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CURIOSITIES

TECHNICAL NOTES

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ASIA PACIFIC

New assessment statements published - 4 February 2025

2025-02-04

The assessment statements for the following industrial chemicals are published under section 37 of the Industrial Chemicals Act 2019.

List of new chemical assessment statements published

Reference number	Chemical name or AICIS approved chemical name (AACN)	End use or generalised end use
VA - 1077 - Assessment Statement - 13 December 2023 [pdf] [562 KB]	6,10-Dodecadien-1-ol, 3,7,11-trimethyl-, (3*S*,6*E*)-	Fragrance ingredient in cosmetic and household products
VA - 1076 - Assessment Statement - 11 December 2023 [pdf] [631 KB]	6,10-Dodecadienal, 3,7,11-trimethyl-, (3*S*,6*E*)-	Fragrance ingredient in cosmetic and household products
VA - 1081 - Assessment Statement - 13 December 2023 [pdf] [553 KB]	Santalum austrocaledonicum, ext.	Component of cosmetic and household products
CA09715 - Assessment Statement - 07 February 2024 [pdf] [417 KB]	Cyclopentanol, 2-methyl-5-(1-methylethyl)-, 1-propanoate	Fragrance ingredient in cosmetic and household products
CA09813 - Assessment Statement - 09 February 2024 [pdf] [435 KB]	2(3*H*)-Furanone, 5-(6-hepten-1-yl) dihydro-, (5*S*)-	Fragrance ingredient in cosmetic and household products
CA09716 - Assessment Statement - 19 February 2024 [pdf] [346 KB]	2-Propenoic acid, 2-methyl-, alkyl ester, polymer with alkyl 2-propenoate, alkyl 2-propenoate, alkyl 2-propenoate and alkyl 2-methyl-2-propenoate	Use for crude oil refining

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Reference number	Chemical name or AICIS approved chemical name (AACN)	End use or generalised end use
CA09798 - Assessment Statement - 05 February 2024 [pdf] [530 KB]	2-Propen-1-aminium, *N*,*N*-dimethyl-*N*-2-propen-1-yl-, chloride (1:1), polymer with .alpha.-(2-methyl-1-oxo-2-propen-1-yl)-.omega.-methoxypoly(oxy-1,2-ethanediyl) and 2-propenamide	Component of liquid fabric softener products
CA09856 - Assessment Statement - 13 May 2024 [pdf] [424 KB]	Phenol, 2-ethoxy-4-(ethoxymethyl)-	Fragrance ingredient in cosmetic and household products
CA09751 - Assessment Statement - 10 May 2024 [pdf] [398 KB]	1,2,4,5,7,8-Hexoxonane, 3,6,9-trimethyl-, 3,6,9-tris(Et and Pr) derivs.	Initiator in modification of plastics
CA09572 - Assessment Statement - 12 February 2023 [pdf] [301 KB]	2-Propenoic acid, 2-methyl-, Cx-y-alkyl esters, polymers with *N*-[(dialkylamino) alkyl]-2-methyl-2-propenamide, alkyl methacrylate, alkyl methacrylate and stearyl methacrylate	Component of driveline and engine oils in automotives
CA09657 - Assessment Statement - 17 May 2024 [pdf] [505 KB]	Alkanedioic acid compd. with N1-(9*Z*)-9-octadecen-1-yl-1,3-propanediamine (1:?)	Corrosion inhibitor in industrial pipes and boilers
CA09630- Assessment Statement - 22 August 2024 [pdf] [541 KB]	4-Pentenal, 2,4-dimethyl-5-(4-methylphenyl)-, (4*E*)-	Fragrance ingredient in cosmetic and household products

Read More

AICIS, 04-02-25

https://www.industrialchemicals.gov.au/news-and-notices/new-assessment-statements-published-4-february-2025

Submit now: consultation on treated seeds closing soon

2025-03-04

Consultation is open on the proposed group standard to close a regulatory gap between imported treated seed, which has previously been unregulated, and locally manufactured treated seed.

The suggested changes aim to reduce the risk of treated seed containing active ingredients that have not been assessed by us before being imported into New Zealand.

The EPA hosted a webinar on 18 February with the treated seed sector to share important information about the proposed changes. The webinar can be viewedhere.

Submissions on the proposed group standard are due by 31 March 2025.

Read More

EPA NZ, 04-03-25

https://www.epa.govt.nz/

Changes to lead levels in paints now in effect

2025-03-04

In August last year, we amended a series of group standards to reduce the maximum allowable levels of lead impurities in paint. We also tightened rules for art materials, such as chalk, crayons, and felt-tip pens.

Lead can cause serious health effects, such as permanent damage to the brain and nervous system, anaemia and kidney damage. It is also toxic to plants, animals, and microorganisms. Although lead is not intentionally added to modern paints, some products can contain trace levels as an impurity.

From 1 March 2025: you can no longer import or manufacture products or substances that do not meet the amended group standards. You can still sell or use those already in the country.

From 1 September 2025: you must dispose of any products that don't meet the amended standards.

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EPA NZ, 04-03-25

https://www.epa.govt.nz/

AMERICA

Lawmakers debate bill that could forever alter lawn care: 'This policy safeguards the health of … our children and grandchildren'

2025-03-03

Maryland has introduced a bill requiring its Department of Agriculture to ban certain pesticides, including PFAS, or "forever chemicals," according to CBS News. This bill may cause some worry about the impact on lawn treatments, but are fewer chemicals in our environment necessarily a bad thing?

There's more than meets the eye with this proposed bill.

President Donald Trump temporarily halted proposed Environmental Protection Agency limits, affecting protections under the Safe Drinking Water Act set for 2027, as noted by CBS News. This rollback prompted Maryland to introduce legislation to limit harmful chemicals at the state level.

Maryland Attorney General Anthony Brown stressed the importance of the regulations, telling CBS News that "this rule permits water systems across the country, including here in Maryland, to regulate and treat these harmful substances."

Environmental advocate Adrienne Esposito of the Citizens Campaign for the Environment expressed concern, saying, "This is really a tragic setback for water protection throughout America." In response, according to CBS News, Maryland joined 17 other states in defending stronger regulations to remove forever chemicals from drinking water.

Read More

TCD, 03-03-25

https://www.thecooldown.com/green-business/maryland-pesticide-ban-pfas-grass-care/

Trump's EPA appointments raise questions about chemical safety policies

2025-03-05

Robert F. Kennedy Jr., now leading the Department of Health and Human Services, has vowed to reduce corporate influence and toxic chemical exposure, but President Donald Trump's Environmental Protection Agency appointments include industry-linked officials known for rolling back environmental regulations.

Ariel Wittenberg and Ellie Borst report for E&E News.

In short:

- Kennedy chairs the new "Make America Healthy Again Commission," which includes EPA and aims to investigate links between corporate influence, chemicals, and chronic diseases in children.
- Yet key EPA appointees, including Nancy Beck and Lynn Ann Dekleva, previously worked to weaken chemical regulations and have ties to industries producing toxic substances like PFAS.
- Unlike Trump's first term, returning officials face fewer ethics restrictions, allowing them to oversee policies affecting their former industry clients.

Read More

EHN, 05-03-25

https://www.ehn.org/trump-s-epa-appointments-raise-questions-about-chemical-safety-policies-2671264617.html

Pushing for federal regulation of PFAS 'forever chemicals'

2025-03-05

PFAS (short for per- and polyfluoroalkyl substances) are a class of more than 14,000 synthetic, highly toxic chemicals that are resistant to heat, oil, stains, grease, and water. Since the invention of Teflon in 1938, PFAS have become widely used in industrial processes as surfactants, lubricants and repellents and in products ranging from cosmetics and hygiene products to clothing, furniture, packaging, pesticides, and firefighting foam. PFAS have been commonly branded as "forever chemicals" because they are nearly indestructible in the environment and in our bodies due to their

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strong fluorine-carbon bond. PFAS persist for thousands of years because they do not break down over time.

PFAS pollution is ubiquitous. PFAS is present in the air, rain, species, atmosphere and water across the Great Lakes basin, which provides drinking water for 60 million people.Studies have shown that more than 99 per cent of people in Canada have PFAS in their blood. These impossible-to-avoid chemicals pose harms to human health and ecosystems.

Read More

ecojustice, 05-03-25

https://ecojustice.ca/file/pushing-for-federal-regulation-of-pfas-forever-chemicals/

EUROPE

Comments on the Clean Industrial Deal

2025-02-26

EuRIC: Big decarbonisation promises, little support for circularity

EuRIC welcomes the Commission's ambition to lay out a plan driving the continent's energy transition and industry empowerment. However,´the Clean Industrial Deal (CID), falls short of delivering the bold measures needed to achieve these goals. It fails to effectively link decarbonisation with circularity or recognise the key role EU recyclers play in cutting carbon emissions and generating resources.

Europe's green transition, strategic autonomy and industrial competitiveness depend on securing its own raw materials. Together with the Metals Action Plan and the Circular Economy Act, the CID has the potential to shape a future-proof industrial, climate, and energy strategy. Yet, its success depends on leveraging competitive decarbonisation measures that tackle Europe's biggest problems; skyrocketing energy prices and the heavy dependence on primary resources.

The CID sets a 24% circular material use target by 2030, but lacks the concrete mechanisms to deliver it. Moreover, the CID focuses heavily on Critical Raw Materials (CRM), which represent only a fraction of Europe's circular material flows, while failing to protect industries already grappling with low demand and rising costs.

Julia Ettinger, EuRIC's Secretary General stated: "The Clean Industrial Deal must drive action, not just ambition. The EU now has all the tools it needs — from the Critical Raw Materials Act to the NZIA and the Clean Industrial Deal itself. The challenge now is to use them effectively. Recyclers urgently need support as they battle skyrocketing energy prices, weak demand and excessive red tape. There can be no decarbonisation and competitiveness without circularity, and no sustainable future without a strong recycling industry."

Zero Waste Europe calls for stronger circularity measures

The Clean Industrial Deal (CID) falls short of fully leveraging the potential of the circular economy for the much-needed economic transition, says environmental network Zero Waste Europe.

One of the ambitions of the CID is to make the EU a world leader in the circular economy by 2030. The CID states the Commission will adopt a Circular Economy Act (CEA) in 2026. This Act is supposed to facilitate the transition from waste management, boost demand for secondary raw materials, and protect valuable materials.

Aline Maigret, Head of Policy at Zero Waste Europe, states: "The Clean Industrial Deal sets a high-level framework that does not go far enough in unlocking the potential of the circular economy. Circularity measures, and the Deal in particular, should serve as a guiding compass for transforming how we consume and produce, empowering communities, and building resilient economies through job creation in circular sectors. The impact of the CID will hinge on the details that emerge next."

Read More

Recycling Magazine, 26-02-25

https://www.recycling-magazine.com/2025/02/27/comments-on-the-green-industrial-deal/

Court Ruling Paves the Way for New Packaging Tax in German Cities

2025-02-09

Numerous cities across Germany are gearing up to implement a new tax on packaging waste, following a recent court ruling that supports local governance in this matter. As the federal government faces legislative gridlock ahead of the upcoming elections, municipal authorities are taking proactive measures to address the growing issue of waste management.

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The city of Tübingen has set a precedent by introducing a packaging tax in 2022, which was recently upheld by the Federal Constitutional Court after a legal challenge. This landmark decision has provided other municipalities with the confidence to pursue similar measures, as they seek innovative solutions to curb waste accumulation.

Federal Minister of the Environment has expressed her approval of the planned packaging taxes, encouraging cities to follow Tübingen's example. The Minister stated that it is imperative for local authorities to come up with intelligent solutions to tackle the waste problem.

As of early 2025, cities like Konstanz have already enacted their own packaging taxes, while others, including Freiburg and Bremen, are in the planning stages. The tax in Tübingen, for instance, imposes a 50-cent charge on disposable coffee cups and takeout containers, and 20 cents on disposable cutlery. This approach aims to reduce single-use plastics and promote more sustainable practices.

Read More

The Munich Eye, 09-02-25

https://themunicheye.com/new-packaging-tax-gains-momentum-german-cities-10126

INTERNATIONAL

Why the French PFAS ban isn't the victory it seems

2025-03-03

Banning "forever chemicals" only from everyday products risks providing cover for industry to continue using these poisons on a grand scale.

There is no greater mistake than to try to leap an abyss in small jumps, remarked British Prime Minister David Lloyd George. He had in mind the Liberals' reluctance to force young men into the army during World War I.

But Lloyd George could equally have been commenting on the decision by the French parliament 10 days ago to ban the infamous PFAS "forever chemicals" from a limited range of consumer goods.

France is not alone. Similar legislation already exists in Denmark, while in the US, more than a dozen states have recently introduced PFAS restrictions covering consumer goods such as personal care products, textiles and food packaging.

The French decision to ban these chemicals was taken amid great fanfare among environmentalists. But France risks setting a bad precedent for the EU as a whole, thereby plunging the continent into an abyss of continuing pollution.

Read More

Chemsec, 03-03-25

https://chemsec.org/why-the-french-pfas-ban-isnt-the-victory-it-seems/

UN sets date for extra session to finalize plastics treaty

2025-03-04

The United Nations Environment Programme on Monday said a new round of negotiations toward a global plastics treaty will take place from August 5 to 14 in Geneva, Switzerland, after countries failed to agree on the parameters of a final agreement last December in Busan, South Korea.

The fifth U.N. Intergovernmental Negotiating Committee (INC-5) meeting intended to yield a legally binding global treaty in Busan was meant to be the final one, but countries remained far apart on the basic scope of a treaty and could agree only to postpone key decisions to the new session that will be dubbed INC 5.2.

The most divisive issues that prevented a final deal in Busan included capping plastic production, managing plastic products and chemicals of concern, and financing to help developing countries implement the treaty.

Read More

Reuters, 04-03-25

https://www.reuters.com/sustainability/climate-energy/un-sets-date-extra-session-finalize-plastics-treaty-2025-03-03/

Highlights from February BPC meeting

2025-03-05

ECHA's Biocidal Products Committee (BPC) adopted two opinions on active substances and six on Union authorisations.

Helsinki, 5 March 2025 – The BPC, in its February meeting, adopted the following opinions on active substances, supporting:
renewal of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet) for product-type 8 (wood preservatives); and

- renewal of 3-iodo-2-propynyl butylcarbamate (IPBC) for product-type 8.

The committee also adopted the following five opinions supporting Union authorisations for:

- a biocidal product family containing Propan-1-ol/Propan-2-ol for product-types 2 (disinfectants and algaecides not intended for direct application to humans or animals) and 4 (food and feed area);
- a biocidal product family containing Propan-1-ol/Propan-2-ol for product-types 1 (human hygiene), 2 and 4;
- a biocidal product containing Hydrogen peroxide for product-types 2, 3 (veterinary hygiene) and 4;
- a biocidal product family containing C(M)IT/MIT (3:1); Glutaral (Glutaraldehyde) for product-types 2 and 4; and
- a biocidal product family containing Glutaral (Glutaraldehyde) for product-types 6 (preservatives for products during storage), 11 (preservatives for liquid-cooling and processing systems) and 12 (slimicides).

Additionally, the BPC adopted its opinion on the data submitted to fulfil a Union authorisation requirement for a biocidal product family containing Active chlorine released from sodium hypochlorite for product-type 2. The committee considered that the data met the post-authorisation conditions.

The BPC also adopted its opinion on a request from the European Commission on adding to the Union authorisation Chlorocresol based products – CID Lines NV a use which was previously not authorised.

Furthermore, the committee discussed the renewal of seven anticoagulant rodenticide substances for product-type 14 (rodenticides), but the adoption of its opinions is expected later this year.

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More information about the committee's conclusions is available in the annex.

The European Commission together with the EU Member States will take the final decisions based on BPC's opinions.

The committee met from 25 to 28 February 2025. The adopted opinions will be available on ECHA's website soon. The next meeting will take place from 12 to 16 May 2025.

Read More

ECHA, 05-03-25

https://echa.europa.eu/-/highlights-from-february-bpc-meeting

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Janet's Corner

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Organic

2025-03-17

https://in.pinterest.com/pin/1100496858946685977/

1,3-Butadiene

2025-03-17

USES [2,3]

Most of the 1,3-Butadiene manufactured is used in the production of synthetic rubber. It is also used in the production of plastics and acrylics. These synthetic materials are used to manufacture automotive tyres and tyre products, automotive hoses, belts, seals, and gaskets. It is also used as a chemical intermediate in the production of some fungicides, and in the manufacture of latex adhesives, nylon carpet backing, paper coatings, pipes, conduits, electrical components and luggage. Small levels of 1,3-Butadiene are found in petrol.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- **Industry sources:** The primary stationary sources of 1,3-Butadiene are petroleum refining, manufacturing of synthetic materials and oil and gas extraction. These all emit to air.
- **Diffuse sources:** Smoking tobacco, agricultural burning, bush or forest fires result in emissions to air.
- **Natural sources:** 1,3-Butadiene is emitted to air as a product of incomplete combustion in bush or forest fires, and the burning of biomass (wood, leaves, agricultural burning), including tobacco leaves.
- **Transport sources:** Motor vehicles emit 1,3-Butadiene to air.
- **Consumer products:** In almost all consumer products produced using 1,3-Butadiene, it has been reacted and is no longer available as 1,3-Butadiene. However, the burning of many consumer products will release 1,3-Butadiene. The burning of petrol (driving), leaves, or tobacco will release 1,3-Butadiene to air.

Routes of Exposure

- Exposure to 1,3 butadiene occurs by breathing urban and suburban air, however these levels are generally very low except in polluted cities or near chemical, plastic, and rubber facilities that use it.
- Breathing contaminated workplace air where it is manufactured or used.
- Breathing contaminated air from car and truck exhaust, waste incineration, or wood fires.

1,3-Butadiene is a colourless, non-corrosive, flammable gas with the molecular formula C4H6. It is slightly soluble in water, more soluble in methanol and ethanol, and readily soluble in common organic solvents such as cyclohexane. [1]
1,3-Butadiene is made from the processing of petroleum and has a mild gasoline-like odour. [1,2]

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- Breathing cigarette smoke.
- Drinking contaminated water near production or waste sites.
- Ingesting foods contained in plastic or rubber food containers, but levels are generally very low or not present at all.
- Skin contact with gasoline and breathing gasoline fumes, but levels are low.

HEALTH EFFECTS [4]

Acute Health Effects

Acute exposure to 1,3-butadiene by inhalation in humans results in irritation of the eyes, nasal passages, throat, and lungs. Neurological effects, such as blurred vision, fatigue, headache, and vertigo, have also been reported at very high exposure levels. Dermal exposure of humans to 1,3-butadiene causes a sensation of cold, followed by a burning sensation, which may lead to frostbite. Tests involving acute exposure of animals in rats and mice have shown 1,3-butadiene to have low acute toxicity.

Carcinogenicity

A large epidemiological study of synthetic rubber industry workers demonstrated a consistent association between 1,3-butadiene exposure and occurrence of leukaemia. Several epidemiological studies of workers in styrene-butadiene rubber factories have shown an increased incidence of respiratory, bladder, stomach, and lymphato-hematopoietic cancers. However, these studies are not sufficient to determine a causal association between 1,3-butadiene exposure and cancer due to possible exposure to other chemicals and other confounding factors. Animal studies have reported tumours at a variety of sites from inhalation exposure to 1,3-butadiene. 1,3-Butadiene is metabolised into genotoxic metabolites by experimental animals and humans. EPA has classified 1,3-butadiene as carcinogenic in human by inhalation.

Other Effects

No information is available on reproductive or developmental effects of 1,3-butadiene in humans. Animal studies using mice have reported developmental effects, such as skeletal abnormalities and decreased foetal weights, and reproductive effects, including an increased incidence of ovarian atrophy and testicular atrophy from inhalation exposure to 1,3-butadiene.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately.
- **Skin Contact:** In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.
- **Frostbite:** Try to warm up the frozen tissues and seek medical attention.
- **Inhalation:** Move exposed person to fresh air. If not breathing, or if breathing is irregular or respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.
- **Ingestion:** As this product is a gas, refer to the inhalation section.
- If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

Workplace Controls & Practices [4]

Control measures include:

- Use only with adequate ventilation.
- Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapour or dust concentrations below any lower explosive limits.
- Use explosion-proof ventilation equipment.

Personal Protective Equipment [5]

- **Eyes:** Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts.

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- **Skin:** Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
- **Respiratory:** Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.
- **Hands:** Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
- In case of large spill: Self-contained breathing apparatus (SCBA) should be used to avoid inhalation of the product.

REGULATION

United States

OSHA: Occupational Safety & Health Administration has set a Permissible Exposure Limit (PEL) of 1ppm TWA for 1,3 butadiene and a short-term exposure limit of 5 ppm

ACGIH: The American Conference of Governmental Industrial Hygienists has established a Threshold Limit Value (TLV) of 4.4mg/m3

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PFAS Levels in Birds' Livers 180 Times Higher Than Expected

2025-02-21

Researchers studying birds and the food they eat are now finding much larger volumes of the toxic PFAS chemicals than before. The substances either never break down or degrade very slowly, which is why they are called 'forever chemicals'.

PFAS (per- and polyfluoroalkyl substances) are a large group of synthetic environmental toxins, and you are most likely full of them too. Forever chemicals do not break down; instead, they accumulate in the natural environment and inside your body.

"PFAS have received a lot of attention in recent years. This is because they are so widely used in industry, at the same time as these substances can also be harmful to many different organisms," said postdoctoral fellow Junjie Zhang, who was recently affiliated with the Norwegian University of Science and Technology (NTNU).

He is the lead author of an article that addresses new findings regarding the toxins. PFAS contain fluorine, and they have received particular attention in Norway because they are used in ski wax, Teflon and fire retardants.

Possible and confirmed harmful effects include various forms of cancer, liver damage, cholesterol disorders, reduced fertility, hormone disorders, developmental disorders in children, and a weakened immune system.

Finding more PFAS than before

Ideally, you do not want these substances in your body, but in practice, it is virtually impossible for humans and many other living organisms to avoid them.

Recent research and a new method for detecting PFAS bring both bad and good news. The bad news is that we are finding PFAS in places we have not previously found them. The good news is that this means we have become better at detecting these substances.

"The biggest increase is in the livers of wading birds. We found up to 180 times more PFAS than previously," said Zhang.

Some of the increase may be due to a new analysis method.

"This suggests that previous methods have not been good enough at detecting certain types of PFAS," said Zhang.

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He was affiliated with the Department of Chemistry at NTNU during the study and collaborated with Professor Veerle Jaspers at the Department of Biology on a project funded by the Research Council of Norway (COAST IMPACT). He is now a postdoctoral fellow at the University of Copenhagen.

Investigating migratory birds and their food

The international research group analyzed samples from migratory birds and the shellfish they eat.

"The East Asian–Australasian Flyway is an important route for millions of migratory birds, including wading birds," said Jaspers.

As the name suggests, this migration route extends between Siberia and East Asia and large parts of Australia.

However, the populations of many bird species along this migration route are rapidly declining. The researchers wanted to find out whether exposure to environmental toxins could be a contributing factor.

The researchers took samples from 25 wading birds. In addition, they collected samples from 30 shellfish found in areas of China where migratory birds often stop to feed. This is because it is common for birds – and humans for that matter – to ingest PFAS through food and water.

Easier to detect substances

The researchers took both liver and blood samples from the birds. They used a new method to analyze the samples, called the Total Oxidizable Precursor (TOP) assay, developed by co-author Lara Cioni. This method makes it easier to detect certain types of PFAS.

A lot of research has been done on one group of PFAS called PFAAs (perfluoroalkyl acids), but little is known about the substances that can be converted into PFAAs. PFAAs are formed when other substances break down, and it is these substances that are more easily detected using TOP.

"The TOP results show a significant increase in several types of harmful substances in all of the samples," said Zhang.

Some of the findings suggest that many forever chemicals originate from sources we are not yet aware of, which is not particularly good news.

According to the researchers, the findings highlight how important it is to conduct more research on the substances that PFAS come from.

"We need to find out more about the sources, but also about the effects PFAS have on wading birds, other animals and humans," said Jaspers.

Technology Networks, 21 February 2025

https://technologynetworks.com

Protein accidentally lassos itself, helping to explain unusual refolding behavior

2025-03-14

Proteins are long molecules that must fold into complex three-dimensional structures to perform their cellular functions. This folding process occasionally goes awry, resulting in misfolded proteins that, if not corrected, can potentially lead to disease. Now, a new study has described a potential mechanism that could help explain why some proteins refold in a different pattern than expected.

"Misfolded proteins can malfunction and lead to disease," said Ed O'Brien, professor of chemistry in the Eberly College of Science, a co-hire of the Institute for Computational and Data Sciences at Penn State, and leader of the research team. "So, understanding the mechanisms involved in the folding process can potentially help researchers prevent or develop treatments for diseases caused by misfolding."

A paper describing the research, which used a combination of computer simulations and refolding experiments to describe the folding kinetics of a protein called phosphoglycerate kinase (PGK), appeared today (March 14) in the journal Science Advances.

"For most proteins, we model the folding process as if there are two states, folded or unfolded," said Yang Jiang, assistant research professor of chemistry in the Eberly College of Science at Penn State and the first author of the paper.

"When we track the progression of a protein from unfolded to folded, we see a characteristic time-dependent pattern that we call the folding kinetics of the protein. Usually, the proportion of unfolded proteins goes down exponentially until essentially all of the proteins are folded, but some proteins don't fit this pattern, and we were interested in the mechanisms that might explain this."

The unusual folding pattern of PGK was first observed experimentally over 25 years ago. Whereas most proteins fit the "two-state" model of exponential folding kinetics, the molecules of PGK followed a different

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pattern to reach a fully folded state. This new pattern was described as "stretched-exponential refolding kinetics," but the structural mechanism that explained this difference remained a mystery—until now.

The research team hypothesized that a recently described class of misfolding may be responsible for PGK's deviation from the traditional two-state model of folding.

"Non-covalent lasso entanglement is a class of misfolding we recently identified where a loop of the protein traps another segment of the protein, essentially intertwining itself incorrectly," O'Brien said. "If a protein like PGK is more prone to this type of misfolding, it could help explain why we see the stretched-exponential refolding kinetics."

To test this hypothesis, the research team first built a computer model to simulate the folding process of PGK. Their simulations recapitulated the stretched-exponential kinetics seen in the earlier experiments. They then explored the intermediate stages of the folding process in their simulations to see if there were structural changes that could explain the stretched refolding.

"We found several examples of misfolding involving entanglements," Jiang said. "Sometimes a new entanglement formed and sometimes an entanglement that was part of the protein's native structure failed to form. In our simulations, we could then remove these misfolding events and saw that the protein folded with the typical two-state exponential pattern."

To confirm the results of their simulation, the research team, which included experimentalist Stephen Fried and lab members at Johns Hopkins University, examined the structural variation of PGK upon refolding in experiments. They found that the misfolded states predicted in the simulations were consistent with the structural signals experimentally observed in the refolded protein. They also found that these misfolded states were long-lived, suggesting that they are a crucial component of the observed stretched-exponential folding kinetics.

"Because of the nature of this type of misfolding, the protein gets stuck," Jiang said. "The protein must backtrack in the folding process to correct the mistake, which takes time and is energetically expensive. The demonstration of this mechanism helps expand our understanding of how proteins are folded and gives an example of how it can go wrong. This is basic research, but it could eventually inform how we develop therapeutics for diseases linked to protein misfolding."

In addition to Jiang, O'Brien and Fried, the research team includes graduate student Ian Sitarik and Assistant Professor of Statistics Hyebin Song at Penn State and co-first author Yingzi Xia and Piyoosh Sharma at Johns Hopkins University.

Phys Org, 14 March 2025

https://phys.org

Artificial Photosynthesis: Scientists Crack Nature's Code for Clean Energy

2025-03-14

Artificial photosynthesis holds the key to cleaner energy and carbon capture, but replicating nature's process is no easy feat.

Harnessing Sunlight: The Magic of Photosynthesis

Photosynthesis is the process plants use to convert sunlight, carbon dioxide, and water into energy-rich sugars and oxygen. This remarkable system fuels plant growth and releases the oxygen we breathe.

If scientists could replicate photosynthesis, the benefits would be immense. Solar energy could be harnessed to remove carbon dioxide from the air and transform it into valuable compounds like carbohydrates. Additionally, since photosynthesis naturally splits water into oxygen and hydrogen, artificial versions could provide a new way to produce clean hydrogen fuel.

Photosynthesis: A Complex Process With Many Participants

Given its potential, researchers around the world are working to develop artificial photosynthesis. However, replicating nature's method is a major challenge. The process involves multiple intricate steps within plant cells, relying on a network of pigments, proteins, and other molecules. Despite these complexities, scientific progress in this field continues to accelerate.

One of the leading experts in artificial photosynthesis is Professor Frank Würthner from Julius-Maximilians-Universität (JMU) Würzburg in Germany. His team has successfully mimicked one of the early steps of natural photosynthesis using an advanced arrangement of artificial dye molecules. This breakthrough has provided new insights into how energy is transferred and stored in the process.

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This achievement, developed in collaboration with Professor Dongho Kim's research team at Yonsei University in South Korea, was published today (March 14) in Nature Chemistry.

Fast and Efficient Energy Transport in a Stacking System

The researchers have succeeded in synthesizing a stack of dyes that is very similar to the photosynthetic apparatus in plant cells – it absorbs light energy at one end, uses it to separate charge carriers, and transfers them step by step to the other end via a transport of electrons. The structure consists of four stacked dye molecules from the perylene bisimide class.

"We can specifically trigger the charge transport in this structure with light and have analyzed it in detail. It is efficient and fast. This is an important step towards the development of artificial photosynthesis," says JMU PhD student Leander Ernst, who synthesized the stacked structure.

Supramolecular Wires as the Goal of the Research Work

Next, the JMU research team wants to expand the nanosystem of stacked dye molecules from four to more components – with the aim of ultimately creating a kind of supramolecular wire that absorbs light energy and transports it quickly and efficiently over longer distances. This would be a further step towards novel photofunctional materials that can be used for artificial photosynthesis.

Sci Tech Daily, 14 March 2025

https://scitechdaily.com

Researchers unveil comprehensive zeolite structures, advancing development of catalysts for petrochemical and renewable energy

2025-03-11

Zeolites, crystalline materials widely used in the petrochemical industry, serve as pivotal catalysts in the production of fine chemicals, with aluminium being the source of active sites within zeolite structures. A research team from The Hong Kong Polytechnic University (PolyU) has revealed the precise location of aluminium atoms in the zeolite framework. This discovery could facilitate the design of more efficient and stable catalysts, aimed at increasing the yield of petrochemical products, achieving efficient renewable energy storage, and controlling air pollution. This advancement will further promote the application of zeolites in

relevant fields. The findings have been published in the international journal Science.

The research is led by Prof. Shik Chi Edman TSANG, Chair Professor of Catalysis and Materials of the PolyU Department of Applied Biology and Chemical Technology. He is joined by Prof. Tsz Woon Benedict LO, Associate Professor, along with first author Dr Guangchao LI, Research Assistant Professor, both from the same department. The team collaborated with researchers from the University of Oxford and the Innovation Academy for Precision Measurement Science and Technology of the Chinese Academy of Sciences.

The unique properties of zeolites, characterised by their well-defined microporous structure, high surface area, and tuneable acidity and basicity, make them indispensable in petrochemical refining, environmental catalysis and fine chemical synthesis. The distribution of substitutional aluminium atoms within the zeolite framework influences the geometry of molecular adsorbates, catalytic activity, and shape and size selectivity. However, accurately locating these aluminium atoms and understanding their impact on the catalytic behaviour of zeolites has posed challenges for the scientific community for decades.

In their research, the team focused on both lab-synthesised and commercial H-ZSM-5 zeolites to bridge the gap between fundamental research and practical application, optimising H-ZSM-5 for advanced catalytic processes. Notably, the team introduced an innovative approach that integrates synchrotron resonant soft X-ray diffraction -- a powerful tool for studying atomic structure -- with probe-assisted solid-state nuclear magnetic resonance (SSNMR) and molecular adsorption methods. This integration revealed the interactions of molecules at the active sites of aluminium atoms. Ultimately, the team has achieved a breakthrough in locating single and pairs of aluminium atoms in a commercial H-ZSM-5 zeolite.

The research findings will facilitate the development of more efficient and selective catalysts, which have wide-reaching implications beyond petrochemicals, offering potential benefits for industries such as renewable energy and pollution control. Reducing energy consumption, this can, in turn, promote sustainability and minimises environmental impact. With regard to petrochemical refining, these catalysts can improve fuel yield and quality, particularly for products like gasoline and olefins, simultaneously lowering energy usage. In the realm of environmental catalysis, they contribute to cleaner air and mitigating air pollution. For

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renewable energy and biofuels, these innovations advance hydrogen storage and utilisation processes, which are crucial for the development of a hydrogen economy.

Prof. Edman Tsang said, "This discovery is a game-changer as it precisely identifies the location of aluminium atoms in the zeolite framework and how they are positioned, providing for the first time a structural elucidation of zeolite frameworks. This breakthrough allows scientists to design more efficient and targeted zeolite catalysts, making the chemical process faster, more energy-efficient and more environmentally friendly."

Prof. Benedict Lo said, "We explored and combined various techniques to achieve a multidimensional view of the distribution of aluminium atoms and their interaction with adsorbed molecules, leading to insights into crucial reaction mechanisms. This provides scientists with a deeper understanding of the structure of zeolites."

Dr Guangchao Li said, "We will develop further novel synthesis methods to precisely control the distribution and concentration of aluminium atoms, as well as their pore architectures in zeolites. This advancement will enable the design of catalysts with optimised activity, selectivity and stability for specific industrial applications."

Looking ahead, the team will work closely with industry partners to translate research outcomes into commercial applications. By leveraging the extensive networks and research strengths of the PolyU-Daya Bay Technology and Innovation Research Institute, which focuses on green chemistry and sustainable catalysis, the team will collaborate with domestic petrochemical companies to promote translational research and accelerate the commercialisation of advanced zeolite catalysts. This effort is bolstered by state-of-the-art PolyU facilities, including the only SSNMR facility in Hong Kong and the soon to be introduced first Dynamic Nuclear Polarisation SSNMR (DNP-SSNMR) spectrometer in the Greater Bay Area and southern China. These resources strengthen the team's research capabilities and facilitate the advancement of their research efforts.

Science Daily, 11 March 2025

https://sciencedaily.com

Color-changing fluorescent dyes enable precise temperature measurements within living cells

2025-03-14

Temperature is a critical variable that influences countless biological processes at the cellular level. However, precisely measuring temperatures within living cells remains challenging. Conventional temperature measurement techniques often lack the spatial resolution needed to detect subtle temperature variations in complex microscopic environments. Additionally, many existing molecular thermometers have significant limitations in terms of their sensitivity, resolution, and applicable targets, highlighting the need for innovative approaches and versatile tools.

Against this backdrop, a research team led by Associate Professor Genichi Konishi from the Institute of Science Tokyo, Japan, has developed a molecular thermometer using a novel solvatochromic fluorescent dye. Their findings, published online in the Journal of the American Chemical Society on March 5, 2025, demonstrate that this new compound enables high-precision temperature measurements through changes in fluorescence properties.

The researchers designed a series of donor–π–acceptor (D–π–A) fluorophores based on a π-extended fluorene structure. These molecules are specially engineered to change their fluorescence properties in response to their surrounding environment's polarity. When the temperature increases, the polarity of the solvent slightly decreases, which causes these dyes to emit light at different wavelengths and intensities.

By measuring the ratio of fluorescence intensities at two specific wavelengths, researchers can precisely calculate temperature changes. This "ratiometric" approach eliminates variables such as dye concentration or excitation light intensity, making it exceptionally reliable for detecting even minute temperature fluctuations within microscopic environments like cellular organelles.

The newly developed dyes exhibited exceptional solvatochromic properties, with shifts exceeding 200 nm between different solvents and emission wavelengths reaching the red region (701–828 nm). Notably, the researchers could perform temperature measurements with a remarkable relative sensitivity of up to 3.0%/°C and a resolution of less than 0.1 °C.

"These results represent the highest sensitivity and resolution reported for small organic single-fluorophore ratiometric fluorescence thermometers

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dispersed in solution, which are ideal for bioimaging," Konishi notes. Through further mechanistic analysis, the team determined the underlying principles leading to the exceptional solvatochromic properties of the proposed dyes, contributing to future molecular thermometer design.

The team successfully demonstrated the practical application of their molecular thermometer by introducing one of the dyes into living human cell cultures. Using ratiometric confocal microscopy, they confirmed that the dye functions effectively as a temperature sensor within cellular environments, particularly in cellular droplets, where local temperature variations may play crucial roles in biological processes.

"This molecular thermometer based on a solvatochromic fluorescent dye is expected to greatly expand the scope of fluorescence thermometry and contribute to uncovering unknown biological phenomena due to its superior spatial resolution, non-invasiveness, and ease of molecular design," explains Konishi.

Beyond biological research applications, this innovative molecular thermometer also shows promise for analyzing the temperature-dependent properties of polymeric materials and other material systems. The researchers plan to develop a library of fluorescence thermometers based on this strategy, to cover various environments of interest.

By providing unprecedented insights into microscopic temperature fluctuations, these novel dyes may help scientists unravel temperature-dependent biological phenomena and contribute to significant advances in fields ranging from cell biology to chemistry and materials science.

Phys Org, 14 March 2025

https://phys.org

A Radioactive Molecule That Shouldn't Exist – But Scientists Made It Happen

2025-03-13

A breakthrough in heavy-element chemistry shatters long-held assumptions about transuranium elements.

- Researchers have discovered "berkelocene," the first organometallic molecule to be characterized containing the heavy element berkelium.

- The molecule was synthesized using just 0.3 milligram of berkelium-249, requiring specialized facilities to handle its extreme sensitivity to oxygen, water, and radioactivity.
- This discovery challenges long-standing theories about the chemistry of transuranium elements, particularly those beyond uranium on the periodic table.

Berkelium: A Mysterious Element

A team of researchers from the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) has discovered "berkelocene," the first-ever organometallic molecule containing the heavy element berkelium.

Organometallic molecules, structures where a metal ion is bonded within a carbon-based framework, are well known for early actinide elements like uranium (atomic number 92). However, they are extremely rare for later actinides, such as berkelium (atomic number 97).

"This is the first time that evidence for the formation of a chemical bond between berkelium and carbon has been obtained. The discovery provides new understanding of how berkelium and other actinides behave relative to their peers in the periodic table," said Stefan Minasian, a scientist in Berkeley Lab's Chemical Sciences Division and one of four co-corresponding authors of a new study published in the journal Science.

A Heavy Metal Molecule with Berkeley Roots

Berkelium is one of 15 actinides in the periodic table's f-block. One row above the actinides are the lanthanides.

The pioneering nuclear chemist Glenn Seaborg discovered berkelium at Berkeley Lab in 1949. It would become just one of many achievements that led to his winning the 1951 Nobel Prize in Chemistry with fellow Berkeley Lab scientist Edwin McMillan for their discoveries in the chemistry of the transuranium elements.

The Challenge of Studying Berkelium

For many years, the Heavy Element Chemistry group in Berkeley Lab's Chemical Sciences Division has been dedicated to preparing organometallic compounds of the actinides, because these molecules typically have high symmetries and form multiple covalent bonds with carbon, making them useful for observing the unique electronic structures of the actinides.

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"When scientists study higher symmetry structures, it helps them understand the underlying logic that nature is using to organize matter at the atomic level," Minasian said.

But berkelium is not easy to study because it is highly radioactive. And only very minute amounts of this synthetic heavy element are produced globally every year. Adding to the difficulty, organometallic molecules are extremely air-sensitive and can be pyrophoric.

"Only a few facilities around the world can protect both the compound and the worker while managing the combined hazards of a highly radioactive material that reacts vigorously with the oxygen and moisture in air," said Polly Arnold, a co-corresponding author on the paper who is a UC Berkeley professor of chemistry and director of Berkeley Lab's Chemical Sciences Division.

Breaking Down the Berkelium Barrier

So Minasian, Arnold, and co-corresponding author Rebecca Abergel, a UC Berkeley associate professor of nuclear engineering and of chemistry who leads the Heavy Element Chemistry Group at Berkeley Lab, assembled a team to overcome these obstacles.

At Berkeley Lab's Heavy Element Research Laboratory, the team custom-designed new gloveboxes enabling air-free syntheses with highly radioactive isotopes. Then, with just 0.3 milligram of berkelium-249, the researchers conducted single-crystal X-ray diffraction experiments. The isotope that was acquired by the team was initially distributed from the National Isotope Development Center, which is managed by the DOE Isotope Program at Oak Ridge National Laboratory.

A Surprising Chemical Structure

The results showed a symmetrical structure with the berkelium atom sandwiched between two 8-membered carbon rings. The researchers named the molecule "berkelocene," because its structure is analogous to a uranium organometallic complex called "uranocene." (UC Berkeley chemists Andrew Streitwieser and Kenneth Raymond discovered uranocene in the late 1960s.)

In an unexpected finding, electronic structure calculations performed by co-corresponding author Jochen Autschbach at the University of Buffalo revealed that the berkelium atom at the center of the berkelocene structure has a tetravalent oxidation state (positive charge of +4), which is stabilized by the berkelium–carbon bonds.

Rethinking the Periodic Table

"Traditional understanding of the periodic table suggests that berkelium would behave like the lanthanide terbium," said Minasian.

"But the berkelium ion is much happier in the +4-oxidation state than the other f-block ions we expected it to be most like," Arnold said.

A New Perspective on Nuclear Science

The researchers say that more accurate models showing how actinide behavior changes across the periodic table are needed to solve problems related to long-term nuclear waste storage and remediation. "This clearer portrait of later actinides like berkelium provides a new lens into the behavior of these fascinating elements," Abergel said.

Sci Tech Daily, 13 March 2025

https://scitechdaily.com

Artificial photosynthesis: Researchers mimic plants

2025-03-14

With artificial photosynthesis, humankind could utilize solar energy to bind carbon dioxide and produce hydrogen. Chemists have taken this one step further: They have synthesized a stack of dyes that comes very close to the photosynthetic apparatus of plants. It absorbs light energy, uses it to separate charge carriers and transfers them quickly and efficiently in the stack.

Photosynthesis is a marvellous process: plants use it to produce sugar molecules and oxygen from the simple starting materials carbon dioxide and water. They draw the energy they need for this complex process from sunlight.

If humans could imitate photosynthesis, it would have many advantages. The free energy from the sun could be used to remove carbon dioxide from the atmosphere and use it to build carbohydrates and other useful substances. It would also be possible to produce hydrogen, as photosynthesis splits water into its components oxygen and hydrogen.

Photosynthesis: a Complex Process With Many Participants

So it's no wonder that many researchers are working on artificial photosynthesis. This is not easy, because photosynthesis is an extremely complex process: it takes place in the cells of plants in many individual

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steps and involves numerous dyes, proteins and other molecules. However, science is constantly making new advances.

One of the leading researchers in the field of artificial photosynthesis is chemist Professor Frank Würthner from Julius-Maximilians-Universität (JMU) Würzburg in Bavaria, Germany. His team has now succeeded in imitating one of the first steps of natural photosynthesis with a sophisticated arrangement of artificial dyes and analysing it more precisely.

The results were obtained in collaboration with Professor Dongho Kim's group at Yonsei University in Seoul (Korea). They have been published in the journal Nature Chemistry.

Fast and Efficient Energy Transport in a Stacking System

The researchers have succeeded in synthesising a stack of dyes that is very similar to the photosynthetic apparatus in plant cells -- it absorbs light energy at one end, uses it to separate charge carriers and transfers them step by step to the other end via a transport of electrons. The structure consists of four stacked dye molecules from the perylene bisimide class.

'We can specifically trigger the charge transport in this structure with light and have analysed it in detail. It is efficient and fast. This is an important step towards the development of artificial photosynthesis,' says JMU PhD student Leander Ernst, who synthesised the stacked structure.

Supramolecular Wires as the Goal of the Research Work

Next, the JMU research team wants to expand the nanosystem of stacked dye molecules from four to more components -- with the aim of ultimately creating a kind of supramolecular wire that absorbs light energy and transports it quickly and efficiently over longer distances. This would be a further step towards novel photofunctional materials that can be used for artificial photosynthesis.

website, date

https://website

Self-optimizing catalysts facilitate water-splitting for the green production of hydrogen

2025-03-11

Hydrogen is a much-debated option in terms of CO_2-neutral energy production. Electrolyzer units that split water into its constituent oxygen and storable hydrogen are supplied with electricity from renewable resources, mainly generated by wind and solar energy. However, catalysts are necessary to facilitate this process. To date, noble metal oxides such as ruthenium dioxide and iridium dioxide are being used as benchmark catalysts. These metals, however, are expensive, rare, and unstable in both acidic and alkaline environments.

Dr. Dandan Gao, a junior group leader at Johannes Gutenberg University Mainz (JGU) and holder of a Walter Benjamin Fellowship sponsored by the German Research Foundation, and her team have managed to devise an alternative form of catalyst using cobalt and tungsten, elements that are readily available at low cost.

"What's so unique about our catalyst is that it actually enhances its performance over time, while conventional catalysts either maintain their performance at a consistent rate or even lose some of their performance because they are insufficiently durable," stated Dr. Dandan Gao. "After the process of optimization, activity is even higher than that of benchmark catalysts." The results of Gao and her team have recently been published in the journal Angewandte Chemie International Edition.

What causes the self-optimization process?

The researchers undertook experimental and theoretical investigations to find an explanation for the extraordinary self-optimization of their catalyst. They were able to determine that the chemical nature of the catalyzing cobalt-tungsten oxide changes during the process of water-splitting. While the cobalt is initially largely present in the form of Co^{2} , it is increasingly converted to Co^{3} .

At the same time, the proportion of the original tungsten W^{5} ion to the W^{6} ion shifts in favor of the latter. "There are two reactions during the splitting of water. The hydrogen evolution reaction (HER), which produces hydrogen gas, and the oxygen evolution reaction (OER), which produces oxygen gas. The OER represents the bottleneck for the whole reaction," explained Gao. "That's why we are so committed to developing a catalyst that can promote the OER half reaction."

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While the OER is initially induced by the tungsten active site, this process is transferred with time to the cobalt active site. Moreover, the electrochemically active surface area of the catalyst also increases over the course of time. The research team also observed alterations to the hydrophilicity of the surface. Its affinity for water increases progressively, which is particularly beneficial in the context of electrochemical water-splitting.

"In general, we recorded notably reduced overpotentials and increased current densities accompanied by a substantial increase in OER kinetics," concluded Gao. All this is positive news for the hydrogen production of the future.

Phys Org, 11 March 2025

https://phys.org

New battery-free electricity source: Tiny plastic beads

2025-03-16

Harnessing a principle known as triboelectrification, researchers have worked out the optimal way to generate an electrical charge in a relatively simple way. The breakthrough could provide a battery-free way to power wearables and other devices.

In the world of clean power generation, triboelectrification is a relatively unknown player. It's basically the same thing as static electricity – the generation of energy through friction when two surfaces rub up against each other, or are pulled apart. While the method will never replace wind, solar, geothermal and other green energy initiatives because of its inability to generate serious power, it could have a home in smaller applications such as medical devices and wearable tech.

In fact, triboelectrification has already been used to develop a sensor for detecting mercury in foods; a tree-mounted device that can detect carbon monoxide and temperature changes to monitor forest fire outbreaks; and a special yarn that can turn any fabric into a mini power plant. Researchers at the University of Alabama have even created an inexpensive triboelectric generator out of double-sided tape and plastic film.

Now, a team of researchers from Brussels, Australia, and Hong Kong has unlocked another secret to the effectiveness of the triboelectric effect. After experimenting with a range of materials, the scientists created nano-sized plastic beads made from melamine and formaldehyde. They then

discovered that mixing the sizes of the beads was the key to the success of efficient triboelectric energy generation.

Specifically, they discovered that larger beads tended to acquire a negative charge while smaller ones tended to become positively charged. By designing a system known as a triboelectric nanogenerator (TENG) with the smaller beads on one side of a thin film and the larger ones on the other, they say it was able to output more electricity than would typically be possible by other triboelectric means. That includes methods that rely on rubbing two rough surfaces together to generate a charge. It should be noted that the current output measured during the experiments was only registered in nanoAmps, so let's not get too excited.

The fact that the beads aren't scraped against each other also means that they can last longer, with testing showing that they could survive 10,000 cycles. The researchers also say beads can be produced without the use of solvents, making them cheaper to manufacture, and that they can be renewed with a simple coating of powder when they do wear out.

New Atlas, 16 March 2025

https://newatlas.com

Soursop: The "anticancer" super-fruit that suddenly has a lot of new fans

2025-03-01

There's newfound interest in a little-known fleshy green fruit native to South and Central America, which has long been used in traditional medicine for protection against bacterial infection and even preventing and treating a vast range of cancers. But what exactly is it?

Soursop (Annona muricata) is a flowering tree native to Central and Southern America, but it can now be found in the Pacific Islands, West Africa and Southeast Asia. It's known by many names, but perhaps its most recognized one is graviola, which is commonly used when it comes in supplement form. And for hundreds of years, traditional medicine practitioners have used the spiky green fruit, bark and leaves for everything from managing diabetes to treating infection and cancers.

But there's been new interest in the plant – and its fruit in particular – in the last year, especially from the Western wellness community seeking alternative medicines rooted in traditional therapeutics. However, the

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science world remains split on its benefits. One thing most experts agree on is that there needs to be more research into it.

"Among all former studies on this plant, the most promising activities are found to be its anticancer, antiparasitic and insecticidal activity," researchers noted in a 2015 review paper in the International Journal of Molecular Sciences. "Further investigations on the biochemical and physiological functions of active compounds and the detailed mechanisms underlying these activities are completely pivotal for the development of pharmaceutical and agricultural products."

What we do know is that the fruit in particular contains bioactive compounds – acetogenins, alkaloids, flavonoids and vitamins – that are generally seen as beneficial, particularly for their cytotoxic effects, or how they work to kill cancer cells. These acetogenins have also been associated with not just blocking cancer growth but cancer prevention. However, a key acetogenin, annonacin, has also been linked to Parkinson's and neurodegenerative diseases.

"The major bioactive compounds identified in Annona Muricata have been classified as Annonaceous acetogenins, which inhibit mitochondrial complex I that leads to a decreased ATP production," researchers found in 2012. "Overall, the compounds that are naturally present in a Graviola extract inhibited multiple signaling pathways that regulate metabolism, cell cycle, survival, and metastatic properties in PC cells. Collectively, alterations in these parameters led to a decrease in tumorigenicity and metastasis of orthotopically implanted pancreatic tumors, indicating promising characteristics of the natural product against this lethal disease."

Plant biologists will recognize that "Annonaceous" refers to the family Annonaceae, which also includes more familiar fruiting trees like the custard apple (Annona reticulata). Both species share some features, like the fruits' creamy white flesh and rather unappealing exteriors, but have a distinct nutritional profile. A cup of soursop fruit has 148 calories, 7.42 g of fiber, 37.8 g of carbohydrates, as well as 30.5 g of sugar, although it has a low glycemic index. The fruit is rich in vitamin C, potassium, magnesium, as well as antioxidants, and potassium. And despite it's appearance, soursop actually tastes pretty good, landing somewhere between strawberry and banana.

While it's been used as a complementary treatment for cancer patients for some time, there's not enough scientific data yet to draw clinical conclusions. Yet another review paper from 2024 found that existing

research suggested that there's a reason soursop has been part of traditional medicine for so long.

"This systematic review has identified that Annona muricata extracts exhibits beneficial effect on cancer, demonstrating cytotoxicity effect through inhibitory effect, apoptosis, and selective killing of cancer cells without affecting normal cells," the researchers noted. "Additionally, it has anti-inflammatory effects by activating the anti-inflammatory pathway through the prostaglandin synthesis pathway."

Putting aside its potential antimocribial, antioxidant and anti-inflammatory benefits, it has also been identified as a neurotoxin and may contribute to neurological conditions. So far, researchers believe this is a result of excess consumption.

"High doses of acetogenins can be neurotoxic and may cause neurodegenerative disorders," scientists noted in a 2022 study published in the journal Molecules. "Some alkaloids present in A. muricata are also believed to affect nerve cells. However, research on the neurotoxicity of annonacin states that neurodegenerative conditions caused by these compounds arise due to continuous exposure or consumption. Further research on the toxicity of A. muricata and clinical trials testing the pure compounds are needed to fully elucidate its pharmacological activities and ensure the safety of A. muricata as a potential drug for various diseases."

And while it's been championed as preventing or "curing" cancer, there's little robust scientific evidence to date to back up these claims. Nonetheless, it's still a healthy addition to a salad or smoothie – that is, if you're able to track this exotic fruit down.

New Atlas, 1 March 2025

https://newatlas.com

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Blood Test Identifies Hard-To-Detect Pancreatic Cancer With 85% Accuracy

2025-02-13

A new blood test could help doctors detect pancreatic cancer earlier, potentially improving survival rates for one of the deadliest cancers.

Researchers at Oregon Health & Science University have developed a test called PAC-MANN, the abbreviation for "protease activity-based assay using a magnetic nanosensor," which uses a small blood sample to detect changes in protease activity — a key indicator of pancreatic ductal adenocarcinoma, or PDAC, the most common and deadly form of pancreatic cancer.

Pancreatic cancer is often diagnosed at an advanced stage, when treatment options are limited. Current tests, such as carbohydrate antigen 19-9, or CA 19-9, are good at indicating prognosis, but aren't sensitive enough for early-stage detection. The new PAC-MANN test fills this gap by identifying signs of cancer-related activity in the blood, helping catch cancers earlier.

"The problem with pancreatic cancer is that we often catch it too late," said Jared Fischer, Ph.D., a scientist with the OHSU Knight Cancer Institute's Cancer Early Detection Advanced Research Center, or CEDAR.

"Our goal with PAC-MANN is to give clinicians a tool that can detect the disease much earlier, when more treatment options are available and there is a better chance of survival."

Fischer, an assistant professor of molecular and medical genetics in the OHSU School of Medicine, is the corresponding author of the new study detailing their new test, published today in the journal Science Translational Medicine.

The study's lead author, Jose L. Montoya Mira, Ph.D., is a research engineer at OHSU's CEDAR. An engineer and biologist by training, he joined the collaborative team to bring his extensive knowledge to create a more cost-effective, high-throughput test that could be used anywhere, not just at specialty labs or large medical universities.

"Our test could be used for people at high risk of pancreatic cancer, which is not targeted by current tests," he said. "It allows for a more robust and less invasive screening, unlike an endoscopic ultrasound and other liquid biopsy tests that require large volumes of blood, thus allowing our test to be performed more frequently for earlier detection."

Quick, accessible, accurate screening

The researchers created a non-invasive test using blood samples from 350 patients from OHSU's Brenden-Colson Center for Pancreatic Care and CEDAR; they either had pancreatic cancer, were at high risk for cancer or were controls. The research team looked for certain proteins, specifically proteases, in the blood that become more active in people with PDAC. By identifying these proteins, they developed a test that could specifically detect pancreatic cancer.

The PAC-MANN test was able to correctly distinguish patients with pancreatic cancer from healthy patients and those with non-cancerous pancreatic issues 98% of the time. It also helped spot early-stage cancer with 85% accuracy when used along with the CA 19-9 test.

Their findings also showed that PAC-MANN could track how well treatments were working. After surgery, researchers observed a decrease in protease activity, suggesting the test may help monitor whether treatments are effective.

"This test isn't just about detection — it could also help us measure how well treatments are working and guide therapeutic options," Fischer said.

"If we can track a patient's response to therapy in real-time, we can make better treatment decisions and improve outcomes."

Unlike traditional tests, PAC-MANN requires only a tiny blood sample and provides a simple fluorescent readout, making it a quick and accessible option for screening.

"The big difference with this test is the cost: It takes only 8 microliters of blood and 45 minutes to run the test at a cost of less than a penny per sample," Montoya said. "This could easily be used in rural and underserved settings, where traditional tests are not or cannot be used."

Montoya and Fischer have plans for more trials, specifically an investigator-initiated trial in collaboration with the OHSU Knight Cancer Institute and CEDAR in patients at high risk of developing pancreatic cancer.

If further validated in clinical trials, PAC-MANN could become a valuable tool for catching pancreatic cancer sooner, giving patients more treatment options and a better chance at survival.

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"Hopefully," Fischer said, "this is one step toward ending cancer as we know it."

Technology Networks, 13 February 2025

https://technologynetworks.com

Green steel plant glugs out first ton of molten metal

2025-03-13

MIT spinout Boston Metal has powered up its electricity driven steel production reactor and made over a ton of metal in a crucial step toward commercializing its process. With clean electricity, the process could make steel with zero CO2 emissions.

According to the World Steel Association, steel production releases almost twice its weight in carbon dioxide (CO2) pollution. Specifically, it says, for every one metric tonne of the metal produced, 1.92 metric tonnes of the greenhouse gas is released. That accounts for between seven and nine percent of global CO2 emissions.

This is because in the ore found in nature, iron is bound to oxygen, creating iron oxide, more commonly known as rust. To begin its journey into steel, the ore is placed into blast furnaces where a type of coal known as coke is burned. Carbon monoxide from the burning coke combines with the oxygen to strip it away, purifying the iron for use as steel but also forming the planet warming greenhouse gas, carbon dioxide.

Joining other efforts to decarbonize the steel-production process such as those using hydrogen to refine iron ore, Boston Metal has pioneered a process known as molten oxide electrolysis (MOE).

This method of producing the metal involves combining iron ore with an electrolyte in a reactor and then using electricity instead of coke to heat the mix to about 1,600 °C (2,900 °F). Doing so causes electrons to split the bonds in the iron ore to purify it while outputting only oxygen. Not a single molecule of carbon dioxide is released during the process.

If the electricity that drives the reaction is provided via a clean method such as wind or solar, then the molten metal that results would be completely carbon neutral.

The key to the success of the recent test that led to the creation of a ton of molten metal is Boston Metal's inert anode which can drive the electrical process in the reactor without degrading. To scale the process, multiple

anodes are required, and the recent output of the Woburn, Massachusetts-based factory proves that such a multi-anode approach is effective.

"We are the only company with a direct and scalable approach to more efficient and clean steelmaking, and I can now say that tonnage steel is flowing from our multi-inert anode MOE cell," said Tadeu Carneiro, CEO of Boston Metal. "With this milestone, we are taking a major step forward in making green steel a reality and we're doing it right here in the US, demonstrating the critical innovation that can enhance domestic manufacturing."

Because the current reactor can only make about a ton or two of material per month, the company plans to build an even larger demonstration plant set to come online in 2026 and begin operations a year later. Ultimately, Boston Metal hopes to license its green production process to other steel manufacturers.

You can watch the molten metal flow from Boston Metal's test plant in the following video.

New Atlas, 13 March 2025

https://newatlas.com

Carbon–boron triple bond formed for the first time in a neutral novel molecule

2024-03-14

Researchers have synthesised a triple bond between carbon and boron for the first time. This discovery could help chemists better understand chemical bonds and inspire other researchers to synthesise compounds that might seem improbable.

There are four elements on the periodic table that can form triple bonds due to their shared chemistry – boron, carbon, nitrogen and oxygen. There are confirmed triple bonds between all possible combinations of the four elements such as carbon monoxide, as well as homonuclear molecules such as nitrogen gas, but there has yet to be a stable triple bond between carbon and boron despite a diverse range of compounds containing B=C double bonds.

Chemists from Julius-Maximilians-Universität (JMU), Germany have now succeeded in synthesising a molecule with a boron-carbon triple bond, which they coined boryne, that is an orange solid at room temperature – as an uncoordinated neutral molecule. They began with a brominated

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boron compound stabilised using carbon-containing ligands, which they then reduced and stabilised, finding the right balance of steric and electronic factors to allow for the isolation of boryne as a metastable species. The researchers then carried out preliminary characterisation and initial reactivity studies of the new molecule to establish its chemical properties.

The molecule has the boron atom in a linear arrangement between two carbon atoms, one of which it shares a triple bond with. Boron is only bonded to two atoms leading to a strong electron deficiency as well as angular strain in the C–B–C unit, meaning a very special set of conditions is required to make it, which explains why it's taken so long for scientists to create the molecule. The team conducted quantum calculations to gain further insight into the electronic structure of boryne and results were in good agreement with experimental data – the bonding is consistent with a true triple bond (one σ and two π bonds). The compound was also found to react in various ways including rearranging upon heating, binding to CO and forming a complex with copper.

The new molecule demonstrated interesting reactivity, so the team are now concentrating their efforts on exploring this. They hope that further research could lead to new chemical synthesis tools advancing understanding of chemical bonding theory.

Chemistry World, 14 March 2025

https://chemistryworld.com

Coffee Grounds and Mushroom Spores Combine in Compostable Alternative to Plastics

2025-02-19

Only 30% of a coffee bean is soluble in water, and many brewing methods aim to extract significantly less than that. So of the 1.6 billion pounds of coffee Americans consume in a year, more than 1.1 billion pounds of grounds are knocked from filters into compost bins and garbage cans.

While watching the grounds from her own espresso machine accumulate, Danli Luo, a University of Washington doctoral student in human centered design and engineering, saw an opportunity. Coffee is nutrient-rich and sterilized during brewing, so it's ideal for growing fungus, which, before it sprouts into mushrooms, forms a "mycelial skin." This skin, a sort of white root system, can bind loose substances together and create a tough, water-resistant, lightweight material.

Luo and a UW team developed a new system for turning those coffee grounds into a paste, which they use to 3D print objects: packing materials, pieces of a vase, a small statue. They inoculate the paste with Reishi mushroom spores, which grow on the objects to form that mycelial skin. The skin turns the coffee grounds — even when formed into complex shapes — into a resilient, fully compostable alternative to plastics. For intricate designs, the mycelium fuses separately printed pieces together to form a single object.

"We're especially interested in creating systems for people like small businesses owners producing small-batch products — for example, small, delicate glassware that needs resilient packaging to ship," said lead author Luo. "So we've been working on new material recipes that can replace things like Styrofoam with something more sustainable and that can be easily customized for small-scale production."

To create the "Mycofluid" paste, Luo mixed used coffee grounds with brown rice flour, Reishi mushroom spores, xanthan gum (a common food binder found in ice creams and salad dressings) and water. Luo also built a new 3D printer head for the Jubilee 3D printer that the UW's Machine Agency lab designed. The new printer system can hold up to a liter of the paste.

The team printed various objects with the Mycofluid: packaging for a small glass, three pieces of a vase, two halves of a Moai statue and a two-piece coffin the size of a butterfly. The objects then sat covered in a plastic tub for 10 days, during which the mycelium formed a sort of shell around the Mycofluid. In the case of the statue and vase, the separate pieces also fused together.

The process is the same as that of homegrown mushroom kits: Keep the mycelium moist as it grows from a nutrient rich material. If the pieces stayed in the tub longer, actual mushrooms would sprout from the objects, but instead they're removed after the white mycelial skin has formed. Researchers then dried the pieces for 24 hours, which halts the fruiting of the mushrooms.

The finished material is heavier than Styrofoam, which closer to the density of cardboard or charcoal. After an hour in contact with water, it absorbed only 7% more weight in water and dried to close its initial weight while keeping its shape. It was as strong and tough as polystyrene and expanded polystyrene foam, the substance used to make Styrofoam.

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Though the team didn't specifically test the material's compostability, all its components are compostable (and, in fact, edible, though less than appetizing).

Because the Mycofluid requires relatively homogeneous used coffee grounds, working with it at significant scale would prove difficult, but the team is interested in other forms of recycled materials that might form similar biopastes.

"We're interested in expanding this to other bio-derived materials, such as other forms of food waste," Luo said. "We want to broadly support this kind of flexible development, not just to provide one solution to this major problem of plastic waste."

Technology Networks, 19 Feb 2025
~shttps://technologynetworks.com

Serendipitous discovery reveals how stress and chemistry etch mysterious spiral patterns

2025-03-13

UCLA doctoral student Yilin Wong noticed that some tiny dots had appeared on one of her samples, which had been accidentally left out overnight. The layered sample consisted of a germanium wafer topped with evaporated metal films in contact with a drop of water. On a whim, she looked at the dots under a microscope and couldn't believe her eyes. Beautiful spiral patterns had been etched into the germanium surface by a chemical reaction.

Wong's curiosity led her on a journey to discover what no one had seen before: Hundreds of near-identical spiral patterns can spontaneously form on a centimeter square germanium chip. Moreover, small changes in experiment parameters, such as the thickness of the metal film, generated different patterns, including Archimedean spirals, logarithmic spirals, lotus flower shapes, radially symmetric patterns and more.

The discovery, published in Physical Review Materials, occurred fortuitously when Wong made a small mistake while attempting to bind DNA to the metal film.

"I was trying to develop a measurement technique to categorize biomolecules on a surface through breaking and reforming of the chemical bonds," Wong said. "Fixing DNA molecules on a solid substrate

is pretty common. I guess nobody who made the same mistake I did happened to look under the microscope."

To learn more about how the patterns formed, Wong and co-author Giovanni Zocchi, a UCLA physics professor, investigated a system that involved evaporating a 10-nanometer thick layer of chromium on the surface of a germanium wafer, followed by a 4-nanometer layer of gold. Next, the researchers placed a drop of mild etching solution onto the surface and dried it overnight, then washed and re-incubated the chip with the same etching solution in a wet chamber to prevent evaporation.

"The system basically forms an electrolytic capacitor," Zocchi said.

Over the course of 24–48 hours, a chemical reaction catalyzed by the metal film etched remarkable patterns on the germanium surface. Investigation of the process revealed that the chromium and gold films were under stress and had delaminated from the germanium as the catalytic reaction proceeded. The resulting stress created wrinkles in the metal film that—under further catalysis—etched the amazing patterns the researchers had seen.

"The thickness of the metal layer, the initial state of mechanical stress of the sample, and the composition of the etching solution all play a role in determining the type of pattern that develops," Zocchi said.

One of the most exciting findings in this study is that the patterns are not purely chemical, but are influenced by residual stress in the metal film. The research suggests that the metal's preexisting tension or compression determines the shapes that emerge. Thus, two processes, one chemical and one mechanical, worked together to yield the patterns.

This type of coupling, formed between catalysis-driven deformations of an interface and the underlying chemical reactions, is unusual in laboratory experiments but common in nature. Enzymes catalyze growth in nature, which deforms cells and tissue. It's this mechanical instability that makes tissue grow into particular shapes, some of which resemble the ones seen in Wong's experiments.

"In the biological world, this kind of coupling is actually ubiquitous," Zocchi said. "We just don't think of it in laboratory experiments because most laboratory experiments about pattern formation are done in liquids. That's what makes this discovery so exciting. It gives us a non-living laboratory system in which to study this kind of coupling and its incredible pattern-forming ability."

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The study of pattern formation in chemical reactions began in 1951 when the Soviet chemist Boris Belousov accidentally discovered a chemical system that could spontaneously oscillate in time, which inaugurated the new fields of chemical pattern formation and nonequilibrium thermodynamics.

At the same time and independently, the British mathematician Alan Turing discovered that chemical systems, later termed "reaction-diffusion systems," could spontaneously form patterns in space, such as stripes or polka dots. The reaction-diffusion dynamics observed in Wong's experiments mirrored the theoretical ones posited by Turing.

Although the field of complex systems in physics and pattern formation enjoyed a time in the spotlight during the 1980s and 90s, to this day, the experimental systems used to study chemical pattern formation in the laboratory are essentially variants of ones introduced in the 1950s. The Wong-Zocchi system represents a major advance in the experimental study of chemical pattern formation.

Phys Org, 13 March 2025

https://phys.org

Cheap and environmentally friendly -- the next generation LEDs may soon be here

2025-03-11

Cost, technical performance and environmental impact -- these are the three most important aspects for a new type of LED technology to have a broad commercial impact on society. This has been demonstrated by researchers at Linköping University in a study published in Nature Sustainability.

"Perovskite LEDs are cheaper and easier to manufacture than traditional LEDs, and they can also produce vibrant and intense colours if used in screens. I'd say that this is the next generation of LED technology," says Feng Gao, professor of optoelectronics at Linköping University.

However, for a technological shift to take place, where today's LEDs are replaced with those based on the material perovskite, more than just technical performance is required. That is why Feng Gao's research group has collaborated with Professor Olof Hjelm and John Laurence Esguerra, assistant professor at LiU. They specialise in how innovations contributing to environmental sustainability can be introduced to the market.

Together, they have investigated the environmental impact and cost of 18 different perovskite LEDs, knowledge that is currently incomplete. The study was conducted using so-called life cycle assessment and techno-economic assessment.

Such analyses require a clear system definition -- that is, what is included and not in terms of cost and environmental impact. Within this framework, what happens from the product being created until it can no longer be used is investigated. The life cycle of the product, from cradle to grave, can be divided into five different phases: raw material production, manufacturing, distribution, use and decommissioning.

“We’d like to avoid the grave. And things get more complicated when you take recycling into account. But here we show that it’s most important to think about the reuse of organic solvents and how raw materials are produced, especially if they are rare materials,” says Olof Hjelm.

One example where the life cycle analysis provides guidance concerns the small amount of toxic lead found in perovskite LEDs. This is currently necessary for the perovskites to be effective. But, according to Olof Hjelm, focusing only on lead is a mistake. There are also many other materials in LEDs, such as gold.

“Gold production is extremely toxic. There are byproducts such as mercury and cyanide. It’s also very energy-consuming,” he says.

The greatest environmental gain would instead be achieved by replacing gold with copper, aluminium or nickel, while maintaining the small amount of lead needed for the LED to function optimally.

The researchers have concluded that perovskite LEDs have great potential for commercialisation in the long term. Maybe they can even replace today’s LEDs, thanks to lower costs and less environmental impact. The big issue is longevity. However, the development of perovskite LEDs is accelerating and their life expectancy is increasing. The researchers believe that it needs to reach about 10,000 hours for a positive environmental impact, something they think is achievable. Today, the best perovskite LEDs last for hundreds of hours.

Muyi Zhang, PhD student at the Department of Physics, Chemistry and Biology at LiU, says that much of the research focus so far is on increasing the technical performance of LED, something he believes will change.

“We want what we develop to be used in the real world. But then, we as researchers need to broaden our perspective. If a product has high

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technical performance but is expensive and isn’t environmentally sustainable, it may not be highly competitive in the market. That mindset will increasingly come to guide our research.”

Science Daily, 11 March 2025

https://sciencedaily.com

A Radioactive Molecule That Shouldn’t Exist – But Scientists Made It Happen

2025-03-13

A breakthrough in heavy-element chemistry shatters long-held assumptions about transuranium elements.

- Researchers have discovered “berkelocene,” the first organometallic molecule to be characterized containing the heavy element berkelium.
- The molecule was synthesized using just 0.3 milligram of berkelium-249, requiring specialized facilities to handle its extreme sensitivity to oxygen, water, and radioactivity.
- This discovery challenges long-standing theories about the chemistry of transuranium elements, particularly those beyond uranium on the periodic table.

Berkelium: A Mysterious Element

A team of researchers from the Department of Energy’s Lawrence Berkeley National Laboratory (Berkeley Lab) has discovered “berkelocene,” the first-ever organometallic molecule containing the heavy element berkelium.

Organometallic molecules – structures where a metal ion is bonded within a carbon-based framework – are well known for early actinide elements like uranium (atomic number 92). However, they are extremely rare for later actinides, such as berkelium (atomic number 97).

“This is the first time that evidence for the formation of a chemical bond between berkelium and carbon has been obtained. The discovery provides new understanding of how berkelium and other actinides behave relative to their peers in the periodic table,” said Stefan Minasian, a scientist in Berkeley Lab’s Chemical Sciences Division and one of four co-corresponding authors of a new study published in the journal Science.

A Heavy Metal Molecule with Berkeley Roots

Berkelium is one of 15 actinides in the periodic table's f-block. One row above the actinides are the lanthanides.

The pioneering nuclear chemist Glenn Seaborg discovered berkelium at Berkeley Lab in 1949. It would become just one of many achievements that led to his winning the 1951 Nobel Prize in Chemistry with fellow Berkeley Lab scientist Edwin McMillan for their discoveries in the chemistry of the transuranium elements.

The Challenge of Studying Berkelium

For many years, the Heavy Element Chemistry group in Berkeley Lab's Chemical Sciences Division has been dedicated to preparing organometallic compounds of the actinides, because these molecules typically have high symmetries and form multiple covalent bonds with carbon, making them useful for observing the unique electronic structures of the actinides.

"When scientists study higher symmetry structures, it helps them understand the underlying logic that nature is using to organize matter at the atomic level," Minasian said.

But berkelium is not easy to study because it is highly radioactive. And only very minute amounts of this synthetic heavy element are produced globally every year. Adding to the difficulty, organometallic molecules are extremely air-sensitive and can be pyrophoric.

"Only a few facilities around the world can protect both the compound and the worker while managing the combined hazards of a highly radioactive material that reacts vigorously with the oxygen and moisture in air," said Polly Arnold, a co-corresponding author on the paper who is a UC Berkeley professor of chemistry and director of Berkeley Lab's Chemical Sciences Division.

Breaking Down the Berkelium Barrier

So Minasian, Arnold, and co-corresponding author Rebecca Abergel, a UC Berkeley associate professor of nuclear engineering and of chemistry who leads the Heavy Element Chemistry Group at Berkeley Lab, assembled a team to overcome these obstacles.

At Berkeley Lab's Heavy Element Research Laboratory, the team custom-designed new gloveboxes enabling air-free syntheses with highly radioactive isotopes. Then, with just 0.3 milligram of berkelium-249, the

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researchers conducted single-crystal X-ray diffraction experiments. The isotope that was acquired by the team was initially distributed from the National Isotope Development Center, which is managed by the DOE Isotope Program at Oak Ridge National Laboratory.

A Surprising Chemical Structure

The results showed a symmetrical structure with the berkelium atom sandwiched between two 8-membered carbon rings. The researchers named the molecule "berkelocene," because its structure is analogous to a uranium organometallic complex called "uranocene." (UC Berkeley chemists Andrew Streitwieser and Kenneth Raymond discovered uranocene in the late 1960s.)

In an unexpected finding, electronic structure calculations performed by co-corresponding author Jochen Autschbach at the University of Buffalo revealed that the berkelium atom at the center of the berkelocene structure has a tetravalent oxidation state (positive charge of +4), which is stabilized by the berkelium–carbon bonds.

Rethinking the Periodic Table

"Traditional understanding of the periodic table suggests that berkelium would behave like the lanthanide terbium," said Minasian.

"But the berkelium ion is much happier in the +4 oxidation state than the other f-block ions we expected it to be most like," Arnold said.

A New Perspective on Nuclear Science

The researchers say that more accurate models showing how actinide behavior changes across the periodic table are needed to solve problems related to long-term nuclear waste storage and remediation. "This clearer portrait of later actinides like berkelium provides a new lens into the behavior of these fascinating elements," Abergel said.

Sci Tech Daily, 13 March 2025

https://scitechdaily.com

Synbiotic chocolate infused with pre- and probiotics could have potential health benefits

2025-03-13

Many people will soon load up Easter baskets with chocolate candy for children and adults to enjoy. On its own, dark chocolate has health

benefits, such as antioxidants that neutralize damaging free radicals. And a report in ACS Food Science & Technology suggests that packing the sweet treat with pre- and probiotics could make it more healthful. Flavoring agents, however, can affect many properties, including moisture level and protein content of the chocolate product.

Probiotics, found in fermented foods such as yogurt and kimchi, are living microbes that improve the gut microbiome, shifting the balance toward beneficial bacteria and yeasts. They can also ease digestive issues and reduce inflammation. These active cultures need food and protection to survive harsh gut conditions, so prebiotics—substances like dietary fibers and oligosaccharides—are sometimes added to probiotic-containing products to create synbiotic foods.

Because chocolate is a treat that many people enjoy, researchers have used it to test various combinations of pre- and probiotics. Some methods for including prebiotics are laborious, so Smriti Gaur and Shubhi Singh explored prebiotics that would not require extensive processing—corn and honey—in chocolate fortified with probiotics.

The team developed five chocolates for their study. One contained only basic chocolate ingredients, including cocoa butter, cocoa powder and milk powder. Four different synbiotic test samples also contained prebiotics (corn and honey), one probiotic (either Lactobacillus acidophilus La-14 or Lactobacillus rhamnosus GG) and one flavor additive (either cinnamon or orange).

When the researchers examined several properties of the chocolate samples, they found that fat levels, which influence texture and mouthfeel, were consistent among all five samples. However, there were differences:

- Flavorings impacted some characteristics of the synbiotic chocolates. For example, orange flavorings decreased pH, increased moisture and enhanced protein levels compared to all the other samples.
- The four synbiotic samples had higher antioxidant levels than the control.
- Synbiotic samples had less "snap" compared to the control, suggesting that the additional ingredients disrupted the structure of the chocolate.

The total microbial counts of the synbiotic chocolate samples decreased during storage, but the probiotic microbes still exhibited viability after 125 days. This time period is longer than other researchers have reported when using different bacteria and prebiotics in chocolates. Finally, when Gaur

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and Singh exposed the synbiotic chocolates to simulated gastrointestinal conditions, the probiotics in the samples maintained substantial viability for more than 5 hours.

The researchers also snuck a taste of the confections. "Personally, we enjoyed the orange-flavored chocolates the most, where the vibrant citrus notes complemented the rich cocoa, and it had a slightly softer texture that made each bite feel more luxurious," says Gaur.

"In the future, we are excited to explore additional health benefits of these chocolates while thoroughly investigating their sensory and nutritional profiles, with the goal of creating an even more wholesome and enjoyable treat."

Pgys Org, 13 March 2025

https://phys.org

Scientists develop solar-powered method to convert sewage sludge into green hydrogen and animal feed

2025-03-12

Scientists at Nanyang Technological University, Singapore (NTU Singapore), have developed an innovative solar-powered method to transform sewage sludge -- a by-product of wastewater treatment -- into green hydrogen for clean energy and single-cell protein for animal feed.

Published in Nature Water, the sludge-to-food-and-fuel method tackles two pressing global challenges: managing waste and generating sustainable resources. This aligns with NTU's goal of addressinghumanity's greatest challenges, such as climate change and sustainability.

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NTU's three-step process

The process begins by mechanically breaking down the sewage sludge. A chemical treatment separates harmful heavy metals from organic materials, including proteins and carbohydrates.

Next, a solar-powered electrochemical process uses specialised electrodes to transform the organic materials into valuable products, such as acetic acid -- a key ingredient for food and pharmaceutical industries -- and hydrogen gas, a clean energy source.

Finally, light-activated bacteria are introduced to the processed liquid stream. These bacteria convert nutrients into single-cell protein suitable for animal feed.

Eco-friendly, cost-effective and scalable

Lab tests showed the new method recovers 91.4 per cent of the organic carbon in sewage sludge and converts 63 per cent of the organic carbon into single-cell protein without producing harmful by-products. In comparison, traditional anaerobic digestion typically recovers and converts around 50 per cent of organic materials in sewage sludge.

The solar-powered process achieves an energy efficiency of 10 per cent, generating up to 13 litres of hydrogen per hour using sunlight, which is around 10 per cent more energy efficient than the conventional hydrogen generation methods.

The NTU process reduces carbon emissions by 99.5 per cent and energy use by 99.3 per cent compared to traditional methods. It also eliminates harmful heavy metals from the sludge, which would otherwise be disposed without proper treatment, making the process an environmentally friendly choice.

First author, Dr Zhao Hu, Research fellow at School of MAE, said, "We hope that our proposed method shows the viability of managing waste sustainably and shift how sewage sludge is perceived -- from waste to a valuable resource that supports clean energy and sustainable food production."

The NTU research team added that while the newly developed process is promising, more studies are needed to determine if it can be scaled up. A key challenge is the cost of using an electrochemical process to completely break down organic materials and extract all heavy metals

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from waste. Additionally, designing a complex system for a wastewater treatment facility adds to the difficulty.

Science Daily, 12 March 2025

https://sciencedaily.com

Molecular probe strategy enhances specific detection of psychoactive α-methyltryptamine

2025-03-13

Tryptamine psychoactive substances, such as α-methyltryptamine (AMT), are monoamine alkaloids characterized by an indole ring structure. Rapid, highly sensitive, and specific identification of trace amounts of AMT is crucial for maintaining social stability and ensuring public safety. However, accurately detecting AMT using specific fluorescent methods is challenging due to the presence of similar amine groups and benzene rings in various other amines.

To address this challenge, a research team led by Prof. Dou Xincun from the Xinjiang Technical Institute of Physics and Chemistry of the Chinese Academy of Sciences (CAS) has developed a novel molecular probe strategy to enhance detection sensitivity and selectivity for AMT.

Their findings, published in Analytical Chemistry, emphasize tuning the electron-withdrawing strength of the π-conjugate bridge to improve the reactivity of Schiff base-based fluorescence probes with amines.

In this study, researchers developed three tricyanofuran (TCF)-based probes with different π-conjugated bridges—benzene, benzothiadiazole, and 2,5-dibromobenzene—tailored for amine-containing analytes. Among these, the aldehyde group in the probe with –C6H2Br2 as the π-conjugate bridge, denoted as BrFS-TCF, showed the highest electrostatic potential, making it the most effective for AMT detection due to its superior reactivity.

The optimized probe demonstrated remarkable performance, achieving a fluorescent detection limit of 13 nM, a colorimetric detection limit of 132 nM, and a response time of less than 0.1 seconds. Additionally, the integration of a convolutional neural network algorithm enabled the probe to distinguish AMT from other primary amines, further enhancing its specificity.

Moreover, the probe's reliability was validated through the detection of trace AMT in artificial saliva and solid residues, showcasing its potential for real-world applications.

This innovative probe design and regulation strategy not only provides a new approach for the specific identification and discrimination of primary amine-containing drugs but also advances the development of methodologies for detecting trace hazards and illicit substances.

Phys Org, 13 March 2025

https://phy.org

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Impact of Repeated Organic Amendments on Trace Element Exposure and Health Risks via the Soil-Vegetable-Human Pathway

Photodegradation Controls of Potential Toxicity of Secondary Sunscreen-Derived Microplastics and Associated Leachates

Immobilization and release behaviors of uranium mediated by the redox processes between manganese oxides and dissolved organic matter: Effects of pH and goethite

ENVIRONMENTAL RESEARCH

Association of infrastructure and operations with antibiotic resistance potential in the dairy environment in India

Associations of parental air pollution and greenness exposures with offspring asthma outcomes

PHARMACEUTICAL/TOXICOLOGY

Effects of Chemical Speciation on Chronic Thyroid Toxicity of Representative Perfluoroalkyl Acids

Aflatoxin B1 exposure induces Alzheimer's disease like pathology by disrupting redox homeostasis and activating ferroptotic signals in C57BL/6 J mice

Prenatal exposure to organochlorine pesticides and polychlorinated biphenyls and risk of testicular germ cell cancer later in life

OCCUPATIONAL

The association between occupational lead exposure and serum levels of vitamin D3 and a bone turnover biomarker in smelter workers

Chemical exposure in females of childbearing age associated with sex hormones: Evidence from an untargeted exposomic approach