CHEMWATCH

# Bulletin Board

## Contents

JUL. 11, 2025

(click on page numbers for links)




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# Contents

JUL. 11, 2025







CHEMWATCH
Bulletin Board
Contents
JUL. 11, 2025

## ASIA PACIFIC

### Model Code of Practice: Healthcare and social assistance industry

*2025-07-04*

The model Code of Practice: Healthcare and social assistance industry provides guidance for duty holders such as employers in the healthcare and social assistance industry on how to meet their work health and safety (WHS) duties and manage risks in their workplaces. The model Code of Practice focuses on hospitals, aged care and disability support, and includes in home-based settings.

An online interactive tool with interactive content and further case studies will be published in 2026.

**Supporting information**

- Health care and social assistance | Safe Work Australia
- Health care and social assistance interactive data dashboard | data.safeworkaustralia.gov.au
- Model Code of Practice: How to manage work health and safety risks
- Model Code of Practice: Hazardous manual tasks
- Guide for managing the risk of fatigue at work

**Publication Date:** 04 Jul 2025

Read More

Safe Work Australia, 04-07-25

https://www.safeworkaustralia.gov.au/doc/model-code-practice-healthcare-and-social-assistance-industry

### Three PFAS chemicals banned this week

*2025-07-08*

The NSW Environment Protection Authority (NSW EPA) has welcomed the agreed national ban on three PFAS – PFOA (perfluorooctanoic acid), PFOS (perfluorooctanesulfonic acid) and PFHxS (perfluorohexane sulfonic acid) – that has come into effect this week.

Under the new chemical scheduling as part of Australia's Industrial Chemicals Environmental Management Standard (IChEMS), the three PFAS



CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 11, 2025

chemicals will be banned from future import, export and manufacture, and new limits have been set for disposal.

This is in addition to a number of other high-risk chemicals that are listed in international conventions such as the Stockholm Convention or designated as the highest risk rating by the Commonwealth.

States will now implement these IChEMS rules in their own jurisdictions. In New South Wales, IChEMS and the chemical register are administered under the Protection of the Environment Operations Act. The EPA's Environment Protection Licences will authorise the use and manufacture of high-risk chemicals so that controls are in place to protect people and the environment.

Read More

Waste Management Review, 03-07-25

https://wastemanagementreview.com.au/three-pfas-chemicals-banned-this-week/

## AMERICA

### DTSC Proposes Adding Microplastics to its Candidate Chemicals List

*2025-06-20*

**WHAT YOU NEED TO KNOW:** The Department of Toxic Substances Control (DTSC) released a rulemaking package that proposes to add microplastics to the Candidate Chemicals List, which would allow DTSC to evaluate products that contribute to microplastic pollution.

**SACRAMENTO** – DTSC today released a rulemaking package that proposes to add microplastics to the Candidate Chemicals List, which would allow DTSC to identify consumer products containing or generating microplastics for future evaluation and possible regulation as Priority Products. A Priority Product is a consumer product that contains one or more Candidate Chemicals that have the potential to harm people or the environment, and that has been formally listed in the California Code of Regulations through rulemaking.

Microplastics are pervasive, persistent, and increasingly linked to potential risks to human health, wildlife and the environment. They have been found in nearly every corner of the planet, including oceans, soil, indoor

air, and even on the highest mountain peaks. They also have been detected in human blood, placenta, lung tissue, and stool samples.

Read More

US California DTSC, 20-06-25

https://dtsc.ca.gov/2025/06/20/dtsc-proposes-adding-microplastics-to-its-candidate-chemicals-list/

## EUROPE

### Safeti-NL version 9.2 - new version of calculation software for environmental safety

*2025-06-24*

The use, production, storage and transport of hazardous substances can pose risks for the environment, for example if a toxic cloud is released or a fire erupts following an incident. For this reason, software is used to model the area in which an incident involving hazardous substances can result in fatalities. In some parts of this area, the chance of an incident and its effects (i.e. the risk) is too great for the construction of new schools, homes or hospitals.

The risks for businesses and transport pipelines using hazardous substances are modelled using the software package Safeti-NL. The outcomes of Safeti-NL modelling are used for licensing and spatial planning. The National Institute for Public Health and the Environment (RIVM) has released a new version, which has been in use since January 2025. As the administrator of Safeti-NL, RIVM has created an overview of the differences between the previous and the current version. In terms of outcomes, the differences are minimal.

The new version is more user-friendly and capable of faster risk modelling. New technical features make it possible to feed data on natural gas pipelines into the model automatically. This is to prepare the software for the entry into force of new legislation and regulations, which is currently foreseen for July 2026. As from that moment, SafetiNL will be used to model the risks associated with natural gas pipelines.



CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 11, 2025

Read More

RIVM, 24-06-25

https://www.rivm.nl/publicaties/safeti-nl-versie-92-nieuwe-versie-rekensoftware-voor-omgevingsveiligheid

### Damage Costs of Nordic emissions of Short-Lived Climate Pollutants and CO2

*2025-06-18*

Nordic greenhouse gas and air pollution emissions continue to negatively affect the environment, human health, the economy, and the possibilities to stabilise climate change. However, there is a lack of knowledge about the damage costs associated with these emissions, especially the damage costs of short-lived climate forcers' (SLCFs) effect on climate change. This report estimates more complete damage costs by incorporating SLCF climate change impact of the emissions and their monetary value. By 2040, SLCF climate damage costs will reach €600M/year in Denmark and Norway, €250M in Finland, and €240M in Sweden. With Nordic CO2 emissions projected to sharply decline, SLCF damage costs may be equally high by 2050. The report calls for policy updates, improved research, and consideration of stronger emission reduction targets.

Read More

Nordic Co-operation, 18-06-25

https://www.norden.org/en/publication/damage-costs-nordic-emissions-short-lived-climate-pollutants-and-co2

### EU Forest Observatory Newsletter - Issue 1 - June 2025

*2025-06-30*

The EU Forest Observatory (EUFO) newsletter will keep you informed about how we are working to monitor and protect forests, both in Europe and around the world. EUFO is part of the European Union's efforts to respond to deforestation and forest degradation. By using satellite data, in-situ measurements and scientific analysis, we aim to provide reliable information that supports better decisions and stronger forest policies and their implementations.

**Date Available:** 2025-06-30

Publications Office of the European Union

Read More

European Commission, 30-06-25

https://publications.jrc.ec.europa.eu/repository/handle/JRC142892

## Germany cancels emissions certificates linked to coal-phase out

*2025-6-25*

For the first time, Germany is cancelling certificates from the European Emissions Trading System to secure the climate effect of the statutory coal phase-out. In total, certificates corresponding to 514,000 tonnes of CO2 will be withdrawn from the market. This measure is the result of the shutdown of the Neurath A and Frechen power plant units in 2022, as stipulated by the Coal Phase-Out Act. As a result, around 890,000 tonnes of CO2 were avoided in the following year, 2023.

A significant portion of the certificates released by the coal phase-out has already been automatically removed from the market by the so-called Market Stability Reserve (MSR). The MSR controls the auction volumes in the European Emissions Trading System. To ensure that the remaining share is also effectively withdrawn, Germany is supplementing this mechanism with a national cancellation. With the publication of the total number of certificates currently in circulation in the European Emissions Trading System – an indicator for market surpluses in emissions trading – by the European Commission at the end of May 2025, the central basis for determining the national cancellation volume of 514,000 certificates has now been established. The cancellation will take place from September until the end of the year and will be implemented by reducing the regular German auction volumes.

Read More

Joint press release by the German Environment Agency and the Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety, 25-06-25

https://www.umweltbundesamt.de/en/press/pressinformation/germany-cancels-emissions-certificates-linked-to



CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 11, 2025

## Assessment framework for the use of treated urban wastewater in agriculture. Phase 2: drinking water, the groundwater ecosystem, people working with irrigation water, residents and passers-by

*2025-06-25*

Assessment framework for use of purified urban wastewater in agriculture. Phase 2: drinking water, the groundwater ecosystem, people who work with irrigation water, local residents and passers-by

**Summary**

In dry summers, there may be too little water to irrigate crops in agriculture and horticulture. Since 2023, treated municipal wastewater may be used for this purpose in the Netherlands. This water may still contain chemicals and pathogens. It is therefore important that this water is clean and safe enough. That is why the RIVM, in collaboration with Wageningen Environmental Research (WUR(Wageningen University & Research)) and the Dutch Food and Consumer Product Safety Authority (NVWA(Netherlands Food and Consumer Product Safety Authority)) developed an assessment framework to test whether the application of treated municipal wastewater is safe for people and the groundwater ecosystem.

It is important that crops that have been sprayed with purified wastewater are still safe to eat. In 2024, it was therefore determined how many chemicals and pathogens may be present in the water. In this follow-up study, RIVM looked at the exposure of the groundwater ecosystem and exposure of people via the air and via drinking water.

**Groundwater ecosystem**

Two options are given for risk limits with a different level of protection for the groundwater ecosystem. The competent authorities are recommended to make a choice depending on the desired level of protection.

**Air and drinking water**

There is little chance that people will become ill if they come into contact with this purified wastewater via a water mist in the air. This concerns people who work with irrigation water, local residents and passers-by. In protected areas where drinking water is made from groundwater, purified wastewater may not be used. There is a chance that chemical substances or pathogens will end up in the drinking water via the groundwater.

**Reason and recommendation**

Since 2020, European legislation has encouraged the use of purified wastewater for crop irrigation during droughts. The Netherlands introduced this legislation in 2023. The RIVM advises the Ministry of Infrastructure and Water Management (IenW(Ministry of Infrastructure and Water Management)) to develop a procedure based on the results of this study and the 2024 study that can be used in practice to determine whether the use of purified wastewater is permitted and useful for specific situations.

Read More

RIVM, 25-06-25

https://www.rivm.nl/publicaties/beoordelingskader-voor-gebruik-gezuiverd-stedelijk-afvalwater-in-landbouw-fase-2

## EU Commission Abandons Anti-Greenwashing Law

*2025-07-01*

On June 20, 2025, the EU Commission announced that, following pressure from conservative lawmakers, it would withdraw new legislation targeting greenwashing. Specifically, the Green Claims Directive--which would compel businesses to independently verify the environmental credentials of their products--was objected to by the center-right European People's Party, based upon arguments that it was unduly burdensome, especially for small businesses. (The more liberal members of the current coalition objected to the withdrawal of this legislation, and subsequent discussions are continuing, although it appears unlikely that any legislation similar in scope to the Green Claims Directive will be enacted in the near future.) Regardless of whether a more modest version of this anti-greenwashing law is ultimately enacted, the fundamental principle reflected by this development remains constant: the EU is currently retreating from the more aggressive climate agenda it had previously propounded.

Read More

The National Law Review, 01-07-25

https://natlawreview.com/article/eu-commission-abandons-anti-greenwashing-law



CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 11, 2025

## Waste incineration under the EU ETS – an assessment of climate benefits (2025 update)

*2025-06-19*

A new study by CE Delft, commissioned by Zero Waste Europe and Reloop, confirms that including waste incineration in the EU Emissions Trading System (EU ETS) would deliver powerful climate and employment benefits.

The main findings of the study include:

1. Massive emissions cuts. Adding incineration to the EU ETS would slash $CO_2$ emissions by 4 to 7 million tonnes in 2030, rising to 18 to 32 million tonnes in 2040.
2. Thousands of new jobs. Transitioning from incineration to recycling would create 8,700 to 16,400 new jobs by 2030, and 11,600 to 21,700 by 2040, as recycling is far more labour-intensive than burning waste

>Read More

Zero Waste Europe, 19-06-25

https://zerowasteeurope.eu/library/waste-incineration-under-the-eu-ets-an-assessment-of-climate-benefits-2/>

## New EU active substance approval decisions

*2025-07-03*

**Apply for product authorisation by the deadline to keep your products on the NI market.**

Following evaluation under the EU Biocidal Products Regulation (EU BPR), a decision has been taken to approve these active substance/product type combinations with the following approval dates. This will affect NI:

**1 October 2026**

- 1,2-benzisothiazol-3(2H)-one (BIT) (CAS 2634-33-5 EC 220-120-9) in product types 6 and 13
- Formic acid (CAS 64-18-6 EC 200-579-1) in product type 6

**1 November 2026**

- 2,2-dibromo-2-cyanoacetamide (DBNPA) (CAS 10222-01-2 EC 233-539-7) in product type 6

**Action for biocidal product suppliers**

If you supply biocidal products containing these active substances in the relevant product types, you must apply for EU BPR product authorisationby the relevant approval date to keep them on the NI market.

New products must not be supplied in NI until product authorisation is granted.

**Action for active substance suppliers**

If you supply these active substances for use in biocidal products of the relevant product types, you may need to apply for technical equivalence.

If you haven't demonstrated technical equivalence for your manufacturing source, EU BPR product authorisation cannot be granted for biocidal products containing your active substance.

Read More

UK HSE, 03-07-25

https://www.hse.gov.uk/

## New EU active substance non-approval decision

*2025-07-03*

**Biocidal products must be phased off the NI market.**

Following evaluation under the EU BPR, a decision has been taken not to approve the following active substance/product type combination. This will affect NI:

- Ethylene oxide (CAS 75-21-8 EC 200-849-9) in product type 2

Biocidal products within the scope of EU BPR containing this active substance in the relevant product type can no longer be:

- supplied in NI after 23 June 2026; or
- used in NI after 23 December 2026

You must manage your stocks of the affected products to ensure they are removed from the NI supply chain by 23 June 2026.

New treated articles containing this active substance in the relevant product type cannot enter the supply chain or be imported into NI after 20 December 2025. Treated articles that have entered NI supply chains before this date can continue to be supplied and used.



CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 11, 2025

**Find out more about treated articles.**

Any affected NI product approvals under the Control of Pesticides Regulations (COPR) will be revoked in line with the above dates.

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UK HSE, 03-07-25

https://www.hse.gov.uk/

# INTERNATIONAL

## Plastics: Next steps for the UN Global Plastics Treaty and key UK and EU regulatory developments

*2025-06-26*

The latest round of negotiations on the development of the UN Global Plastic Treaty will commence in Geneva, Switzerland, in August, aiming to deliver the first legally binding treaty tackling plastic pollution across the entire plastic lifecycle (production, consumption, and waste). While the negotiations are ongoing, for businesses that produce or use plastics, including in packaging, there are already a number of UK and EU regulatory developments in this space. In this article we explore the UN Global Plastics Treaty as well as five key regulations that already regulate the use of plastic in products.

In March 2022, it was agreed at the UN Environment Assembly that a Global Plastics Treaty (the Treaty) was required to address the rapidly increasing levels of plastic pollution negatively impacting the environment and sustainable development more generally. It was agreed that the Treaty would take the form of a legally binding agreement to address plastic pollution by setting both quantitative and qualitative targets for parties at a global level, considering the full lifecycle of plastics with a view to regulating plastic products, chemicals used in plastics and also product design.

Read More

Lexology, 26-06-25

https://www.lexology.com/library/detail.aspx

## Better air pollutant and greenhouse gas emission data for Uzbekistan, with the support of UNECE

*2025-06-20*

Sound emission data is the first step in designing effective emission reduction policies as it provides information about the main sources in a country. As one of the key obligations under the Convention on Long-range Transboundary Air Pollution (Air Convention) is emission reporting, UNECE has been assisting countries in the region to improve emission inventories with a view to facilitating their ratification and/or implementation of the Air Convention and its key protocols. Most recently, UNECE has also developed an e-learning course onhow to report emissions under the Air Convention, with the aim to explain the importance of emission inventories for clean air policy development, the requirements for emission inventory reporting and methods for emission estimation.

Uzbekistan has made significant progress in air quality management over the last years and intents to accede to the Air Convention. To support the country in this process, UNECE facilitated a workshop on emission inventory development this week (Tashkent, 17-20 June 2025). Since the country has already submitted its Biennial Transparency Report (BTR) under the Paris agreement and given that activity data is largely the same for greenhouse gas (GHG) and air pollutant emission inventories, the workshop capitalized on the data collection work already done as a starting point. Promoting an integrated approach to inventory development, expert presentations highlighted the benefits of building a single coordinated system for estimating both GHG and air pollutant emissions in terms of efficiency and cost-effectiveness. Compiling air pollutant and GHG inventories in tandem can also help improve data quality and allows decision-makers to improve tracking of the impact of air pollution and GHG mitigation measures.

Read More

UNECE, 20-06-25

https://unece.org/media/Sustainable-Development/news/403726



CHEMWATCH
Bulletin Board


## ECHA focuses on SME and stakeholder support following survey results

*2025-07-01*

Helsinki, 1 July 2025 – The European Chemicals Agency (ECHA) will prioritise, as an integral part of its work, the support of small and medium-sized companies (SMEs), improving communication with stakeholders and increasing innovation and efficiency in tools and resources. These areas of focus were identified in the recent stakeholder perception survey as ones where stakeholders believe the agency should improve.

The results of the survey, commissioned in early 2025 to measure stakeholder's perception of ECHA, show that it is viewed as a trusted and accessible agency that delivers reliable data, services and support to stakeholders, but that there are areas for improvement.

Following an analysis of the results, and considering the report's overall recommendations, the agency will focus on actions in three key areas in 2025-2026 to address stakeholder concerns:

- Foster collaboration and knowledge sharing
- Implement an action plan to support SMEs;
- Enhance communication and transparency
- Centralise the coordination of stakeholder feedback;
- Review and increase transparency of existing stakeholder platforms;
- Review the accredited stakeholder system;
- Drive innovation and efficiency
- Further develop ECHA's IT tools, website and ECHA CHEM database.

Dr. Sharon McGuinness, ECHA's Executive Director said:

"We appreciate stakeholders' engagement in this process and the feedback and insights provided which will contribute to our work. Following our analysis of the report, we see that the main development areas that stakeholders' highlight largely align with those identified and prioritised in our strategy and work plan.

"Therefore, by concentrating on these three areas, ECHA aims to reinforce how it supports and works with its stakeholders and partners to achieve its vision of chemical safety through science, collaboration and knowledge."

# REACH Update

JUL. 11, 2025

Overall Report Recommendations

The survey report highlighted a total six recommendations for the organisation which could contribute to enhancing ECHA's work in delivering its vision of chemical safety through science, collaboration and knowledge. These are:

1. Streamline organisational structure and improve accessibility;
2. Enhance stakeholder engagement and representation;
3. Foster collaboration and knowledge sharing;
4. Drive innovation and efficiency;
5. Enhance communication and transparency; and
6. Address resource constraints and optimise allocation.

**Next steps**

The next perception survey will be run in 2027 to measure progress against ECHA's commitment.

Read More

ECHA, 01-07-25

https://www.echa.europa.eu/-/echa-focuses-on-sme-and-stakeholder-support-following-survey-results



CHEMWATCH
Bulletin Board

# Janet's Corner

JUL. 11, 2025

## Who am I?

*2025-07-11*

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

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

**I am the eighth element on the periodic table.**

## Chlorine

*2025-07-11*

### USES [2,3]

Chlorine is typically used in industrial plastic production, metal degreasing and dry cleaning solvents, textiles, agrochemicals and many more industrial and consumer products. It is used in bromine extraction and production of chlorates. In addition, chlorine is involved in water purification, disinfecting agents, especially as bleach. Typical household bleach does not contain pure chlorine, but does contain sodium hypochlorite, which is created from reacting chlorine and sodium hydroxide. Drinking water and public pools are disinfected by chlorine in hypochlorous acid.

### EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

#### Exposure Sources

- Because chlorine is so reactive, it is not normally detected in the environment except for very low levels in the air above seawater.
- You may be exposed through breathing, skin and eye contact if accident involving chlorine takes place nearby, such as a liquid chlorine spill, a leak from a chlorine tank, or a leak from a facility that produces or uses chlorine.
- You may also be exposed to chlorine if you mix household chemicals such as toilet cleaner with bleach. Mixing household cleaners containing ammonia with bleach may also release dangerous chemicals into the air.
- You may be exposed to chlorine gas through the improper use of swimming pool chemicals.
- People who work in places where chlorine is made or used may be exposed to low levels over a period of time

**Chlorine is a chemical element with symbol Cl and atomic number 17.**

#### Routes of Exposure

Exposure to chlorine can occur through:

- inhalation;
- ingestion;
- contact with the eyes;
- contact with the skin



CHEMWATCH
Bulletin Board
Hazard Alert
JUL. 11, 2025

### HEALTH EFFECTS [4]

#### Acute Health Effects

Chlorine is a potent irritant in humans to the eyes, the upper respiratory tract, and the lungs. Several acute (short-term) studies have reported the following effects: tickling of the nose at 0.014 to 0.054 parts per million (ppm); tickling of the throat at 0.04 to 0.097 ppm; itching of the nose and cough, stinging, or dryness of the nose and throat at 0.06 to 0.3 ppm; burning of the conjunctiva and pain after 15 minutes at 0.35 to 0.72 ppm; and discomfort ranging from ocular and respiratory irritation to coughing, shortness of breath, and headaches above 1.0 ppm. Higher levels of chlorine have resulted in the following effects in humans: mild mucous membrane irritation at 1 to 3 ppm; chest pain, vomiting, dypsnea, and cough at 30 ppm; and toxic pneumonitis and pulmonary oedema at 46 to 60 ppm. Chlorine is extremely irritating to the skin and can cause severe burns in humans. Acute animal tests in rats and mice have shown chlorine to have high acute toxicity via inhalation.

#### Carcinogenicity

No information is available on the carcinogenic effects of chlorine in humans from inhalation exposure. Several human studies have investigated the relationship between exposure to chlorinated drinking water and cancer. These studies were not designed to assess whether chlorine itself causes cancer, but whether trihalomethanes or other organic compounds occurring in drinking water as a result of chlorination are associated with an increased risk of cancer. These studies show an association between bladder and rectal cancer and chlorination by-products in drinking water. An NTP study reported no evidence of carcinogenic activity in male rats or male and female mice, and equivocal evidence, based on an increase in mononuclear cell leukaemia, in female rats, from ingestion of chlorinated or chloraminated water. EPA has not classified chlorine for carcinogenicity.

#### Other Effects

Workers chronically exposed to chlorine gas have exhibited respiratory effects, such as eye and throat irritation, and airflow obstruction. Animal studies have reported decreased body weight gain, eye and nose irritation, and non-neoplastic lesions and respiratory epithelial hyperplasia from chronic inhalation exposure to chlorine. The Reference Dose (RfD) for chlorine is 0.1 milligrams per kilogram body weight per day (mg/kg/d) based on no observed adverse effects in rats. EPA has not established

a Reference Concentration (RfC) for chlorine. CalEPA has established a chronic reference exposure level of 0.00006 milligrams per cubic metre (mg/m3) based on respiratory epithelial lesions in rats.

## SAFETY

### First Aid Measures [5]

- **Inhalation:** Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. If patient finds breathing difficult and develops a bluish discolouration of the skin (which suggests a lack of oxygen in the blood - cyanosis), ensure airways are clear of any obstruction and have a qualified person give oxygen through a face mask. Apply artificial respiration if patient is not breathing. Seek immediate medical advice.
- **Skin Contact:** If skin or hair contact occurs, immediately remove any contaminated clothing and wash skin and hair thoroughly with running water. If swelling, redness, blistering or irritation occurs seek medical assistance. For skin burns, cover with a clean, dry dressing until medical help is available. Launder contaminated clothing before reuse.
- **Eye Contact:** If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre or a doctor, or for at least 15 minutes.
- **Ingestion:** Immediately rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.
- **Medical attention and special treatment:** Treat symptomatically. Effects may be delayed. Delayed pulmonary oedema may result.

### Personal Protective Equipment [4]

The selection of PPE is dependant on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors. The following equipment is recommended with adequate ventilation:

- Overalls;
- Chemical goggles;
- Full face shield;



CHEMWATCH
Bulletin Board
Hazard Alert
JUL. 11, 2025

- Elbow-length impervious gloves;
- If inhalation risk exists, wear air-supplied mask meeting the requirements of AS/NZS 1715 and AS/NZS 1716.
- Always wash hands before smoking, eating, drinking or using the toilet.
- Wash contaminated clothing and other protective equipment before storage or re-use.

## REGULATION

### United States

**United States**

- **OSHA:** The Occupational Safety and Health Administration's permissible exposure limit (PEL) for chlorine is 1 ppm (3 milligrams per cubic metre (mg/m3) as a ceiling limit. A worker's exposure to chlorine shall at no time exceed this ceiling level [29 CFR 1910.1000, Table Z-1].
- **NIOSH:** The National Institute for Occupational Safety and Health has established a recommended exposure limit (REL) for chlorine of 0.5 ppm mg/m3 as a TWA for up to a 10-hour workday and a 40-hour workweek and a short-term exposure limit (STEL) of 1 ppm (3 mg/m m3)[NIOSH 1992].
- **ACGIH:** The American Conference of Governmental Industrial Hygienists has assigned chlorine a threshold limit value (TLV) of 0.5 ppm (1.5 mg/m m3) as a TWA for a normal 8-hour workday and a 40-hour workweek and a short-term exposure limit (STEL) of 1.0 ppm (2.9 mg/m m3) for periods not to exceed 15 minutes. Exposures at the STEL concentration should not be repeated more than four times a day and should be separated by intervals of at least 60 minutes [ACGIH 1994, p. 15].

**Australia**

- Safe Work Australia has established a TWA (parts per million) of 1 and a TWA (mg/m3) of 3
- Australian Drinking Water Guidelines: Maximum of 1 mg/L (i.e. 0.001 g/L)

## REFERENCES

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8. http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/eh52_aust_drinking_water_guidelines_update_120710_0.pdf



CHEMWATCH
Bulletin Board


Method used in water simulations can cause errors, study confirms

*2025-07-09*

More than a year ago, computational scientists at the Department of Energy's Oak Ridge National Laboratory published a study in the Journal of Chemical Theory and Computation that raised a serious question about a long-standing methodology used by researchers who conduct molecular dynamics simulations involving water. What if using the standard 2 femtosecond (2 quadrillionths of a second) time step—the time interval at which computer simulations are analyzed—leads to inaccurate results?

Now, the same ORNL team has published a new study in the journal Chemical Science that reaffirms their original observations by showing how using these "standard" time steps can affect simulations of liquid water. The team's calculations reveal that the potential for errors caused by using a 2 (or more) femtosecond time step is even greater than they had anticipated.

"I was a little bit surprised. I was hoping for much more subdued effects, but the errors can be big," said co-author Dilip Asthagiri, a senior computational biomedical scientist in ORNL's Advanced Computing for Life Sciences and Engineering group.

"What we are saying is, 'With the benefit of knowledge gained over the last 50 years of studies on water, let's do the statistical mechanics at the most accurate, converged level so that we can better assess the errors in the simulation and focus on issues that we should address.' It's an evolution of science."

**Previous research**

Water is the most prevalent component of biomolecular simulations—from protein ensembles to nucleic acids—and inaccurately simulating it can lead to errors for research results in biomolecular structure, function, dynamics and assembly. Industries ranging from pharmaceutical to petroleum rely on accurate water simulations to attain a competitive edge for their products and operations.

According to the team's findings, using anything greater than a 0.5 femtosecond time step can lead to violations of equipartition—the requirement for simulations that the average kinetic energy for each type of motion should be the same. This lack of equipartition can introduce errors in both dynamics and thermodynamics when simulating water using a rigid-body description.

Treating water as a rigid body rather than as a flexible bond between hydrogen and oxygen allows scientists to use longer time steps. The technique dates to 1977, when complex computations were more time-consuming and expensive. The longer the time step, the greater the total physical time that can be modeled in the simulation.

Although the Oak Ridge Leadership Computing Facility's Frontier and other modern supercomputers can reduce the time to solution enough to enable fewer approximations, using a smaller time step inevitably increases the computational cost.

"Sometimes with this kind of study, people may not know how to deal with the conclusions. Eventually, people become aware of it, and then it gradually gets adopted down the road," said co-author Tom Beck, section head of Science Engagement in the National Center for Computational Sciences at ORNL.

"But the point is to say, 'If we're going to really do predictive science for a given model—in order to test that model versus experiment—we need to accurately represent the underlying thermodynamics and dynamics.'"

**New findings**

In their new study, the team—Asthagiri, Beck and Arjun Valiya Parambathu—used Frontier to simulate samples of liquid water, and they explored various system sizes and different combinations of temperature and pressure. They conducted these simulations at time steps that ranged from 0.5 to 3.5 femtoseconds in intervals of 0.5 femtoseconds.

"One of the issues in capturing the physics of water is to accurately capture the pressure and volume behavior," Asthagiri said. "What our study shows is, using the same pressure, doing the simulation at longer time steps will give you different volumes or give you alternatively different densities. But if you go to very short time steps, the results all converge, and you get a consistent prediction."

The ORNL team has also been investigating the role of hydration in the thermodynamics of protein folding. Understanding protein folding is a crucial area of study in biology, particularly for research into the molecular basis of diseases and drug discovery.

The winners of the 2024 Nobel Prize in Chemistry were researchers in protein structure prediction and computational protein design whose work was assisted by ORNL's High Flux Isotope Reactor. An important



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

physical effect in protein folding is the change in the volume of the protein-water system.

"What we find is that in the simulation of neat liquid water, the error in total system volume that one makes in using a long time step can be as high as or higher than the typical volume change in protein folding. The same goes for the hydration free energy. While the implications of this finding will need to be worked out for actual protein folding and assembly processes in liquid water, our results suggest the need for much care," Asthagiri said.

Although the team did hear from some skeptical peers about the findings of their initial study, it was also cited as a reference in papers published in Molecular Physics, Physical Chemistry Chemical Physics, ACS Nano and the Journal of Chemical Theory and Computation.

"Why are we even doing this? Our eventual goal is going to much larger simulations of biological molecules and of cellular systems, and that's really what we want to go and study," Asthagiri said. "But we've been sidetracked into this because we just want to get the basics right before we go and do these extremely large simulations. We need to know how to simulate the matrix of life better so that we can study the biological processes better."

Phys Org, 9 July 2025

https://phys.org

## Record-Shattering Molecule Stores Data at "Dark Side of the Moon" Temperatures

*2025-07-03*

A new molecule may soon enable tiny hard drives that store vastly more data. Withstanding extreme cold, it paves the way for dense and efficient storage solutions.

Researchers from The University of Manchester and The Australian National University (ANU) have developed a novel molecule capable of storing data at extremely low temperatures, comparable to the frigid conditions on the moon's dark side at night.

Their results, published in Nature, point toward the potential for future data storage devices no larger than a postage stamp, yet capable of holding up to 100 times more information than today's leading technologies.

"The new single-molecule magnet developed by the research team can retain its magnetic memory up to 100 Kelvin, which is about minus 173 degrees Celsius, or as cold as an evening on the moon," co-lead author Professor Nicholas Chilton, from the ANU Research School of Chemistry, said.

"This is a significant advancement from the previous record of 80 Kelvin, which is around minus 193 degrees Celsius. If perfected, these molecules could pack large amounts of information into tiny spaces.

"Pink Floyd's The Dark Side of the Moon was released in 1973. Technology has come a long way since then and nowadays we listen to music through new digital mediums such as Spotify and even TikTok.

"This new molecule could lead to new technologies that could store about three terabytes of data per square centimeter. That's equivalent to around 40,000 CD copies of The Dark Side of the Moon album squeezed into a hard drive the size of a postage stamp, or around half a million TikTok videos."

**Responding to massive data demands**

As internet use continues to rise, with more people streaming content, using social media, and uploading data to the cloud, the need for advanced information technology systems capable of handling vast volumes of digital information is rapidly increasing.

Magnetic materials have traditionally been central to data storage, with current hard drives relying on the magnetization of small areas composed of many atoms that work collectively to preserve information.

In contrast, single-molecule magnets can store data within individual molecules, eliminating the need for neighboring atoms and opening the door to significantly higher storage densities.

**Bringing magnets closer to practicality**

But the challenge has always been the incredibly cold temperatures required for them to function.

"While still a long way from working in a standard freezer, or at room temperature, data storage at 100 Kelvin, or about minus 173 degrees Celsius, could be feasible in huge data centers, such as those used by Google," co-lead author Professor David Mills, from The University of Manchester, said.



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

"Although the new magnet still needs cooling far below room temperature, it is now well above the temperature of liquid nitrogen, a readily available coolant, which is 77 Kelvin, or around minus 196 degrees Celsius.

"So, while we won't be seeing this type of data storage in our mobile phones for a while, it does make storing information in huge data centers more feasible."

The key to the new magnets' success is its unique structure, with the rare earth element dysprosium located between two nitrogen atoms. These three atoms are arranged almost in a straight line – a configuration predicted to boost magnetic performance but realized now for the first time.

Usually, when dysprosium is bonded to only two nitrogen atoms it tends to form molecules with more bent or irregular shapes. In the new molecule, the researchers added a chemical group called an alkene that acts like a molecular pin, binding to dysprosium to hold the structure in place.

**Simulating quantum spin behavior**

"At ANU, we've developed a new theoretical approach to simulate the molecule's magnetic behavior, using only the fundamental equations of quantum mechanics, which has allowed us to explain why this particular molecular magnet performs so well compared to previous designs," Professor Chilton said.

"We were able to achieve this by leveraging the massive computational resources of the National Computational Infrastructure at ANU and the Pawsey Supercomputing Research Centre in Western Australia, including their large banks of GPU-accelerated compute nodes, to simulate the time-dependence of the electron spins in this molecular material.

"This has enabled us to explain why this new molecule, with its linear arrangement of atoms at its core, can show magnetic memory at such high temperatures. This molecule will now serve as a blueprint moving forward to guide the design of even better molecular magnets that can retain their data at even higher temperatures.

"In the more than 50 years since the release of The Dark Side of the Moon, technology has progressed leaps and bounds. It's exciting to think how technologies will continue to evolve in the next half a century."

Sci Tech Daily, 3 July 2025

https://Scitechdaily.com

## Bedtime Pistachio Snacking May Change Gut Bacteria in Prediabetes

*2025-07-08*

Prediabetes affects a third of people in the United States and most of them will develop Type 2 diabetes, yet effective dietary intervention strategies remain limited. Pistachios have shown promise in improving markers of diet quality, yet little is known about how they influence the gut microbiome — a key player in glucose regulation and inflammation.

A new study led by Kristina Petersen, associate professor of nutritional sciences at Penn State, determined that nighttime pistachio consumption affects gut bacteria in adults with prediabetes. Though the potential therapeutic implications of the findings remain unclear, according to Petersen, they may prove significant for people who are working to improve their metabolic health.

The findings, published in the journal Current Developments in Nutrition, suggested that replacing a traditional carbohydrate-based bedtime snack with pistachios may reshape the gut microbiome. A previous study by these researchers demonstrated that pistachios have a similar effect on blood glucose as 15 to 30 grams of carbohydrates.

"A common dietary recommendation for individuals with prediabetes is to consume a nighttime snack consisting of 15 to 30 grams of carbohydrates to help regulate overnight and morning blood glucose levels," said Terrence Riley, lead author of this research who earned his doctorate in nutritional sciences at Penn State and currently works as a postdoctoral research fellow at Louisiana State University. "As an example, you could eat one or two slices of whole grain bread."

Researchers observed that consuming about two ounces of pistachios each night for 12 weeks resulted in significantly different stool microbial community profiles compared to those who consumed the recommended 15 to 30 grams of a carbohydrate snack. Specific bacterial groups, including Roseburia and members of the Lachnospiraceae family —



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

known as "good" bacteria that produces beneficial short-chain fatty acids like butyrate — were more abundant following the pistachio condition.

According to Petersen, butyrate serves as a primary energy source for colon cells, helps maintain the gut barrier and supports anti-inflammatory processes.

"Pistachios seem to be able to meaningfully shift the gut microbial landscape in adults with prediabetes especially when consumed as a nighttime snack," Petersen said. "These microbiome changes may offer other long-term health benefits — potentially helping to slow the development of Type 2 diabetes or to reduce systemic inflammation — which we hope to explore in future research."

The study involved 51 adults with prediabetes and was conducted over two 12-week periods separated by a break, so the effects of the first part of the trial would not affect the second part. By the end of the study, all participants received both treatments. Stool samples were collected and analyzed using 16S rRNA gene sequencing, a technique that can help classify bacteria based on their genetic makeup.

Petersen noted that participants who ate pistachios also experienced reductions in several bacterial groups that have been linked to less favorable metabolic outcomes.

"Levels of Blautia hydrogenotrophica — a bacterium that helps produce compounds that can build up in the blood and harm kidney and heart health — were lower after pistachio consumption," Petersen said. "Levels of Eubacterium flavonifractor, which breaks down beneficial antioxidant compounds from foods like pistachios, also decreased."

Petersen added that the strength of this study is the design used — a randomized crossover clinical trial, in which all participants receive both treatments in a randomized order. By including all participants in the pistachio group and the standard care group, the study helped the researchers better understand how specific foods like pistachios can influence the gut microbiome.

While the study demonstrated shifts in gut bacteria, it remains unclear whether these changes directly translate to improvements in health — a question that requires further research, Petersen said.

Technology Networks, 8 July 2025

https://technologynetworks.com

## Targeting MXenes for sustainable ammonia production

*2025-07-08*

In a hunt for more sustainable technologies, researchers are looking further into enabling two-dimensional materials in renewable energy that could lead to sustainable production of chemicals such as ammonia, which is used in fertilizer.

This next generation of low-dimensional materials, called MXenes, catalyzes the production of air into ammonia for foods and transportation for high-efficiency energy fertilizers.

MXenes has a wide range of possibilities that allow for highly flexible chemical compositions, offering significant control over their properties.

This research is addressed in the Journal of the American Chemical Society in an article by chemical engineering professors Drs. Abdoulaye Djire, Perla Balbuena and Ph.D. candidate Ray Yoo.

Djire and his team are challenging the traditional assumption that the performance of transition metal-based materials can be solely attributed to the type of metal used.

"We aim to expand our understanding of how materials function as catalysts under electrocatalytic conditions," Djire said. "Ultimately, this knowledge may help us identify the key components needed to produce chemicals and fuels from Earth-abundant resources."

Depending on the MXene structure, utilizing the lattice nitrogen reactivity can tune the vibrational properties of MXenes by switching from a carbon to nitrogen atom. The vibrational properties refer to the way in which molecules vibrate due to the energy they contain.

The tunability of the MXenes' properties enables them to be tailored for specific applications in renewable energy, making them promising alternative candidates for cost-inefficient electrocatalyst materials, Yoo said.

"MXenes are the ideal candidates as transition metal-based alternative materials. They have promising potential due to their many desirable qualities," Yoo said. "Nitride MXenes play an important role in electrocatalysis, as shown through their improvement in performance compared to the widely studied carbide counterparts."

The work was complemented by first-principles computational analyses performed by Ph.D. student Hao-En Lai in Dr. Balbuena's group. The group



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

evaluated changes in the surface vibrational modes caused by energy-relevant solvents in contact with MXenes. With these additional findings, the authors quantified the interactions of molecules, especially in the context of ammonia synthesis.

Throughout this research, Djire, Yoo and the team have investigated the vibrational properties of titanium nitride using Raman spectroscopy, a non-destructive chemical analysis technique which provides detailed information about chemical structure.

"I feel that one of the most important parts of this research is the ability of Raman spectroscopy to reveal the lattice nitrogen reactivity," Yoo said. "This reshapes the understanding of the electrocatalytic system involving MXenes.

Studies involving Raman spectroscopical characterization with nitride MXenes and polar solvents could lead to major breakthroughs, Yoo said.

"We demonstrate that electrochemical ammonia synthesis can be achieved through the protonation and replenishment of lattice nitrogen," Djire said. "The ultimate goal of this project is to gain an atomistic-level understanding of the role played by the atoms that constitute a material's structure."

Phys Org, 8 July 2025

https://phys.org

## Korean Scientists Transform $CO_2$ Into Liquid Gold

*2025-07-03*

Breakthrough $CO_2$ conversion technology achieves record-setting efficiency in producing high-value chemical fuels.

As climate change continues to escalate and carbon emissions hit record highs, the urgency to find effective ways to recycle carbon dioxide (CO2) has never been greater. With the global movement toward carbon neutrality gaining momentum, innovative methods for turning CO2 into useful fuels and chemicals are rapidly gaining interest.

Among these, converting CO2 into alcohol-based products is especially promising due to the high energy content and economic value of these compounds. Despite this potential, the process has long been hindered by low efficiency and challenges in scaling up to industrial levels.

Recently, a team of scientists from the Gwangju Institute of Science and Technology (GIST) in South Korea, led by Professor Dr. Jaeyoung Lee, Dr. Minjun Choi, and Dr. Sooan Bae, introduced a significant breakthrough in this area.

Their new approach to CO2-to-alcohol conversion sets a global performance record by combining exceptional efficiency with large-scale production capability. Published in Nature Catalysis, their research reveals an electrochemical technique that transforms CO2 into 'allyl alcohol,' a high-value compound with various industrial applications.

**Challenges in $CO_2$ Reduction to High-Value Compounds**

Electrochemical reduction technology of CO2 is a key technology in the carbon-neutral era that could convert CO2 (the main culprit of global warming) into useful substances. However, selectively producing high value-added compounds with three or more carbon atoms, such as allyl alcohol, poses several challenges. Firstly, current methods enable very low Faraday efficiency—less than 15% of the electrical energy used actually goes into producing the desired compound, while the rest is wasted. Secondly, the reaction path is complex and the intermediates have low stability, adding to the inefficiency of the process.

"Allyl alcohol (C3H6O) is a very useful substance that can be used in various chemical reactions," explains Prof. Lee, "But producing these high value-added compounds in liquid state is difficult due to the complex carbon-carbon (C–C) bond formation and the low stability of the reaction intermediate."

The technology developed by the researchers was remarkable. The team created a phosphorus-rich copper catalyst by integrating copper phosphide ($CuP_2$) into a membrane-electrode assembly alongside a nickel–iron (NiFe) oxidation catalyst. Using this catalyst in the electrochemical setup, they achieved a Faraday efficiency of 66.9%, which is about 4 times higher than the existing best technology (<15%). This high efficiency proves the excellent selectivity of the catalyst that minimizes the production of unnecessary byproducts and selectively produces only the desired substance.

In addition, the technology also recorded a partial current density of 735.4 mA cm−2 and a production rate of 1643 μmol cm−2 h−1 in a process that can apply 1100 mA cm−2 per unit area of the electrode. These metrics represent the highest reported performance to date and also underscore its potential for large-scale applications.



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

**Industrial Relevance and Broader Impact**

As allyl alcohol is used as an essential raw material across various industries as plastics, adhesives, sterilizers, and fragrances, this technology could be a game-changer for its mass production.

Furthermore, the method was also unique in its mechanism. Where conventional methods operate through carbon monoxide pathway, this method revealed a new reaction pathway in which the carbon-carbon (C–C) bond was formed during the conversion of an intermediate group from formate to formaldehyde. This mechanism greatly increases the commercial value of the product because it directly produces liquids which are easier to store and transport.

This technology marks a breakthrough in the carbon neutrality era and is expected to open new avenues for economical electrochemical carbon capture and utilization technology by selectively converting CO2 which has only one carbon atom into allyl alcohol, a multi-carbon high value-added compound (C3+) with three or more carbon atoms.

"This CO2 conversion technology could open new business directions for the coal, petrochemical, and steel industries which are facing growing emission pressures," emphasizes Prof. Dr. Lee. "We see it as a key stepping stone toward a carbon-neutral era through scalable science and technology."

By shifting the focus beyond conventional C1 and C2 targets, the study broadens the scope of CO2 valorization toward more complex, higher-value molecules. Dr. Choi clarified that while the approach holds promise, further integration into continuous-flow and zero-gap membrane-electrode assembly systems might enable scalable, sustainable production of liquid fuels and chemical precursors from CO2—significantly reducing the reliance on fossil fuels and paving the way to a greener future.

Sci Tech Daily, 3 July 2025

https://scitechdaily.com

## New Compound Defies Fundamental Principle of Organometallic Chemistry

*2025-07-08*

Previously considered improbable, the new discovery in coordination chemistry could open exciting possibilities in catalysis and materials science.

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

"For many transition metal complexes, they are most stable when surrounded by 18 formal valence electrons. This is a chemical rule of thumb on which many key discoveries in catalysis and materials science are based," said Dr. Satoshi Takebayashi, lead author of the paper published in Nature Communications, in collaboration with scientists from Germany, Russia, and Japan. Ferrocene is a classic example that embodies this rule. "We have now shown for the first time that it is possible to synthesize a stable 20-electron ferrocene derivative," he added.

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

**Rebuilding our conceptual understanding**

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

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

This is important because even though ferrocene is already used in reactions involving electron transfer, known as redox reactions, it has traditionally been limited to a narrow range of oxidation states. By enabling access to new oxidation states through the formation of an Fe–N bond in this derivative, it expands the ways in which ferrocene can gain or



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

lose electrons. As a result, it could become even more useful as a catalyst or functional material across a variety of fields, from energy storage to chemical manufacturing.

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

**A platform for future innovation**

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

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

Technology Networks, 8 July 2025

https://technologynetworks.com

## Why too much ultrasound slows chemical reactions

*2025-07-08*

Osaka Metropolitan University researchers have solved a long-standing mystery in the field of sonochemistry: why do chemical reactions slow down when ultrasonic power becomes too strong?

Their findings, published in Ultrasonics Sonochemistry, allow for smarter use of ultrasound in science and industry, such as for environmental cleanup or the creation of useful nanoparticles.

Although ultrasound is inaudible to the human ear, it plays a powerful role in sonochemistry. When ultrasonic waves are applied to a liquid, they generate microscopic bubbles that rapidly expand and collapse, a process called acoustic cavitation. The collapse produces bursts of energy that momentarily reach temperatures comparable to the surface of the sun, triggering chemical reactions.

"Typically, increasing ultrasonic output speeds up the reaction," said Takuya Yamamoto, associate professor at Osaka Metropolitan University's Graduate School of Engineering and lead author of this study. "But once the output exceeds a certain level, the reaction rate rapidly drops. That paradox has puzzled researchers for years."

This counterintuitive phenomenon is also one of the key challenges in developing practical industrial uses for ultrasound.

To uncover the mechanism behind this "ultrasonic reversal," the team conducted six types of experiments, including bubble imaging, sonochemiluminescence observations, and sound pressure measurements, along three types of numerical simulations that modeled bubble behavior and internal temperatures.

Their findings revealed that when ultrasonic power becomes too strong, the intense movement of bubbles distorts the ultrasonic waves. This distortion suppresses bubble growth and drastically reduces the number of active bubbles capable of driving chemical reactions—ultimately slowing the overall reaction rate.

The researchers also identified three distinct regions of ultrasonic reactions, each characterized by different wave patterns and bubble dynamics. These insights help explain how chemical reaction rates, bubble growth, acoustic streaming, and degassing behavior all change depending on the intensity of the ultrasound.

"Our study helps demystify a complex phenomenon during which sound waves, fluid motion, and bubble physics are all interacting," Yamamoto said.

Understanding this balance is key to making sonochemistry more predictable and scalable for real-world use.

"We hope this result will open the door to broader industrial applications of ultrasonic technology, from synthesizing nanoparticles to breaking down persistent pollutants like PFAS, the so-called 'forever chemicals,'" Yamamoto said.

Phys Org, 8 July 2025

https://phys.org



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

## Ancient-fossil bioconcrete traps 142% more carbon – and it's strong as hell

*2025-07-10*

Using intricate geometry found in nature and refined through aerospace and biomedical design, scientists have now 3D-printed these forms into concrete to boost strength and capture carbon – creating a scalable building material that benefits both people and planet.

A team of materials scientists, designers and engineers from the University of Pennsylvania (UPenn) has collaborated on a unique biomineral-infused concrete that draws from the fossilized architecture of microscopic algae to create an entirely new kind of concrete. It's lightweight, structurally sound and can capture up to 142% more CO2 than traditional materials. It also uses less cement without compromising any compressive-strength metrics.

While sustainable, strong alternatives to standard concrete aren't new – we've covered too many to mention – this material is particularly promising. Its "secret recipe" is built around diatomaceous earth (DE), a naturally occurring, powdery substance that's made from the fossilized remains of diatoms – small, hard-shelled ancient algae. In engineering materials, DE is lightweight, has a high surface area and has a favorable porousness that's ideal for absorbing CO2.

"Usually, if you increase the surface area or porosity, you lose strength," says co-senior author Shu Yang, Chair of the Department of Materials Science at UPenn's School of Engineering and Applied Science. "But here, it was the opposite; the structure became stronger over time."

While concrete may be second in terms of materials we rely (water is the first), it accounts for a massive 8% of global greenhouse emissions. And current methods of attempting to make things "greener" are expensive, convoluted and limited in their CO2-capturing abilities.

During testing, the UPenn team found that its experimental design achieved "an additional 30% higher CO2 conversion" when the geometry was even further refined, and it did so while maintaining strength similar to traditional concrete.

"It was one of those rare moments where everything just worked better and looked nicer," said Yang.

The researchers first engineered a "cementitious paste," which was fluid enough to work with 3D-printing mechanics. This involved a mix of

Portland cement, fine sand, and silica fume. A superplasticizer was also added to reduce water content while ensuring that the unique mix was still compatible for printing.

"Concrete isn't like conventional printing materials," said Kun-Hao Yu, a former postdoctoral researcher at UPenn. "It has to flow smoothly under pressure, stabilize quickly after extrusion, and then continuously strengthen as it cures."

Robotic 3D printing was then used to create lattice-like structures – or triply periodic minimal surfaces (TPMS) – inspired by nature's handiwork in forming bones and shells, These forms could provide both the space to capture carbon and provide the structural integrity of traditional concrete. The printed material was then left to cure (strengthen). Finally, a coat of calcium hydroxide was applied to boost its carbon capture properties.

The end result was a scalable, printable concrete that not only does the job structurally but also pulls carbon from the atmosphere, without complex processing or high cost.

"But it wasn't just about aesthetics or reducing mass," said co-senior author Masoud Akbarzadeh, associate professor of architecture at the Weitzman School of Design. "It was about unlocking a new structural logic. We could reduce material by almost 60%, and still carry the load, showing it's possible to do so much more with so much less."

As a zoologist (who isn't particularly enamored by building materials), I am admittedly biased when it comes to what sets this concrete apart. While most of us who don't work in the field of microscopic marine biology or micropaleontology may never come across diatoms in our lifetime, they're pretty remarkable organisms. These small, single-celled algae are able to create intricate, beautiful shells made of silica (the same material in glass), called frustules. Each one is nanostructured with symmetry and microscopic pores. And each diatom assembles these incredible, intricate structures atom by atom, using proteins and enzymes to extract dissolved silica from the water they're submerged in.

What's more, we believe there are more than 100,000 diatom species, and together they produce 20-30% of the oxygen that keeps the planet alive. Which is more than all the rainforests on Earth manage. No shame to the rainforests and their heavy lifting, of course.

Drawing on diatoms for inspiration, the UPenn scientists may have come up with something that can benefit the planet almost as much as these



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

tiny organisms. The team found that DE's intricate internal pore network provided a robust pathway for carbon dioxide to diffuse into the structure, but also that the curing process allowed for calcium carbonate to form, boosting strength and CO2 uptake.

"We ran a lot of trials," Yang said. "What surprised us most was that despite the high porosity that normally acts an impediment to stress, the material actually got stronger as it absorbed CO2."

Once the researchers had perfected their design, it was sliced into layers for printing. The components were then tested against traditional concrete and found to use 68% less material while increasing surface-area-to-volume ratio by more than 500%. The TPMS slab had 90% of the compressive strength of concrete but 32% higher CO2 uptake per unit.

So, a TPMS cube, compared to a solid cube of traditional concrete, was able to absorb 146% more CO2, or 32% more CO2 per unit of cement (comparing gram to gram).

Now, the scientists are looking to scale up their novel material to form floors, facades, and load-bearing panels. They're also investigating using DE with other compounds to see if the diatoms have even more to offer us.

"We want to push this idea further," said Yang. "What if we could remove the cement altogether? Or use waste streams as the reactive component?"

"The moment we stopped thinking about concrete as static and started seeing it as dynamic – as something that reacts to its environment – we opened up a whole new world of possibilities," she added.

The research was published in the journal Advanced Functional Materials.

New Atlas, 10 July 2025

https://newatlas.com

## Breaking barriers in science education for the visually impaired with chemistry you can feel, hear and smell

*2025-07-04*

Chemistry came alive in a reimagined form at the 75th Yusuf Hamied Chemistry Camp for Visually Challenged Students, hosted at the Indian Institute of Technology (IIT), Bombay.

Whether it's the vibrant red and green flames of strontium and barium salts during a flame test or the striking 'golden rain' formed by the

reaction between lead nitrate and potassium iodide, the visual drama of chemical reactions is often what captivates students. The very spectacle that makes chemistry so appealing can also become a significant barrier, shutting visually impaired students out of the full experience while leaving educators grappling with how to make the subject accessible to everyone.

Guided by the belief that chemistry is for everyone, this inclusive education project set out to go beyond the usual high school chemistry experiments. The team redesigned the experiments to engage touch, smell and sound. The result was a rich, multi-sensory experience that allowed 59 visually impaired students from schools in Mumbai, Nasik, Pune and Solapur to explore the wonders of chemistry.

The initiative was supported by the Royal Society of Chemistry (RSC) and funded by Yusuf Hamied, chairman of Cipla.

The camp introduced a new handbook featuring six hands-on experiments developed by Chandramouli Subramanian of IIT Bombay, which were translated into braille. Students were divided into small groups, and each experiment was run by a volunteer from the institute, enabling the students to carry out the activities independently.

'Science must be accessible to all,' said Swetavalli Raghavan, head of innovation strategy and government affairs at the RSC. 'This initiative helps break the myth that chemistry is a visual science. With the right tools and teaching methods, we can open up the world of scientific inquiry to every learner, regardless of ability.'

**When light becomes sound**

Tactile chemistry kits, featuring textured materials, raised diagrams and braille labels, have helped make science more accessible for students with visual impairments. But Subramaniam pointed out that these kits can be costly for schools. Therefore, his team focused on adapting experiments usually included in the school curriculum.

A school science fair classic, the potato battery experiment shows how a vegetable can power a small electronic device. By inserting two different metals, typically zinc and copper, into a potato, students create a simple electrochemical cell that generates a small voltage that can power low-energy devices, such as LEDs. The team simply replaced the LED with a buzzer.

In designing the activity, the team also aimed to give students a broader understanding of energy conversion. As Subramaniam explained, the



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

experiment became a starting point for a larger conversation – tracing how plants absorb solar energy through photosynthesis, store it as chemical energy in the form of sugars, and how that same energy, now held in a potato or lemon, can be released and transformed into sound through a simple electrochemical reaction.

Experiments involving heat were handled with extra care. These included an esterification, where a carboxylic acid and an alcohol reacted in the presence of an acid catalyst to yield a fruity-scented ester when heated in an oil bath. Unlike other activities where students did most of the work themselves this step required hands-on support from the volunteers.

In addition to pre-measuring the chemicals and carefully supervising each step. 'One great thing that [the] professor suggested was to put on blindfolds and do your experiments one or two times, so that you're sensitised to their experiences,' says Devashish Bhave, a volunteer at the camp. 'We even tried each other's experiments with blindfolds on to check if our instructions were clear enough.' He highlighted that this exercise was a powerful reminder that what might seem simple or obvious with sight becomes much more complex without it.

'Doing the experiment 72 times might sound repetitive, even boring, but it was one of the best experiences I've had in a lab,' adds Devashish. 'Each time a student dropped Mentos into the [fizzy drink] bottle and sealed it with the balloon-fitted cap, the balloon began to expand as gas was released. I would ask them to feel the balloon becoming bigger. The joy and excitement that they had on their faces made every single time worth it.'

In conversations with volunteers, several students shared that they had arrived at the camp feeling hesitant, even afraid of the lab, due to past experiences. However, by the end, they felt hopeful about pursuing a career in science.

'We have chemistry as a subject in school, but the experiments in the syllabus were always taught verbally, we never had the chance to do them ourselves,' says Saee, one of the workshop participants. 'This was the first time I experienced chemistry hands-on, and it gave me the confidence to know I'm capable of doing these experiments. Now, I'm excited to explore even more.'

Chemistry World, 4 July 2025

https://chemistryworld.com

## What Happens Inside Soft Materials When They Deform?

*2025-07-08*

New research led by the University of Liverpool in collaboration with the University of New South Wales (Sydney, Australia) provides a significant step forward in understanding the micro-scale mechanisms that govern the behaviour of soft materials.

Soft materials are a type of material that can be easily bent, compressed, or indented with minimal force. They are widely used in everyday items such as toothpaste and lotions, and play critical roles in fields like food science, biomedical applications, textiles, and industrial processes, including 3D printing and battery manufacturing.

In a new study published in the Journal of Colloid and Interface Science, researchers have, for the first time, directly mapped what happens inside a particular type of soft material – liquid crystals – when they are deformed.

The research team used advanced techniques to visualise how these materials respond at the microscopic level to various types of stress and strain.

Their findings challenge long-standing assumptions about how easily the internal behaviour of soft materials can be detected with traditional measurements, providing valuable insights for improving manufacturing and processing techniques.

Rheo-microscopy was used to track and quantify dynamic structural changes in soft materials in real time. This method allowed them to distinguish between solid-like and fluid-like behaviours occurring simultaneously within the same material.

Dr Esther García-Tuñón, Senior Lecturer in Materials Science and Engineering and UKRI Future Leaders Fellow, led the research.

She said: "This is the first study to directly map heterogeneous flows and internal structures in a liquid crystal like this. Until now, most studies relied on bulk mechanical measurements and scattering techniques, which have important limitations. Our method offers a more accessible and detailed way to understand what's happening inside."

One of the study's key breakthroughs was observing how structural transitions inside the material correlated not with smooth, idealized flow—as previously assumed—but with localized fracture events. These



CHEMWATCH
Bulletin Board
Gossip
JUL. 11, 2025

insights provide a foundation for more accurate computational models and have implications for the shelf life, mixing, and extrusion processes of soft materials.

Dr García-Tuñón is a leading researcher in advanced materials processing and complex fluids working at the interface between Chemical Engineering and Materials Science.

The study draws on her expertise in chemistry and engineering and her roles with the University of Liverpool's Materials Innovation Factory and the Virtual Advanced Rheometry Centre in the School of Engineering.

Technology Networks, 8 July 2025

https://technologynetworks.com

## New boron nitride coating for glass reduces heat loss and saves energy

*2025-07-10*

A new coating for glass developed by Rice University researchers and collaborators could help reduce energy bills, especially during the cold season, by preventing heat-loss from leaky windows. The material—a transparent film made by weaving carbon into the atomic lattice of boron nitride—forms a thin, tough layer that reflects heat, resists scratches and shrugs off moisture, UV light and temperature swings.

The researchers simulated how the material would behave in an actual-sized building in cities with cold winters like New York, Beijing and Calgary, showing it improved energy savings by 2.9% compared to existing alternatives. With over 4 billion square feet of new windows installed annually in the U.S. alone, the savings can add up.

According to a study published in Advanced Materials, the coating's durability allows it to be placed on the exterior-facing side of the glass—a major advantage over conventional low-emissivity (low-E) coatings.

Emissivity describes a material's ability to radiate heat as thermal energy; lower values mean less heat escapes through the glass. Traditional low-E coatings are prone to degradation from environmental factors like humidity and temperature fluctuations, which requires them to be placed on windows' interior-facing sides.

"Although pure boron nitride shows almost similar emissivity to glass, when you add a small amount of carbon to it, the emissivity lowers significantly—and this changes the game altogether," said Pulickel Ajayan, Rice's Benjamin M. and Mary Greenwood Anderson Professor of Engineering and professor of materials science and nanoengineering.

To create the coating, the team used pulsed laser deposition, a technique in which short, high-energy laser bursts strike a solid boron nitride target, sparking plasma plumes that disperse into vapor then settle onto a substrate; in this case, glass. Because the process takes place at room temperature, it avoids the high heat typically required for making adhesive coatings.

"From the synthesis point of view, coating boron nitride on glass is truly amazing and very exciting," said Abhijit Biswas, lead author on the study and an expert in thin film synthesis.



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

Ajayan noted the same low-temperature boron nitride deposition technique could be adapted for other materials besides glass, including polymers, textiles and possibly even biological surfaces. Moreover, other scalable techniques—such as roll-to-roll chemical vapor deposition or sputtering—could eventually make commercial production feasible with the right process optimization.

"This broadens the application space for boron nitride coatings significantly," said Ajayan, who is the corresponding author on the study. Researchers in his group at Rice have been studying boron nitride thin film growth for years, interested in the material's standout mechanical, thermal and optical properties.

From a raw materials standpoint, boron nitride is less expensive than the silver or indium tin oxide used in most commercial low-E glass. Still, the researchers caution against direct cost comparisons, since the materials differ in durability, processing methods and technological maturity.

Even so, the team sees promise in the coating's long-term performance, especially in harsh environments where existing materials fall short.

Phys Org, 10 July 2025

https://phys.org

## Coastal Sewage Spills Could Be Contributing Billions of Microplastics to the Air

*2025-07-09*

A combination of sewage overflows and coastal winds could be sending billions of airborne microplastic particles into the world's coastal towns and cities, a new study suggests.

Scientists analyzed existing records on two years of combined sewer overflows into Plymouth Sound, alongside same-day and long-term meteorological and satellite data to assess how often conditions for aerosolization (the transfer of particles from water to air) occurred.

They found that on 178 days within the two-year period, sewage spills from land to sea coincided with winds of at least 6.5metres per second (23.4km/h) pushing back to shore and towards the city of Plymouth.

This, they say, could have resulted in microplastics and nanoplastics known to be discharged through sewage spills being lifted from the sea – specifically, according to the meteorological data, this could have happened during almost 1,600 hours (10%) of the period studied.

Once there, the airborne particles could have been breathed in by local residents, with an increasing and emerging body of research suggesting microplastics can have a range of detrimental effects on human health.

By examining satellite data, the scientists also found river plumes coincident with sewage spills detectable up to around 10km offshore, with a significant degradation in coastal water clarity during late autumn and early winter over the past decade. These months coincided with peak spill months.

The study, published in the journal Scientific Reports, was conducted by experts in marine science, human health and big data from the University of Plymouth and Plymouth Marine Laboratory.

It draws together existing research which has highlighted the presence of microplastics in sewage overspills, and the role of the wind in picking up and transporting sea spray and sea foam into the air and onto land.

The researchers say that with thousands of cities in the UK and worldwide still using combined sewer systems, comprising sewerage from treatment works and storm runoff, their findings suggest coastal spills – when combined with onshore aerosolizing winds – may serve as a plausible and previously overlooked source of airborne microplastics.

Increasingly, I have been reading separate studies about incredibly high concentrations of microplastics and nanoplastics in sewage spills, how winds are stripping microplastics and nanoplastics from the ocean surface into the air, and the negative impacts of ingested or inhaled microplastics and nanoplastics on human health. Our study is the first to make the connection between water pollution and air quality, and raises the question about potential health risks.

Based on their theoretical findings, the research team has called for further investigation into any links between sewage spills, air quality and any potential risks to human health.

They have also recommended future scientific studies integrate air quality monitoring with assessments of coastal water quality so as to better understand potential exposure pathways.

Dr David Moffat, Artificial Intelligence and Data Scientist Lead at Plymouth Marine Laboratory and co-author on the study, said:

"There has always been a gap between the amount of microplastics we believed were being deposited in the oceans, and the concentrations that



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

were observed by ship-based measurements. We think we have finally worked out why, and the impacts on human health are concerning."

The health implications of this work are important. Inhaled microplastics can cross into our blood streams and from there can accumulate in organs such as our brains and livers. We need legislation to force our UK water supply companies to remove microplastics from our waste water systems.

Technology Networks, 7 July 2025

https://technologynetworks.com

## Scientists Unveil Cheaper, Smarter Way To Capture Carbon Dioxide

*2025-07-10*

Scientists at Georgia Tech's School of Chemical and Biomolecular Engineering (ChBE) have introduced a new method aimed at reducing carbon dioxide ($CO_2$) levels in the atmosphere, a key strategy for addressing climate change.

Although various direct air capture (DAC) technologies have emerged in recent years, their widespread use has been limited due to high costs and energy demands.

In a recently published study in Energy & Environmental Science, the Georgia Tech team unveiled a more cost-effective and energy-efficient way to capture $CO_2$ by using very cold air and commonly available porous sorbent materials, opening the door for broader application of DAC in the future.

**Harnessing Already Available Energy**

The approach, developed in collaboration with researchers from Oak Ridge National Laboratory in Tennessee and from Jeonbuk National University and Chonnam National University in South Korea, involves integrating DAC with the regasification process of liquefied natural gas (LNG). This industrial step, which turns LNG back into gas for use, generates extremely low temperatures that can be repurposed for efficient $CO_2$ capture.

LNG, which is a natural gas cooled into a liquid for shipping, must be warmed back into a gas before use. That warming process often uses seawater as the source of the heat and essentially wastes the low temperature energy embodied in the liquified natural gas.

Instead, by using the cold energy from LNG to chill the air, Georgia Tech researchers created a superior environment for capturing $CO_2$ using materials known as "physisorbents," which are porous solids that soak up gases.

Most DAC systems in use today employ amine-based materials that chemically bind CO2 from the air, but they offer relatively limited pore space for capture, degrade over time, and require substantial energy to operate effectively. Physisorbents, however, offer longer lifespans and faster $CO_2$ uptake but often struggle in warm, humid conditions.

The research study showed that when air is cooled to near-cryogenic temperatures for DAC, almost all of the water vapor condenses out of the air. This enables physisorbents to achieve higher $CO_2$ capture performance without the need for expensive water-removal steps.

"This is an exciting step forward," said Professor Ryan Lively of ChBE@GT. "We're showing that you can capture carbon at low costs using existing infrastructure and safe, low-cost materials."

**Cost and Energy Savings**

The economic modeling conducted by Lively's team suggests that integrating this LNG-based approach into DAC could reduce the cost of capturing one metric ton of $CO_2$ to as low as $70, approximately a threefold decrease from current DAC methods, which often exceed $200 per ton.

Through simulations and experiments, the team identified Zeolite 13X and CALF-20 as leading physisorbents for this DAC process. Zeolite 13X is an inexpensive and durable desiccant material used in water treatment, while CALF-20 is a metal-organic framework (MOF) known for its stability and CO2 capture performance from flue gas, but not from air.

These materials showed strong $CO_2$ adsorption at -78°C (a representative temperature for the LNG-DAC system) with capacities approximately three times higher than those found in amine materials that operate at ambient conditions. They also released the captured and purified $CO_2$ with low energy input, making them attractive for practical use.

"Beyond their high CO2 capacities, both physisorbents exhibit critical characteristics such as low desorption enthalpy, cost efficiency, scalability, and long-term stability, all of which are essential for real-world applications," said lead author Seo-Yul Kim, a postdoctoral researcher in the Lively Lab.



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

**Leveraging Existing Infrastructure**

The study also addresses a key concern for DAC: location. Traditional systems are often best suited for dry, cool environments. But by leveraging existing LNG infrastructure, near-cryogenic DAC could be deployed in temperate and even humid coastal regions, greatly expanding the geographic scope of carbon removal.

"LNG regasification systems are currently an untapped source of cold energy, with terminals operating at a large scale in coastal areas around the world," Lively said. "By harnessing even just a portion of their cold energy, we could potentially capture over 100 million metric tons of $CO_2$ per year by 2050."

As governments and industries face increasing pressure to meet net-zero emissions goals, solutions like LNG-coupled near-cryogenic DAC offer a promising path forward. The next steps for the team include continued refinement of materials and system designs to ensure performance and durability at larger scales.

"This is an exciting example of how rethinking energy flows in our existing infrastructure can lead to low-cost reductions in carbon footprint," Lively said.

The study also demonstrated that an expanded range of materials could be employed for DAC. While only a small subset of materials can be used at ambient temperatures, the number that are viable grows substantially at near-cryogenic temperatures.

"Many physisorbents that were previously dismissed for DAC suddenly become viable when you drop the temperature," said Professor Matthew Realff, co-author of the study and professor at ChBE@GT. "This unlocks a whole new design space for carbon capture materials."

Sci Tech Daily, 10 July 2025

https://scitechdaily.com

## Plants engineered for optimal biofuel production

*2025-07-10*

Arabidopsis may seem like a simple plant, but at the University of Missouri, plant biochemist Jay Thelen is using it as a powerful model to explore ways to boost oil production—an important step toward creating more sustainable, plant-based energy sources.

To meet the increasing global demand for biofuels, scientists are already modifying plant genes to boost the amount of plant oil being produced. That's because inside the plant, a complex network of metabolic pathways turns sunlight, carbon dioxide (or atmospheric carbon), water and nutrients into vital compounds including oil, the foundational ingredient of biofuel.

Genes give instructions to enzymes, and, in turn, those enzymes help control the plant's metabolic pathways. But we are only beginning to understand how modifying these genes to produce more oil affects the plant's other metabolic pathways, which are all interconnected.

In their new study, Thelen and his colleagues have charted how plant metabolism responds to these genetic changes. Their findings will provide fellow scientists with clues for how to tweak a plant's oil production to create the maximum amount of biofuel.

"Comparative omics reveals unanticipated metabolic rearrangements in a high-oil mutant of plastid acetyl-CoA carboxylase," was published in the Journal of Proteome Research.

"Because oil production utilizes central metabolic pathways, we know that engineering plants to produce more oil ultimately impacts other pathways—creating constraints on carbon supply," said Thelen, professor of biochemistry in Mizzou's College of Agriculture, Food and Natural Resources.

"By using the knowledge we gained in this large-scale biological study, we can identify these metabolic bottlenecks and release these constraints through targeted engineering in order to maximize desirable products, such as oil."

**Surprising findings**

One of the study's most unexpected findings challenged a long-held observation that oil content in seeds is inversely proportional to protein. In other words, if you try to increase oil, protein goes down and vice versa. However, Thelen and colleagues found simultaneous increases in both oil and protein content in the seeds.

"The surprising co-increase in protein suggests that it might be possible to simultaneously enhance multiple valuable components within plants that are grown for both oil and protein traits, rather than being forced into a trade-off," Thelen said.



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

"This study of a gene knockout for a regulatory gene for fatty acid production could offer clues for the engineering of seeds with a higher overall content of desirable substances, offering greater value."

Another unexpected result revealed an energy-wasting "futile cycle." Even as the genetically modified plants made more oil, they also triggered processes that broke those oils down.

"We noticed that the plants upregulated pathways for lipid mobilization, seemingly breaking down the lipids (fatty acids) they were trying to overproduce," he said. "In future research, we want to try to discover what caused this unusual metabolic response, and ultimately slow down fatty acid catabolism to minimize this wasteful cycle."

**Maximizing efficiency**

The team's long-term goal is to help develop more efficient oil-producing plants such as camelina and pennycress—fast-growing cover crops—to quickly absorb carbon dioxide and turn it into oil in the most efficient way possible.

"This carbon dioxide can be put into various products, such as simple and complex sugars, waxes, organic acids and oils," said Thelen, who is also a principal investigator in the Christopher S. Bond Life Sciences Center.

"The goal of genetic engineering is to move as much of that carbon from those less valuable products into creating seed oil, the principal agronomic product for oilseed cover crops."

Phys Org, 10 July 2025

https://phys.org

## Chemists discover 'anti-spice' that could make chilli peppers less hot

*2025-05-14*

An analysis of compounds in chilli peppers has revealed chemicals that seem to negate their heat-giving capsaicinoids. This explains why the Scoville scale for measuring spicyness isn't always accurate, and could eventually lead to the development of an "anti-spice" condiment

Accidentally made your food too spicy? One day, you might be able to reach for an "anti-spice" condiment to tame the heat of a dish, thanks to

the discovery of chemicals found in chilli peppers that counteract their spicy sensation.

A chilli's heat comes from compounds called capsaicinoids, which bind to receptors on nerve fibres within your mouth, sending impulses to the brain that create a burning sensation similar to those caused by a fire's heat or a sting.

Chilli aficionados compare the heat of different strains using the Scoville scale, which is based on the concentration of capsaicinoids, yet some varieties aren't quite as hot as their Scoville rating suggests they should be. To investigate, Devin Peterson at the Ohio State University and his colleagues used an analytical method known as liquid chromatography-mass spectrometry to determine how much of two capsaicinoids – capsaicin and dihydrocapsaicin – were in powdered samples of 10 types of peppers, including chile de árbol, African bird's eye and Scotch bonnet.

Then they gave samples of tomato juice containing powder from the different chillis to a panel of tasters. Each contained the same amount of capsaicin and dihydrocapsaicin – which should have been enough to give all the samples a relatively mild kick of 800 Scoville units.

But the tasters perceived the heat from the 10 peppers as different, so Peterson and his colleagues performed additional chemical analyses. This identified three compounds in the chilli powder – capsianoside I, roseoside and gingerglycolipid A – that were present in high quantities in the chillies that weren't as intense as they should have been according to the Scoville scale. All three compounds are glucosides, molecules that contain the sugar glucose.

A group of 37 tasters then tested two samples at once, one containing these suspected spice-killing compounds and one without, placed on either side of their tongue to stop an enflamed tongue affecting a second taste test. Their feedback revealed that the compounds decreased the chilli intensity by between 0.7 and 1.2 points on a 15-point scale, on average.

"They are effectively anti-spice compounds," says Peterson. He isn't yet sure how they work, but says they could be altering receptors on nerve fibres in the mouth in a way that results in a reduction in their burning signals.

Knowing about these anti-spice chemicals could allow growers to breed or genetically modify plants so they lack them to create valuable, even hotter



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

chillis, or breed very mild fruit with higher amounts of anti-spice, says Peterson.

Using the compounds could also enable the creation of a household ingredient to tone down excessive heat in dishes, he says, or they could work as relievers for severe pain by blocking pain signals.

"Sometimes when I've ordered food with my kids and it's too spicy, that's a no-go," says Peterson. "So, the idea of having some kind of a natural compound to dial it back may be appealing."

"The way the study was done using the half tongue was very clever," says Barry Smith at the University of London's School of Advanced Study, adding that it shows the Scoville scale isn't a very precise instrument for describing how hot a chilli is.

Smith also wonders if the perceived intensity of menthol or mint, which cause a cooling sensation in a similar way to how capsaicinoids cause a burning one, could also be muted by these kinds of compounds.

New Scientist, 14 May 2025

https://newscientist.com

## AI system decode polymer–solvent interactions for materials discovery

*2025-07-10*

A study published in npj Computational Materials presents a new AI system that uses computer vision and language processing to interpret complex polymer–solvent interactions such as swelling, gelation and dispersion from images and videos.

The paper is titled "A multi-model vision assistant for autonomous interpretation of polymer–solvent solvation behaviors."

Polymer–solvent systems are notoriously tricky to analyze due to the variety of behaviors involved and the subjective nature of manual assessments. This new approach integrates multiple AI models—including convolutional neural networks to understand static and dynamic visual data and a vision–language module that generates descriptive captions—providing an objective, scalable way to track and describe solvation phenomena.

"Polymers and solvents don't always behave predictably and human evaluations can vary," said Liew. "Our AI assistant can see what's happening in detail and put it into words, making it easier to analyze data quickly and reliably—especially for high-throughput experiments."

This system promises to accelerate materials discovery by enabling automated, repeatable interpretation of experimental results, removing bottlenecks caused by manual screening.

The work is part of Ph.D. research by Zheng Jie Liew, supported by Ziad Elkhaiary, who contributed to the project while completing the department's Advanced Chemical Engineering (ACE) Master's, under the supervision of Professor Alexei A. Lapkin in the Sustainable Reaction Engineering research group at the University of Cambridge's Department of Chemical Engineering and Biotechnology.

Elkhaiary's contribution during his ACE Master's highlights the research-led teaching ethos of the department.

"It's rewarding to see our students actively shaping cutting-edge science," said Lapkin. "Contributing to real projects prepares them for the challenges of sustainable chemical engineering."

Phys Org, 10 July 2025

https://phys.org

## Scientists Mapped the Secret World of Platinum Atoms – And It Changes Everything

*2025-07-07*

Scientists at ETH Zurich have developed a powerful method to look deep inside single-atom catalysts—materials where every atom plays a vital role in driving chemical reactions. By using a technique called nuclear magnetic resonance (similar to the technology behind MRI scans), they've uncovered how platinum atoms interact with their surroundings on an atomic level. This breakthrough could lead to greener, more efficient ways to make chemicals using fewer precious materials.

- Researchers used nuclear magnetic resonance to study individual platinum atoms inside solid materials.
- The technique revealed which atoms are connected to platinum and how they are positioned in space.



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

- This detailed atomic insight allows scientists to design more uniform and effective single-atom catalysts.
- The findings open the door to faster, cleaner chemical reactions that use less platinum and generate less waste.
- The method could help advance sustainable chemistry by improving how catalysts are made and used.

**The Power and Cost of Catalysis**

Catalysis, the process of speeding up chemical reactions by adding a special substance, plays a huge role in modern life. In fact, about 80 percent of all chemical products—from fuels to pharmaceuticals—are made using catalysts. Technologies like car exhaust systems and fuel cells also rely on them.

One of the most effective and widely used catalysts is platinum. It's incredibly good at triggering reactions, but it comes with major downsides. Platinum is rare, expensive, and its production releases a significant amount of carbon dioxide. That's why scientists are eager to find ways to use less of it, while still getting maximum performance.

**Precision Engineering With Single Atoms**

In recent years, researchers have been exploring a new class of catalysts known as single-atom catalysts. These are materials where individual platinum atoms are spread out on a porous surface, such as carbon that's been infused with nitrogen. The nitrogen atoms help anchor each platinum atom in place, ensuring every single atom plays a role in the chemical reaction.

Now, a team of scientists led by Javier Pérez-Ramírez and Christophe Copéret at ETH Zurich, along with collaborators from the Universities of Lyon and Aarhus, have made an exciting discovery. They found that these single-atom catalysts are much more complex than previously believed.

Using a powerful technique called nuclear magnetic resonance (similar to what's used in MRI scans), the team revealed that each platinum atom sits in a slightly different environment. These tiny differences in atomic surroundings actually affect how well each atom performs as a catalyst.

Their findings, recently published in Nature, open the door to creating smarter, more efficient catalysts. By fine-tuning the atomic structure around each platinum atom, future materials could deliver better performance with less environmental impact—a big win for both industry and the planet.

**From Serendipity to Scientific Innovation**

"Until now individual platinum atoms could only be observed through the 'lens' of an electron microscope – which looks impressive but doesn't tell us much about their catalytic properties," says Pérez-Ramírez. Together with Copéret he thought about how one might characterize the individual platinum atoms more precisely. The collaboration began with a chance encounter during a meeting in the framework of the NCCR Catalysis program.

After the meeting, the two researchers developed the idea to try nuclear magnetic resonance. This method, on which the MRI in a hospital is based and which is typically used for investigating molecules in laboratories, the spins of atomic nuclei in a strong static magnetic field react to oscillating magnetic fields of a certain resonant frequency. In molecules, this resonant frequency depends on how the different atoms are arranged inside the molecule. "Likewise, the resonant frequencies of the single platinum atoms are influenced by their atomic neighbours – for instance, carbon, nitrogen or oxygen – and their orientation relative to the static magnetic field," Copéret explains.

This leads to many different resonant frequencies, much like the different tones in an orchestra. Finding out which instrument is producing a particular tone isn't easy. "As luck would have it, during a visit to Lyon one of us met a simulation expert from Aarhus who was visiting there at the same time," says Copéret. Such encounters, and the collaborations resulting from them, are essential for scientific progress, he adds. Together with the ETH-collaborator, the simulation expert developed a computer code that made it possible to filter out the many different "tones" of the individual platinum atoms from the muddle.

**Charting Atomic Neighborhoods**

Ultimately, this led to a breakthrough in the description of single-atom catalysts: the research team were now able to compile a kind of map showing the type and position of atoms surrounding the platinum atoms. "This analytical method sets a new benchmark in the field," says Pérez-Ramírez.

With this method, which is broadly accessible, production protocols for single-atom catalysts can be optimized in such a way that all platinum atoms have tailored environments. This is the next challenge for the team. "Our method is also important from an intellectual property standpoint,"



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

says Copéret: "Being able to precisely describe catalysts at the atomic level enables us to protect them through patents."

Sci Tech Daily, 7 July 2025

https://scitechdaily.com

## Tomatoes in the Galápagos Are De-Evolving

*2025-06-25*

On the younger, black-rock islands of the Galápagos archipelago, wild-growing tomatoes are doing something peculiar. They're shedding millions of years of evolution, reverting to a more primitive genetic state that resurrects ancient chemical defenses.

These tomatoes, which descended from South American ancestors likely brought over by birds, have quietly started making a toxic molecular cocktail that hasn't been seen in millions of years, one that resembles compounds found in eggplant, not the modern tomato.

In a study published recently in Nature Communications, scientists at the University of California, Riverside, describe this unexpected development as a possible case of "reverse evolution," a term that tends to be controversial amongst evolutionary biologists.

That's because evolution isn't supposed to have a rewind button. It's generally viewed as a one-way march toward adaptation, not a circular path back to traits once lost. While organisms sometimes re-acquire features similar to those of their ancestors, doing so through the exact same genetic pathways is rare and difficult to prove.

However, reversal is what these tomato plants appear to be doing.

"It's not something we usually expect," said Adam Jozwiak, a molecular biochemist at UC Riverside and lead author of the study. "But here it is, happening in real time, on a volcanic island."

The key players in this chemical reversal are alkaloids. Tomatoes, potatoes, eggplants, and other nightshades all make these bitter molecules that act like built-in pesticides, deterring insect predators, fungi, and grazing animals.

While the Galápagos are famous as a place where animals have few predators, the same is not necessarily true for plants. Thus, the need to produce the alkaloids.

The researchers began this project because alkaloids in crops can be problematic. In high concentrations they are toxic to humans, hence the desire to understand their production and reduce them in the edible parts of fruits and tubers.

"Our group has been working hard to characterize the steps involved in alkaloid synthesis, so that we can try and control it," Jozwiak said.

What makes these Galápagos tomatoes interesting isn't just that they make alkaloids, but that they're making the wrong ones, or at least, ones that haven't been seen in tomatoes since their early evolutionary days.

The researchers analyzed more than 30 tomato samples collected from distinct geographic locations across the islands. They found that plants on eastern islands produced the same alkaloids found in modern cultivated tomatoes. But on western islands, the tomatoes were churning out a different version with the molecular fingerprint of eggplant relatives from millions of years ago.

That difference comes down to stereochemistry, or how atoms are arranged in three-dimensional space. Two molecules can contain exactly the same atoms but behave entirely differently depending on how those atoms are arranged.

To figure out how the tomatoes made the switch, the researchers examined the enzymes that assemble these alkaloid molecules. They discovered that changing just four amino acids in a single enzyme was enough to flip the molecule's structure from modern to ancestral.

They proved it by synthesizing the genes coding for these enzymes in the lab and inserting them into tobacco plants, which promptly began producing the old compounds.

The pattern wasn't random. It aligned with geography. Tomatoes on the eastern, older islands, which are more stable and biologically diverse, made modern alkaloids. Those on the younger, western islands where the landscape is more barren and the soil is less developed, had adopted the older chemistry.

The researchers suspect the environment on the newer islands may be driving the reversal. "It could be that the ancestral molecule provides better defense in the harsher western conditions," Jozwiak said.

To verify the direction of the change, the team did a kind of evolutionary modeling that uses modern DNA to infer the traits of long-extinct



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

ancestors. The tomatoes on the younger islands matched what those early ancestors likely produced.

Still, calling this "reverse evolution" is bold. While the reappearance of old traits has been documented in snakes, fish, and even bacteria, it's rarely this clear, or this chemically precise.

"Some people don't believe in this," Jozwiak said. "But the genetic and chemical evidence points to a return to an ancestral state. The mechanism is there. It happened."

And this kind of change might not be limited to plants. If it can happen in tomatoes, it could theoretically happen in other species, too. "I think it could happen to humans," he said. "It wouldn't happen in a year or two, but over time, maybe, if environmental conditions change enough."

Jozwiak doesn't study humans, but the premise that evolution is more flexible than we think is serious. Traits long lost can re-emerge. Ancient genes can reawaken. And as this study suggests, life can sometimes find a way to move forward by reaching into the past.

"If you change just a few amino acids, you can get a completely different molecule," Jozwiak said. "That knowledge could help us engineer new medicines, design better pest resistance, or even make less toxic produce. But first, we have to understand how nature does it. This study is one step toward that."

Technology Networks, 25 June 2025

https://technologynetworks.com

## Less than 1% of 300,000 environmentally relevant chemicals in the US have monitoring data

*2025-07-07*

An analysis of US surface water monitoring records has found that less than 1% of chemicals of potential environmental concern have suitable monitoring data available. The researchers said the findings highlighted both the shortcomings of, and prospects for, macroscale chemical risk evaluations in the US and globally.

The ever-increasing speed with which new chemicals are entering the environment has created a significant challenge for the assessment of environmental risks. To find out how the availability of surface water monitoring data affects the interpretation of chemical risk, the researchers

compiled 112 million chemical monitoring records for almost 2000 chemicals, along with 78 million environmental records collated between 1958 and 2019 from across the US. They then linked this monitoring data with established toxicity thresholds collated from regulatory sources for over 170,000 chemicals.

'If you want to evaluate chemicals in the environment, there's generally two things you should look at,' explains Ralf Schulz, an environmental scientist based at the University of Kaiserslautern-Landau, in Germany, who led the study. 'One thing is the toxicity of a chemical – at what level does it produce harm to organisms or to humans. And the second question … at what concentration does a chemical occur in the environment? And this is what we looked at in our study – we took a very, very large monitoring data set from the USA … and we asked ourselves, what can we learn from the monitoring data if we look at them at such a macro scale?'

The analysis of the data enabled them to reach three key conclusions. The first was that there is a relatively large volume of chemicals where there is toxicity information available, but no monitoring data. 'To put that into perspective, in the US, for example, they consider roughly 300,000 chemicals as being environmentally relevant, and less than 1% of those come along with monitoring data,' explains Schulz. 'So, for less than 1% of these 300,000 do we have monitoring and toxicity data so that we are able to make an evaluation about their risks.'

Secondly, when they put the spatial, temporal and chemical information together they saw how well the US had done in the past monitoring chemicals and managing them, but that more recently the quantity of different chemicals present in water systems has made tracking them very challenging. 'In the 1970s, [the US] did very well in monitoring heavy metals; they saw that heavy metals were at high levels, and they took measures to reduce the pollution, and these measures were effective,' says Schulz. 'But then in the 2000s and now recently, the sheer number [of chemicals] that they have to deal with has grown so much that they really do have problems to monitor all of them.'

Finally, the researchers found that detection limits were hugely important when assessing the risk posed by certain chemicals. '[This is] the lowest concentration at which you can measure a chemical in the environment, because they are, for some chemicals, relatively low so you can monitor all of them, but for some chemicals, and particularly some insecticides – the so-called pyrethroids, a modern group of insecticides that is used globally



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

in agriculture – it is very often the case that the detection limits are much higher than the toxicity thresholds, and then you cannot measure the concentrations that you need to measure, and then you don't know if there's a risk or not.'

**Unique resource**

The study focused on US water pollution because of the availability of data, but Schulz says he thinks the findings are indicative of a general problem with chemical monitoring. 'You can see that in many countries the analytical limits for some groups of chemicals are not low enough … [and] this aspect of the toxicity values and the monitoring data and to what extent they fit together, that is a general global problem,' says Schultz. 'With this very large dataset, we really have a very, very strong statistical and data-based evidence that these conclusions that we have made, at least for the US, are really valid.'

Schulz says that, going forward, it is key for countries to think about the groups of chemicals that are of highest importance to them and then focus monitoring on those. 'Some areas are probably mainly contaminated by urban chemicals or industrial chemicals, others by agriculture, others by mining … [this means] you can spend your restricted amounts of money in a more effective way, and then really looking at disease chemicals with the appropriate methods that are able to detect them,' he adds.

Chunlong Zhang, an environmental scientist at the University of Houston-Clear Lake, describes the study as 'the first of its kind to examine in detail the adequacy of our water quality monitoring (exposure) data for the purpose of aquatic risk (effect) assessment'. While he is not surprised by the results after four decades working in this field, he is surprised that it fell to a German group to perform the analysis on US data.

'This is unprecedented work with an exhaustive list of novel approaches adopted for data retrieval, formalisation, processing and curation,' he notes. 'A very unique feature of this work is its supporting database in macroscale over chemical, spatial and temporal dimensions in the US – ie, 64 million surface water monitoring records on 1900 chemicals ranging from 1958 to 2019 on 310,000 sites in the US.'

Zhang adds that instrumentation and detection limitations, as well as overlooked daughter metabolites for many organic compounds, not

considered by the team, may mean that even the 'less than 1%' figure is an underestimate.

Chemistry World, 7 July 2025

https://chemistryworld.com

## "Chemo Brain" Resembles Cognitive Decline Seen in Aging

*2025-06-27*

While chemotherapy can be lifesaving, it also damages DNA and leads to cognitive issues known as "chemo brain." These effects resemble the memory and learning problems seen in older adults, prompting University of Oklahoma researchers to investigate this unique overlap of cognitive decline.

Their work has resulted in three recent publications in the journals Geroscience and Aging Cell. Lead author Anna Csiszar, MD, PhD, a professor of neurosurgery at the University of Oklahoma College of Medicine, said that the similarities between the aging brain and chemo brain may yield answers that apply to both.

"There are several parallels in these two situations," Csiszar said. "In both, there is decreased blood flow in the brain when it is at rest and a smaller increase in blood flow when the brain is active. In addition, the blood-brain barrier, a protective layer that prevents harmful substances from entering the brain, is disrupted, which triggers inflammation in the brain. Finally, there is an accumulation of senescent cells in both brains. Senescent cells, sometimes called 'zombie cells,' are in a suspended state of not being dead nor being able to fulfill their normal function, which also causes inflammation."

When people receive chemotherapy, the drug kills cells that are dividing rapidly. While this can eliminate cancer cells, it also damages healthy cells, leading to side effects like chemo brain. In a Geroscience paper, the research team studied several chemotherapy drugs in mice for their effects on the brain, including the commonly used paclitaxel and cisplatin. They found that even though the chemo drugs caused DNA damage in different ways, their characteristics were the same in how they affected cognition.

Because of the blood-brain barrier, chemotherapy drugs do not directly enter and damage the brain. Instead, chemotherapy harms endothelial cells, the type of vascular cell most susceptible to damage. When the



CHEMWATCH
Bulletin Board
Curiosities
JUL. 11, 2025

endothelial cells are impaired, they become senescent and produce inflammatory substances that compromise the blood-brain barrier.

Csiszar and her team also studied ways to improve cognition. In a study published in Aging Cell, they tested senolytics in aging mice. Senolytics are drugs that can induce senescent cells to die through apoptosis, the typical process by which cells are removed. By selectively removing senescent cells, cognition improved.

"Our study demonstrated that if we remove these senescent cells, we can improve cerebral blood flow and the health of the blood-brain barrier, and eventually improve cognition," she said.

Researchers took the study a step further to determine the ideal time window for administering senolytics to have the most positive effect on the brain's vasculature and cognition. They tested senolytics in mice of all ages and ultimately discovered the drug was most effective when the mice were about 16 months old, which researchers believe equates to 50 to 55 years old in humans.

"We found that to be the best time frame to eliminate senescent cells and protect cognitive health," she said. "You can give senolytics later and still eliminate the cells and protect the brain's vasculature, but by then, the cognitive changes are irreversible."

Whether a result of chemotherapy or as part of normal aging, cognitive impairment can affect quality of life. Csiszar said she hopes this intersecting field of study yields answers that will ultimately improve troubling gaps in cognition.

"There is truly an intersection between aging research and cancer research," she said. "These teams represent the future of research, and we have wonderful momentum on our campus."

Technology Networks, 27 June 2025

https://technologynetworks.com

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# Bulletin Board

## Technical Notes

JUL. 11, 2025

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

## CHEMICAL EFFECTS

Investigation of the Effect of Exposure to Liquid Chemicals on the Strength Performance of 3D-Printed Parts from Different Filament Types

Machine Learning and Large Language Models for Modeling Complex Toxicity Pathways and Predicting Steroidogenesis

Machine Learning Models Based on Enlarged Chemical Spaces for Screening Carcinogenic Chemicals

## ENVIRONMENTAL RESEARCH

Assessment of vape shop built environment: airborne nicotine, particulate matter, ventilation, hazard identification, workplace practices, and safety perceptions

Exploring the combined toxic effects of tri-n-butyl phosphate and polystyrene micro/nano-plastics on Daphnia magna under environmentally relevant concentrations

Harnessing Cannabis sativa L. for integrated environmental remediation and circular biomass use

## PHARMACEUTICAL/TOXICOLOGY

Cancer Care Affordability and the Healthcare Team: Expanding an Assessment of Clinical Perceptions and Attitudes in Nursing

EARLYBIRD: catching the earliest changes of the bone and intervertebral discs in children at increased risk for scoliosis development with MRI - study protocol of a prospective observational cohort study

## OCCUPATIONAL

Artisanal Gold Mining in Mongolia: Silica Exposure and Silicosis Risk Factors-Field Survey

Modeling the impact of health care worker masking to reduce nosocomial SARS-CoV-2 transmission under varying adherence, prevalence, and transmission settings