CHEMWATCH

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(click on page numbers for links)

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ASIA PACIFIC

High-quality regulatory decisions and an investment in our people, systems and stakeholder relationships

2025-09-05

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has released its Strategic Plan for 2025–30, outlining a clear purpose to protect the health and safety of people, animals and the environment, and to support primary industries, biosecurity and international trade for all Australians. The plan sets out 5 strategic objectives that will shape the agency's priorities over the next 5 years. Its release coincides with the release of the APVMA Corporate Plan 2025-29

Read More

APVMA, 05-09-25

https://www.apvma.gov.au/sites/default/files/2025-08/APVMA%20Strategic%20Plan%202025-30.pdf

Update: Fireworks Code of Practice

2025-09-04

The EPA is revising how information about retail fireworks is communicated to stakeholders.

We will be replacing the HSNOCOP-18 Code of Practice for Retail Fireworks with updated guidance based on the Hazardous Substances (Fireworks) Regulations 2001 and relevant EPA Notices.

The current code is outdated and no longer reflects the regulatory framework or industry practices.

After reviewing our approach, we have determined that a formal Code of Practice is no longer necessary. Instead, targeted guidance will make it easier for businesses and the public to understand the rules, while allowing the EPA to update information more efficiently.

The Fireworks Regulations apply to all retail fireworks approved by the EPA

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under the HSNO Act 1996. Before importing or manufacturing any retail fireworks, you must make sure the product has a valid HSNO approval.

The EPA intends to revoke the current code and will publish notice of this in the Gazette.

Read More

EPA NZ, 04-09-25

https://www.epa.govt.nz/news-and-alerts/latest-news/

Court decision highlights need to follow hazardous substances rules

2025-09-04

The Environmental Protection Authority (EPA) welcomes the court decision in a recent prosecution that highlights the importance of following the rules for hazardous substances.

Every New Zealand manufacturer, importer, or supplier of hazardous substances has a legal responsibility to comply with the Hazardous Substances and New Organisms Act 1996 (HSNO Act) and any EPA Notice—including the Hazardous Substances (Hazardous Property Controls) Notice 2017 (HPC Notice).

The consequence of non-compliance

On 8 August 2025, the Hamilton District Court fined Ham Chem Hamilton Chemicals Limited (HamChem) $35,000 following the company's guilty plea to four charges under the HSNO Act.

The charges related to the supply of hazardous substances—on multiple occasions—in breach of their respective approvals or group standards, and clause 13 of the HPC Notice.

Read More

EPA NZ, 04-09-25

https://www.epa.govt.nz/news-and-alerts/latest-news/court-decision-highlights-need-to-follow-hazardous-substances-rules/

Time to prepare for disposal of chlorpyrifos

2025-009-03

By preparing for disposal now and exploring safer alternatives, you'll help protect people and the environment.

We encourage all users of chlorpyrifos products to get ready to dispose of them.

This follows the decision, announced in July 2025, to ban the crop insecticide chlorpyrifos and begin a phase-out. A decision-making committee found that risks to people and the environment of using the insecticide outweighed the benefit.

Read More

EPA NZ, 03-09-25

https://www.epa.govt.nz/news-and-alerts/latest-news/time-to-prepare-for-disposal-of-chlorpyrifos/

Best Practice Review – have your say on Australia's work health and safety laws

2025-09-03

Safe Work Australia is inviting all those with an interest in WHS to participate and provide feedback through our formal consultation process. You can contribute to the review in whatever form is most convenient for you – through a written submission in response to the discussion paper, by completing the survey on the Safe Work Australia Consultation Hub or by contacting us directly (via the bestpracticereview@swa.gov.au email address). In assessing proposals for change, Safe Work Australia Members and WHS ministers will consider whether they strengthen and maintain harmonisation, reflect best practice and support the object of the model WHS Act.

The formal consultation process, including written submissions, will close at 5:00 pm on Monday 3 November 2025. However, we will continue to meet with interested parties until the end of March 2026 and feedback can be provided using the best practice email address above until that date as well. A final report with the findings and recommendations from the Best Practice Review will be provided to WHS ministers in mid-2026.

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Read More

Safe Work Australia, 03-09-25

https://consult.swa.gov.au/best-practice-review

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has published 3 new Instructional Templates

2025-09-03

1. Efficacy and Crop Safety Overview – Instructional Template (Crops)
2. Efficacy Overview – Instructional Template (Non-crop situations)
3. Efficacy and Crop Safety Overview – Instructional Template (Permits)

The templates provide guidance and examples on the structure and content that is required in Efficacy and Crop Safety Overviews, supporting applications for new agricultural products and new uses.

The templates were drafted in consultation with stakeholders during 2 Efficacy Workshops held on 21 May and 1 July 2025.

The use of these templates is not mandatory but is strongly recommended. Using the templates will help to ensure all necessary information is provided and presented in a manner that will assist the APVMA in the evaluation of your application, reducing the likelihood of requests for further information during the assessment.

Read More

APVMA. 03-09-25

https://www.apvma.gov.au/

AMERICA

Eco-NAMs Webinar Series | State of the Science for Bioaccumulation: An Integrated, Weight of Evidence Approach

2025-09-05

The Eco-NAMS webinar seriesExternal Link Disclaimer is co-organized by the U.S. Food and Drug Administration, U.S. Environmental Protection Agency, European Medicines Agency, Health and Environmental Sciences

Institute, National Institute for Environmental Studies (Japan), and PETA Science Consortium International e.V.

The series aims to offer the most informative and up-to-date science on the use of new approach methodologies (NAMs) for ecotoxicity assessments (Eco-NAMs) and provides an open forum for scientists from academia, industry, non-government organizations, regulatory authorities, and other interested parties including the general public to learn about and discuss various ecotoxicity NAMs topics.

The first webinar in the series, State of the Science for Bioaccumulation: An Integrated, Weight of Evidence ApproachExternal Link Disclaimer, will feature presentations by Dr. Pippa Curtis, Senior Specialist at the Chemical Assessment Unit, United Kingdom Environment Agency (UK EA), and Dr. Michelle Embry, Deputy Director of the Health and Environmental Sciences Institute (HESI).

Read More

US FDA, 05-09-25

https://www.fda.gov/news-events/fda-meetings-conferences-and-workshops/eco-nams-webinar-series-state-science-bioaccumulation-integrated-weight-evidence-approach-09102025

EPA Updates Aquatic Life Benchmarks for Registered Conventional and Antimicrobial Pesticides

2025-09-03

Today, the U.S. Environmental Protection Agency (EPA) has released an updated version of the Aquatic Life Benchmarks. These benchmarks are estimates of the concentrations below which pesticides (including conventional and antimicrobial pesticides) are not expected to present a risk of concern for freshwater organisms.

The updated Aquatic Life Benchmarks represent 782 chemicals (parent compounds and degradates) including newly registered pesticides or new values for previously registered pesticides and selected degradates. The updates include:

- Benchmarks for four newly registered pesticides and their two degradates (new registrations); and
- Revised benchmarks for one existing active ingredient.

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EPA based these benchmarks on toxicity values from scientific studies that the agency has reviewed and used in publicly accessible ecological risk assessments in support of regulatory decisions for pesticides. For each of the pesticides listed in the Aquatic Life Benchmarks table, the table provides a link to the source documents for the benchmarks.

State, tribal, and local governments use these benchmarks in their interpretation of water quality monitoring data. Comparing a measured concentration of a pesticide in water to its Aquatic Life Benchmarks can help in interpreting monitoring data and in identifying and prioritizing monitoring sites that may require further investigation. For example, the benchmarks provide federal, state, and local agencies and other interested parties information with which to interpret water monitoring data on pesticides. International regulatory authorities and researchers also use these data in their work.

This update supersedes the previous version published August 22, 2024. EPA intends to continue to update these benchmarks annually.

Read the summary of updated benchmarks or see the complete Aquatic Life Benchmarks table.

Read More

US EPA, 03-09-25

https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/summary-september-2025-updates-aquatic-life

Europe bans chemical used in some gel nail polishes, classifying it as a 'reproductive toxicant'

2025-09-05

The European Union is now prohibiting the use of a key chemical ingredient in some gel nail polishes and other cosmetic products.

The ban, which went into effect this week, targets the use of trimethylbenzoyl diphenylphosphine oxide or TPO, which was classified as a type of "reproductive toxicant" by European regulators, according to the European Commission.

TPO works as a photoinitiator, meaning it responds to light. In gel nail polish, it helps the polish set under ultraviolet or UV light.

Read More

CNN, 05-09-25

https://edition.cnn.com/2025/09/04/health/gel-nail-polish-chemical-ban-europe-wellness

GB public consultation: alternatives for anticoagulant rodenticide products

2025-09-04

Deadline: 30 September 2025

HSE is consulting on the availability, or lack, of suitable alternatives for rodenticide products containing anticoagulant active substances.

Anticoagulant rodenticide active substances have been identified as fulfilling at least one of the exclusion criteria set out in Article 5(1) of the GB Biocidal Products Regulation (GB BPR). But they are approved in accordance with Article 5(2) as they are essential to prevent serious danger to human and animal health, and the environment. They are therefore considered to be candidates for substitution under Article 10(1).

Where a biocidal product contains an active substance that is a candidate for substitution, a comparative assessment must be carried out as set out in Article 23 before the product can be authorised or renewed.

To inform this comparative assessment, HSE has launched a public consultation to gather information on the availability of suitable and sufficient alternatives to anticoagulant rodenticides.

Read More

UK HSE, 04-09-25

https://consultations.hse.gov.uk/crd-biocides/gb-bpr-anticoagulant-rodenticides/

Next milestone in universal PFAS restriction process completed

2025-08-26

Final revision of background document for universal PFAS restriction is now completed. Authorities from five countries (Germany, the Netherlands, Norway, Denmark and Sweden) have taken into account the feedback of more than 5 600 comments from stakeholders. Relevant input

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has been implemented into the background document which has been shared with the European Chemicals Agency(link is external) (ECHA) and published on their website.

In January 2023, an extensive Annex XV report initiating a restriction process for PFAS was submitted by the REACH-competent national authorities from Germany, the Netherlands, Norway, Denmark and Sweden, in the following referred to as Dossier Submitters (DS). It concerns more than 10 000 substances that are very persistent in the environment together with other concerning intrinsic properties. PFAS-based products are also widely used in society.

Since the end of the six-month consultation(link is external) on the Annex XV report in September 2023, the initial report, called background document (BD) in this stage of the process, has been updated in phases by the DS to take into account the information from the consultation.

The DS completed the final version of the background document (BD) and shared it with the European Chemicals Agency (ECHA) on the 24th of June 2025. This concludes the work of the DS in this phase of the restriction process.

Read More

RIVM, 26-08-25

https://www.rivm.nl/en/news/next-milestone-in-universal-pfas-restriction-process-completed

REACH Update

SEP. 12, 2025

Three proposals to identify new substances of very high concern (SVHCs)

2025-09-03

The substances and examples of their uses are:

- n-Hexane (EC 203-777-6)

Used in formulation and polymer processing and in coatings and cleaning agents.

- 4,4'-methylenediphenol (BPF, Bisphenol F) (EC 210-658-2)

Not registered.

- 4,4'-[2,2,2-trifluoro-1-(trifluoromethyl)ethylidene]diphenol and its salts (EC -)

Used as process regulators in polymer materials and in rubber production and processing.

Have your say until **16 October 2025**.

Testing proposals

We have launched 14 new consultations on testing proposals.

Have your say until **16 October 2025**.

Read More

ECHA, 03-09-25

https://echa.europa.eu/view-article/-/journal_content/title/echa-weekly-3-september-2025

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Janet's Corner

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Who am I?

2025-12-09

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

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

I am element number 14.

Chloroacetic Acid

2025-09-12

USES [2,3]

Chloroacetic acid is used in the manufacture of cellulose ethers (used mainly for drilling muds, detergents, food, and pharmaceuticals), as a post-emergence contact herbicide and defoliant, and in the manufacture of glycine and thioglycolic acid. It is also used in the manufacture of various dyes, synthetic caffeine, and organic chemicals.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Individuals are most likely to be exposed to chloroacetic acid in the workplace.
- Chloroacetic acid may be released to the environment during its production and use.

Routes of Exposure

Chloroacetic acid can be absorbed into the body by inhalation and contact with the skin and eyes. It can also enter the body via ingestion.

HEALTH EFFECTS [4]

Acute Health Effects

- Acute inhalation or dermal exposure to chloroacetic acid may cause severe damage to the skin and mucous membranes in humans. Chloroacetic acid irritates and may burn the skin, eyes, and respiratory tract.
- Depression of the central nervous system may occur in humans following acute inhalation exposure.
- Acute exposure by ingestion of chloroacetic acid may interfere with essential enzyme systems in the body and cause intestinal perforation and peritonitis in humans.
- Mice acutely exposed by ingestion have exhibited neurological dysfunction.
- Tests involving acute exposure of animals in rats, mice, and guinea pigs have demonstrated chloroacetic acid to have extreme toxicity from inhalation and moderate to high acute toxicity from ingestion.

Chloroacetic acid, industrially known as monochloroacetic acid (MCA), is the organo-chlorine compound with the formula ClCH2CO2H. This carboxylic acid is a useful building-block in organic synthesis. [1] Liquid chloroacetic acid is a colourless solution of the white crystalline solid. The acid concentration can be up to 80%. In solid form, chloroacetic acid is colourless to light-brown crystal-line material. In water, it is soluble and sinks. It is cor-rosive to metals and tissue. [2] The odour of chloroacetic acid is penetrating, similar to vinegar. [1,2]

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Carcinogenicity

- No information is available on the carcinogenic effects of chloroacetic acid in humans.
- Chloroacetic acid was not found to be tumorigenic to mice when administered via gavage or by subcutaneous injection or when applied to the skin.
- In a National Toxicology Program (NTP) study, no statistically significant increases in tumour incidences were reported in rats and mice exposed to chloroacetic acid via gavage.
- EPA has not classified chloroacetic acid for potential carcinogenicity.

Other Effects

- Phenanthrene may cause a skin allergy. If allergy develops, very low future exposure can cause itching and a skin rash.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
- **Skin Contact:** If the chemical got onto the clothed portion of the body, remove the contaminated clothes as quickly as possible, protecting your own hands and body. Place the victim under a deluge shower. If the chemical got on the victim's exposed skin, such as the hands: Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.
- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** Allow the victim to rest in a well-ventilated area. Seek immediate medical attention.
- **Serious Inhalation:** Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not

breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

- **Ingestion:** Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Workplace Controls & Practices [4]

- Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits.
- If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling chloroacetic acid:

- Splash goggles;
- Synthetic apron;
- Vapour and dust respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves.

Personal Protection in Case of a Large Spill:

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

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REGULATION

United States

No exposure limits have been set for chloroacetic acid.

REFERENCES

1. http://pubchem.ncbi.nlm.nih.gov/compound/chloroacetic_acid#section=Color
2. http://www.epa.gov/ttn/atw/hlthef/chloroac.html
3. http://www.cdc.gov/niosh/ipcsneng/neng0235.html
4. http://www.sciencelab.com/msds.php?msdsId=9923404
5. http://en.wikipedia.org/wiki/Chloroacetic_acid
6. http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/639/Workplace_Exposure_Standards_for_Airborne_Contaminants.pdf

World's first koala chlamydia vaccine approved for rollout across country

2025-09-09

Australia's embattled koalas have been given some good news for once, with the approval of the world's first chlamydia vaccine for the marsupial. More than a decade in the making, the vaccine will protect koalas from the widespread disease that causes painful urinary tract infections, infertility, blindness and death.

Developed by University of the Sunshine Coast (UniSC) scientists, with the support of global institutions including the University of Saskatchewan's Vaccine and Infectious Disease Organization (VIDO), the International Vaccine Institute, the University of British Colombia and Dalhousie University, with funding from the Bill and Melinda Gates Foundation, the vaccine is a milestone in the efforts to save vulnerable koalas.

"UniSC knew a single-dose vaccine – without the need for a booster – was the answer to reducing the rapid, devastating spread of this disease, which accounts for as much as half of koala deaths across wild populations," said Professor of Microbiology Peter Timms, who spearheaded the research. "Some individual wild colonies, where infection rate can be as high as 70%, are edging closer to extinction every day.

"We were determined to do the hard yards to move from research to this vital next stage – a high-quality, veterinary-approved product that can now be used in wildlife hospitals, veterinary clinics and in the field to protect the nation's most at-risk koalas," he added.

The last IUCN Red List evaluation for the koala Phascolarctos cinereus was more than 10 years ago, in 2014. Since then, the species has faced many challenges accelerating their population loss in Australia: habitat clearance, disease and wildfires. In the summer of 2019, more than 6,200 koalas in New South Wales – 15% of the state's population – are thought to have perished in the devastating fires. There fires are expected to become more common and more extreme in the climate crisis.

The vaccine, manufactured by Tréidlia Biovet and approved by Australia's veterinary medicine regulators, is a major move in helping to keep these animals away from the brink of extinction and prevent unnecessary suffering through this disease. Until now, the only intervention has been antibiotics, which in turn upset the koala's delicate digestive tract – one fine-tuned to solely eat eucalyptus leaves. This disruption has led to koalas starving and, in some cases, dying as a result. And antibiotics don't protect koalas from repeat infections.

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The path to the vaccine also included the largest and longest study of wild koalas, also led by UniSC. Over the span of a decade, 680 koalas were tracked, and five vaccine trials saw 165 animals given the shot. This ultimately confirmed the vaccine's safety and efficacy.

Over a decade, 680 koalas were tracked, with five vaccine trials involving 165 koalas.

"This study found it reduced the likelihood of koalas developing symptoms of chlamydia during breeding age and decreased mortality from the disease in wild populations by at least 65%," said Sam Phillips, a UniSC researcher who led the extensive trials. "The vaccine has been trialed on hundreds of wild koalas, others in captivity and wildlife hospitals, and over multiple generations.

"It's based on Chlamydia pecorum's major outer membrane protein (MOMP), and offers three levels of protection – reducing infection, preventing progression to clinical disease, and, in some cases, reversing existing symptoms," Phillips added.

The vaccine has six components, designed to provide widespread protection for the native wildlife regardless of where they're located across Australia. Importantly, it's a minimally invasive intervention, with an individual koala only needing one jab for life.

"Three [of the six components] are the proteins of chlamydia, designed to cover the different strains of chlamydia circulating in different parts of the country," Timms said. "There are also three parts to the adjuvant, which we are very pleased to have designed as a single-shot adjuvant. Many vaccines require a booster, but we've purposely developed a vaccine that only requires one shot, and for a wild animal like koalas, that is what you really need."

However, the vaccine's approval is just the first step. More funding will be required to roll out vaccination programs to populations around the country. And administering jabs to wildlife is not as easy as taking a pet to the vet – koalas sleep up to 20 hours a day, hidden high in tree canopies where they remain well-camouflaged. Because they're most active at night, are solitary outside of mating, and are spread over vast distances, getting the medicine to the animals presents a lot of logistical challenges.

"Every contribution will go towards vaccinating at-risk koalas and to help reverse the alarming impacts of this disease," Timms said. "We are also

continuing to refine the product and conduct ongoing research to ensure the vaccine's long-term success."

The trial research was published in 2024 in the Nature Partner Journals' Vaccines.

New Atlas, 9 September 2025

https://newatlas.com

New Study Reveals Concerning Amount of Microplastics in Human Brains

2025-02-04

Microplastics appeared to show more prominent presence over the course of the past decade, according to medical researchers in the USA.

Microplastics are tiny—smaller than five millimeters in size, according to the National Ocean Service—but science is continually teaching us how they accumulate to have not-so-tiny implications on our health.

As remnants of deteriorating plastic items, these microscopic particles can be found everywhere from cosmetics and cleaning items to produce, seafood, and table salt. And while more research is needed to understand the full effect on humans, studies on microplastics in cell cultures and marine wildlife indicate oxidative damage, DNA damage, and an increased risk of cancer, according to Harvard Medicine. Researchers have found microplastics to be present throughout most of the human body, including the liver, kidneys, heart, testicles, placenta, and, yes, brain. In fact, rates of microplastics found in human brains appear to be on the rise.

A 2025 study published in Nature Medicine revealed that the amount of microplastics and nanoplastics, a type of microplastic invisible to the human eye, found in brains notably increased over a period of just eight years.

Biology, pharmacology, and engineering researchers from the University of New Mexico studied postmortem human livers, kidneys, and brains samples from 2016 and 2024 autopsies. They determined the brains contained seven to 30 times the amount of microplastics found in the livers and kidneys. Further, brain samples obtained from deceased dementia patients had an "even greater" presence.

What's more, the researchers found that the average brain contained seven grams of microplastics—the weight of a disposable plastic spoon.

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"These results highlight a critical need to better understand the routes of exposure, uptake and clearance pathways and potential health consequences of plastics in human tissues, particularly in the brain," the researchers report.

One silver lining from the study, however, is that the amount of microplastics found in the brains of people, both young and old, were similar when they died. "This suggests that our bodies do clear these nanoparticles," noted Dr. Matthew Campen, the lead author of the study, who added that "we're not just accumulating them over our lifetimes."

That's progress, as 2024 research found that people consume the equivalent of 12 plastic grocery bags in microplastics each year.

For daily wellness updates, subscribe to The Healthy by Reader's Digest newsletter and follow The Healthy on Facebook and Instagram. Keep reading:

- This Food Packaging "Significantly" Produces Microplastics in Urine, Says New Research
- Do 'Forever Chemicals' Leak Into Your Frozen Foods in the Microwave? Experts Respond
- New Study: 5 Toxic Metals Found in 14 Tampon Brands
- This Color Plastic May Increase Cancer Risk Up to 300%, Finds New Study

The Healthy, 4 February 2025

https://thehealthy.com

Scientists Transform Plastic Waste Into Efficient CO2 Capture Materials

2025-09-08

Decomposed PET plastic can be repurposed as key ingredient in carbon capture materials.

As CO2 concentrations in the atmosphere keep rising regardless of years of political intentions to limit emissions, the world's oceans are drowning in plastics, which threatens marine environments and ecosystems.

The key global problems are often interconnected, and typically, the solution to one problem creates another one while the clock keeps ticking. But what if we could solve several problems at the same time?

It's almost too good to be true, but a new cutting-edge invention promises to do just that. Researchers at the University of Copenhagen have developed a method where one man's trash really does become another man's "treasure", when decomposed PET plastic becomes the main ingredient in efficient and sustainable CO2 capture.

We know the material from plastic bottles, textiles, and many other uses: PET plastic is one of the most widely used types of plastic in the world, but when it has served its purpose, it becomes a pressing global environmental issue. This is because it ends up in landfills in many parts of the world, where it breaks down into polluting microplastics that spread to the air, soil and groundwater. A large portion also end up in the oceans.

"The beauty of this method is that we solve a problem without creating a new one. By turning waste into a raw material that can actively reduce greenhouse gases, we make an environmental issue part of the solution to the climate crisis," says Margarita Poderyte from the Department of Chemistry at the University of Copenhagen, lead author of the research paper disclosing the invention.

The solution is a potential win-win on a global scale, where plastic waste not only does not end up in nature but also becomes an active player in climate mitigation.

With the new chemical technology, researchers can transform PET plastic waste that is overlooked by recyclers into a primary resource in a new form of CO2 sorbent they have developed. The process 'upcycles' it to a new material the researchers have named BAETA, which can absorb CO2 out of the atmosphere so efficiently that it easily compares with existing carbon capture technologies.

Sustainable, flexible and scalable

The BAETA material has a powdery structure that can be pelletized, and a chemically 'upgraded' surface, which enables it to very effectively bind and chemically capture CO2. Once saturated, CO2 can be released through a heating process allowing the CO2 to be concentrated, collected and stored or converted into a sustainable resource. In practice, the researchers expect the technology to be first installed on industrial plants with exhausts from chimneys passing through BAETA units to cleanse them of CO2.

The research paper is published in Science Advances journal, which describes the chemical process behind the invention. The process is gentle

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compared to existing technologies and, at the same time, well-suited for industrial scaling.

"The main ingredient is plastic waste that would otherwise have an unsustainable afterlife, and the synthesis we use, where the chemical transformation takes place, is gentler than other materials for CO2 capture because we can make the synthesis in ambient temperatures. It also has the advantage that the technology can be scaled up more easily," Margarita Poderyte says.

She is seconded by co-author and Associate Professor at the Department of Chemistry, Jiwoong Lee, who highlights the material's flexibility also.

"One of the impressive things about this material is that it stays effective for a long time. And flexible. It works efficiently from normal room temperature up to about 150 degrees Celsius, making it very useful. With this kind of tolerance to high temperatures, the material can be used at the end of industrial plants where the exhausts are typically hot," Jiwoong Lee says.

From laboratory to innovation at the end of the chimney

With a potentially revolutionary idea, a proven method and an effective finished product, the researchers are now ready for the next step.

"We see great potential for this material, not just in the lab, but in real-life industrial carbon capture plants. The next big step is scaling up to produce the material in tonnes, and we're already working to attract investments and make our invention a financially sustainable business venture," Margaryte Poderyte says.

The technical challenges do not worry the researchers. Instead, the decisive challenge, they say, is to persuade decision-makers to make the necessary investments. If they succeed in that, the invention could ultimately lead to significant changes.

A sea of cheap plastic

Large amounts of PET plastic accumulate in our oceans, damaging ecosystems and breaking down into microplastics, the consequences of which are yet unknown. That sort of plastic is very well suited for the technology.

"If we can get our hands on the highly decomposed PET plastic floating in the world's oceans, it will be a valuable resource for us as it's so well suited for upcycling with our method," Margarita Poderyte says.

The researchers hope that their invention can help to fundamentally change the way we see climate and environmental issues as separate problems.

"We're not talking about stand-alone issues, nor will the solutions be. Our material can create a very concrete economic incentive to cleanse the oceans of plastic," Jiwoong Lee says.

Technology Networks, 8 September 2025

https://technologynetworks.com

Electric shocks disrupt drug-resistant yeast's cell walls to boost antifungal treatment

2025-09-10

Resistant to most antifungal drugs, the yeast Candidozyma auris is spreading globally and has caused recent outbreaks in US hospitals. The US Centers for Disease Control and Prevention (CDC) classifies it as an urgent threat. To meet the need for better treatments, researchers at Carnegie Mellon University are developing a novel way to combat drug resistance.

There are currently few methods to control C. auris infections, which spread through contact. Most infections start on the skin and can enter the bloodstream if unchecked. The mortality rate is high for immunocompromised individuals.

In Chemical Engineering Journal, Tagbo Niepa, Camila Cué Royo, and collaborators demonstrate the potential of electrochemical therapy to treat C. auris, both alone and in combination with currently available antifungal drugs.

"We're trying to maximize the effects of drugs that are already available but are not working," says Cué Royo, a Ph.D. student in chemical engineering.

Electrochemical therapy delivers a low dose of electrical current.

"The current is below our perception level, so we wouldn't even feel it on the skin," says Niepa, associate professor of chemical engineering and biomedical engineering. The technology has shown promise in eradicating bacteria and other species of yeast. Niepa and Cué Royo's study is the first to describe its effect on C. auris.

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They evaluated cell viability and metabolic functions under three different levels of electrical current. Their findings show that C. auris responds in a dose-dependent manner. Treatment with electrochemical therapy becomes more effective as the level of current increases.

Higher current levels have more effects on cell shape, structure, and other indicators of health. In response to the electrochemical stress, C. auris cells become hyperactive. Toxic material starts to accumulate in them, and they activate their internal machinery to try to clear it. Unable to recover from the stress, the cells eventually die. Higher current levels kill more cells.

At lower levels, electrochemical therapy damages cell membranes but does not kill C. auris. When Niepa and Cué Royo tested a low level of electrical current in combination with a common class of antifungal drugs, they found that the two treatments, which do not work individually, can be effective in combination.

The antifungal drug caspofungin can interrupt the ability of C. auris to replicate, but it only works on cells that are metabolically active.

"Owing to their innate ability, C. auris cells commonly remain dormant when they are exposed to drugs in a biological environment. During that dormancy, the drug does not have an effect," says Niepa.

Before administering electrochemical therapy, Niepa and Cué Royo observed antifungal drug molecules accumulating on C. auris cell walls. Healthy cells can control their permeability, and they do not allow the drug to diffuse in. After using a low level of electrical current to damage the cell walls, Niepa and Cué Royo observed the drug molecules inside the cells.

For antifungal drugs that are currently ineffective, delivering them with a low dose of electrochemical therapy could make them more potent. The treatment method also has implications for the development of new drugs.

"If we're able to potentiate a drug, we can use a lower dose and minimize the possibility of resistance developing," says Cué Royo.

Niepa has extensively studied the mechanisms of how electrochemical therapy works.

"We have a better understanding of our next step toward applications because we know exactly what is happening here," he says. With Cué Royo

and other collaborators, he is developing an electrochemical bandage that can be applied to the skin to treat C. auris and other infections.

Phys Org, 10 September 2025

https://phys.org

Worse Than We Thought: "Forever Chemicals" Are Far More Acidic Than Previously Believed

2025-09-11

New and more precise acidity measurements may help make PFAS easier to track.

Per- and polyfluoroalkyl substances (PFAS) are nicknamed "forever chemicals" in part because their acidity helps them linger in the environment.

Many of these toxic chemicals are strongly acidic, so they readily shed protons and take on a negative charge, which lets them dissolve in water and spread more easily.

New work shows some PFAS are even more acidic than earlier estimates — a key piece of information for forecasting their movement through the environment and their potential effects on human health.

The study, led by the University at Buffalo, introduced a rigorous experimental approach to determine acidity for 10 PFAS types and three common breakdown products.

Published in the journal Environmental Science & Technology Letters, the team reported acid dissociation constants, or pKa values, that were generally lower and sometimes far lower than prior experimental results and predictions from computational chemistry. For example, the pKa of GenX, a replacement for perfluorooctanoic acid (PFOA) used in Teflon manufacturing, was about one thousand times lower than a previously reported measurement.

The lower the pKa, the more likely a chemical is to give up a proton and exist in its charged form.

"These findings suggest that previous measurements have underestimated PFAS' acidity. This means their ability to persist and spread in the environment has been mischaracterized, too," says the study's

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corresponding author, Alexander Hoepker, PhD, a senior research scientist with the UB RENEW Institute.

More accurate pKa measurements help efforts to understand the behavior of PFAS in the environment. A chemical's pKa could mean the difference as to whether it remains dissolved in water, sticks to soil or a biological membrane, or perhaps volatilizes into the air.

"If we're going to understand how these concerning chemicals spread, it's very important we have a reliable method for the accurate determination of their pKa values," says Diana Aga, PhD, director of RENEW and SUNY Distinguished Professor and Henry M. Woodburn Chair in the UB Department of Chemistry.

The work was supported by the National Science Foundation and done in collaboration with Scott Simpson, PhD, professor and chair of the St. Bonaventure Department of Chemistry, and researchers from Spain's Institute of Environmental Assessment and Water Research.

Combining experiments with computations

PFAS are made of a highly fluorinated, water-repelling tail and a more water-loving headgroup. Many of the most scrutinized PFAS have a highly acidic headgroup, making them more likely to give up a proton and exist in its charged form.

Whether a PFAS exists in its neutral or charged form depends on the pH level of their surrounding environment. That's where pKa comes in. It tells scientists the pH level at which a given PFAS is equal to flip from neutral to charged, or vice versa.

But there has been much disagreement about the pKa measurements of some PFAS, like PFOA, with different teams coming up with widely different values. One of the reasons for this may be the glass used during their experiments.

"PFAS likes to stick to glass. When that happens, it throws off traditional, so-called bulk measurements that quantify how much PFAS is in a solution," Hoepker says. "In other cases, too much organic solvent is used to get PFAS into solution, which similarly biases the pKa measurement."

To address this challenge, the UB team used fluorine and proton (hydrogen) nuclear magnetic resonance (NMR) spectroscopy — think MRI for molecules. NMR places a sample in a strong magnetic field and probes its atomic nuclei with radio waves.

When a PFAS headgroup is negatively charged, nearby fluorine atoms respond at a different (radio) frequency.

Reading these atom-level signatures lets the researchers tell whether a PFAS molecule is charged or neutral — capabilities that other methods that have been used previously cannot provide.

"This unique measurement allows NMR to inherently account for PFAS losses to glass or other adsorption behaviors, so your pKa measurements don't end up way off the mark," Hoepker says.

Some PFAS are so acidic (pKa of less than zero) that generating them in their neutral form would require super-acidic conditions (a pH level of less than zero) that are impractical in standard labs. In those cases, the research team paired NMR experiments with electronic-structure calculations using density functional theory to predict the NMR shifts of the neutral and ionized forms.

"We augmented partial NMR datasets with computational predictions to arrive at more accurate pKa values," Hoepker says. "This NMR-centered hybrid approach — integrating experimental measurements with computational analyses — enhanced our confidence in the results and, to our knowledge, has not previously been applied to PFAS acidity."

Problem PFAS measured more accurately

The PFAS that has been the most difficult to measure is PFOA, once commonly used in nonstick pans and deemed hazardous by the Environmental Protection Agency last year.

The team found its pKa to be –0.27, meaning it will be negatively charged at practically any realistic pH level. Previous experimental studies had measured its pKa as high as 3.8 and more commonly around 1, while the computational methods COSMO-RS and OPERA had determined its pKa at 0.24 and 0.34, respectively.

Trifluoroacetic acid (TFA) — an emerging PFAS increasingly detected in waters worldwide and likely transported through the atmosphere and deposited by rain — was found to be far more acidic than previously reported, with a pKa of around 0.03. Earlier estimates had anywhere from 0.30 to 1.1.

Notably, the team determined the pKa values for several prominent emerging PFAS that had never been measured, such as 5:3 fluorotelomer carboxylic acid (5:3 FTCA), and PFAS ethers like NFDHA and PFMPA that

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are newer PFAS but are also likely to pose challenges for regulators due to their health effects.

"This new experimental approach of determining pKa values for PFAS will have wide-ranging applications, from being able to validate computationally derived values, to facilitating the development of machine learning models that can better predict pKa values of newly discovered PFAS contaminants when reference standards are not available," Aga says. "In turn, knowledge of the pKa values of emerging PFAS will allow researchers to develop appropriate analytical methods, remediation technologies, and risk assessment strategies more efficient

Sci Tech Daily, 9 September 2025

https://scitechdaily.com

Fat molecules and water interact in surprising ways within collagen fibrils

2025-09-10

Researchers from the Faculty of Natural Sciences at Chemnitz University of Technology have discovered fat molecules in natural collagen fibrils, the main component of connective tissue. Their research, published in Soft Matter, shows how fats affect the mechanical properties and water content of collagen fibrils.

Collagen fibrils are the basic building blocks of skin, tendons, ligaments, and bones. They hold our bodies together. Fats and oils have long been used to soften and protect leather, which consists of collagen molecules. However, it is not known how many fat molecules are contained in natural collagen fibrils.

Knowing the precise chemical composition of collagen fibrils is important for understanding biochemical processes involved in tissue growth, aging, and disease. In chemistry, the various molecular components are usually separated to study the properties of pure substances. However, biological systems contain thousands of different chemical molecules, all of which are likely important.

The team of physicists and chemists from the Faculty of Natural Sciences at Chemnitz University of Technology discovered that triacylglycerols—a very common type of natural fat molecule—assemble between collagen molecules, thereby influencing the cohesion of much larger collagen fibrils. This finding is essential for understanding the biomechanics of

connective tissue. It also demonstrates how embedded lipids can affect binding forces between proteins at the molecular level.

The researchers examined collagen fibrils from chicken tendons and discovered that they contained an unexpectedly high amount of triacylglycerols, also known as neutral fats. These fat molecules comprise about 9% of the volume of dry collagen fibrils and are randomly incorporated into the crystal lattice of collagen molecules. The fat molecules act as plasticizers, reducing the water content of the collagen fibrils. This finding challenges the current understanding of the chemical composition of natural collagen fibrils.

To determine the triacylglycerol content and its effects on the mechanical properties of individual collagen fibrils, Dr. Martin Dehnert and Prof. Dr. Robert Magerle of the Chair of Chemical Physics at Chemnitz University of Technology developed a new analysis protocol based on atomic force microscopy.

They used a washing sequence in which the fats adhering to the fibrils are first removed with a nonpolar solvent (hexane). Then, they dissolved the fat molecules out of the interior of the fibrils using a polar solvent, a mixture of dichloromethane and methanol.

After each washing step, they examined the resulting changes in the collagen fibrils using atomic force microscopy. This allows the shape and mechanical properties of the collagen fibrils, which are approximately 100 nanometers thick, to be determined very accurately. Finally, using Raman and NMR spectroscopy, they identified the fats contained in the collagen fibrils as triacylglycerols.

"Our findings show how fats and water interact in natural collagen fibrils," explains Magerle. He adds, "This suggests that there may be a link between the fats present in our diet and the biomechanics of connective tissue. We plan to investigate this in more detail in the future."

Phys Org, 10 September 2025

https://phys.org

The invisible plastic threat you can finally see

2025-09-10

A joint team from the University of Stuttgart in Germany and the University of Melbourne in Australia has developed a new method for the straightforward analysis of tiny nanoplastic particles in environmental samples. One needs only an ordinary optical microscope and a newly developed test strip -- the optical sieve. The research results have now been published in Nature Photonics.

"The test strip can serve as a simple analysis tool in environmental and health research," explains Prof. Harald Giessen, Head of the 4th Physics Institute of the University of Stuttgart. "In the near future, we will be working toward analyzing nanoplastic concentrations directly on site. But our new method could also be used to test blood or tissue for nanoplastic particles."

Nanoplastics as a danger to humans and the environment

Plastic waste is one of the central and acute global problems of the 21st century. It not only pollutes oceans, rivers, and beaches but has also been detected in living organisms in the form of microplastics. Until now, environmental scientists have focused their attention on larger plastic residues. However, it has been known for some time that an even greater danger may be on the horizon: nanoplastic particles. These tiny particles are much smaller than a human hair and are created through the breakdown of larger plastic particles. They cannot be seen with the naked eye. These particles in the sub-micrometer range can also easily cross organic barriers such as the skin or the blood-brain barrier.

Color changes make tiny particles visible

Because of the small particle size, their detection poses a particular challenge. As a result, there are not only gaps in our understanding of how particles affect organisms but also a lack of rapid and reliable detection methods. In collaboration with a research group from Melbourne in Australia, researchers at the University of Stuttgart have now developed a novel method that can quickly and affordably detect such small particles. Color changes on a special test strip make nanoplastics visible in an optical microscope and allow researchers to count the number of particles and determine their size. "Compared with conventional and widely used methods such as scanning electron microscopy, the new method is considerably less expensive, does not require trained personnel to operate, and reduces the time required for detailed analysis," explains Dr. Mario Hentschel, Head of the Microstructure Laboratory at the 4th Physics Institute.

Optical sieve instead of expensive electron microscope

The "optical sieve" uses resonance effects in small holes to make the nanoplastic particles visible. A study on optical effects in such holes was first published by the research group at the University of Stuttgart in 2023. The process is based on tiny depressions, known as Mie voids, which are edged into a semiconductor substrate. Depending on their diameter and depth, the holes interact characteristically with the incident light. This results in a bright color reflection that can be seen in an optical microscope. If a particle falls into one of the indentations, its color changes noticeably. One can therefore infer from the changing color whether a particle is present in the void.

"The test strip works like a classic sieve," explains Dominik Ludescher, PhD student and first author of the publication in "Nature Photonics." Particles ranging from 0.2 to 1 µm can thus be examined without difficulty. "The particles are filtered out of the liquid using the sieve in which the size and depth of the holes can be adapted to the nanoplastic particles, and subsequently by the resulting color change can be detected. This allows us to determine whether the voids are filled or empty."

Number, size, and size distribution of particles can be determined

The novel detection method used can do even more. If the sieve is provided with voids of different sizes, only one particle of a suitable size will collect in each hole. "If a particle is too large, it won't fit into the void and will be simply flushed away during the cleaning process," says Ludescher. "If a particle is too small, it will adhere poorly to the well and will be washed away during cleaning." In this way, the test strips can be adapted so that the size and number of particles in each individual hole can be determined from the reflected color.

Synthesized environmental samples examined

For their measurements, the researchers used spherical particles of various diameters. These are available in aequous solutions with specific nanoparticle. Because real samples from bodies of water with known nanoparticle concentrations are not yet available, the team produced a suitable sample themselves. The researchers used a water sample from a lake that contained a mixture of sand and other organic components and added spherical particles in known quantities. The concentration of plastic particles was 150 µg/ml. The number and size distribution of the nanoplastic particles was also be determined for this sample using the "optical sieve."

Can be used like a test strip

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"In the long term, the optical sieve will be used as a simple analysis tool in environmental and health research. The technology could serve as a mobile test strip that would provide information on the content of nanoplastics in water or soil directly on site," explains Hentschel. The team is now planning experiments with nanoplastic particles that are not spherical. The researchers also plan to investigate whether the process can be used to distinguish between particles of different plastics. They are also particularly interested in collaborating with research groups that have specific expertise in processing real samples from bodies of water.

Science Daily, 10 September 2025

https://sciencedaily.com

Prussian Blue finally transformed into octahedral structure after 300 years

2025-09-10

For the first time in more than three centuries, Prussian Blue—long confined to its rigid cubic shape—has been transformed into an octahedral structure. A research team has successfully synthesized this new morphology by replacing water with a specialized solvent, glycerol, during the crystal growth process.

Their findings were recently published online in Advanced Functional Materials.

Accidentally discovered around the 1700s, Prussian Blue possesses a hollow three-dimensional framework that allows ions to move in and out with ease. These unique properties have enabled its use across diverse fields, from sodium-ion battery electrodes to radioactive cesium removal, catalysis, and environmental remediation.

However, until now, its morphology had been limited. When synthesized in water, the reaction proceeds too quickly, making it difficult to control particle growth and producing only cubic particles. This constraint has prevented scientists from exploring shape-dependent properties or unlocking new applications.

POSTECH researchers found the solution in the solvent. By using viscous glycerol instead of water, they were able to slow down crystal growth. In this glycerol medium, small cubic particles are initially nucleated, then repeatedly dissolved and recrystallized, self-assembling into octahedra

structures. In effect, these tiny cubes stacked and transformed into gem-like eight-faced structures.

When tested as an electrode material in sodium-ion hybrid capacitors, the octahedral Prussian Blue demonstrated remarkable advantages. Its higher surface area enhanced electrochemical reactivity, while long-term charge–discharge cycling test confirmed stable performance. Simply changing the crystal shape resulted in significant performance improvements.

The research team included Prof. Changshin Jo (Department of Battery Engineering & Department of Chemical Engineering, POSTECH), Prof. Sangmin Lee (Department of Chemical Engineering, POSTECH), and Ph.D candidate Seunghye Jang (Department of Battery Engineering, POSTECH) as well as Dr. Carsten Korte of Forschungszentrum Jülich (Germany), who contributed to the structural analysis.

This study is the first to demonstrate that specific solvents can control both the growth rate and the orientation of Prussian Blue crystals. Beyond glycerol, the team anticipates that other organic solvents may enable the design of previously unprecedented crystal morphologies.

Prof. Jo stated, "The significance of this research lies not only in successfully creating a new morphology of Prussian Blue, but also in establishing the fundamental principles that enable us to observe and control its growth process. With the capability to design diverse morphologies, we anticipate a substantial expansion of applications, ranging from advanced energy storage systems to environmental purification technologies."

Phys Org, 10 September 2025

https://phys.org

Cannabis Use Linked to Fertility Risks in Women

2025-09-09

Cannabis boosts egg maturation but increases chromosome errors, reducing viable embryos in fertility treatment.

Cannabis is one of the most widely used drugs among people of reproductive age, yet its effects on female fertility are only just beginning to be understood.

Researchers at the CReATe Fertility Centre in Toronto, Canada, found that while THC (tetrahydrocannabinol) exposure was linked to higher egg

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maturation, it also increased errors in chromosomes, leading to fewer healthy embryos.

The study was published in Nature Communications.

Rising cannabis use raises questions about fertility

Cannabis use is increasing worldwide. Legal changes and easier access have led to an increase in the number of people using it – and at higher strengths. In many countries, cannabis is now one of the most common recreational drugs among people of reproductive age. THC, the psychoactive ingredient, has risen in potency from ~3% in the 1980s to ~15% today, with some strains closer to 30%.

THC interacts with the endocannabinoid system, which plays a role in both brain function and reproduction. Research on male fertility shows cannabis can affect sperm count, motility and DNA. There is also evidence linking cannabis use in pregnancy to effects on the placenta and fetal development.

However, the female side of fertility has been harder to study. Very little is known about how cannabis affects oocytes, the eggs that begin embryo development. Access to these cells is limited and most existing studies have focused instead on animal models, with mixed results.

Oocytes are finite in number and sensitive to environmental factors. Any changes in their development could affect fertility and the health of future embryos.

"In humans, we previously demonstrated that THC and its metabolites reach the ovarian follicle," said the authors of the recent study.

The new research examined how THC exposure influenced human oocytes.

Cannabis exposure affects egg maturation and embryo quality

The team looked at 1,059 follicular fluid samples from in vitro fertilisation (IVF) patients. Around 6% (62) of the samples tested positive for THC metabolites, although 73% of those with THC in their samples had not reported cannabis use.

Concentrations of these metabolites were linked to a higher rate of oocyte maturation; however, the embryos that developed from these oocytes were less likely to have the correct number of chromosomes. Patients who

tested positive for THC had a significantly lower rate of euploid embryos compared to matched controls.

The second part of the study tested immature oocytes donated by 24 patients in controlled lab experiments. These eggs were exposed to THC levels similar to those found in IVF patients or to higher concentrations reported in animal studies.

At both doses, THC changed gene activity in the oocytes. Many of the affected genes were involved in inflammation, the extracellular matrix and chromosome segregation – processes essential for egg quality and embryo development.

When the researchers looked more closely at these oocytes, they saw more errors in how chromosomes separated, along with abnormal spindle structures. These changes translated into a higher rate of aneuploidy (embryos with the incorrect number of chromosomes).

The increase in maturation was only observed when THC levels were higher than the average concentrations measured in the IVF patient group.

Fertility counselling should address cannabis risks

THC exposure seemed to push oocytes to mature; however, that came at the cost of genetic stability. For patients undergoing IVF, THC exposure could mean fewer embryos with the right number of chromosomes, which might reduce the number of viable embryos available and lengthen the time to pregnancy.

"These findings underscore the need for increased awareness and caution among people with ovaries, particularly those undergoing fertility treatments," said the authors.

There are, however, important limits to this work. The oocytes studied were a specific type collected during IVF and may not reflect eggs maturing naturally. The retrospective design also meant there was no information on how often, how much or how cannabis was used. Age is another important factor in oocyte quality, and the study was not powered to separate results by patient age.

Future work will focus on how THC disrupts egg biology at the molecular level, and on larger studies that track pregnancy and live birth outcomes.

"Our study highlights the importance of informing patients about the potential risks associated with cannabis consumption and provides a basis for regulatory bodies, medical professional societies and public health

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organizations to establish recommendations and guidelines regarding cannabis consumption during fertility treatment," the authors concluded.

Technology Networks, 9 September 2025

https://technologynetworks.com

Electron irradiation converts hydrocarbon crystals into nanodiamonds

2025-09-05

Nanodiamonds – important for wide-ranging applications, including biomedical imaging, drug delivery, quantum computing and sensors – have now been made from petroleum-derived adamantane crystals by firing high-energy electrons at them. The synthesis, which was discovered by chance, creates defect-free nanodiamonds under ultra-low-temperatures in a vacuum without catalysts, additives or a support medium and could offer a quick, safer and low-cost alternative to existing high pressure and high temperature methods.

Adamantane is a naturally occurring crystalline hydrocarbon isolated from petroleum whose structure closely resembles diamond, both having tetrahedral symmetric carbon skeletons with their carbon atoms arranged in the same spacial pattern. Owing to their similarity, it was thought that, in theory, the C–H bonds of adamantane could be precisely cut, or activated, to form new C–C bonds and thus convert it to diamond.

'The real problem was that no one thought it feasible,' says Eiichi Nakamura at the University of Tokyo, Japan. Now, however, Nakamura's lab has stumbled upon a way to do it, by irradiating adamantane with high-energy electrons. 'Our synthesis is a true bottom-up synthesis, where adamantane molecules are assembled one-by-one three-dimensionally to form spherical single crystalline nanodiamonds of narrow size distribution,' he explains.

In conventional, top-down syntheses, nanodiamonds are obtained by converting carbon sources under extreme conditions – pressures of tens of gigapascals and temperatures of thousands of kelvin – to produce thermodynamically stable diamond, or chemical vapour deposition techniques where the end product is unstable.

The team inadvertently made the discovery when following on from an unrelated study that had devised a way to use electron diffraction to measure the entropy of melting crystals. They were particularly intrigued

by the observation of an extremely small entropy disorder in adamantane, which was comparable to that of gold crystals.

Curious about this, Nakamura's student Jiarui Fu set out to explore the electron diffraction more closely, carefully firing electrons for a long time at an adamantane crystal that was already disordered and not supposed to show any diffraction peaks. But unexpectedly, Fu saw the gradual appearance of diffraction rings. 'It became immediately apparent for him that the rings were due to nanoscale diamonds,' says Nakamura.

Further experiments honed the process, demonstrating that electron irradiation of adamatane crystals at between 80 and 200 kiloelectron volts in a vacuum at 100K for tens of seconds produced defect-free nanodiamonds 2–4nm in diameter, while giving off hydrogen gas. Time-resolved transmission electron microscopy revealed the initial formation of adamantane oligomers and their transformation into spherical nanodiamonds. Meanwhile, other hydrocarbons that were tested didn't form nanodiamonds.

'The findings open a new paradigm for understanding and controlling chemistry in the fields of electron lithography and surface engineering,' says Nakamura. One promising application, he says, is the synthesis of doped quantum dots, essential for the construction of quantum computers and sensors. 'By the use of the existing electron lithography setup, the method will be readily amenable for the construction of a nanodiamond array at the nanoscale.'

'This novel approach capitalises on the unique property of diamondoids, which undergo single-electron oxidation to generate a radical cation that loses a hydrogen atom, leaving behind a radical that subsequently initiates subsequent reactions with additional starting materials to form fused diamond particles,' comments Peter Schreiner who studies nanodiamonds at the University of Giessen, Germany. 'As adamantane is readily accessible and electron-irradiation scalable, this method promises a new, viable diamond particle synthesis.'

Chemistry World, 5 September 2025

https://chemistrtyworld.com

Seaweed could help build the cities of tomorrow

2025-09-05

Once a harmless drifter in the Sargasso Sea, an algae known as sargassum is now flooding tropical beaches, from Brazil to the Caribbean, with stinky, toxic piles. As it rots, it releases gases like ammonia and methane, turning paradise into a health hazard.

It's bad for tourism, fishing, and marine life, and worse, most of it ends up dumped in landfills. No reuse. No recycling. Just rot.

Can we turn this tide into something useful?

For some time now many smart minds have been finding ways to repurpose products previously considered waste. Seaweed has been a particular target for many. In 2020, researchers developed an affordable and commercially viable process to convert waste seaweed into biofuel, fertilizer, and other products. And in 2022, scientists from the Indian Institute of Technology developed seaweed-based membranes for greener soundproofing.

Now, a new study published in the Journal of Materials in Civil Engineering reports that sargassum seaweed could be transformed into the next generation of eco-friendly building blocks.

The researchers discovered that mixing sargassum algae into ceramic clay makes the clay lighter, greener, and cooler. These algae-infused clays can be used in concrete to reduce weight, for slabs to improve insulation, and as a gardening material.

João Adriano Rossignolo, a professor at the Department of Biosystems Engineering at the School of Animal Science and Food Engineering of the University of São Paulo (FZEA-USP), who coordinated the study, said, "Normally, sargassum is collected and disposed of in landfills without any practical use. That's why we decided to research a way to take advantage of this large amount of biomass on the beaches."

Before conducting construction experiments, researchers thoroughly inspected the raw materials. To create lightweight ceramic clay aggregates, they blended sargassum seaweed into clay in three concentrations: 0%, 20%, and 40%. These mixtures were then shaped through extrusion, similar to squeezing clay through a mold, and fired at temperatures of 800, 900, and 1,000 °C (1,472, 1,652, and 1,832 °F) using both traditional and microwave ovens.

Once the algae-infused clay samples were prepared, researchers tested them for shrinkage, water absorption, porosity, density, and strength. They also compared the environmental impact of these new materials with that of traditional expanded clay using a life cycle assessment (LCA).

The findings showed that adding sargassum, especially at a 40% concentration, made the clay lighter. However, only the samples baked in microwave ovens met the required strength standards across all temperatures. This was due to better densification and a more refined internal structure.

The life cycle assessment (LCA) revealed a promising finding: materials made from sargassum seaweed outperformed traditional expanded clay in terms of environmental impact. That finding led researchers to a bold conclusion: microwave-sintered sargassum clay isn't just viable, it's a smart way to tackle the seaweed surge along tropical coastlines.

Using algae to produce lightweight ceramic aggregates helps reduce the use of natural resources and enhances energy efficiency. But the innovation didn't stop there.

The team also explored using sargassum in particulate panels for furniture and construction, as well as in fiber cement tiles, replacing limestone with sargassum ash.

"The results were surprising," Rossignolo said, "as we were able to use 30% sargassum in the panels and replace 100% of the limestone with its ash, with results that fully comply with current standards for these products and improve the durability and mechanical properties of the materials."

The study was published in the Journal of Materials in Civil Engineering.

New Atlas, 5 September 2025

https://newatlas.com

This deep-sea worm turns two toxins into a harmless mineral

2025-09-09

A deep-sea worm survives in toxic conditions around hydrothermal vents by converting arsenic and sulfur into a benign mineral. This natural biomineralisation process allows Paralvinella hessleri to tolerate elevated levels of arsenic and provides the worm with its striking yellow colour.

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Hydrothermal vent fluids are rich in numerous substances that are toxic to most species, including heavy metals, arsenic, and hydrogen sulfide. But now a research team led by oceanographer Chaolun Li, from the Chinese Academy of Sciences in Qingdao, has discovered that P. hessleri neutralises arsenic and hydrogen sulfide by combining them into arsenic trisulfide crystals, also known as orpiment. These granules are safely stored within the worm's epithelial cells and give the worm a distinctive yellow colour.

Using advanced microscopy, elemental analysis, genomic and proteomic studies, the researchers revealed how specialised transport proteins and haemoglobins help transfer arsenic and sulfide into intracellular vacuoles, where they are safely immobilised as orpiment. The researchers describe the survival strategy as 'fighting poison with poison' due to the way in which two chemical threats are converted into an inert mineral.

Li's team also points out that P. hessleri's use of biomineralisation as a detoxification strategy is unusual, as the process is more commonly associated with tissue reinforcement.

Chemistry World, 9 September 2025

https://chemistryworld.com

Scientists Grow "Gold Quantum Needles" for Sharper Biomedical Imaging

2025-09-11

Potential applications range from biomedical imaging to the conversion of light energy.

University of Tokyo researchers Shinjiro Takano, Yuya Hamasaki, and Tatsuya Tsukuda have directly imaged how the geometric arrangement of atoms in gold nanoclusters develops at the very earliest stages of growth.

Under the same conditions, the team also "grew" an unexpected elongated nanocluster structure that they named "gold quantum needles." Because these "needles" respond strongly to near-infrared light, they could enable much sharper biomedical imaging and more effective light-energy conversion. The findings were reported in the Journal of the American Chemical Society.

Gold may evoke luxury, yet at the nanoscale, it is a vital material in modern technology because it forms unusual structures with distinct properties. Gold nanoclusters with fewer than 100 atoms are typically produced by reducing, that is, adding electrons, gold precursor ions in the presence of

protective ligands. Despite this, achieving precise control over size, shape, and composition remains difficult.

Opening the "Black Box" of Cluster Formation

"Over the past years," says Tsukuda, the principal investigator, "much effort has been devoted to understanding the correlation between the structure and physicochemical properties of the nanoclusters. However, the formation process is regarded as a black box. We initiated this project with the belief that understanding the initial stages of cluster formation will lead to the development of new, targeted synthesis methods for desired structures."

The researchers thus set out to determine the geometric structures of gold nanoclusters at the initial stages of their formation. They used slightly unusual synthesis conditions to trap the nanoclusters in the very first stages of growth. Single-crystal X-ray diffraction analysis, an X-ray for chemical compounds, if you will, revealed that gold nanoclusters grew anisotropically, at a different rate in different directions.

The Discovery of Gold Quantum Needles

Moreover, the analysis revealed an entirely new structure: pencil-shaped nanoclusters composed of triangular trimers and tetrahedral tetramers. The researchers named them "gold quantum needles" because the electrons confined in these nanoclusters demonstrated quantized behavior, a quantum phenomenon in which electrons can take only specific potential energies.

"We could retroactively explain the formation processes of a series of small gold nanoclusters under our unusual synthetic conditions," Tsukuda explains. "However, the formation of needles with a base of a triangle of three gold atoms instead of a nearly spherical cluster is a serendipitous finding that was far beyond our imagination."

The structural snapshots the researchers acquired of the stepwise growth of gold nanoclusters greatly contribute to our understanding of the formation mechanism. However, Tsukuda is already thinking about the next steps.

"We would like to explore synthesizing other, unique nanoclusters by refining the synthesis conditions further. We would also like to collaborate

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with other experts to promote the application of gold quantum needles, leveraging their exceptional optical properties."

Sci Tech Daily, 11 September 2025

https://scitechdaily.com

Pinning down protons in water- basic science success story

2025-09-11

The movement of protons through electrically charged water is one of the most fundamental processes in chemistry. It is evident in everything from eyesight to energy storage to rocket fuel—and scientists have known about it for more than 200 years.

But no one has ever seen it happen. Or precisely measured it on a microscopic scale.

Now, the Mark Johnson lab at Yale has—for the first time—set benchmarks for how long it takes protons to move through six charged water molecules. The discovery, made possible with a highly customized mass spectrometer that has taken years to refine, could have far-reaching applications for researchers in years to come.

"We show what happens in a tiny molecular system where there is no place for the protons to hide," said Johnson, the Arthur T. Kemp Professor of Chemistry in Yale's Faculty of Arts and Sciences, and senior author of a new study in the journal Science. "We're able to provide parameters that will give theorists a well-defined target for their chemical simulations, which are ubiquitous but have been unchallenged by experimental benchmarks."

Johnson has spent decades developing new tools to analyze chemical reactions, such as the deformation of networks of interconnected water molecules in the presence of electrical charge—a key property of water. But water's ability to transport positive charge, via protons, has proven elusive—due, in part, to the intrinsically quantum mechanical nature of protons.

"They aren't polite enough to stay in one place long enough to let us observe them easily," Johnson said. "They are thought to conduct the charge through an atomic-scale relay mechanism, in which protons jump from molecule to molecule."

For the study, Johnson and his team studied the proton transfer that occurs when six molecules are attached to 4-aminobenzoic acid carrying an extra proton, a small, positively charged molecule ideally suited for studying water-mediated proton movement.

"To monitor the movement of the charge, you need a special type of organic molecule that can attach a proton in two different locations that are easily differentiated by the color of light they absorb," said Payten Harville, a Ph.D. student in chemistry in the Yale School of Graduate Studies and co-lead author of the new study, along with fellow Ph.D. student Abhijit Rana. "It's designed so that the only way for protons to get from one docking site to the other is to hitch a ride on a water network 'taxi.'"

Johnson's team runs these molecules through their paces with a specialized mass spectrometer that they've adapted to enable multiple interactions with carefully timed pulses of laser light. Located in Yale's Sterling Chemistry Laboratory, the 30-foot-long device consists of carefully orchestrated piping, electronics, lasers, and a "refrigerator" that chills the molecules down to nearly absolute zero. The tiny assembly of water around the molecule is synthesized, triggered to react, and destructively analyzed for formation of products ten times a second.

"It took years to get the instrument to this point," Rana said. "And we have finally succeeded in measuring the rate of a chemical reaction that occurs within a finite system."

Even so, the reaction is so difficult to pin down that the researchers are only able to set parameters for its beginning and end.

"We can't see it in the intermediate, but we know where the proton started and where it ended up," Johnson said. "And now we know how long it takes to get there."

Thien Khuu, a graduate of the Johnson lab who is now a postdoctoral fellow at the University of Southern California, is co-author of the study.

Phys Org, 11 Sepetember 2024

https://phys.org

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Self-Healing, Shape-Shifting, Smart Plastic Is Stronger Than Steel

2025-08-12

A carbon-fiber plastic composite that heals itself like skin and reshapes under heat is set to revolutionize the aerospace, defense and commercial industries.

Aerospace engineering and materials science researchers at Texas A&M University have uncovered new properties of an ultra-durable, recyclable, smart plastic — paving the way for transformative applications in the defense, aerospace and automotive industries.

The breakthrough — funded by the U.S. Department of Defense and published in Macromolecules and the Journal of Composite Materials — was led by Dr. Mohammad Naraghi, director of the Nanostructured Materials Lab and professor of aerospace engineering at Texas A&M, in close collaboration with Dr. Andreas Polycarpou at The University of Tulsa.

Their work explored the mechanical integrity, shape-recovery and self-healing properties of an advanced carbon-fiber plastic composite called Aromatic Thermosetting Copolyester (ATSP).

"What's really exciting is that this material isn't just ultra-durable — it's also adaptive. From on-demand healing in damaged aircraft to enhancing passenger safety in vehicles, these properties make it incredibly valuable for future materials and design innovations," said Naraghi.

Healing damage on demand

ATSP opens new frontiers in industries where performance and reliability are critical, and failure isn't an option.

"In aerospace applications, materials face extreme stress and high temperatures," Naraghi said. "If any of these elements damage any part of an airplane and disrupt one of their main applications, then you could perform on-demand self-healing."

As ATSP matures and scales, it holds the potential to transform commercial and consumer industries, particularly the automotive sector.

"Because of the bond exchanges that take place in the material, you can restore a car's deformations after a collision, and most importantly, significantly improve vehicle safety by protecting the passenger," Naraghi said.

ATSP is also a more sustainable alternative to traditional plastics. Its recyclability makes the material an ideal candidate for industries aiming to reduce environmental waste without compromising durability or strength.

"These vitrimers, when reinforced with discontinuous fibers, can undergo level cycling — you can easily crush and mold it into a new shape, and this can happen across many, many cycles, and the chemistry of the material basically doesn't degrade," he said.

Uncovering ATSP's capabilities

"ATSPs are an emerging class of vitrimers that combine the best features of traditional plastics," Naraghi said. "They offer the flexibility of thermoplastics, with the chemical and structural stability of thermosets. So, when combined with strong carbon fibers, you get a material that is several times stronger than steel, yet lighter than aluminum."

What sets ATSP apart from traditional plastics is its self-healing and shape-recovery capabilities.

"Shape recovery and self-healing are two facets of the same mechanism," Naraghi explained. "With shape recovery, it refers to the bond exchange within a continuous piece of material — a kind of built-in 'intelligence.' And, in self-healing, there's discontinuity in the material like a crack. These are the properties we investigated."

To investigate its properties, the researchers used a novel stress-test called cyclical creep testing.

"We applied repeated cycles of tensile, or stretching, loads to our samples, monitoring changes in how the material accumulated, stored and released strain energy," Naraghi said.

Using cyclical loading, the researchers identified two critical temperatures within the material.

"The first is the glass transition temperature, or the temperature at which the polymer chains can move around easily, and the second is the vitrification temperature. That's the temperature at which these bonds are thermally activated enough that you can see massive bond exchanges to cause healing, reshaping and recovery," he said.

The team then conducted deep-cycle bending fatigue tests, periodically heating the material to around 160 degrees Celsius to trigger self-healing.

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Their results showed that the ATSP samples not only endured hundreds of stress and heating cycles without failure, but that they actually grew more durable during the healing process.

"Much like skin can stretch, heal and return to its original shape, the material deformed, healed and 'remembered' its original shape, becoming more durable than when it was originally made," Naraghi said.

Crack, heal, repeat

Naraghi and his team put the heat-resistant ATSP through five grueling stress cycles, each followed by high temperature exposure at 280 degrees Celsius.

The goal? To assess the material's performance and self-healing properties.

After two full damage-healing cycles, the material returned to nearly full strength. By the fifth cycle, healing efficiency dropped to about 80% because of mechanical fatigue.

"Using high-resolution imaging, we observed that the composite after damage and healing was similar to the original design, though repeated damage caused some localized mechanical wear attributed to manufacturing defects," Naraghi said.

Still, the material's chemical stability and self-healing behaviors remained reliable across all five cycles.

"We also observed that there was no thermal degradation or breakdown in the material, demonstrating its durability even after damage and healing," Naraghi said.

Powering Innovation Through Strategic Partnerships

Naraghi's work, sponsored by the Air Force Office of Scientific Research (AFOSR) and in collaboration with ATSP Innovations, underscores Texas A&M's commitment of driving technological innovations into revolutionary capabilities that advance U.S. defense and industry priorities.

"Our partnerships are very important," Naraghi said. "In addition to supporting us financially, the program managers at AFOSR collaborate with us and offer valuable guidance on questions that could have been overlooked. Our close collaboration with ATSP Innovations has also proven to be very fruitful and very important."

The research team's breakthrough represents more than an emerging class of materials; it's a blueprint for how bold science and strategic partnerships can redefine a future where plastics don't just endure, they evolve and adapt.

"My students and post-docs do the heavy lifting — I cannot thank them enough," Naraghi added. "It's through trial and error, collaborations and partnerships that we turn exciting curiosity into impactful applications."

Technology Networks, 12 August 2025

https://technologynetworks.com

An avoidable contamination catastrophe

2025-09-09

A drug contamination tragedy in Argentina has seen medical fentanyl killing patients by causing microbial infections. The official death toll sits at 51, although authorities suspect up to 100 deaths could be associated with the tainted drug.

Microbial contamination of drug batches is, unfortunately, a persistent issue. Even the most stringently run facilities can be susceptible to accidental contamination. Fortunately, most such incidents are intercepted either by internal quality control or routine regulatory checks before any harm is inflicted on patients. But when those safeguards fail, the consequences are severe.

Unlike some cases of chemical adulteration – such as in the glycol-contaminated cough syrups that killed hundreds of children in The Gambia, Indonesia and Uzbekistan in 2022–23 – microbial contamination is rarely deliberate. Mostly it stems from lapses in hygiene protocols, or use of substandard ingredients.

Decisions made by drugmakers can, however, make contamination more or less likely. And with huge pressure on manufacturers to keep generic drug prices low, there is a temptation to trade off rigorous hygiene and quality assurance against speed and productivity. Cheaper methods of detecting contamination – such as cell-culture or enzyme-based assays – are slow, and can miss microbes that don't grow easily in the lab. And while faster, more comprehensive testing protocols are available using mass spectrometry, Raman spectrometry or DNA detection via PCR, they are significantly more expensive.

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The microbes are also getting tougher to kill. Widespread use of biocides contributes to the growing threat of antimicrobial resistance. Cleaning procedures that were previously effective may no longer be sufficient to eradicate the most stubbornly resistant microbes. Those microbes are also more likely to cause infections that resist treatment with existing drugs, making early detection of contamination even more important.

None of these factors relieve Argentina's HLB Pharma (or any other drugmaker) of its responsibility to adhere to quality and hygiene standards – investigations suggest persistent quality deficiencies at the company and its laboratory partner. Nor do they excuse the seemingly lenient enforcement actions by Argentina's regulator, ANMAT. But they add to the growing strain on supply chains for generic drugs, which already operate on thin profit margins. Extreme competition on prices undermines investment in quality assurance or maintaining, renewing and upgrading aging equipment. As long as that continues, it's likely drug shortages and related quality issues such as contamination will persist or even increase.

Chemistry World, 9 September 2025

https://chemistryworld.com

AI uncovers hidden rules of some of nature's toughest protein bonds

2025-09-11

Imagine tugging on a Chinese finger trap. The harder you pull, the tighter it grips. This counterintuitive behavior also exists in biology. Certain protein complexes can form catch-bonds, tightening their grip when force is applied. These interactions are essential in processes ranging from how bacteria attach to our cells to how tissues in our body hold together under stress.

But a fundamental mystery has lingered: Do catch-bonds need to be stretched to a certain threshold before they strengthen, or do they activate as soon as force is applied?

In a new study, Dr. Marcelo Melo (Colorado State University, formerly Auburn) and Dr. Rafael Bernardi (Auburn University) provide an answer. By combining large-scale molecular simulations with artificial intelligence, they discovered that catch-bonds "switch on" almost immediately after force is applied.

Their paper, "AI Uncovers the Rapid Activation of Catch-Bonds under Force," is published in the Journal of Chemical Theory and Computation.

AI as a molecular detective

To crack the problem, the team simulated the behavior of a bacterial protein complex called cellulosomes, one of the strongest catch-bond systems known in nature. Using steered molecular dynamics simulations—essentially a computational microscope that stretches molecules atom by atom—they generated hundreds of high-resolution "movies" of the protein under stress.

AI regression models were then trained to predict when the protein complex would rupture. Surprisingly, the AI could make accurate predictions using only short snippets of simulation data, well before the bond actually broke.

"This told us that the proteins already 'decide' their level of resilience right after the pulling begins," said Dr. Bernardi, Associate Professor of Physics at Auburn University. "The catch-bond mechanism is activated almost instantly."

Understanding catch-bonds is not just a curiosity. They are central to how bacteria like Staphylococcus aureus resist being washed away, how our immune cells stick to blood vessels, and how tissues such as cartilage endure constant mechanical stress.

"These are systems where life has learned to use force as an advantage," explained Dr. Bernardi. "By learning from them, we can design new biomaterials, adhesives, and even drug strategies that work with mechanical stress instead of against it."

A new blueprint for bioengineering

The study also highlights the power of AI to make sense of complex biological data. Instead of relying on static structures, the models captured dynamic patterns of motion across protein interfaces, finding the subtle signals that predict stability.

"This is exciting because it shows AI can detect early signs of resilience that humans would miss," said Dr. Bernardi. "That opens the door to using these tools in drug design, biomaterials, and synthetic biology."

The research demonstrates the growing role of computational biophysics at the interface of AI and biology. "This project shows how physics, biology, and artificial intelligence can come together to answer questions that none of us could solve alone," said Dr. Bernardi.

Phys Org, 11 September 2025

https://phys.org

Chemists Create Next-Gen Rocket Fuel Compound That Packs 150% More Energy

2025-09-12

UAlbany chemists created manganese diboride, a high-energy material with potential for rocket fuel and new technologies.

Chemists at the University at Albany have developed a high-energy compound that could transform rocket fuel and make space travel more efficient. When ignited, this compound produces significantly more energy per unit of weight and volume than current propellants.

For rockets, this means that less fuel would be needed to achieve the same mission duration or payload capacity, leaving more space for essential equipment and supplies. The research was published in the Journal of the American Chemical Society.

"In rocket ships, space is at a premium," said Assistant Professor of Chemistry Michael Yeung, whose lab led the work. "Every inch must be packed efficiently, and everything onboard needs to be as light as possible. Creating more efficient fuel using our new compound would mean less space is needed for fuel storage, freeing up room for equipment, including instruments used for research. On the return voyage, this could mean more space is available to bring samples home."

The compound, manganese diboride (MnB2), is more than 20% higher in energy density by weight and about 150% higher by volume compared with aluminum, which is currently used in solid rocket boosters. Despite its potency, it is remarkably stable and only ignites when exposed to an ignition source such as kerosene.

Beyond rocket propulsion, the boron-based structure of MnB2 shows wide-ranging potential. Work from the Yeung lab indicates it could also strengthen catalytic converters in automobiles and act as a catalyst for breaking down plastics.

It Takes Heat to Make Heat

Manganese diboride is part of a group of chemical compounds long suspected to have unusual properties, but progress in studying them has been limited by the challenge of actually producing the material.

"Diborides first started getting attention in the 1960s," said UAlbany PhD student Joseph Doane, who works with Yeung. "Since these initial looks, new technologies are allowing us to actually synthesize chemical compounds that were once only hypothesized to exist.

"Knowing what we do about the elements on the periodic table, we suspected that manganese diboride would be structurally asymmetrical and unstable — factors which together would make it highly energetic — but until recently, we couldn't test it because it couldn't be made. Successfully synthesizing pure manganese diboride is an exciting achievement in and of itself. And now, we can test it experimentally and discover new ways to put it to use."

Producing manganese diboride requires extreme heat, generated by a device known as an "arc melter." To begin, manganese and boron powders are pressed into a pellet and sealed inside a reinforced glass chamber. A narrow electrical current is then directed at the pellet, heating it to nearly 3,000°C (over 5,000°F). The molten substance is rapidly cooled to preserve its structure. On the atomic scale, this process forces the central manganese atom to bond with more atoms than usual, creating a crowded arrangement tightly compressed like a coiled spring.

Unlocking the structure through deformation

When exploring new chemical compounds, being able to physically produce the compound is critical. You also need to be able to define its molecular structure in order to better understand why it behaves the way it does.

UAlbany PhD student Gregory John, who works with computational chemist Alan Chen, built computer models to visualize manganese diboride's molecular structure. These models revealed something critical: a subtle skew, known as "deformation," which gives the compound its high potential energy.

"Our model of the manganese diboride compound looks like a cross-section of an ice cream sandwich, where the outer cookies are made of a lattice structure comprised of interlocking hexagons," said John. "When you look closely, you can see that the hexagons aren't perfectly symmetrical; they're all a little skewed. This is what we call 'deformation.' By

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measuring the degree of deformation, we can use that measure as a proxy to determine the amount of energy stored in the material. That skew is where the energy is stored."

Here's another way to picture it.

"Imagine a flat trampoline; there's no energy there when it's flat," said Yeung. "If I put a gigantic weight in the center of the trampoline, it will stretch. That stretch represents energy being stored by the trampoline, which it will release when the object is removed. When our compound ignites, it's like removing the weight from the trampoline and the energy is released."

New Materials Need New Compounds

"There's this consensus among chemists that boron-based compounds should have unusual properties that make them behave unlike any other existing compounds," said Associate Professor of Chemistry Alan Chen. "There's an ongoing quest to figure out what those properties and behaviors are. This sort of pursuit is at the heart of materials chemistry, where creating harder, stronger more extreme materials requires forging brand-new chemicals. This is what the Yeung lab is doing — with findings that could improve rocket fuel, catalytic converters and even processes for recycling plastics.

"This study is also a great example of the scientific process, where researchers pursue interesting chemical properties even when they're not certain what specific applications might emerge. Sometimes, present case included, the results are serendipitous."

Yeung's interest in boron compounds started when he was a grad student at the University of California, Los Angeles. His project aimed to discover compounds harder than diamond.

"I distinctly remember the first time I made a compound related to manganese diboride," Yeung said. "There I was, holding this new material that was supposed to be super hard. Instead, it started to get hot and changed into a pretty orange color. I thought, 'Why is it orange? Why is it glowing? It shouldn't be glowing!' That's when I realized how energetic boron compounds can be. I put a pin in it to explore in the future, and that's exactly what we are working on now."

Sci Tech Daily, 11 September 2025

https://scitechdaily.com

New method streamlines detection of carcinogenic compounds in food products

2025-09-11

In today's world, people are increasingly prioritizing their health and well-being, with daily exercises and calorie-tracking apps becoming the new norm. People are therefore interested in incorporating highly nutritious food items such as fruits and vegetables into their diet plans.

However, these foods—owing to contamination as well as due to certain cooking methods such as heating, smoking, grilling, roasting, and frying—may contain polycyclic aromatic hydrocarbons (PAHs) (hydrophobic organic compounds comprising multiple fused aromatic rings) and their derivatives. PAHs comprise some carcinogenic compounds, posing significant risks to human health.

In this context, it is indispensable to extract, detect, and analyze PAHs in food. Traditional PAH extraction techniques—including solid-phase, liquid-liquid, and accelerated solvent extraction—are cost-effective but time-consuming, environmentally unfriendly, and require extensive manual work.

Recently, scientists have proposed the QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) method to streamline and accelerate the extraction of organic compounds. This novel technique reduces extraction time, improves accuracy and recovery rates, and simplifies sample preparation, making it safe, reliable, and efficient for PAH analysis.

In a recent study, a team of researchers from the Department of Food Science and Biotechnology, Seoul National University of Science and Technology, led by Professor Joon-Goo Lee, utilized the QuEChERS method to determine eight PAHs (benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd] pyrene, dibenz[a,h]anthracene, and benzo[g,h,i]perylene in food.

Their findings are published in the journal Food Science and Biotechnology.

The researchers extracted PAHs using acetonitrile. This was followed by purification via different methods involving various combinations of sorbents. The researchers validated the QuEChERS extraction method through a number of food matrices, finding that the calibration curves for the eight PAHs demonstrated remarkable linearity, with the R2 value exceeding 0.99.

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Further, the gas chromatography–mass spectrometry analysis revealed that the limits of detection ranged from 0.006 to 0.035 µg/kg, while the limits of quantification ranged from 0.019 to 0.133 µg/kg. Notably, recoveries ranged from 86.3 to 109.6% at 5 µg/kg, 87.7 to 100.1% at 10 µg/kg, and 89.6 to 102.9% at 20 µg/kg, with precision values between 0.4 and 6.9% in all food matrices.

Prof. Lee states, "This method not only simplifies the analytical process, but also demonstrates high efficiency in detection compared to conventional methods. It can be applied to a wide range of food matrices."

In the industrial sector, this method could be used for inspecting food products for safety management. Furthermore, it is expected to lead to cost reduction and improved safety for workers.

"Our research can improve public health by providing safe food. It also reduces the use and emission of hazardous chemicals in laboratory testing," concludes Prof. Lee.

Overall, this study showcases that the developed PAH analysis method based on the QuEChERS approach is environmentally friendly, rapid, and accurate.

Phys Org, 11 September 2025

https://phys.org

New Quantum Behavior Found in Unusual Superconducting Material

2025-08-18

The observation could help to inform new ways of designing quantum materials, such as superconductors, topological insulators and spin-based electronics.

Researchers at Rice University and collaborating institutions have discovered direct evidence of active flat electronic bands in a kagome superconductor. This breakthrough could pave the way for new methods to design quantum materials — including superconductors, topological insulators and spin-based electronics — that could power future electronics and computing technologies. The study, published in Nature Communications, centers on the chromium-based kagome metal $CsCr_3Sb_5$, which becomes superconducting under pressure.

Kagome metals, characterized by their two-dimensional lattices of corner-sharing triangles, have recently been predicted to host compact molecular orbitals, or standing-wave patterns of electrons that could potentially facilitate unconventional superconductivity and novel magnetic orders that can be made active by electron correlation effects. In most materials, these flat bands remain too far from active energy levels to have any significant impact; however, in $CsCr_3Sb_5$, they are actively involved and directly influence the material's properties.

Pengcheng Dai, Ming Yi and Qimiao Si of Rice's Department of Physics and Astronomy and Smalley-Curl Institute, along with Di-Jing Huang of Taiwan's National Synchrotron Radiation Research Center, led the study.

"Our results confirm a surprising theoretical prediction and establish a pathway for engineering exotic superconductivity through chemical and structural control," said Dai, the Sam and Helen Worden Professor of Physics and Astronomy.

The finding provides experimental proof for ideas that had only existed in theoretical models. It also shows how the intricate geometry of kagome lattices can be used as a design tool for controlling the behavior of electrons in solids.

"By identifying active flat bands, we've demonstrated a direct connection between lattice geometry and emergent quantum states," said Yi, an associate professor of physics and astronomy.

The research team employed two advanced synchrotron techniques alongside theoretical modeling to investigate the presence of active standing-wave electron modes. They used angle-resolved photoemission spectroscopy (ARPES) to map electrons emitted under synchrotron light, revealing distinct signatures associated with compact molecular orbitals. Resonant inelastic X-ray scattering (RIXS) measured magnetic excitations linked to these electronic modes.

"The ARPES and RIXS results of our collaborative team give a consistent picture that flat bands here are not passive spectators but active participants in shaping the magnetic and electronic landscape," said Si, the Harry C. and Olga K. Wiess Professor of Physics and Astronomy, "This is amazing to see given that, until now, we were only able to see such features in abstract theoretical models."

Theoretical support was provided by analyzing the effect of strong correlations starting from a custom-built electronic lattice model, which

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replicated the observed features and guided the interpretation of results. Fang Xie, a Rice Academy Junior Fellow and co-first author, led that portion of the study.

Obtaining such precise data required unusually large and pure crystals of $CsCr_3Sb_5$, synthesized using a refined method that produced samples 100 times larger than previous efforts, said Zehao Wang, a Rice graduate student and co-first author.

The work underscores the potential of interdisciplinary research across fields of study, said Yucheng Guo, a Rice graduate student and co-first author who led the ARPES work.

"This work was possible due to the collaboration that consisted of materials design, synthesis, electron and magnetic spectroscopy characterization and theory," Guo said.

Technology Networks, 18 August 2025

https://technologynetworks.com

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Technical Notes

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A covalent organic polymer fluorescent probe for highly selective and sensitive UO22+ detection in water and food samples

Valorizing spent lithium iron phosphate battery in biomass pyrolysis for production of valuable chemicals and mitigating pollutant emissions

"Fight Fire with Fire": Trace-Water-Induced Controllable Synthesis of Hydrophobic Armors to Stabilize Metal-Organic Cage-Based Crystalline Frameworks

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Decoding the Interactions Between Antibiotics and Microplastics-Chemistry, Environmental Impacts, and Mitigation Approaches- A State-of-the-Art Review

Urban surface water flows contribute more PFAS to marine environments than treated wastewater

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Multiple maternal occupational exposures during pregnancy and intrauterine growth: analysis of the French Longitudinal Study of Children - ELFE cohort, using data-driven approaches

Toxicity and efficacy of antibody-drug conjugates in advanced solid tumors: a retrospective single-center analysis of clinical trials

Exposure to high levels of perfluoroalkyl substances through drinking water and risk of cardiovascular morbidity and mortality in a Swedish register-based study

OCCUPATIONAL

Depression outcomes correlated to exposure to per- and poly-fluoroalkyl substances (PFAS)

Cholinergic Dysfunction in Occupational Manganese Exposure