenges of modern plastics," Gu said. "Our goal was to find a new chemical strategy that would allow plastics to degrade naturally under everyday conditions without the need for special treatments."

How Polymers and Chemical Bonds Work

Polymers are made of many repeating units linked together, much like beads on a string. Plastics fall into this category, as do DNA, RNA and proteins. DNA and RNA consist of chains of smaller units known as nucleotides, while proteins are built from amino acids.

What holds these units together are chemical bonds, which act like glue at the molecular level. In polymers, these bonds connect one building block to the next. Strong bonds give plastics their durability, but they also make them difficult to break down once discarded. Gu's research focused on designing bonds that stay strong during use but become easier to break later when degradation is desired.

Programmable Plastics With Built-In Weak Points

This research does more than make plastics degradable. It makes their breakdown programmable.

The key discovery involved carefully arranging parts of the plastic's chemical structure so they sit in just the right positions to begin breaking apart when triggered. Gu compares the idea to folding a piece of paper so it tears easily along a crease. By effectively "pre-folding" the structure at a molecular level, the plastic can fall apart thousands of times faster than usual.

Despite this built-in vulnerability, the plastic's overall chemical composition remains unchanged. That means it stays strong and useful until the moment degradation is activated.

"Most importantly, we found that the exact spatial arrangement of these neighboring groups dramatically changes how fast the polymer degrades," Gu said. "By controlling their orientation and positioning, we can engineer the same plastic to break down over days, months or even years."

Matching Plastic Lifetimes to Real-World Uses

This level of control allows plastics to be designed with lifespans that fit their purpose. Food packaging might only need to last a single day, while automotive components must hold up for many years. The researchers showed that degradation can be built in from the start or activated later using ultraviolet light or metal ions.

The potential applications extend well beyond reducing plastic pollution. Gu said the same chemistry could lead to timed drug delivery capsules or coatings that erase themselves after a set period.

"This research not only opens the door to more environmentally responsible plastics but also broadens the toolbox for designing smart, responsive polymer-based materials across many fields," he said.

Safety Testing and the Road Ahead

For Gu, the long-term vision is simple. Plastics should do their job and then disappear.

"Our strategy provides a practical, chemistry-based way to redesign these materials so they can still perform well during use but then break down naturally afterward," he said.

Early laboratory tests indicate that the liquid produced when the plastics break down is not toxic, though Gu emphasized that further testing is needed to confirm long-term safety.

Looking back, Gu said he was surprised that an idea sparked during a quiet hike actually worked.

"It was a simple thought, to copy nature's structure to accomplish the same goal," he said. "But seeing it succeed was incredible."

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Expanding the Research

Gu and his team are now pushing the research further. They are closely examining whether the small fragments left behind after plastic breakdown pose any risk to living organisms or ecosystems, ensuring safety across the entire life cycle of the material.

They are also exploring how their chemical approach could be applied to conventional plastics and integrated into existing manufacturing processes. At the same time, they are testing whether the method can be used to create capsules that release medication at carefully controlled times.

While technical challenges remain, Gu believes that continued development, along with collaboration with plastic manufacturers focused on sustainability, could bring this chemistry into everyday products.

Other Rutgers scientists who contributed to the study included: Shaozhen Yin, a doctoral student in the Gu lab who is first author on the paper; Lu Wang, an associate professor in the Department of Chemistry and Chemical Biology; Rui Zhang, a doctoral student in Wang's lab; N. Sanjeeva Murthy, a research associate professor at the Laboratory for Biomaterials Research; and Ruihao Zhou, a former visiting undergraduate student.

Science Daily, 4 January 2026

https://sciencedaily.com

Wood made transparent using rice and egg whites could replace windows

2025-03-26

Windows and smartphone screens may one day be constructed from transparent wood laced with egg whites and safely composted at the end of their life.

Researchers are interested in using wood to make biodegradable alternatives to glass with better insulating properties, or to replace plastic in electronic devices. Wood has been turned into a transparent material before by modifying or removing the organic polymer lignin from it and then injecting epoxy as a replacement, but this results in a non-biodegradable product.

Now Bharat Baruah at Kennesaw State University in Georgia and his colleagues have developed a process that replaces the synthetic epoxy with natural egg white and rice extract.

"[Previous examples of transparent wood are] very hard to synthesise, hard to make and you spend a lot of time and energy and money to make those, so that's why we thought about creating something that we can make easily and naturally," says Baruah.

He was inspired to use egg whites by buildings in his home state of Assam in India, which date back to the 1500s and use a cement-like mixture that included sand, sticky rice and egg whites. "That was the cement in those days, and those buildings are still there," says Baruah. "They're still there after more than four or five centuries and it was always fascinating to me."

The team took sheets of balsa wood and drenched them with sodium sulphite, sodium hydroxide and diluted bleach inside a vacuum chamber to remove the lignin and hemicellulose, leaving only a paper-like cellulose structure. The voids in the material were then filled with a mixture of rice extract and egg white before being dried in an oven at 60°C (140°F) to create a semi-transparent plate with a slight brown tint. "It's not 100 per cent transparent, but it is semi-transparent," says Baruah. "And it's biodegradable."

Baruah and his colleagues built a small birdhouse fitted with a transparent wood window as a rudimentary mock-up, and found that it stayed 5 to 6°C (9 to 11°F) cooler inside when exposed to a heat lamp than the same birdhouse fitted with a glass window. The research will be presented today at the spring meeting of the American Chemical Society in San Diego, California.

Further research will investigate the strength and thermal properties of the material, as well as techniques to improve the transparency, says Baruah.

New Scientist, 26 March 2025

https://newscientist.com

Stiff gels slow germs: Mapping the hydrogel properties that control bacterial growth

2026-02-11

Hydrogels are soft, jelly-like materials that can absorb large amounts of water. They are widely used in medical technologies such as contact

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lenses and wound dressings, and are also a staple of laboratory research, where they are used to grow bacteria. But scientists have long struggled to explain why some hydrogels readily support bacterial growth while others appear to suppress it.

Recent research from the University of Warwick, published in Communications Materials, shows that the answer lies not only in the physical properties of the material, particularly its stiffness and hydration, but also on bacterial cell surface characteristics.

Testing bacteria across diverse hydrogels

The researchers tested four common bacterial species, including Gram-negative (Escherichia coli), Pseudomonas fluorescens (P. fluorescens) and Gram-positive (Staphylococcus aureus (S. aureus), Bacillus subtilis (B. subtilis)) using hydrogels with different stiffness and water contents, covering 120 conditions. To better mimic real-world conditions, the gel surfaces were gently pricked with bacteria, allowing them to enter the material through small defects, as they might in damaged medical devices or dressings.

Across all species tested, bacteria grew more rapidly in softer, more hydrated gels. In contrast, firmer, lower water content materials consistently slowed bacterial expansion, both on the surface and within the gel.

"Due to their enhanced hydration and elasticity, softer, wetter gels give bacteria room to expand and make it easier for nutrients to move through the material," says Andrea Dsouza, Research Associate, Warwick Medical School. "Stiffer gels with lower water content create more physical resistance and a less favorable environment for growth."

How nutrients and charge shape growth

The team also found that the nutrient solutions used to feed the bacteria affected growth mainly by changing the gel's physical properties—such as stiffness and water retention—rather than by acting as better or worse food sources. This insight may help explain why previous studies of bacterial growth in gels have often produced conflicting results.

The researchers also identified a more selective mechanism at work. In some cases, negatively charged gels repelled bacteria harboring negatively charged groups on the cell surface, particularly at higher gel concentrations, further limiting growth through electrostatic interactions.

"By studying stiffness, hydration, nutrient conditions and surface charge together, we were able to build a much clearer picture of how hydrogels regulate bacterial growth," says senior author Associate Professor Jérôme Charmet. "It's the combination of these factors that matters."

Designing smarter materials and dressings

The findings have implications in both directions. For microbiologists, they offer guidance on how to design gels that better support bacterial cultures in the lab. For materials scientists and biomedical engineers, they point to physical design strategies—rather than chemical additives or antibiotics—that could help prevent harmful bacteria from gaining a foothold.

Dsouza adds, "Moisture helps wounds heal, but too much softness can also help bacteria. The challenge is designing dressings that stay wet enough for tissue repair while remaining mechanically hostile to microbes."

As antibiotic resistance continues to rise, designing materials that are physically hostile to bacteria may provide a valuable new line of defense against infection.

Phys Org, 11 February 2026

https://phys.org

Foie gras made without force-feeding thanks to molecular mimicry

2025-03-25

The French delicacy foie gras could be made more ethically thanks to a technique that replicates the way fats are metabolised in force-fed birds, although the process still depends on farmed animals.

Foie gras is made from the liver of a duck or goose that has been force-fed via a tube. As a result of this process, known as gavage, the organ swells to as much as 10 times its usual volume as the animal stores the excess fat.

According to researchers, the experience of eating foie gras depends not only on its high fat content but also on the microscopic distribution of that fat.

Now Thomas Vilgis at the Max Planck Institute for Polymer Research in Mainz, Germany, and his colleagues have developed a new process that creates the same texture in the liver from a normally reared and slaughtered duck or goose, using fat from the same bird.

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"I'm a big fan of foie gras," says Vilgis. "I was just fascinated by this by this mouthfeel – it was so different from other pâtés – and so I asked myself, what is it?"

His team had previously tried to make a pâté with the same ratio of fat and liver as foie gras, but the results were disappointing. In further experiments, they added collagen to replicate the density of foie gras, but it resulted in something that felt like rubber in the mouth.

Then Vilgis realised that the pancreas in force-fed animals releases an enzyme that splits the fats before storing them in the liver was a way of efficiently storing the large fat molecules as smaller crystalline material.

He and his colleagues found that they could replicate this process by treating fat with an enzyme called lipase from the yeast Candida rugosa. "The lipase is a molecular scissor," says Vilgis. The treated fat is then blended with the liver to create the faux foie gras.

The team carried out a host of scientific tests including nuclear magnetic resonance spectroscopy to compare the faux foie gras to real samples, with promising results. But, crucially, Viglis says the aroma and taste also had "practically no difference" from the real thing.

The process has now been patented and the researchers are in talks with industry about commercialising it and bringing a faux foie gras to market.

Because of ethical concerns, and because producing foie gras traditionally is illegal in some countries, including the UK, a number of alternative methods have previously been developed that claim to produce similar results. There are also at least two companies looking to bring lab-grown foie gras to market.

Dawn Carr from People for the Ethical Treatment of Animals (PETA) says lab-grown meat is a more ethical route than the new lipase process, which still involves the rearing and slaughter of animals. "We simply do not need to kill animals for a fleeting moment of taste," says Carr. "The future of foie gras is already here, and there's no force-feeding or throat-slitting necessary."

New Scientist, 25 March 2025

https://newscientist.com

Scientists unlocked a superconductor mystery under crushing pressure

2025-12-21

Superconductors are materials that allow electrical current to flow with no resistance. This unique ability makes them extremely valuable for technologies such as efficient power transmission, energy storage, magnetic levitation systems, and quantum computers.

The challenge is that superconductivity usually occurs only at very low temperatures, far below everyday conditions. This limitation has prevented widespread practical use. That picture began to change with the discovery of superconductivity in hydrogen-rich materials. Hydrogen sulfide (H3S) becomes superconducting at 203 Kelvin (-70°Celsius), while lanthanum decahydrid (LaH10) reaches superconductivity at 250 Kelvin (-23°Celsius). These temperatures are far higher than those of earlier superconductors and are above the boiling point of liquid nitrogen, which is why scientists classify them as high temperature superconductors. Their discovery marked a major step toward the long-standing goal of room-temperature superconductivity.

The Superconducting Gap and Why It Is Crucial

At the heart of superconductivity is a feature known as the superconducting gap. This property reveals how electrons join together to form the superconducting state and serves as a clear signature that distinguishes a superconductor from an ordinary metal.

Understanding the superconducting gap is essential because it directly reflects how electrons interact inside the material. Without measuring this gap, scientists cannot fully explain why a material becomes superconducting or what mechanism makes resistance disappear.

Why Measuring Hydrogen Superconductors Is So Difficult

Despite their importance, hydrogen-rich superconductors such as H3S have been extremely challenging to study. These materials can only be created under enormous pressures that exceed atmospheric pressure by more than a million times. Because of these extreme conditions, widely used techniques like scanning tunneling spectroscopy and angle-resolved photoemission spectroscopy cannot be applied.

As a result, the superconducting gap in these materials had remained unmeasured, leaving a major gap in scientists' understanding of how high-temperature superconductivity works in hydrogen-rich compounds.

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A New Tunneling Technique Breaks the Barrier

To solve this problem, researchers at the Max Planck Institute in Mainz developed a planar electron tunneling spectroscopy method that can operate under these extreme pressures. This new approach made it possible to directly probe the superconducting gap in H3S for the first time.

With this technique, the team obtained a clear picture of the superconducting state in hydrogen-rich materials, overcoming a barrier that had limited progress in the field for years.

What the Measurements Revealed

The researchers found that H3S has a fully open superconducting gap of approximately 60 millielectronvolt (meV). They also studied its deuterium counterpart, D3S, which showed a smaller gap of about 44 meV. Deuterium is a hydrogen isotope and has one more neutron.

This difference is significant because it confirms that superconductivity in H3S is driven by interactions between electrons and phonons. Phonons are quantized vibrations of a material's atomic lattice. The results support long-standing theoretical predictions about the mechanism behind superconductivity in hydrogen-rich compounds.

Why This Breakthrough Matters

For the researchers in Mainz, the achievement goes beyond technical success. It provides a foundation for uncovering the fundamental origins of high-temperature superconductivity in hydrogen-based materials. "We hope that by extending this tunneling technique to other hydride superconductors, the key factors that enable superconductivity at even higher temperatures can be pinpointed. This should ultimately enable the development of new materials that can operate under more practical conditions," states Dr. Feng Du, first author of the now published study.

Dr. Mikhail Eremets, a leading figure in high-pressure superconductivity research who deceased in November 2024, described the study as "the most important work in the field of hydride superconductivity since the discovery of superconductivity in H3S in 2015." Vasily Minkov, project leader of High-Pressure Chemistry and Physics at the Max Planck Institute for Chemistry, added: "Mikhail´s vision of superconductors operating at room temperature and moderate pressures comes a step closer to reality through this work."

A Brief History of Superconductivity

Superconductivity refers to the ability of certain materials to conduct electrical current without resistance. It was first discovered in pure mercury in 1911 by Heike Kamerlingh Onnes. For many decades, scientists believed this phenomenon could only occur at temperatures near absolute zero (-273 °C).

That assumption changed in the late 1980s when Georg Bednorz and Karl Alexander Müller discovered copper-oxide superconductors, also known as cuprates, that exhibited high-temperature superconductivity under normal atmospheric pressure. This discovery sparked worldwide research efforts.

Over time, scientists reached critical temperatures (Tc) of about 133 K at ambient pressure and 164 K under high pressure. Progress then stalled until hydrogen-rich compounds entered the picture.

Hydrogen-Rich Materials Push the Limits

The discovery of superconductivity in H3S at megabar pressures, with a Tc = 203 K by the research group led by Dr. Mikhail Eremets, represented a turning point. Soon after, even higher critical temperatures were observed in hydrogen-rich metal hydrides such as YH9 (Tc ≈ 244 K) and LaH10 (Tc ≈ 250 K).

Current theoretical models now suggest that superconductivity above room temperature may be possible in several hydrogen-dominated systems when subjected to extreme pressure.

Cooper Pairs and the Meaning of the Superconducting Gap

In normal metals, electrons near the Fermi level can move freely. The Fermi level represents the highest energy level electrons can occupy in a solid at absolute zero. When a material becomes superconducting, electrons instead form paired states known as Cooper pairs and enter a collective quantum state.

In this state, paired electrons move together without scattering off phonons or impurities in the crystal lattice, which eliminates electrical resistance. This pairing creates an energy gap near the Fermi level called the superconducting gap. The gap represents the minimum energy required to break a Cooper pair and plays a protective role by stabilizing the superconducting state against disturbances.

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The superconducting gap is a defining feature of superconductivity. Its size and symmetry provide critical insight into how electrons interact and pair, making it a key fingerprint of the underlying superconducting mechanism.

Science Dailu, 21 December 2025

https://sciencedaily.com

Biofilm made from fish skin could be a sustainable alternative for food packaging

2026-02-09

Using the skin of an Amazonian fish known as tambatinga as the raw material, researchers at the University of São Paulo (USP) and EMBRAPA Pecuária Sudeste—a decentralized unit of the Brazilian Agricultural Research Corporation (EMBRAPA) located in São Carlos, São Paulo state—have developed a biofilm that can be used in food packaging.

A sustainable source of biopolymer collagen

The tambatinga, the result of crossbreeding the female tambaqui (Colossoma macropomum) and the male pirapitinga (Piaractus brachypomus), is recognized for its excellent growth performance and as a valuable, sustainable source of collagen-rich material. Due to its tropical origin, the skin of this species may contain higher levels of amino acids, which can enhance the functional and structural properties of the gelatin derived from it.

In a study, the animal was used to produce biodegradable polymers that could replace, at least partially, the films (thin, flexible materials) used in food packaging made from synthetic materials, such as petroleum. The results were published in the journal Foods.

How the gelatin films are produced

"We've been working for over 25 years on the development of films based on biopolymers, such as proteins and polysaccharides, with the aim of applying this material to food packaging and reducing the environmental impact, since there are many problems associated with the accumulation of synthetic packaging in nature," says food engineer Paulo José do Amaral Sobral. Sobral is a professor in the Department of Food Engineering at the USP campus in Pirassununga.

The first step of the experiment was to clean the fish skins and subject them to a gelatin extraction process using hot water and acetic acid to remove impurities. Next, films were made from the material, using two grams of gelatin for every 100 grams of film-forming solution. The result was a transparent, flexible material with uniform surfaces.

Performance, limitations, and next steps

Additionally, the material proved to be highly resistant and able to block ultraviolet rays more effectively and have lower water vapor permeability than other gelatin-based materials reported in the literature. These results demonstrate the potential of fish skin, which is generally considered industrial waste, as a renewable, high-value raw material for producing sustainable biopolymers.

Despite the promising results, the obtained material had one limitation: sensitivity to moisture. "For that reason, for now, they can only be used in dehydrated products, such as nuts and chestnuts," says Sobral.

The researcher believes it is necessary to continue the work to enable the use of the biopolymer obtained from tambatinga skin in food packaging, pharmaceuticals, and biomedical products. This would add economic value to the aquaculture sector and promote an integrated, environmentally responsible production chain.

Phys Org, 9 February 2026

https://phys.org

Thirty-six children have suffered toxin poisoning symptoms linked to baby formula recalls, health chiefs reveal

2026-02-05

Thirty-six babies have suspected toxin poisoning after drinking contaminated batches of baby formula, the UK Health Security Agency has announced.

UKHSA said it and partner agencies had received 24 notifications in England, seven in Scotland, three in Wales, one in Northern Ireland and one from the Crown Dependencies of children developing symptoms consistent with cereulide toxin poisoning.

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It comes one month after food giants Nestlé and Danone announced they would recall several batches of 12 SMA Infant Formula, Follow-On Formula and Aptamil Formula products in the UK as a precaution.

The products, Nestlé said, could potentially contain cereulide - a potentially deadly toxin that can lead to the rapid onset on nausea, vomiting and abdominal cramps.

The Food Standards Agency (FSA) added the toxin is highly heat-resistant, meaning that it's unlikely to be destroyed by heating, boiling water, or when making the baby formula.

The contamination in both the Nestle and Danone formulas originated from a shared, third-party ingredient supplier in China, officials have said.

French authorities are also currently investigating the deaths of two infants who consumed formula contaminated with the cereulide toxin last month.

The toxin, which stops cells in the body from being able to make energy, is frequently associated with food poisoning from contaminated rice, pasta, and dairy products.

It causes rapid-onset symptoms - which can begin within 15 minutes to six hours - like nausea, vomiting, and abdominal cramps, and has been linked to several deaths in recent years.

Parents have been urged to stop using affected products, switch to an alternative and contact their GP or NHS 111 if their baby has already consumed the formula.

The toxin is believed to have originated in an oil added to the formula during production, according to the FSA.

The ingredient, called arachidonic acid (ARA) oil, is an omega-6 fatty acid that naturally occurs in human breast milk, but is an optional addition to baby formula.

ARA oil is produced using microbial fermentation - whereby bacteria is purposely grown on organic compounds to convert them into energy, acids or alcohols.

If the process is not done properly, it can cause the growth of the wrong - and potentially dangerous - bacteria, experts have warned.

In a statement, Nestle previously said: 'We want parents and caregivers to know that the safety of our products and the well-being of infants is our top priority.'

'Following the detection of a quality issue in an ingredient provided by a leading supplier, Nestlé has undertaken testing of all arachidonic acid (ARA) oil and corresponding oil mixes used in the production of its potentially affected infant formula products.

'We want to reassure parents and families: we have taken the necessary steps in impacted countries, in close alignment with authorities, to recall all potentially affected products. This is to prioritise the health and well-being of families and their babies.'

Danone has also spoken out and said it 'never compromises on food safety'.

In a statement, the company said: 'In light of the current situation in the industry, some local food safety authorities are evolving their guidance.

'This is a targeted recall, mainly in Europe, of only a very limited number of specific batches of infant formula products. This does not impact any Danone products in the Irish market and our infant formula products can be purchased and used as normal.'

Bacillus cereus is a spore-forming bacterium that can contaminate a range of food products and when allowed to grow, certain strains can produce the cereulide toxin, the UKHSA said.

Bacillus cereus food poisoning and cereulide toxin poisoning symptoms most commonly involve vomiting, but may include stomach cramping and diarrhoea.

Symptoms usually have a rapid onset between 15 minutes to up to six hours after ingestion. They usually resolve within 24 hours providing there is no ongoing exposure to the toxin.

Ingestion of the toxin rarely causes more significant illness, however a 'few' cases of liver or kidney injury, muscle breakdown and multi-organ failure have been reported, the UKHSA said.

Individuals at high risk of complications include young children and the immunocompromised.

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The FSA urged people with any affected products to stop using them, switch to an alternative and contact their GP or NHS 111 if their baby has already consumed the formula.

If formula is prescribed, parents should speak to a pharmacist or doctor before switching, the FSA said.

More details about which batches have been recalled can be found on food.gov.uk or on the Nestle website.

Daily Mail, 5 February 2026

https://dailymail.co.uk

New 3D printing ink uses 70% lignin and recycles with water

2026-02-12

Additive manufacturing (AM) methods, such as 3D printing, enable the realization of objects with different geometric properties, by adding materials layer-by-layer to physically replicate a digital model. These methods are now widely used to rapidly create product prototypes, as well as components for vehicles, consumer goods and medical technologies.

A particularly effective AM technique, called direct ink writing (DIW), entails the 3D printing of objects at room temperature using inks with various formulations. Most of these inks are based on fossil-derived polymers, materials that are neither recyclable nor biodegradable. Recently introduced lignin-derived inks could be a more sustainable alternative. However, they typically need to be treated at high heat or undergo permanent chemical bonding processes to reliably support 3D printing. This prevents them from being re-utilized after objects are printed, limiting their sustainability.

Moving towards sustainable 3D printing

The team at Hereon's Institute of Functional Materials for Sustainability in Teltow was inspired by the idea that sustainable materials should not be a compromise and could be the primary structural components of inks for 3D printing. "We wanted to demonstrate that waste-derived materials like lignin can meet the technical demands of modern 3D printing while improving sustainability," explains Dr. Maria Balk, one of the lead authors of the paper. "To do this, we transformed an industrial waste product into a water-based 3D printing ink that can be fully recycled simply by adding water."

Prof Francesca Toma, corresponding author of the paper published in ACS Sustainable Chemistry & Engineering, highlights the broader context: "Industrial waste streams are an untapped opportunity. Lignin is one of the most abundant components of wood, yet largely underused. Turning it into a fully recyclable material shows how waste can drive innovation in an industry that urgently needs sustainable solutions."

Approximately 70% of the printable ink created by Dr. Balk and her colleagues consists of lignin. Lignin is produced during paper-making processes or can directly be extracted from biomass. While it is generally treated as waste, the researchers used it to create their recyclable ink for 3D printing.

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Full recyclability for circular manufacturing

The new ink was found to easily flow through 3D printer nozzles when pressure is applied to it, rapidly recovering its strength after printing. In contrast with most lignin-based inks introduced in the past, it solidifies to create desired objects without the need for any chemical or heat treatments.

One of the most exciting findings is that the printed objects can be recycled multiple times through rehydration without losing performance," says Dr. Balk. "This is still very rare in additive manufacturing and could offer a realistic pathway toward circular manufacturing in 3D printing, where materials can be reused instead of discarded, significantly reducing waste and CO2 emissions."

The recent efforts by these scientists could open new possibilities for the sustainable 3D printing of a wide range of objects, including customized product prototypes and components for various technologies. The team's recyclable ink could soon be improved and tested further to facilitate its future commercialization. "We are now interested in scaling the process and exploring real-world applications, particularly in areas where low-energy processing and recyclability are crucial," adds Balk.

Phys Org, 12 February 2026

https://phys.org

Estée Lauder fined US$750,000 in Canada over PFAS cosmetics breach

2026-02-05

THE WHAT? Estée Lauder Cosmetics Ltd. has been fined US$750,000 in Canada for violating the Canadian Environmental Protection Act, 1999, after pleading guilty to two environmental offences.

THE DETAILS The Ontario Court of Justice ruled on January 13, 2026, that the company failed to notify the federal government about a "significant new activity" and did not comply with a subsequent environmental protection compliance order. The case stemmed from a May 2023 inspection, when Environment and Climate Change Canada discovered that certain Estée Lauder eyeliner products contained Perfluorononyl Dimethicone, a per- and polyfluoroalkyl substance (PFAS), often referred to as a "forever chemical."

Under Canadian law, the importation, sale, or distribution of cosmetics containing this ingredient requires prior government notification so potential health and environmental risks can be assessed. In addition to the fine—directed to the Environmental Damages Fund—the court ordered Estée Lauder to notify its shareholders of the conviction, and the company will be added to Canada's Environmental Offenders Registry.

THE WHY? The ruling underscores Canada's tightening scrutiny of PFAS and reinforces regulatory expectations for cosmetics companies to disclose and manage the environmental and health risks associated with "forever chemicals."

Global Cosmetics News, 5 February 2026

https://globalcosmeticsnews.com

Gluten-based vegan leather gains strength with heat and UV treatment

2026-02-12

A process that combines heat and UV exposure has shown it's possible to turn wheat gluten into a vegan leather that is flexible, water resistant and almost matches the strength of animal leather without using synthetic polymers or chemical crosslinkers.1 The physical treatments reorganise gluten's native protein network, creating bonds that give the material its enhanced properties.

The global leather goods industry was valued at over $500 billion (£370 billion) in 2025 and is expected to keep growing over the next decade. Yet concerns over the environmental impact and animal welfare issues associated with conventional leather have intensified efforts to develop greener, more ethical alternatives. However, most bio-based leather substitutes struggle to replicate natural leather's mechanical properties under wet and dry conditions and those that do rely on chemical crosslinkers and water-repellent coatings.

Now, a team led by Dongyeop Oh from Korea University in South Korea has developed a new approach to preparing gluten-based vegan leather. 'It's really like making bread,' jokes team member Soyeon Kim. 'We add water and glycerol to gluten and mould it into a film. Gluten consists of 2–3% of cysteine residues and an [initial] mild thermal treatment induces the oxidation of these cysteine residues to form disulfide bonds, leading to the formation of a 3D gluten network, which is both durable and flexible. [Then], high temperature heating and an ultraviolet treatment

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promotes the formation of new covalent compounds like cysteinyl–DOPA [dihydroxyphenylalanine], which enhance the water resistance of the gluten leather.'

The resulting material demonstrated a tensile strength of 10–14MPa and a toughness of 4.6MJ m-3, in contrast to the 0.4–1.75MPa tensile strength of previous solvent-cast, gluten-based materials.2 'Previous gluten films have used strong bases to hydrolyse the gluten, which prevented the formation of gluten networks,' explains Kim. Moreover, subsequent tanning with tannic acid and iron chloride produced a gluten leather with a tensile strength of 17.2MPa, comparing favourably to animal-based leather's tensile strength of 17.9MPa.

However, large-scale production of these materials is unlikely to be straightforward. 'These bio-based materials have to be processed at high water and plasticiser (glycerol) content,' comments Michael Meyer, an expert in biopolymers from the FILK Freiberg Institute in Germany. '[This] water must be dried out during production and the plasticiser must not bleed out after use. [Additionally], the researchers have used expensive, pure gluten, whereas industrial quality gluten may contain residual starch which may lead to discolouration due to the Maillard reaction.'

Oh, Kim, and co-workers are aware of these challenges. 'Gluten is a naturally-derived protein and so we need to standardise the process to ensure its reproducibility,' adds Kim. 'We also need to scale up the production and control the material's biodegradation. Thankfully, there's been increasing interest in vegan leather in the fashion industry and so I'd like to commercialise gluten leather if we have the opportunity to.'

Chemistry World, 12 February 2026

https://chemistryworld.com

Fentanyl makeover: Core structural redesign could lead to safer pain medications

2026-02-12

Fentanyl is one of the most effective drugs for managing severe pain, yet it carries substantial risks of addiction and respiratory depression, the dangerous and sometimes fatal slowed breathing. These safety concerns have limited the use of the drug despite how well it works. Meanwhile, the ease and low cost of manufacturing have enabled widespread illegal production, fueling an overdose epidemic that claimed more than 70,000 U.S. lives in 2023.

Now, chemists at Scripps Research have modified fentanyl's molecular structure to develop a version that reduces respiratory depression while fully preserving its pain-relieving properties.

The findings, published in ACS Medicinal Chemistry Letters, suggest that future modifications could yield next-generation opioid therapies that carry less risk of addiction, overdose, and death.

"For decades, the pharmaceutical industry has been constrained by the assumption that major structural changes to opioids would eliminate their analgesic properties," says senior author Kim D. Janda, the Ely R. Callaway Jr. Professor of Chemistry at Scripps Research. "Our research has identified a different possibility—that fundamental structural redesign can preserve pain relief while improving safety."

Synthetic opioids like fentanyl occupy a complex position in medicine. Initially promoted as breakthrough medications with minimal addiction risk (claims that have proven tragically false), they remain essential for managing severe acute pain despite their significant dangers.

Radically redesigning fentanyl's core

In this study, Janda used a medicinal chemistry strategy known as "bioisosteric replacement," which is often used to redesign molecules to have similar, but improved qualities when compared to the original counterparts.

To engineer this improvement, the team replaced the central ring structure with an entirely different geometry: a structure called 2-azaspiro[3.3]heptane, which looks like the links of paper chains.

This "spirocyclic" shape of 2-azaspiro[3.3]heptane consists of two small, four-sided rings that are connected at a single point, representing a dramatic departure from the original construction.

"Rather than tweaking small parts of the molecule, we replaced the entire central structure with something that looks completely different in three-dimensional space," says first author Arran Stewart, a research associate in the Janda laboratory.

Maintaining pain relief while boosting safety

Despite this significant structural shift, the bioisosteric replacement of fentanyl's central core was remarkably effective in blocking pain. The team attributes this to its binding affinity, or how tightly a drug attaches to its target receptors. Opioid drugs, specifically, attach to their target receptors

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through an electrical attraction between a positively charged part of the drug and a negatively charged amino acid inside the receptor's binding pocket.

This critical anchor point allows the receptor to recognize and respond to the drug. The structural redesign preserves this essential anchor while changing many of the other molecular contacts, maintaining enough receptor activation to produce pain relief even though it has a different overall binding pattern than fentanyl.

Notably, the new compound showed no detectable recruitment of the beta-arrestin pathway, a cellular signaling corridor that scientists believe contributes to respiratory depression and other dangerous side effects.

The research indicated that slowed breathing occurred only at very high doses and was temporary, with breathing returning to normal within 25–30 minutes. The analog also left the body quickly, with a half-life of approximately 27 minutes—a short-acting profile that could be beneficial in controlled medical settings.

Next steps toward safer opioid tools

This retooling of the fentanyl scaffold is a new chemical addendum in Janda's broader strategy to address opioid overdose and adverse effects. The team plans to leverage this discovery to develop new opioid patent-free vaccines that train the immune system to recognize and neutralize fentanyl molecules before they reach the brain.

"Finding ways to preserve the analgesic properties of the synthetic opioids without encumbering the perils of respiratory depression could help derisk the toxicity associated with synthetic opioid use while providing a new conduit for pain management," says Janda.

Phys Org, 12 February 2026

https://phys.org

Levels of Atmospheric PFAS in Toronto Plummeted During the Pandemic

2026-01-30

A new study out of York University has found that the amount of atmospheric trifluoroacetic acid (TFA), the tiniest forever chemical, significantly declined in Toronto during COVID in 2020, which researchers say is good news for the world's ability to mitigate it in the future.

"When we turned off the tap, so to speak, and we all went home and stopped normal activities, we saw a really quick response, a dramatic reduction of TFA. But the real surprise is that the results point to TFA being formed from short-lived chemical precursors emitted into the atmosphere," says York University atmospheric chemist Professor Cora Young, senior author of the paper published today. "I was so surprised when we saw that it had decreased during the pandemic, but I had to double and triple check the data because I didn't believe it at first."

The reason it is such good news, says Young is "that when there is an immediate response after emissions reduction, it tells us that we should be able to figure out how to minimize the emissions and control the formation of TFA in the future. We could have a lot more control over this than we previously thought and that's very exciting. If we don't know where it's coming from, it's very difficult for us to regulate."

Unfortunately, as people returned to work and daily life, these levels have crept back up and they peak in the summer when there is more light, which is needed for its creation. A short-chain per- and polyfluoroalkyl substance (PFAS), TFA forms in the atmosphere when various chemical emissions come together.

"TFA is something that we haven't known a lot about before, but we're learning more now that we can measure it," says York University PhD Candidate Daniel Persaud, the paper's lead author. "With levels of TFA dropping during the pandemic, it now gives us a lot more information about its thousands of sources, such as industrial and vehicle air conditioner emissions."

The researchers collected and analyzed monthly measurements of both wet (rain and snow) and dry deposition - gases and particles that land on surfaces and form a layer of dust, for example, on windows and car windshields - from the Air Quality Research Station on roof of York's Petrie Science and Engineering Building between 2018 to 2024.

What is still unknown, is the effect of long-term exposure on people and wildlife. Young says TFAs are already orders of magnitude higher in the environment than some of the other PFAS, such as perfluorooctanoic acid, known as PFOA. PFOA was the subject of successful lawsuits with hundreds of millions in payouts, including from DuPont, which is also the focus of the 2019 documentary Dark Waters.

"The short-chain PFAS precursors were supposed to be more benign, and many are, but not all and so that created more unknowns about their

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effect. There is preliminary evidence that is behaving in ways we didn't expect. We're finding it at high concentrations in food, for example," says Young of York Faculty of Science.

"We didn't think that PFASs like TFA could bioaccumulate, but they've been found to accumulate in plants, and can be found in the food people and wildlife eat. It has even been found in human blood. Our exposure could still be quite high, even if it's not bioaccumulating. If TFA levels in the environment are driven by short-lived emissions, then that's something we can actually address now."

A little history

The main precursor chemicals that form short-chain PFASs are the second generation of chemicals designed to replace the ozone-depleting chlorofluorocarbons (CFCs), phased out globally starting with the 1987 Montreal Protocol. These first-generation replacement chemicals remain for years to decades in the atmosphere and can slowly react to form short-chain, persistent PFAS, like TFA, thought to be better than CFCs at the time, but these forever chemicals are now found everywhere from the Arctic to the Antarctic and there is no way to turn back the clock on them.

"The change from long-lived to short-lived precursors was made for climate reasons because the long-lived ones are also really potent greenhouse gases," says Persaud of the Faculty of Science. "We previously though the biggest source of TFA was first-generation CFC replacements, but our results show the important role of short-lived, next-generation replacements."

An example of that change is that in North America all car air conditioners from 2019 onwards now use a short-lived TFA precursor rather than the long-lived PFAS precursors. However, if these performance chemicals for air conditioners are finding their way into the atmosphere, it's expensive for car manufacturers and consumers for alike.

Technology Networks, 30 January 2026

https://technologynetworks.com

RNA strand that can almost self-replicate may be key to life's origins

2026-02-12

According to the RNA world hypothesis, life began when RNA molecules evolved the ability to make more copies of themselves. Now we have

discovered an RNA molecule that is almost capable of this – it can carry out the key steps involved, just not all at once.

"It's been a long quest to get to the point where you can convince yourself that RNA has the capacity to make itself under the right conditions. I think this shows that it is possible," says Philipp Holliger at the MRC Laboratory of Molecular Biology in Cambridge, UK.

In living cells, proteins carry out key tasks such as catalysing chemical reactions, and the recipes for making them are stored in double-stranded DNA molecules. RNA is a chemical cousin of DNA that usually exists in the form of single strands.

It isn't as good for storing information as DNA because it is less stable, but it can do something DNA can't: fold up to form protein-like enzymes that can catalyse chemical reactions. Because RNA can both store information and act as a catalyst, it was suggested as early as the 1960s that life might have begun with RNA molecules capable of catalysing their own formation.

But finding such molecules has proved really difficult. Researchers had long assumed that self-replicating RNAs must be relatively large and complex, but it turns out to be very hard to unfold large RNAs to replicate them.

What's more, while it has been shown that relatively short RNA molecules can form spontaneously in the right conditions, large molecules are very unlikely to have done so.

"This led us to think, well, maybe we're wrong. Maybe something simple, something small, could carry out this process," says Holliger. "And so we went looking, and we found one."

RNAs are made of building blocks called nucleotides. The team started by generating a trillion random sequences that were 20, 30 or 40 nucleotides long. From these, they picked out three that could carry out reactions such as joining nucleotides together. The three were joined together and put through several rounds of evolution – randomly changing, or mutating, parts of the sequence and selecting the better-performing variants.

The resulting molecule, called QT45, is just 45 nucleotides long. In alkaline water that is just above freezing, it can use single-stranded RNA as a template for making complementary strands by joining together short strands of two or three nucleotides, including making a sequence

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complementary to its own. "It's currently quite slow and low-yielding, but that's not a surprise," says Holliger.

QT45 can also make more copies of itself from those complementary strands. "This is, for the first time, a piece of RNA that can make itself and its encoding strand, and those are the two constituent reactions of self-replication," says Holliger. But so far, the team hasn't managed to get both reactions to happen in the same container. The plan is now to both evolve the molecule further and experiment with conditions such as freeze-thaw cycles to see if both reactions could happen at once.s

"The most exciting thing is, once the system begins to self-replicate, it should become self-optimising," Holliger says. That's because the error-ridden process will produce a lot of variations, a few of which may work better, producing more of themselves, and so on.

"The new results from the Holliger lab are exceptional and a significant advance, pushing things even closer to a fully self-replicating RNA," says Sabine Müller at the University of Greifswald in Germany.

"Perhaps the most significant aspect of this finding is to discover a moderately sized RNA oligomer sequence with these self-synthesising capabilities," says Zachary Adam at the University of Wisconsin-Madison.

The number of 45-nucleotide-long RNA sequences alone is "unimaginably large", Adam points out, so the team did well to find QT45 from a starting point of just a trillion random sequences.

On the early Earth, molecules similar to QT45 might have been able to self-replicate in an environment a bit like modern-day Iceland, Holliger says, with ice present, but also hydrothermal activity to drive freeze-thaw cycles and create pH gradients. Some sort of compartmentalisation would be needed to isolate the key components, he thinks, but there are many ways this can happen, from pockets of meltwater in ice to cell-like vesicles forming spontaneously from fatty acids.

New Scientist, 12 February 2026

https://newscientist.com

Bio-based coating reveals harmful UV exposure by shifting color

2026-02-12

Researchers at the Technical University of Munich (TUM) have developed a coating using proteins and bacteria that could enable the development of T-shirts that warn of excessive sun exposure or labels that reveal damage to light-sensitive materials. The coating reliably detects contact with UV-A radiation, is bio-based, and could open the door to a wide range of new materials that draw on the biological functions of cells.

The protein mEosFP can blush: When exposed to UV-A light, it shifts from a green shade called "Vegan Villain" to a red known as "End of Summer." Because of this pronounced color shift, the protein is a strong candidate for UV-A sensors that indicate when certain thresholds are reached. Until now, however, it remained unclear how to integrate such proteins into paints and coatings in a stable, functional way—without compromising material properties.

A team led by Volker Sieber, Professor of Chemistry of Biogenic Resources and Rector of the TUM Campus Straubing, has now engineered a solution to this problem. The result is a sustainable, bio-based alternative to conventional UV-A-sensors, which typically rely on fossil raw materials such as oil and coal. Their findings could serve as a blueprint for advances in the emerging field of so-called living materials, which aim to combine the strengths of biology and technology. In these biohybrid materials, organisms such as fungi, algae, proteins, or bacteria are embedded in solid materials so that they can repair themselves, grow, or respond to environmental stimuli.

Bacteria shield the protein

For the study published in Advanced Materials Interfaces, the team cultivated E. coli bacteria engineered to produce the target protein. At first, they separated the protein from the bacterial cells and mixed the purified protein into paint formulations—without success. The coating showed only weak coloration and its material properties deteriorated, with the surface becoming rough and leathery.

The researchers achieved success once they stopped separating the proteins from the bacteria and incorporated the entire biomass into the formulation. "The bacteria seem to act as a kind of protective space for the proteins, shielding them from the chemical and physical influences within the coating," explains Amelie Skopp, the study's lead author.

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The color change begins within minutes of exposure, becomes clearly visible after about 15 minutes, and is fully developed after roughly an hour. The more intense the UV-A radiation, the stronger the resulting color. Potential applications include outdoor apparel that warns of excessive UV exposure, storage and shipping of light-sensitive pharmaceuticals, and monitoring of UV-based surface disinfection processes.

An opportunity in the Anthropocene

"We've shown that coatings can be equipped with biological added functions without losing their inherent material properties," says Skopp. She and co-first author Matea Marošević were recently awarded the TUM IDEAward together with other team members for a start-up concept building on this technology. The team is currently working on a bio-based filtration technology designed to capture volatile organic compounds from industrial processes and convert them into harmless substances.

Sieber is convinced: "Biological systems offer an enormous diversity of functions we can harness. The possibilities range from materials like ours that make environmental conditions visible to future solutions capable of capturing and breaking down hard-to-avoid greenhouse gases such as methane. The fact that we have now managed to stably integrate biological components into coatings is an important starting point for developments we urgently need in light of today's global challenges."

Phys Org, 12 February 2026

https://phys.org

Pilot Whale Samples Show Reduced PFAS Exposure in Subarctic Ocean

2026-01-28

PFAS, or per- or polyfluoroalkyl substances, are ubiquitous in modern life. First produced at the end of World War II, these chemicals are in everything from furniture and cosmetics to food packaging, non-stick pans and clothing. They have also infiltrated our water, soil, and food, making PFAS a major concern for human and ecological health.

Beginning in the early 2000s, some of the most common and well-studied PFAS were phased out through a combination of industry shifts and international regulations. A new study from Harvard has found that since that phaseout, North Atlantic pilot whales have more than 60% lower concentrations of these chemicals in their bodies.

The study, published in Proceedings of the National Academy of Sciences, overcomes a long-standing challenge in the detection and measurement of PFAS concentrations. While older, so-called legacy PFAS are well understood and easy to detect, newer generations of chemicals are harder to pinpoint.

"With legacy PFAS, we know a lot more about their environmental transport and impacts on organisms," said lead author Jennifer Sun, a recent Ph.D. graduate and current postdoctoral fellow. "But we have a lot less information about what is going on with many newer compounds that have been produced to replace the phased-out legacy PFAS."

Senior author Elsie Sunderland, the Fred Kavli Professor of Environmental Chemistry in the John A. Paulson School of Engineering and Applied Sciences, has likened the PFAS problem to whack-a-mole: Once researchers understand the exposure and health implications of one chemical, a new one is developed.

To overcome that challenge, the researchers took a new approach: Instead of measuring individual PFAS, they measured bulk organofluorine, which captures the fluorine in most PFAS compounds. They used these measurements as a proxy for total concentrations of PFAS, including newer types of PFAS that are harder to identify on their own.

Armed with this approach, the researchers studied whale tissue samples in collaboration with longtime research partners in the North Atlantic Ocean's Faroe Islands, who maintain a unique, long-term archive of pilot whale tissues. As apex predators, the whales are considered sentinels of marine pollution because their bodies retain chemical exposures for long periods, and they exist in the outer ocean, demonstrating how far harmful compounds can travel into the environment. The researchers found that overall organofluorine levels were primarily made up of four legacy PFAS that together peaked in the mid-2010s and had declined by more than 60% by 2023.

"Production phase-outs, which were initially voluntary and later driven by regulation, have been quite effective at reducing concentrations of these chemicals in near-source communities as well as more remote ecosystems, which I think is very positive and important to emphasize," said Sun.

Surprisingly, this reduction comes at a time when global production of new PFAS is actually on the rise, which begs the question: if most of the newer PFAS aren't accumulating in ocean ecosystems like the legacy ones, where are they accumulating?

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"Generally, the ocean is thought to be the terminal sink for human pollution on land. But we are not seeing substantial accumulation of the newest PFAS in the open ocean. So, where are they?" Sunderland asked. "While our results are good news for ocean contamination, it suggests newer PFAS may behave differently from the legacy ones. It underscores the need to place stronger regulations on ongoing PFAS production to mitigate future impacts."

Technology Networks, 28 January 2026

https://technologynetworks.com

Stopping to smell the lemons can help reduce stress

2009-07-24

Stopping to smell the roses is a good mantra to encourage you to take the time to appreciate what's around you. Stopping to smell the lemons might not have the same ring to it, but scientists in Japan have shown how doing just that can actually alter gene activity and blood chemistry in ways that measurably reduce stress.

The use of fragrant plant oils to improve mood and health has been around since ancient times and more recently aromatherapy has become a popular form of alternative medicine. One of the most widely used substances used in aromatherapy to soothe away emotional stress is linalool, a chemical found in citrus fruits, lavender, sweet basil, birch trees and other plants. And now science has shown why.

The scientists exposed lab rats to stressful conditions (presumably getting them to do some public speaking) while inhaling and not inhaling linalool. Those exposed to linalool saw stress-elevated levels of neutrophils and lymphocytes - key parts of the immune system – return to near-normal levels and a reduction in the activity of more than 100 genes that go into overdrive in stressful situations.

The researchers say their findings could form the basis of new blood tests for identifying fragrances that can soothe stress.

The team's findings can be found in the American Chemical Society's Journal of Agricultural and Food Chemistry.

New Atlas, 24 July 2009

https://newatlas.com

Scientists create smart synthetic skin that can hide images and change shape

2026-02-06

Synthetic materials are widely used across science, engineering, and industry, but most are designed to perform only a narrow range of tasks. A research team at Penn State set out to change that. Led by Hongtao Sun, assistant professor of industrial and manufacturing engineering (IME), the group developed a new fabrication technique that can produce multifunctional "smart synthetic skin." These adaptable materials can be programmed to perform a wide variety of tasks, including hiding or revealing information, enabling adaptive camouflage, and supporting soft robotic systems.

Using this new approach, the researchers created a programmable smart skin made from hydrogel, a soft, water-rich material. Unlike conventional synthetic materials with fixed behaviors, this smart skin can be tuned to respond in multiple ways. Its appearance, mechanical behavior, surface texture, and ability to change shape can all be adjusted when the material is exposed to external triggers such as heat, solvents, or physical stress.

The findings were published in Nature Communications, where the study was also selected for Editors' Highlights.

Inspired by Octopus Skin and Living Systems

Sun, the project's principal investigator, said the concept was inspired by cephalopods such as octopuses, which can rapidly alter the look and texture of their skin. These animals use such changes to blend into their surroundings or communicate with one another.

"Cephalopods use a complex system of muscles and nerves to exhibit dynamic control over the appearance and texture of their skin," Sun said. "Inspired by these soft organisms, we developed a 4D-printing system to capture that idea in a synthetic, soft material."

Sun also holds affiliations in biomedical engineering, material science and engineering, and the Materials Research Institute at Penn State. He described the process as 4D printing because the printed objects are not static. Instead, they can actively change in response to environmental conditions.

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Printing Digital Instructions Into Material

To achieve this adaptability, the team used a method called halftone-encoded printing. This technique converts image or texture data into binary ones and zeros and embeds that information directly into the material. The approach is similar to how dot patterns are used in newspapers or photographs to create images.

By encoding these digital patterns within the hydrogel, the researchers can program how the smart skin reacts to different stimuli. The printed patterns determine how various regions of the material respond. Some areas may swell, shrink, or soften more than others when exposed to temperature changes, liquids, or mechanical forces. By carefully designing these patterns, the team can control the material's overall behavior.

"In simple terms, we're printing instructions into the material," Sun explained. "Those instructions tell the skin how to react when something changes around it."

Hiding and Revealing Images on Demand

One of the most eye-catching demonstrations involved the material's ability to conceal and reveal visual information. Haoqing Yang, a doctoral candidate in IME and the paper's first author, said this capability highlights the potential of the smart skin.

To demonstrate the effect, the team encoded an image of the Mona Lisa into the hydrogel film. When the material was washed with ethanol, it appeared transparent and showed no visible image. The hidden image became clear only after the film was placed in ice water or gradually heated.

Yang noted that the Mona Lisa was used only as an example. The printing technique allows virtually any image to be encoded into the hydrogel.

"This behavior could be used for camouflage, where a surface blends into its environment, or for information encryption, where messages are hidden and only revealed under specific conditions," Yang said.

The researchers also showed that concealed patterns could be detected by gently stretching the material and analyzing how it deforms using digital image correlation analysis. This means information can be revealed not only visually, but also through mechanical interaction, adding an extra level of security.

Shape Shifting Without Multiple Layers

The smart skin also demonstrated remarkable flexibility. According to Sun, the material can easily shift from a flat sheet into complex, bio-inspired shapes with detailed surface textures. Unlike many other shape-changing materials, this transformation does not require multiple layers or different substances.

Instead, the changes in shape and texture are controlled entirely by the digitally printed halftone patterns within a single sheet. This allows the material to replicate effects similar to those seen in cephalopod skin.

Building on this capability, the team showed that multiple functions can be programmed to work together. By carefully designing the halftone patterns, they encoded the Mona Lisa image into flat films that later transformed into three-dimensional forms. As the sheets curved into dome-like shapes, the hidden image slowly appeared, showing that changes in shape and visual appearance can be coordinated within one material.

"Similar to how cephalopods coordinate body shape and skin patterning, the synthetic smart skin can simultaneously control what it looks like and how it deforms, all within a single, soft material," Sun said.

Expanding the Potential of 4D-Printed Hydrogels

Sun said the new work builds on earlier research by the team on 4D-printed smart hydrogels, which was also published in Nature Communications. That earlier study focused on combining mechanical properties with programmable transitions from flat to three-dimensional forms. In the current research, the team expanded the approach by using halftone-encoded 4D printing to integrate even more functions into a single hydrogel film.

Looking ahead, the researchers aim to create a scalable and versatile platform that allows precise digital encoding of multiple functions within one adaptive material.

"This interdisciplinary research at the intersection of advanced manufacturing, intelligent materials and mechanics opens new opportunities with broad implications for stimulus-responsive systems, biomimetic engineering, advanced encryption technologies, biomedical devices and more," Sun said.

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The study also included Penn State co-authors Haotian Li and Juchen Zhang, both doctoral candidates in IME, and Tengxiao Liu, a lecturer in biomedical engineering. H. Jerry Qi, professor of mechanical engineering at Georgia Institute of Technology, also collaborated on the project.

Science Daily, 6 February 2026

https://sciencedaily.com

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Technical Notes

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Association of exposure to personal care product chemicals with maternal thyroid health: a prospective cohort study integrated with targeted risk assessment for environmental chemicals strategy

Heavy and trace metals toxicity implications in the breakdown of cellular homeostasis: A risk factor for rheumatoid arthritis pathogenesis

Differential Toxicity of Perfluorooctane Sulfonate (PFOS) in Wild-Type and Oatp1d1 Mutant Zebrafish Larvae

ENVIRONMENTAL RESEARCH

Monsoon-driven nutrient pollution assessment and source tracking in tropical mountain headwaters using positive matrix factorisation

PHARMACEUTICAL/TOXICOLOGY

Early childhood blood lead concentrations and selective attention among school-age children: Evidence consistent with a causal association and effect modification by sleep duration

Kidney cancer and occupational agricultural exposures in the AGRIculture and CANcer cohort

Per- and polyfluoroalkyl substances in waters associated with oil and gas development in the Denver Basin

OCCUPATIONAL

Multimetal Exposure and its Association with Neutrophil Extracellular Traps (NETs) Markers and Prothrombotic Biomarkers in Occupational Groups

Association and biological pathways between lifetime occupational exposure to workplace hazards and incident chronic obstructive pulmonary disease and cardiovascular disease in middle-aged and older adults

Increased risks of systemic and abdominal obesity associated with long-term exposure to PM2.5 constituents