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ASIA PACIFIC

Common Technical Q&As on New Cosmetic Ingredients by China NIFDC

2025-03-17

On March 17, 2025, the National Institutes for Food and Drug Control (NIFDC) released a FAQ document on technical review of cosmetics related to new cosmetic ingredients. We have collected the latest FAQs and translated them into English for your reference.

1. **How is the Safety Monitoring Period for New Cosmetic Ingredients Calculated?**

According to Article 19 of the Measures for the Administration of Cosmetic Registration and Filing, new cosmetic ingredients that have been registered or notified are subject to a safety monitoring system. The safety monitoring period is three years, starting from the date when the first cosmetic product using the new ingredient obtains registration or completes notification.

2. What Are the Obligations of the New Ingredient Registrant/Notifier and the Cosmetic Product Registrant/Notifier During the Safety Monitoring Period?

The new ingredient registrant/notifier should establish a post-market safety risk monitoring and evaluation system to track and assess the safety of the new ingredient. They should continuously monitor and evaluate its usage and safety profile. Additionally, they are required to collect and analyze data on the ingredient's use and safety, and submit an "Annual Report" within the specified timeframe as required. If any circumstances outlined in Article 22 of the Measures for the Administration of Cosmetic Registration and Filing arise, the registrant/notifier should immediately conduct research, implement necessary risk control measures, and promptly submit a "Risk Control Report."

Read More

CIRS, 17-03-25

https://www.cirs-group.com/en/cosmetics/common-technical-q-and-as-on-new-cosmetic-ingredients-by-nifdc

South Korea Proposes Revisions to the Review Regulations for the Designation and Modification of Cosmetic Ingredient Usage Standards

2025-03-25

South Korean authorities have issued proposed revisions to the cosmetic ingredient usage standards that aim to clarify the scope and requirements for submitting materials when applying for the cancellation or modification of prohibited ingredients. This would ensure the rationality and standardization of the review process for the designation or modification of cosmetic ingredient usage standards. The Ministry of Food and Drug Safety (MFDS) of South Korea issued Announcement No. 92 of 2025, on February 21.

Read More

CIRS, 25-03-25

https://www.cirs-group.com/en/cosmetics/south-korea-proposes-revisions-to-the-review-regulations-for-the-designation-and-modification-of-cosmetic-ingredient-usage-standards

Have your say – linking NICNAS public reports to Inventory chemical records

2025-03-27

What's this about?

We'd like your thoughts on a proposal to provide direct links to NICNAS* assessment reports from about 700 online chemical records of the Australian Inventory of Industrial Chemicals (the Inventory). These would display similarly to AICIS assessment and evaluation statements links that are currently on Inventory chemical records.

The purpose is to improve access to assessment information, when the terms of Inventory listing include a 'specific information requirement'.

Importantly, we would not disclose any protected information, such as protected chemical names and CAS numbers.

*The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) was the former scheme that AICIS replaced on 1 July 2020.

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Read More

AICIS, 27-03-25

https://www.industrialchemicals.gov.au/consultations/have-your-say-linking-nicnas-public-reports-inventory-chemical-records

Information requirements for assessment certificate applications of 'designated fluorinated chemicals'

2025-03-27

What's this about?

Designated fluorinated chemicals are a subset of per- and polyfluoroalkyl substances (PFAS) that capture the PFAS chemicals of highest concern to human health and the environment. This includes longer chain PFAS chemicals that are similar to PFOS, PFOA and PFHxS.

AICIS assesses the health and environmental risks of designated fluorinated chemicals that are not on the Australian Inventory of Industrial Chemicals (the Inventory), after an application for an assessment certificate is submitted through the form in AICIS Business Services. The chemical can only be manufactured or imported into Australia if AICIS issues an assessment certificate.

Our information requirements for these certificate applications are based on the latest scientific knowledge about PFAS chemicals. It includes requirements for toxicological studies on the chemical and information about impurities and degradation products.

We are seeking your feedback on the clarity of the information requirements that will be added to the form for an AICIS assessment certificate application for a chemical that is a 'designated fluorinated chemical' – will an applicant be able to clearly understand these requirements?

Read More

AICIS, 27-03-25

https://www.industrialchemicals.gov.au/consultations/information-requirements-assessment-certificate-applications-designated-fluorinated-chemicals

AMERICA

Trump's EPA wants to get rid of a rule that protects you from chemical disasters

2025-03-26

A little past 4 a.m. on June 21, 2019, workers at the Philadelphia Energy Solutions oil refinery in Philadelphia noticed a leak from a corroded pipe, and were immediately on high alert. The leak had originated in Unit 433, known among workers as the "bogeyman" because it contained the highly explosive chemical hydrofluoric acid, or HF. When released in large quantities, the chemical can form a dense, toxic vapor cloud that hugs the ground and can travel many miles. Contact with this cloud can be deadly; if it ignites, it could cause a massive explosion.

Sure enough, a vapor cloud materialized and ignited, causing three large explosions and a massive fire that sent smoke "pouring into the sky." Pieces of equipment the size of cars flew through the air, miraculously landing in the Schuylkill River without hitting any homes. The force of the explosions threw workers back, injuring five, but ultimately did not cause any fatalities. Workers remembering the incident years later agreed that it could have been much worse.

Read More

Fast Company, 26-03-25

https://www.fastcompany.com/91304720/trumps-epa-wants-to-get-rid-of-a-rule-that-protects-you-from-chemical-disasters

TCE Is Linked to Heart Defects in Babies, Cancer and Parkinson's. Republicans in Congress Want to Reverse a Ban on It.

2025-03-26

The toxic substance, used in dry cleaning and manufacturing, has been linked to a host of serious health problems. A Biden-era ban on the chemical has faced multiple challenges since Trump took office.

Although it was too late for him to benefit, Daniel Kinel felt relieved in December when the Environmental Protection Agency finally banned TCE. The compound, which has been used for dry cleaning, manufacturing and

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degreasing machines, can cause cancer, organ damage and a potentially fatal heart defect in babies, according to independent studies and the EPA. It has also been shown to greatly increase people's chances of developing Parkinson's disease.

Kinel and three of his colleagues were diagnosed with Parkinson's disease. They all worked in a law office in Rochester, New York, that sat next to a dry cleaner that had dumped TCE into the soil. Kinel was diagnosed with the neurodegenerative condition at age 43, after working there for seven years. His three colleagues have since died. At least 15 of the firm's partners developed cancers related to TCE.

Read More

ProPublica, 26-03-25

https://www.propublica.org/article/tce-ban-cancer-parkinsons-trump-republicans

California launches statewide pesticide notification system

2025-03-26

Santoyo is a community organizer at the Center on Race, Poverty & the Environment, one of the 200 coalition partners that, for over a decade, has pushed California Department of Pesticide Regulation (DPR) to create a statewide notification system to let people know when potentially dangerous pesticides will be applied near them.

On Monday, the DPR officially launched that system in Kern County, where Santoyo lives. SprayDays showcases upcoming applications of pesticides classified by the state as "restricted materials" in fields across California between 48 and 24 hours in advance. People can register to get notifications about pesticide applications within one square-mile of their homes, workplaces, or schools.

The notification system details the intended application time, the product and its active ingredient, the application method (ground or by air), and the area where it will be applied.

"This system builds on more than 60 years of public pressure to end pesticide secrecy in California," said Mark Weller, campaign director at Californians for Pesticide Reform, the coalition that led the push to get the

system approved."These communities have been demanding a heads up so that people can take precautions."

Read More

EHN, 26-03-25

https://www.ehn.org/california-pesticides-sprayday-2671517106.html

EUROPE

Printing inks and adhesive chemicals detected in a wide variety of foods

2025-03-10

Scientists analyze a diversity of food samples available on the Belgian market for the presence of 110 printing ink and adhesive chemicals; detect target compounds in 39 out of 52 samples; chemicals include suspect carcinogen and caprolactam above legislative limit; while there is no European printing ink regulation, national positive lists exist for Switzerland and Germany

Printing inks and adhesives are commonly used on food packaging and their chemicals can migrate into foodstuffs. For instance, phthalates have been found to migrate from adhesive labels into fruits and vegetables (FPF reported). Scientists have identified 7413 substances that are known to be used in printing inks and adhesives applied to plastic food packaging, of which they ranked 636 as high priority substances due to their health concerns (FPF reported). But a broad assessment of ink and adhesive chemicals in food is missing.

Bram Miserez from Ciboris, Zwijnaarde, Belgium, and co-authors analyzed 52 food samples for the presence of 110 chemicals used in printing inks and adhesives. In their article, published on February 24, 2025, in the journal Food Chemistry, they reported that the majority of the analyzed food samples (39 samples) contained at least one of the target chemicals. Caprolactam (CAS 105-60-2) usually used in synthetic fibers and a known skin and eye irritant was one of the most commonly detected chemicals and its levels were above the legislative limit. One sample contained the primary aromatic amine and suspect carcinogen 2-methyl-5-nitroaniline (CAS 99-55-8). Overall, 16 of the 110 chemicals were present in at least one sample. Based on these results, the scientists called for the regular assessment of printing ink and adhesive chemicals in foodstuffs. Printing

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inks have previously been identified as priority products by the US state of Washington due to concerns that they release polychlorinated biphenyls (PCBs, FPF reported).

Read More

FPF, 10-03-25

https://foodpackagingforum.org/news/printing-inks-and-adhesive-chemicals-detected-in-a-wide-variety-of-foods

Paris approves making 500 streets car-free

2025-03-24

Parisians have approved an ambitious plan to block 500 streets to road traffic and replace miles of asphalt with plants and trees, signaling a willingness to support climate policies even if they might have a disruptive impact on daily life.

The nonbinding proposal by Mayor Anne Hidalgo passed with nearly 66 percent of the vote, according to returns published Monday, after residents age 16 or over headed to the polls Sunday.

While the proposal's supporters say the program will make the city more livable and help combat climate change, critics say the changes will make the city more difficult to navigate and further fuel the divide between Parisians and those who live in the suburbs.

"With this vote, Parisians have the choice of whether or not to accelerate Paris's adaptation to climate change, the fight against pollution and the improvement of the living environment within 300 meters of their homes,"

Read More

The Washington Post, 24-03-25

https://www.washingtonpost.com/world/2025/03/23/paris-car-free-vote-anne-hidalgo/

Europe can't build a green industrial future with yesterday's chemicals. Here's what needs to be done

2025-03-24

Europe has turned to industrial policy to future-proof its economy and combat climate change. But without simultaneously tackling the chemical pollution crisis, the EU's industrial policy plan could cripple the very

economy it's trying to strengthen. Here's how to protect people and planet and boost industry at the same time.

Last month, the European Union presented what it calls a Clean Industrial Deal, a bold attempt to boost Europe's competitiveness while tackling the climate crisis. This "industrial deal" is the latest example of industrial policies being back — with a bang!

Some of you may say "industrial-what-now?!" and some of you may not have noticed the trend. But it's a bang, alright.

Read More

Chemsec, 24-03-25

https://chemsec.org/europe-cant-build-a-green-industrial-future-with-yesterdays-chemicals-heres-what-needs-to-be-done/

Revealed: EU to label toxic substances as 'green'

2025—03-20

Proposals to water down European legislation will allow major investments to be labelled green and sustainable, even though the companies they support are using toxic substances in their products, ChemSec can reveal.

PRESS RELEASE: The small print of draft legislation published by Brussels last month contains proposals to allow thousands of substances to be categorised as "sustainable", despite documented concerns over their health effects.

These include galaxolide, a hormone disruptor used in cosmetics and fragrances, and NBBS, a high-volume commercial plastic softener that is neurotoxic and has been found to induce spastic myelopathy in rabbits.

They also include TFA, a PFAS "forever chemical", the build-up of which in drinking water across Europe is a major concern given fears that it damages the unborn child.

Read More

Chemsec, 20-03-25

https://chemsec.org/revealed-eu-to-label-toxic-substances-as-green/

Call for comments: draft Risk Profile of substances proposed as POPs

2025-03-26

Deadline: 19 May 2025

The UK is a party to the United Nations' Stockholm Convention on POPs, which are substances that persist in the environment, accumulate in living organisms and pose a risk to our health and the environment.

They can be transported by air, water or migratory species across international borders, reaching regions where they have never been manufactured or used.

The Department for Environment, Food and Rural Affairs (Defra) invites stakeholders to provide comments on the draft Risk Profile (RP) for the following substance group:

- Polybrominated dibenzo-p-dioxins and dibenzofurans (PBDD/Fs), including mixed polybrominated/chlorinated dibenzo-p-dioxins and dibenzofurans (PBCDD/Fs), a group of chemical substances proposed as POPs to the UN's POPs Review Committee (POPRC)

PBDD/Fs and PBCDD/Fs are being considered for inclusion in Annex C of the Stockholm Convention. While there is no evidence of intentional manufacture, these substances are unintentionally generated through thermal processes involving brominated flame retardants (BFRs), including the uncontrolled burning of waste containing BFRs such as polybrominated diphenyl ethers (PBDEs).

The RP provides further analysis of the data submitted in the original proposal and evaluates the recommendation to list these substances as POPs. It also outlines evidence that demonstrates how these substances meet the criteria for POP classification.

Read More

UKGOV, 26-03-25

https://www.gov.uk/government/publications/call-for-comments-draft-risk-profile-of-a-substance-proposed-as-a-persistent-organic-pollutant-pop-2025

REACH Update

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Member States plan to evaluate 28 substances in 2025-2027

2025-03-26

Based on the Member State Committee's opinion, we have adopted and published the Community rolling action plan (CoRAP) for 2025-2027 on 25 March 2025.

Eight substances are planned to be evaluated in 2025, while twenty are listed for 2026 and 2027.

Registrants who need to update their dossiers with new relevant information, such as hazard, tonnages, use, and exposure, can follow this guide for advice.

Read More

ECHA, 26-03-25

https://echa.europa.eu/documents/10162/879660/corap_update_2025-2027_en.pdf/2a2c35da-f341-d0b1-6802-9aab4685e576#msdynttrid=v8NEyLI9kK3R1H6s8nlbaAC-2yjZXRltO5V5mVQDk7M

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Chemistry Comics

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https://www.smbc-comics.com/

Nitric Acid

2025-04-04

USES [2,3]

Nitric acid is used in a wide variety of chemical processes where cleaning, oxidising or etching is required, including making synthetic fibres, dying, electrical circuit board making, electroplating, explosives, laboratory chemicals, metal cleaning and etching, semiconductors, pharmaceutical manufacture. It is used in the manufacture of fertilisers and other organic chemicals, in the printing industry for photoengraving, in jewellery manufacturing, and for wet chemical etching.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- **Industry sources:** Released from industries producing, using or handling nitric acid, for example chemical plants, metal, electronic, printing, glass, rubber and plastics plants and industries. Where ever very high temperature combustion takes place in the atmosphere in the presence of nitrogen, oxygen and water. May be present in small amounts in some wastewater from intensive farm factories and other facilities, which produce wastewater containing high level of nitrogen.
- **Diffuse sources:** May be present in exhaust gases from motor vehicles, the exhaust of incinerators or other chemical plants, or where these are in contact with moisture in the air. Unlikely to persist in nature because it readily reacts with a wide variety of naturally occurring substances.
- **Natural sources:** Rare in nature as a gas in the atmosphere, in groundwater around active volcanic regions, or drainage from areas where accumulated organic or animal wastes are present.
- **Transport sources:** Exhaust chambers in motor vehicles.
- **Consumer products:** Could be retained as small amounts in products where it has been used in the manufacturing or treatment process.

Routes of Exposure

The major routes of exposure to nitric acid are:

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

Nitric acid, also known as aqua fortis and spirit of niter, is a highly corrosive strong mineral acid with the molecular formula HNO3. The pure compound is colourless, but older samples tend to acquire a yellow cast due to decomposition into oxides of nitrogen and water. Most commercially available nitric acid has a concentration of 68%. When the solution contains more than 86% HNO3, it is referred to as fuming nitric acid. Depending on the amount of nitrogen dioxide present, fuming nitric acid is further characterised as white fuming nitric acid or red fuming nitric acid, at concentrations above

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HEALTH EFFECTS [4]

Acute Health Effects

- Nitric acid is irritating and corrosive to all tissues with which it comes into contact. The severity of effects is dependent upon concentration and duration of exposure.
- Acute inhalation of nitric acid vapour can lead to symptoms such as ocular and nasal irritation, sore throat, cough, chest tightness, headache, ataxia and confusion
- In severe cases, pulmonary oedema may develop hours or days following exposure
- Acute ingestion may cause burns to the oesophagus and stomach, which can include ulceration, haemorrhage and perforation. Abdominal pain, difficulty swallowing, nausea, salivation, vomiting, diarrhoea and haematemesis may also occur, and in some cases may be fatal
- Dermal exposure may result in deep burns, blisters and permanent scarring
- Ocular exposure may cause corneal burns, lacrimation, conjunctivitis, photophobia and, in severe cases, could lead to permanent blindness

Other Effects

- Chronic inhalation exposure to nitric acid can cause respiratory irritation, leading to bronchitis and airways hyperreactivity and erosion of dental enamel.
- Chronic ingestion is unlikely due to the adverse effect of acute ingestion
- Dermal exposure to low concentrations of nitric acid can result in dermatitis
- Nitric acid is not considered to be carcinogenic or mutagenic

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. 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. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
- **Serious Inhalation:** Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
- **Ingestion:** Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Workplace Controls & Practices [4]

Exhaust ventilation or other engineering controls should be provided to keep the airborne concentrations of vapours below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the workstation location.

Personal Protective Equipment [5]

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

- Face shield;
- Full suit;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves;
- Boots

Personal Protective Equipment in Case of a Large Spill:

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

REGULATION

United States

NIOSH: The National Institute for Occupational Safety & Health has established a Recommended Exposure Limit (REL) for nitric acid of TWA 2 ppm (5 mg/m^3) and short-term concentrations of 4 ppm (10 mg/m^3)

OSHA: The Occupational Safety and Health Administration has set a Permissible Exposure Limit (PEL) for nitric acid of TWA 2 ppm (5 mg/m^3)

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Curiosity Rover Detects Largest Organic Compounds Ever Found on Mars

2025-03-25

The finding expands on the kinds of ancient molecules that can be preserved in the Martian surface.

Scientists analyzing pulverized rock onboard NASA's Curiosity rover have found the largest organic compounds on the Red Planet to date. The finding, published Monday in the Proceedings of the National Academy of Sciences, suggests prebiotic chemistry may have advanced further on Mars than previously observed.

Scientists probed an existing rock sample inside Curiosity's Sample Analysis at Mars (SAM) mini-lab and found the molecules decane, undecane, and dodecane. These compounds, which are made up of 10, 11, and 12 carbons, respectively, are thought to be the fragments of fatty acids that were preserved in the sample. Fatty acids are among the organic molecules that on Earth are chemical building blocks of life.

Living things produce fatty acids to help form cell membranes and perform various other functions. But fatty acids also can be made without life, through chemical reactions triggered by various geological processes, including the interaction of water with minerals in hydrothermal vents.

While there's no way to confirm the source of the molecules identified, finding them at all is exciting for Curiosity's science team for a couple of reasons.

Curiosity scientists had previously discovered small, simple organic molecules on Mars, but finding these larger compounds provides the first evidence that organic chemistry advanced toward the kind of complexity required for an origin of life on Mars.

The new study also increases the chances that large organic molecules that can be made only in the presence of life, known as "biosignatures," could be preserved on Mars, allaying concerns that these compounds get destroyed after tens of millions of years of exposure to intense radiation and oxidation.

This finding bodes well for plans to bring samples from Mars to Earth to analyze them with the most sophisticated instruments available here, the scientists say.

"Our study proves that, even today, by analyzing Mars samples we could detect chemical signatures of past life, if it ever existed on Mars,"

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said Caroline Freissinet, the lead study author and research scientist at the French National Centre for Scientific Research in the Laboratory for Atmospheres, Observations, and Space in Guyancourt, France.

In 2015, Freissinet co-led a team that, in a first, conclusively identified Martian organic molecules in the same sample that was used for the current study. Nicknamed "Cumberland," the sample has been analyzed many times with SAM using different techniques.

Curiosity drilled the Cumberland sample in May 2013 from an area in Mars' Gale Crater called "Yellowknife Bay." Scientists were so intrigued by Yellowknife Bay, which looked like an ancient lakebed, they sent the rover there before heading in the opposite direction to its primary destination of Mount Sharp, which rises from the floor of the crater.

The detour was worth it: Cumberland turns out to be jam-packed with tantalizing chemical clues to Gale Crater's 3.7-billion-year past. Scientists have previously found the sample to be rich in clay minerals, which form in water. It has abundant sulfur, which can help preserve organic molecules. Cumberland also has lots of nitrates, which on Earth are essential to the health of plants and animals, and methane made with a type of carbon that on Earth is associated with biological processes.

Perhaps most important, scientists determined that Yellowknife Bay was indeed the site of an ancient lake, providing an environment that could concentrate organic molecules and preserve them in fine-grained sedimentary rock called mudstone.

"There is evidence that liquid water existed in Gale Crater for millions of years and probably much longer, which means there was enough time for life-forming chemistry to happen in these crater-lake environments on Mars," said Daniel Glavin, senior scientist for sample return at NASA's Goddard Space Flight Center in Greenbelt, Maryland, and a study co-author.

The recent organic compounds discovery was a side effect of an unrelated experiment to probe Cumberland for signs of amino acids, which are the building blocks of proteins. After heating the sample twice in SAM's oven and then measuring the mass of the molecules released, the team saw no evidence of amino acids. But they noticed that the sample released small amounts of decane, undecane, and dodecane.

Because these compounds could have broken off from larger molecules during heating, scientists worked backward to figure out what structures

they may have come from. They hypothesized these molecules were remnants of the fatty acids undecanoic acid, dodecanoic acid, and tridecanoic acid, respectively.

The scientists tested their prediction in the lab, mixing undecanoic acid into a Mars-like clay and conducting a SAM-like experiment. After being heated, the undecanoic acid released decane, as predicted. The researchers then referenced experiments already published by other scientists to show that the undecane could have broken off from dodecanoic acid and dodecane from tridecanoic acid.

The authors found an additional intriguing detail in their study related to the number of carbon atoms that make up the presumed fatty acids in the sample. The backbone of each fatty acid is a long, straight chain of 11 to 13 carbons, depending on the molecule. Notably, non-biological processes typically make shorter fatty acids, with less than 12 carbons.

It's possible that the Cumberland sample has longer-chain fatty acids, the scientists say, but SAM is not optimized to detect longer chains.

Scientists say that, ultimately, there's a limit to how much they can infer from molecule-hunting instruments that can be sent to Mars. "We are ready to take the next big step and bring Mars samples home to our labs to settle the debate about life on Mars," said Glavin.

Technology Networks, 25 March 2025

https://technologynetworks.com

Mercury-free electrochemical lithium isotope separation could fuel a fusion future

2025-04-01

A cheap and non-toxic way to selectively separate lithium isotopes – without using huge amounts of mercury – could help supply the future fuel needs of fusion reactors. The new approach uses a porous vanadium oxide compound that acts as an isotope-sensitive filter, sequestering the lighter lithium-6 isotope, while allowing lithium-7 to pass through faster. 'If nuclear fusion plans become a reality, we'll need to produce tonnes of lithium-6 per day and I think that this would be a very competitive method for doing so,' says Sarbajit Banerjee of ETH Zürich in Switzerland and Texas A&M University in the US who led the study.

Promising advances in nuclear fusion have sparked renewed interest in this technology as a sustainable energy source and lithium-6 plays a key

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role in the process. But the standard method for isolating this isotope from the much more abundant lithium-7 isotope requires a lot of mercury to take advantage of the fact that lithium isotopes have varying solubility in amalgams. The demand for so much of this heavy metal led to the conventional approach being banned in the US over 60 years ago.

'The most common fusion process involves a deuterium–tritium reaction, but tritium is pretty rare, so the idea is to generate it on site,' says Banerjee. He explains that this is done by bombarding a lithium-containing material with neutrons. 'The light stable isotope lithium-6 is a superb neutron absorber and is therefore useful for the production of tritium,' comments Abby Kavner from the University of California, Los Angeles, who wasn't involved in the study.

Banerjee points out that only about 7% of all the lithium in the world is lithium-6. That's why his team have focused on extracting this important isotope from fracking and oil drilling wastewater. 'We're flowing water streams through something that looks like a desalination cell and are electrochemically capturing the lithium inside empty spaces of the vanadium oxide,' Banerjee says. He explains that the porous material acts as a cathode that captures the positively charged lithium ions from the solution within its tunnelled structure when a voltage is applied to the system. The process can separate the two isotopes because the lithium-6 ions bind more strongly to the vanadium oxide, while the lithium-7 ions are able to pass through. 'If you think of the bonds between V2O5 and lithium as a spring, you can imagine that lithium-7 is heavier and more likely to break that bond, whereas lithium-6, because it's lighter, reverberates less and makes a tighter bond,' explains co-first author Andrew Ezazi of Texas A&M. The researchers are now taking steps to scale up their process.

Kavner adds that vanadium plays a key role in this process due to its electrochemical properties. 'The result is an inexpensive, non-toxic electrochemical filter that can not only isolate lithium ions from multicomponent solutions, but also control the relative rates of migration of the lithium isotopes through the filters,' she says. 'The resulting single-pass isotope enrichment factors improve by almost 15%, which seems modest but compounds during the multi-pass enrichment process.'

'You have to run the process multiple times – probably 20 times or more – looping it around to get increasingly pure lithium-6,' explains Banerjee. 'And of course it depends on the lithium source you're using. If you use a dirty water source, that's a bit more complicated. If you use a pretty clean

source of highly enriched lithium brine and all you want to do is isotope separation, that's easier.' Banerjee notes that under ideal conditions, it's possible to achieve 30% lithium-6 enrichment within 25 cycles and that an enrichment of up to 90% can be reached after 45 cycles.

sChemistry World, 1 April 2025

https://chemistryworld.com

New plastic dissolves in the ocean overnight, leaving no microplastics

2025-03-27

Plastics are durable and strong, which is great while they're being used but frustrating when they end up in the environment. Scientists at RIKEN in Japan have developed a new type of plastic that's just as stable in everyday use but dissolves quickly in saltwater, leaving behind safe compounds.

The benefit of plastics is that they're made with strong covalent bonds that hold their molecules together, meaning they take a lot of energy to break. This is why they're so sturdy, long-lasting and perfect for everything from packaging to toys.

But those same strong bonds become a problem after the useful life of a plastic product is over. That cup you used once and threw away will sit in landfill for decades, even centuries, before it fully breaks down. And when it does, it forms microplastic pieces that are turning up in all corners of the natural world, including our own bodies, where they wreak havoc on our health in ways we're only just beginning to understand.

RIKEN researchers have now developed a new type of plastic that can work just as well as the regular stuff when it's needed, and break down readily into safe compounds when it's not. It's made of what are known as supramolecular polymers, which have reversible bonds that function like sticky notes that can be attached, removed and reattached, according to the team.

The team wanted to make a specific type of supramolecular polymer that would be strong enough for the usual uses of plastic, but could also be made to break down quickly when required, under mild conditions and leaving only non-toxic compounds.

After screening a range of molecules, the researchers identified a particular combination that seemed to have the right properties – sodium

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hexametaphosphate, which is a common food additive, and monomers based on guanidinium ions, which are used in fertilizers. When these two compounds are mixed together in water, they form a viscous material that can be dried to form plastics.

A reaction between the two ingredients forms "salt bridges" between the molecules that make the material strong and flexible, like conventional plastic. However, when they're soaked in saltwater, the electrolytes unlock those bonds, and the material dissolves.

In practice, the team found that the material was just as strong as normal plastic during use, and was non-flammable, colorless and transparent. Immersed in saltwater though, the plastic completely dissolved in about eight and a half hours.

There's one major hurdle with any degradable plastic material of course: what if it comes into contact with the catalyst for its destruction before you want it to? A plastic cup is no good if certain liquids can dissolve it, after all.

In this case, the team found that applying hydrophobic coatings prevented any early breaking down of the material. When you eventually want to dispose of it, a simple scratch on the surface was enough to let the saltwater back in, allowing the material to dissolve just as quickly as the non-coated sheets.

While some biodegradable plastics can still leave behind harmful microplastics, this material breaks down into nitrogen and phosphorus, which are useful nutrients for plants and microbes. That said, too much of these can be disruptive to the environment as well, so the team suggests the best process might be to do the bulk of the recycling in specialized plants, where the resulting elements can be retrieved for future use.

But if some of it does end up in the ocean, it will be far less harmful, and possibly even beneficial, compared to current plastic waste.

A paper describing the research was published in the journal Science.

New Atlas, 27 March 2025

https://newatlas.com

Scientists Discover New Heavy Metal Molecule "Berkelocene"

2025-03-11

This is the first organometallic molecule to be characterized containing the heavy element berkelium.

A research team led by the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) has discovered "berkelocene," the first organometallic molecule to be characterized containing the heavy element berkelium.

Organometallic molecules, which consist of a metal ion surrounded by a carbon-based framework, are relatively common for early actinide elements like uranium (atomic number 92), but they are scarcely known for later actinides like 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.

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.

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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.

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.

"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.

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.

Technology Networks, 11 March 2025

https://technologynetworks.com

A New Breakthrough in Methane-to-Ethanol Conversion Offers Hope For Cleaner Energy

2025-03-18

An international team of scientists has reached a major milestone in sustainable energy research, developing a highly efficient method for converting methane into ethanol.

Their findings, published in Nature, highlight a photocatalytic approach that achieves an impressive 80 % selectivity and a methane conversion rate of 2.3 % in a single run using a packed-bed flow reactor. The system also boasts an apparent quantum efficiency (AQE) of 9.4 %, a strong indicator of its effectiveness in converting light into usable energy.

Background

Ethanol is widely recognized as a key component in the energy sector, serving as a liquid hydrogen carrier and a crucial feedstock for various industrial applications aimed at reducing carbon emissions. The global ethanol market exceeds $100 billion, with a steady annual growth rate of around 7 %. Meanwhile, methane—abundant in natural and shale gas—continues to be underutilized, often flared for heating despite its potential as a valuable chemical feedstock. However, its chemical stability presents significant challenges for efficient conversion.

Traditional methods rely on high-temperature, high-pressure syngas processes, which are both energy-intensive and inefficient in product selectivity. Direct methane-to-ethanol conversion has remained elusive due to difficulties in achieving selective carbon-carbon (C-C) coupling.

A New Approach to Catalytic Conversion

The breakthrough stems from the use of a covalent triazine framework (CTF-1) polymer, which features a unique intramolecular junction between

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alternating benzene and triazine units. This design enhances charge separation and prolongs charge lifetimes, while also enabling targeted adsorption of oxygen and water molecules.

This structure facilitates precise C-C coupling, minimizing the risk of overoxidation into carbon dioxide and water. When further enhanced with platinum, the catalyst demonstrates a highly promising ethanol production rate.

Comparison to Traditional Methods

Conventional methane conversion methods, such as Fischer-Tropsch synthesis, require extreme temperatures (> 700 °C) and pressures (~20 bar) to activate methane's strong C-H bonds. These processes demand high energy input and multiple conversion steps.

Previous attempts at photocatalytic conversion have struggled with either low selectivity or efficiency due to limitations in catalyst design. The newly developed CTF-1 catalyst outperforms these methods, achieving over 20 times higher quantum efficiency while maintaining high selectivity.

Potential Applications and Broader Impacts

Methane, though a valuable resource, is also a potent greenhouse gas. Converting it directly into ethanol through a single-step photocatalytic process offers a promising route toward decarbonizing the chemical and fuel industries. Ethanol, being a liquid, is easier to store, transport, and distribute compared to gaseous hydrogen. It can be directly reformed onboard low-carbon vehicles, including those in urban transport, shipping, and emerging low-altitude aviation sectors. This advancement could play a crucial role in achieving carbon neutrality.

Future Research and Development

The research team, led by Professor Guo, plans to refine the catalyst design and further optimize the conversion process. These efforts will be part of a broader collaboration under the UGC Theme-Based Research Scheme and the RGC-EU Collaborative Innovation Scheme, aimed at accelerating sustainable chemical production.

With methane utilization remaining a key challenge in the transition to cleaner energy, this breakthrough offers a practical and scalable solution, opening new doors for the future of low-carbon fuel technologies.

Azo Materials, 18 March 2025

https://azom.com

Nuclear fusion fuel could be made greener with new chemical process

2025-03-20

Lithium-6 is a crucial material for nuclear fusion reactors, but isolating it is challenging – now researchers have found a way to do this without using toxic mercury

Limitless power from nuclear fusion may be a step closer following the accidental discovery of a new process to supply the isotope lithium-6, which is vital to providing fuel for a sustainable fusion reactor.

The least challenging fusion process involves combining two isotopes of hydrogen, deuterium and tritium, to yield helium, a neutron and a lot of energy. Tritium, a rare, radioactive isotope of hydrogen, is difficult and expensive to source. "Breeder" reactors seek to manufacture tritium by bombarding lithium with neutrons.

Lithium atoms exist as two stable isotopes: lithium-7 makes up 92.5 per cent of the element in nature and the rest is lithium-6. The rarer isotope reacts much more efficiently with neutrons to produce tritium in a fusion reaction.

However, the two lithium isotopes are extremely difficult to separate. Until now, this has only been achieved at a large scale using a highly toxic process reliant on mercury. Due to the environmental impact, this process has not been employed in Western countries since the 1960s and researchers are forced to rely on dwindling stockpiles of lithium-6 produced before the ban.

Sarbajit Banerjee at ETH Zurich in Switzerland and his colleagues have now discovered an alternative method serendipitously, while they were looking at ways to clean water contaminated by oil drilling.

The researchers noticed that the cement membranes they employed, containing a lab-made compound called zeta vanadium oxide, collected

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large quantities of lithium and seemed to disproportionately isolate lithium-6.

Zeta vanadium oxide contains tunnels surrounded by oxygen atoms, says Banerjee. "Lithium ions move through these tunnels, which happen to be just the right size [to bind lithium-6]," he says. "We found that lithium-6 ions are bound more strongly and are retained within the tunnels."

The researchers don't fully understand why lithium-6 is preferentially retained, but based on simulations, they believe it has to do with the interactions between the ions and the atoms at the edges of the tunnels, says Banerjee.

He says they have only isolated less than a gram of lithium-6 so far, but they hope to scale up the process so it can produce tens of kilograms of the isotope. A commercial fusion reactor is expected to need tonnes of the element every day.

"However, these challenges pale in comparison to the bigger challenges with plasma reactors and laser ignition for fusion," says Banerjee.

New Scientist, 20 March 2025

https://newscientist.com

Frontier molecular orbital theory aids single-atom catalyst design

2025-04-02

Single-atom catalysts (SACs), with their excellent metal atom utilization and unique physicochemical properties, hold promise for broad applications, especially in heterogeneous catalysis and energy conversions. Essentially, the activity and stability of SACs are governed by the pair of metal-adsorbate and metal-support interactions. However, the rationale of these interactions with their catalytic performance of SACs in nature and a unified theoretical model to describe both activity and stability remain elusive.

To address this challenge, a team led by Prof. Lu Junling from the University of Science and Technology of China (USTC), along with Prof. Wu Xiaojun from USTC and Associate Researcher Yang Bing from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS), innovatively introduced the frontier molecular orbital (FMO) theory into SAC design. The study was published in Nature.

In this work, the team constructed 34 palladium (Pd) SACs on 14 semiconductor supports. By adjusting support size and composition, they were able to precisely tune the lowest unoccupied molecular orbital (LUMO) and highest occupied molecular orbital (HOMO) energy levels of the supports. The energy positions of LUMO and HOMO with particle size were experimentally determined by ultraviolet-visible (UV-Vis) spectroscopy and Mott–Schottky plots.

Aberration-corrected high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) confirmed atomic dispersion of Pd on metal oxide particles (MOx). In situ diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS) and X-ray photoelectron spectroscopy (XPS) further demonstrated enhanced Pd-MOx electronic interactions.

In the reaction of semi-hydrogenation of acetylene, Pd SACs supported on nanoscale ZnO and CoOx exhibited a 20-fold activity enhancement over bulk oxide-supported counterparts while maintaining high selectivity. Notably, Pd1 SACs on 1.9 nm ZnO achieved a remarkable turnover frequency (TOF) of 25.6 min^{-1} at 80 °C, surpassing all the Pd1 SACs reported in the literature. These catalysts also demonstrated exceptional stability over 100 hours without coke formation or metal aggregation.

Correlation of the intrinsic activities with the properties of Pd1 discloses that the activities of Pd1/MOx SACs didn't show a clear correlation with the Pd charge states. In contrast, their activities showed a linear scaling relationship with the LUMO positions of the n- and p-type oxide particle supports in Pd1/MOx.

Theoretical calculations elucidated the underlying mechanism: reducing ZnO size elevates its LUMO level and widens the bandgap. The elevated LUMO of support reduces its energy gap with the HOMO of Pd1 atoms, which promotes Pd1–support orbital hybridizations for high stability.

Meanwhile, the variation of Pd1–support orbital hybridizations further amends the LUMO of anchored Pd1 atoms to enhance Pd1–adsorbate interactions for high activity. These findings are consistent with the FMO theory.

This work presents the first direct experimental substantiation of FMO theory in full view and provides a general descriptor for the design of a highly active and stable SAC for the first time. These findings open a new and operational approach for high-throughput screening of proper metal-

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support pairs to achieve high activity and stability, particularly powered by artificial intelligence.

Phys Org, 2 April 2025

https://phys.org

Novel nuclear rocket fuel test could accelerate NASA's Mars mission

2025-04-02

A team from the Department of Energy's Oak Ridge National Laboratory, joined by university students, recently traveled to The Ohio State University Research Reactor to conduct a novel experiment on nuclear thermal rocket fuel coatings—one that could help propel NASA's astronauts to Mars faster and more efficiently.

"Our experiment aimed to test a fuel coating technique and evaluate if it can withstand the intense environment of a nuclear thermal rocket," said Brandon Wilson, an R&D staff member in ORNL's Nuclear and Extreme Environment Measurement group. "Testing materials at exceptionally high temperatures is a first and a crucial step toward helping NASA mature and qualify nuclear fuels for manned space exploration using nuclear thermal propulsion technology."

Nuclear thermal propulsion, or NTP, is a potentially game-changing technology for NASA's crewed missions to Mars in the 2040 timeframe. NTP engines use a nuclear reactor to heat hydrogen to ultra-high temperatures and then expel the heated hydrogen through a nozzle, which generates thrust and moves the rocket through space more efficiently than a traditional chemical rocket. In effect, NTP engines could drastically reduce transit times to Mars while reducing overall mission costs and the effects of radiation and zero gravity on astronauts.

However, developing and testing materials to withstand conditions unlike anything else on Earth has remained a challenge.

ORNL has pioneered a technique to coat fuel and reactor core materials in zirconium carbide, which can protect these critical components from hydrogen infiltration and corrosion without impacting the reactor's neutronics. To test this coating under the combined effects of high temperature and high radiation, researchers in the lab's Nuclear and Extreme Environment Measurement group designed the In-Pile

Steady-State Extreme Temperature Testbed (INSET), a specialized high-temperature furnace designed to operate within a nuclear reactor.

A second iteration of INSET is now the only available technology that can rapidly heat materials from room temperature to 2,200 degrees Celsius in about five minutes while allowing for quick handling after neutron irradiation.

Developed at ORNL with significant design contributions from University of Tennessee graduate student Emily Hutchins, INSET 2.0 is a cost-effective option for conducting multiple experiments both inside and outside a reactor. Because of its versatile design, INSET can be used to evaluate any research reactor with a port diameter greater than eight inches, offering unmatched versatility for high-temperature materials testing.

INSET was used to perform irradiation testing of coated surrogate particles at The Ohio State University Research Reactor. There, four different nuclear thermal rocket fuel sample surrogates coated in zirconium carbide were placed in INSET and irradiated for two days under repeated temperature cycling.

The experiment team included Wilson, Hutchins, and Bryan Conry, an ORNL post-doc research associate, as well as Pavel Shilenko, a cadet at West Point. Hutchins and Shilenko were the primary operators of the experiment, setting up the INSET furnace and recording data throughout the two-day test.

“I am exceptionally proud of Emily and Pavel,” said Wilson. “Their contributions to this project produced an important milestone for this research, in addition to a learning experience that I hope will shape their future as leaders in nuclear science and engineering.”

Later this spring, the team will conduct post-irradiation analysis at ORNL to assess the coatings’ performance and their ability to protect the fuel under operational conditions.

“The findings from this experiment will represent a crucial step in advancing nuclear thermal propulsion technology for future human space exploration,” said Wilson.

ORNL’s Katherine Montoya, Eddie Lopez Honorato, Craig Gray, Bob Sitterson, Nick Prins and N. Dianne Bull Ezell also contributed to this experiment. The team acknowledges the support of the Ohio State

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University Nuclear Reactor Laboratory and the assistance of the reactor staff members.

Phys Org, 2 April 2025

https://phys.org

X-ray spectroscopy reveals unexpected proton attraction

2025-04-02

Proton transfer in aqueous systems is a fundamental process occurring constantly around us. It involves a molecule losing a proton, which then associates with another molecule. Given its significance in fields such as electrochemistry, energy conversion, and biology, scientists have been rigorously investigating its mechanisms for more than 200 years since the first model was proposed.

Now, an international team of researchers are investigating these dynamics using X-ray spectroscopy, which allows them to examine how individual atoms behave within a molecule. Their experiments were conducted at the Japanese synchrotron-radiation facility SPring-8. The study, now published in the Journal of the American Chemical Society, brought together researchers from Japan, Germany, Russia, Switzerland and Sweden.

“It is not uncommon for X-ray excitations to lead to ultrafast dissociation, where atoms rapidly leave the excited molecule,” explains Zhong Yin, who led the study. “This time, however, we found the complete opposite: the local excitation instead attracts a proton, creating a new kind of state that we call associative.”

Yin and his colleagues selectively excited the aqueous hydroxyl ion (OH–) and investigated the mechanism by which an associative state attracts a proton from neighboring water molecules. They observed a shoulder spectral feature, in addition to the strong local decay in Resonant Inelastic X-ray Scattering (RIXS)—a technique that measures the energy loss of X-rays scattered by atoms, revealing details about the molecular environment. This showed an isotope effect in aqueous OH–/OD–.

Using state-of-the-art cluster calculations, the researchers found that the smaller peak feature comes from an associative state in aqueous OH–, where a proton approaches the OH–/OD– after resonant excitation. This new observation in the scattering process of the solvated hydroxide ion

shows that nuclear dynamics in RIXS can involve associative states, in addition to the dissociative states observed in systems like water and acetic acid.

Victor Kimberg, who led the theoretical analysis, adds that this result not only clarifies the mechanism behind proton transfer, but also broadens the applicability of X-ray spectroscopy. "The atom-specific site-selectivity in RIXS is a crucial advantage compared to alternative photon-based methods and could be an ideal technique for investigating local properties and dynamics in solutions with a wide range of chemical and biological applications."

Phys Org, 2 April 2025

https://phys.org

Researchers recycle wind turbine blade materials to make improved plastics

2025-04-03

A new method to recycle wind turbine blades without using harsh chemicals resulted in the recovery of high-strength glass fibers and resins that allowed Washington State University researchers to re-purpose the materials to create stronger plastics.

The innovation provides a simple and environmentally friendly way to recycle wind turbine blades to create useful products.

Reporting in the journal, Resource, Conservation, and Recycling, the team of researchers cut the lightweight material that is commonly used in wind turbine blades, called glass fiber-reinforced polymer (GFRP), into approximately two inch-sized blocks. They then soaked the flakes in a bath of low-toxicity organic salt in pressurized, superheated water for about two hours to break down the material. They then re-purposed its components to make stronger plastics.

"It works very well, especially considering the mild conditions that we applied," said Cheng Hao, a former graduate student in the School of Mechanical and Materials Engineering and co-first author on the paper. "The solvent is a green solvent, and also the temperature is acceptable for this purpose."

The GFRP material has traditionally been very difficult to recycle. While thermoplastics, the type of plastic used in milk bottles, can be melted and easily re-used, the glass-fiber composites are typically made with

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thermosets. These types of composites are cured and can't easily be undone and returned to their original materials. The first generation of modern wind turbines made of composites from the 1990s are now reaching the end of their lifetimes, creating a significant challenge for disposal. The glass fiber-reinforced material makes up about two-thirds of a wind turbine blade's total weight. Furthermore, when the blades are made, about 15% of the material is also wasted in manufacturing.

"As wind energy grows, recycling and reusing wind turbine waste is becoming increasingly urgent," said Jinwen Zhang, corresponding author and a professor in the School of Mechanical and Materials Engineering. "This recycling method is scalable, cost-effective, and environmentally friendly, providing a sustainable solution for reusing large quantities of glass fiber reinforced waste."

In their work, the researchers soaked the blade material in a mild solution of zinc acetate, which is used in medicines, such as in throat lozenges and food additives. The mild solution allowed the researchers to recover glass fibers and resins in good condition which they then added directly to thermoplastics to produce strong composite materials with up to 70% of the recycled glass fiber materials. Moreover, the researchers were able to recover and reuse most of the catalyzing zinc acetate solution through simple filtration.

"The ease of the catalyst recovery enhances the overall sustainability and cost-effectiveness of the method," said Zhang, who conducts research in the Composite Materials and Engineering Center.

When the researchers added the recycled material to nylon plastic and tested it, they found that the additional fibers made the nylon more than three times stronger and more than eight times stiffer. They also found that the recycled GFRP material can reinforce other plastics, such as polypropylene and the type of plastics used in milk jugs and shampoo bottles.

"For this work, we didn't need to fully break down all the bonds and push the reaction to completion," said Baoming Zhao, co-first author and research assistant professor in the Composite Materials and Engineering Center, "As long as we can break the cross-linked network into smaller pieces, and they are melt processable, we can compound that with nylon and get a new composite. We are not separating the resin from the fiber -- we just blend everything with nylon and get a new composite."

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The researchers are continuing studies to make the chemical conditions even easier for recycling by reducing the requirements for pressurization. Working with WSU's Office of Commercialization they also hope to develop blade materials that are fully recyclable in the first place.

The work was funded by the Department of Energy's Office of Energy Efficiency and Renewable Energy.

Science Daily, 3 April 2025

https://sciencedaily.com

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Curiosities

Brain waves become spoken words in AI breakthrough for paralysis

2025-04-01

California-based researchers have developed an AI-powered system to restore natural speech for paralyzed people in real time and using their own voices.

This new technology from researchers at University of California Berkeley and University of California San Francisco, takes advantage of devices that can tap into the brain to measure neural activity, along with AI that actually learns how to build the sounds of a patient's voice.

That's far ahead of advancements as recent as last year in the field of brain-computer interfaces for synthesizing speech.

"Our streaming approach brings the same rapid speech decoding capacity of devices like Alexa and Siri to neuroprostheses," explained Gopala Anumanchipalli, an assistant professor of electrical engineering and computer sciences at UC Berkeley and co-principal investigator of the study that appeared this week in Nature Neuroscience. "Using a similar type of algorithm, we found that we could decode neural data and, for the first time, enable near-synchronous voice streaming. The result is more naturalistic, fluent speech synthesis."

What's neat about this tech is that it can work effectively with a range of brain sensing interfaces. That includes high-density electrode arrays that record neural activity directly from the brain surface (like the setup the researchers used), as well as microelectrodes that penetrate the brain's surface, and non-invasive Surface Electromyography (sEMG) sensors on the face to measure muscle activity.

Here's how it works. First, the neuroprosthesis fitted to the patient samples neural data from their brain's motor cortex, which controls speech production. AI then decodes that data into speech. Cheol Jun Cho, who co-authored the paper, explained, "... what we're decoding is after a thought has happened, after we've decided what to say, after we've decided what words to use and how to move our vocal-tract muscles."

That AI was trained on brain function data captured from the patient silently attempting to speak the words that appeared on a screen in front of them. This allowed the team to map the neural activity and the words they were trying to say.

In addition, a text-to-speech model – developed using the patient's own voice before they were injured and paralyzed – generates the audio that you can hear from the patient 'speaking.'

In the proof-of-concept demonstration above, it appears the resulting speech isn't entirely perfect or completely naturally paced, but it's darn close. The system begins decoding brain signals and outputting speech within a second of the patient attempting to speak; that's down from 8 seconds in a previous study the team conducted in 2023.

This could greatly improve the quality of life for people with paralysis and similar debilitating conditions like ALS, by helping them communicate everything from their day-to-day needs to their complex thoughts and connect with loved ones more naturally.

The researcher's next steps will see them speed up the AI's processing for generating speech more quickly and explore ways to make the output voice more expressive.
New Atlas, 1 April 2025

https://newatlas.com

Mercury-free electrochemical lithium isotope separation could fuel a fusion future

2025-04-01

A cheap and non-toxic way to selectively separate lithium isotopes – without using huge amounts of mercury – could help supply the future fuel needs of fusion reactors. The new approach uses a porous vanadium oxide compound that acts as an isotope-sensitive filter, sequestering the lighter lithium-6 isotope, while allowing lithium-7 to pass through faster. 'If nuclear fusion plans become a reality, we'll need to produce tonnes of lithium-6 per day and I think that this would be a very competitive method for doing so,' says Sarbajit Banerjee of ETH Zürich in Switzerland and Texas A&M University in the US who led the study.

Promising advances in nuclear fusion have sparked renewed interest in this technology as a sustainable energy source and lithium-6 plays a key role in the process. But the standard method for isolating this isotope from the much more abundant lithium-7 isotope requires a lot of mercury to take advantage of the fact that lithium isotopes have varying solubility in amalgams. The demand for so much of this heavy metal led to the conventional approach being banned in the US over 60 years ago.

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'The most common fusion process involves a deuterium–tritium reaction, but tritium is pretty rare, so the idea is to generate it on site,' says Banerjee. He explains that this is done by bombarding a lithium-containing material with neutrons. 'The light stable isotope lithium-6 is a superb neutron absorber and is therefore useful for the production of tritium,' comments Abby Kavner from the University of California, Los Angeles, who wasn't involved in the study.

Banerjee points out that only about 7% of all the lithium in the world is lithium-6. That's why his team have focused on extracting this important isotope from fracking and oil drilling wastewater. 'We're flowing water streams through something that looks like a desalination cell and are electrochemically capturing the lithium inside empty spaces of the vanadium oxide,' Banerjee says. He explains that the porous material acts as a cathode that captures the positively charged lithium ions from the solution within its tunnelled structure when a voltage is applied to the system. The process can separate the two isotopes because the lithium-6 ions bind more strongly to the vanadium oxide, while the lithium-7 ions are able to pass through. 'If you think of the bonds between V2O5 and lithium as a spring, you can imagine that lithium-7 is heavier and more likely to break that bond, whereas lithium-6, because it's lighter, reverberates less and makes a tighter bond,' explains co-first author Andrew Ezazi of Texas A&M. The researchers are now taking steps to scale up their process.

Kavner adds that vanadium plays a key role in this process due to its electrochemical properties. 'The result is an inexpensive, non-toxic electrochemical filter that can not only isolate lithium ions from multicomponent solutions, but also control the relative rates of migration of the lithium isotopes through the filters,' she says. 'The resulting single-pass isotope enrichment factors improve by almost 15%, which seems modest but compounds during the multi-pass enrichment process.'

'You have to run the process multiple times – probably 20 times or more – looping it around to get increasingly pure lithium-6,' explains Banerjee. 'And of course it depends on the lithium source you're using. If you use a dirty water source, that's a bit more complicated. If you use a pretty clean source of highly enriched lithium brine and all you want to do is isotope separation, that's easier.' Banerjee notes that under ideal conditions, it's

possible to achieve 30% lithium-6 enrichment within 25 cycles and that an enrichment of up to 90% can be reached after 45 cycles.

Chemistry World, 1 April 2025

https://chemistryworld.com

PFAS From Fluorochemical Plant Found in Household Dust

2025-04-01

Researchers from the GenX Exposure Study have detected PFAS (per- and polyfluoroalkyl substances) associated with a nearby fluorochemical plant in the household dust of homes located in Cumberland and Bladen counties, North Carolina. Homes closer to the plant had higher concentrations of those specific PFAS than homes located farther away.

Additionally, the researchers detected high levels of other PFAS not necessarily associated with the fluorochemical plant in over 90% of samples taken from homes. Overall, the findings indicate that household dust can be an additional PFAS exposure source.

"PFAS exposure via contaminated well water is relatively well studied but, given the air emissions from the plant, we wanted to learn whether household dust was also a source of exposure," says Nadine Kotlarz, assistant professor of civil, construction, and environmental engineering, member of North Carolina State University's Center for Human Health and the Environment (CHHE), and corresponding author of the work.

In February 2019, the team collected dust samples from 65 homes located within ~6 miles (9 km) of the plant; these homes had previously undergone well-water testing as part of the GenX Exposure Study. They targeted 48 PFAS, including 12 PFEAs (or per- and polyfluoroalkyl ether acids, a subset of PFAS) specifically associated with the fluorochemical plant that were also detected in the drinking water wells of nearby residents. They also included ultrashort chain PFAS in the testing due to increasing reports of their presence in dust and people.

Every dust sample had at least one PFAS detected. GenX was present in 89% of the samples, and an additional six of the 12 PFEAs were detected in over 75% of the samples. Dust concentrations of six PFEAs (PEPA, PMPA, PFMOAA, PFO2HxA, GenX, and Nafion byproduct 2) decreased significantly as home distance from the fluorochemical plant increased.

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The team also found TFA, an ultrashort chain PFAS, in 89% of dust samples. This compound had the highest median concentration of the 48 targeted PFAS in the study. Ultrashort chain PFAS like TFA are an emerging class of PFAS that originate from breakdown of refrigerants.

"For people living near the fluorochemical facility, it would be natural to wonder how important dust exposure may be," says Jane Hoppin, environmental epidemiologist at NC State and principal investigator of the GenX Exposure Study.

"Generally speaking, we know that dust exposure can contribute to overall exposure, and that small children tend to have higher dust exposures than adults," Hoppin says. "This study demonstrates the need for evaluating household dust for PFAS in impacted communities. Additionally, we need to identify the sources of short chain PFAS, such as TFA."

The study appears in Environmental Science and Technology and was supported by research funding from the National Institute of Environmental Health Sciences (1R21ES029353), NC State's Center for Human Health and the Environment, the Center for Environmental and Health Effects of PFAS (P42 ES0310095), and the NC Policy Collaboratory.

Technology Networks, 1 April 2025

https://technologynetworks.com

Coffee brewing methods can have a big impact on heart health

2025-03-30

The method used to brew coffee can significantly affect levels of natural cholesterol-raising compounds called diterpenes, according to a new study. It might be that the way your coffee is made is affecting your heart health.

Available on all seven continents, coffee truly is a global beverage. Indeed, over 2.25 billion cups of the stuff are consumed every day around the world. And coffee is generally equated with positive health benefits thanks to its bioactive compounds.

However, new research led by Uppsala University in Sweden investigated how the brewing method used to make coffee can affect levels of natural compounds called diterpenes that can raise low-density lipoprotein, also known as LDL or 'bad' cholesterol, levels, which can, in turn, affect cardiovascular health.

"Considering how much coffee is consumed in Swedish workplaces, we wanted to get a picture of the content of cholesterol-elevating substances in coffee from these types of machines," said David Iggman, a researcher at the University's Clinical Nutrition and Metabolism Unit and the study's corresponding author. "We studied fourteen coffee machines and could see that the levels of these substances are much higher in coffee from these machines than from regular drip-filter coffee makers."

Previous research had already demonstrated that boiled coffee – Turkish coffee, for example – contained high levels of the worst of these diterpenes, cafestol and kahweol, whose LDL-cholesterol-elevating properties have been known about since the 1990s. And it was known that filter paper removed these troublesome diterpenes from boiled coffee. In 2020, a 20-year-long Norwegian study found that consuming unfiltered coffee was associated with higher mortality risk from cardiovascular causes than consuming filtered coffee. This led to the implementation in 2023 of the Nordic Nutrition Recommendations, which recommends filtered coffee as the safer choice.

For the present study, the researchers, aware that large amounts of machine-brewed coffee are consumed at work, aimed to ascertain the concentrations of diterpenes in samples from machine coffees from real-life Swedish public spaces. They took samples from 14 machines across four healthcare facilities, selecting the standard setting and size for a cup of brewed coffee. Two samples were taken from each machine, two to three weeks apart. Of the 14 machines, 11 were brewing coffee machines, and three were liquid-model machines. A brewing machine makes coffee by running hot water through ground coffee, whereas a liquid-model machine mixes pre-made liquid coffee concentrate with hot water to instantly make a cup of coffee.

Additional common, homemade coffee brews were prepared for comparison: drip-brewed coffee, percolator, French press/cafetière, and boiled coffee. The same boiled coffee was filtered through a two-layer polyester-acrylic sock, apparently recommended as a replacement for a paper coffee filter. In addition to the homemade brews, four espresso samples were collected at three cafeterias and one laboratory workplace coffee machine.

Each sample was analyzed using liquid chromatography-tandem mass spectrometry (LC-MS), and cafestol and kahweol levels were measured. Coffees from brewing machines had higher diterpene concentrations than paper-filtered coffee, but lower than boiled coffee. Brewing machine

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coffee had a median cafestol of 175.7 mg/L and a median kahweol of 141.8 mg/L. For liquid-model machines, there was one outlier sample with unusually high concentrations of cafestol and kahweol (344.2 mg/L and 288.2 mg/L, respectively). When this outlier was omitted, the mean was 5.9 mg/L cafestol and 4.8 mg/L kahweol, on par with paper-filtered variants. Filtering boiled coffee with a cafestol concentration of 939.2 mg/L through a sock considerably reduced its cafestol to 28.0 mg/L. Other coffee variants had intermediate concentrations of cafestol – between 68.7 mg/L to 91.2 mg/L – except the espresso samples, which had cafestol levels of up to 2,446.7 mg/L.

"From this, we infer that the filtering process is crucial for the presence of these cholesterol-elevating substances in coffee," Iggman said. "Obviously, not all coffee machines manage to filter them out. But the problem varies between different types of coffee machines, and the concentrations also showed large variations over time."

The researchers also calculated the diterpenes' estimated effects on blood LDL cholesterol. The average cup volume they obtained from the coffee machines was 137.5 ml (4.6 fl oz). The researchers estimated that replacing three cups of brewing machine coffee with paper-filtered coffee five days a week would reduce LDL cholesterol by 0.58 mmol/L. For context, they say that the effect of diterpenes would be equivalent to adding 60 ml (2 fl oz) of full-fat (40%) cream to each cup of paper-filtered coffee.

"Most of the coffee samples contained levels that could feasibly affect the levels of LDL cholesterol of people who drank the coffee, as well as their future risk of cardiovascular disease," said Iggman. "For people who drink a lot of coffee every day, it's clear that drip-filter coffee, or other well-filtered coffee, is preferable. To determine the precise effects on LDL cholesterol levels, we would need to conduct a controlled study of subjects who would drink the coffee."

The study was published in the journal Nutrition, Metabolism & Cardiovascular Diseases.

New Atlas, 30 March 2025

https://newatlas.com

Breakthrough Transforms Chemical Manufacturing – Boosting Speed, Safety and Sustainability

2025-03-28

A major breakthrough in liquid catalysis is transforming how essential products are made, making the chemical manufacturing process faster, safer and more sustainable than ever before.

Researchers from Monash University, the University of Sydney, and RMIT University have developed a liquid catalyst that could transform chemical production across a range of industries – from pharmaceuticals and sustainable products to advanced materials.

By dissolving palladium in liquid gallium the team, led by Associate Professor Md. Arifur Rahim from Monash University's Department of Chemical and Biological Engineering, created a self-regenerating catalytic system with unprecedented efficiency.

The new catalyst demonstrated extraordinary performance in Suzuki-Miyaura cross-coupling reactions – a Nobel Prize-winning technique used to form carbon-carbon (C C) bonds – essential in pharmaceuticals, agrochemicals and materials science.

Their breakthrough, published in Science Advances, could revolutionize the production of essential products across industries, from life-saving pharmaceuticals and eco-friendly agrochemicals to advanced materials like plastics, polymers and electronic components.

"This new catalyst takes advantage of the unique fluid-like behavior of palladium atoms in a liquid gallium mixture, making it exceptionally effective at speeding up reactions – accelerating them up to 100,000 times faster than the best existing palladium catalysts," Associate Professor Rahim said.

Explaining the process further, Senior co-author from RMIT Dr Andrew J. Christofferson said: "We found that palladium atoms would sit just below the liquid surface, activate the gallium atoms above, and the reaction would happen there. This is completely different from a solid-state catalyst."

Md. Hasan Al Banna, the paper's first author, emphasised another key feature: "Another distinctive feature of this system is its operation as a true heterogeneous catalyst without the leaching of palladium ions, which can contaminate pharmaceutical products and present significant health risks."

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The researchers hope their work will inspire further innovations in catalyst design, paving the way for greener, more efficient industrial processes worldwide.

Senior co-author Professor Kourosh Kalantar-Zadeh said: "This advancement is set to transform chemical manufacturing, delivering faster, safer and more sustainable production across industries, from pharmaceuticals to advanced materials."

Azom Materials, 28 March 2025

https://azom.com

Microplastics in the Body: A Cause for Concern?

2025-03-25

While early studies indicate risks, experts urge that more research is still needed.

In the 1960s, a group of scientists made a strange discovery; they found small pieces of plastic inside the stomachs of the albatrosses. Over subsequent decades, more and more research would link the rising levels of marine plastic pollution with the discovery of plastics inside the bodies of various fish and seabirds.

The term "microplastic" appeared for the first time in 2004, in a seminal paper examining how marine plastic breaks down in the ocean to form microscopically small granular and fibrous fragments that can accumulate in marine habitats. In the past two decades, these microplastics have turned up everywhere – from the depths of the Mariana Trench to the most remote reaches of the Arctic.

Today, researchers are looking at microplastics much closer to home – inside our bodies.

A flurry of recent papers has found microplastics inside human organs, brain tissue, breast milk and in the blood. Concurrently, scientists have been hard at work attempting to decipher whether the presence of these plastics in our bodies may be linked to serious adverse health effects.

Microplastics and your body

High production volume polymers were first identified and quantified in human blood samples in 2022, in a paper published in Environment International. Conducted by Dutch researchers from the Vrije Universiteit Amsterdam and the Amsterdam University Medical Center, the study

aimed to develop a robust and sensitive analytical method for measuring plastic particles measuring ≥700 nm in blood samples.

The resulting double-shot pyrolysis-gas chromatography-mass spectrometry (DS-Py-GC-MS) technique was then used on blood samples donated by 22 healthy volunteers, finding a mean concentration of 1.6 µg/ml plastic particles in human blood. Polyethylene terephthalate (PET), polyethylene and various polystyrenes were the most widely seen plastic types, making this study the first to identify high production volume polymers in human blood.

"Despite the low sample numbers and low concentrations detected, the analytical methods used are very robust and these data therefore unequivocally evidence the presence of microplastics and/ or nanoplastics in blood samples," commented Dr. Alice Horton, an anthropogenic contaminants scientist at the National Oceanography Centre, in a statement to the Science Media Centre shortly following the paper's publication. "This is a concerning finding given that particles of this size have been demonstrated in the lab to cause inflammation and cell damage under experimental conditions."

While it is believed that the primary route of human exposure to microplastics is through ingesting contaminated food and water, very small microplastics and nanoplastics come with a risk that they might be inhaled and distributed deep into the lungs.

A 2022 study led by researchers at the University of Hull found that, of the 13 human lung tissue samples they analyzed using micro–Fourier transform infrared (µFTIR) spectrometry, 39 different types of microplastic were found across 11 samples. Additionally, some level of microplastic contamination was found in all regions of the lung, with the lower lung generally carrying the greatest microplastic load.

"Before it's possible to comment with any certainty of the physical and chemical toxicity of inhaled microplastics we need to understand what we are being exposed to sound particle characterization and establish where these particles are ending up," Prof. Kevin Thomas, director of the Queensland Alliance for Environmental Health Sciences at the University of Queensland, previously told Technology Networks.

"In vitro studies suggest that these [airborne] particles can induce inflammatory responses and oxidative stress in lung tissues, but I would question whether the model microplastics used are representative of what we are being exposed to," he cautioned.

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Microplastics and your brain

In early 2025, a study published in Nature Medicine reported having found evidence that microplastics can accumulate inside the human brain, as well as in the liver and kidneys.

The main focus of the study lay in using Py-GC-MS to study various post-mortem frontal cortex brain samples, provided by forensic pathologists from 2016 and 2024 autopsy specimens.

Additional analysis using attenuated total reflectance–Fourier transform infrared spectroscopy (ATR-FTIR) and scanning electron microscopy with energy-dispersive spectroscopy were also performed.

The study found microplastics in the liver, kidney and brain samples, concluding that there appeared to be an increasing trend in microplastic concentrations in the brain and liver between 2016 and 2024. Brain samples belonging to people with dementia tended to exhibit a greater microplastic presence, however the study highlights that due to its experimental design, this cannot be interpreted as a causal link – only associative.

"I can see this paper getting a lot of attention due to its scary-sounding title, but I'd urge caution. Before we get headlines like 'Our brains are now made of plastics,' we need to step back and look at how this study was conducted and what that might mean for the results," commented Prof. Oliver Jones, a professor of chemistry at RMIT University, in a statement to the Science Media Centre.

"The main analytical method used in this study was Py-GC-MS. This method can give false results when used to measure plastics because fats (which the brain is mainly made of) give the same pyrolysis products as polyethylene (the main plastic reported). The authors did try to address this concern, but I am not certain they were able to account for everything," Jones pointed out. "Overall, the work is interesting, but the low sample numbers and potential analytical issues mean that care should be taken when interpreting the results."

The shortcomings of the Py-GC-MS technique is something that Dr. Matthew Campen, lead author of the Nature Medicine study, is very aware of. Speaking to Technology Networks shortly after the article appeared in pre-print, Campen cautioned that Py-GC-MS is not a "settled science" and acknowledged that questions remain over the specificity of the technique for assessing polymers.

"Many chemists and health scientists around the planet are currently working to optimize this approach to ensure that we have confidence in this technique," Campen told Technology Networks.

"Py-GC-MS assesses the total mass concentration of plastics – that is in µg/g. This does not tell us much about the size, but when we consider linking chemicals to health effects, we always use mass concentration," he added.

Microplastics and your health

The majority of microplastic research to date has focused on developing better methods for the detection, identification and continued monitoring of these plastics in the environment. There are comparatively fewer studies investigating the potential health effects of microplastic exposure and accumulation in humans.

Studies in mice have suggested that the ingestion of microplastics can cause changes in the intestinal microbiome, resulting in gastrointestinal issues including abdominal pain, bloating and changes to bowel habits. Microplastic exposure in mice has also been linked to increased oxidative stress and cognitive dysfunction.

Studies using human cell lines have also indicated potential adverse effects. Experiments with human lung and respiratory cell lines have shown associations between exposure to nanoplastics and mitochondrial damage, as well as autophagic cell death.

While these types of studies do indicate potential harms, the common refrain of most published literature examining the effects of microplastics on the human body is that more research is still needed before any firm conclusions can be drawn.

A recent literature review, published in Environment & Health, found that although current toxicity research appears to show links between exposure and intestinal injuries, "almost all the studies on the toxicity of microplastics use experimental models, and the harm to the human body is still unclear," the paper stated.

This broadly aligns with the findings of a 2022 report from the World Health Organization, which concluded that "the available data do not allow firm conclusions on the risks to human health of inhalation or ingestion of [nano- and microplastics (NMP)], but, as NMP are part of the [particulate matter (PM)] mixture, the health impacts will not exceed those of PM." However, the report also takes care to note that its findings "do

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not, however, imply that exposure to NMP is 'safe', as concluded by some stakeholders."

While scientists continue to unravel the potential health effects of microplastics on our bodies, others are searching for solutions to the growing microplastics problem – whether that be through developing better microplastic remediation technologies or creating new fully-biodegradable plant-based plastics that won't leave any pesky microplastics behind.

Technology Networks, 25 March 2025

https://technologynetworks.com

No microplastic particle is safe from bounty-hunting "microcleaners"

2025-03-28

Wouldn't it be great if there were a way of chasing down waterborne microplastic particles and catching them for removal, as opposed to just passively filtering them out of water bodies? Well, experimental new "microcleaners" can reportedly do that very thing.

By definition, microplastics are fragments of plastic smaller than 5 millimeters in diameter.

Found in waterways around the world, they come from a number of sources. These include chunks of floating plastic waste that break down into smaller pieces; products such as certain toothpastes which contain plastic microbeads; synthetic clothing that sheds fibers while being washed; and car tires that release bits of rubber which make their way into storm sewers.

Researchers are still trying to understand how people's health may be affected by ingesting the particles in and of themselves. That said, harmful bacteria are often drawn to microplastics, living on or around the particles – and we definitely shouldn't be eating or drinking those microbes.

That's where the microcleaners come in.

Developed by Prof. Orlin Velev and colleagues at North Carolina State University, they take the form of tiny pellets which are in turn composed of multiple particles known as soft dendritic colloids. Such particles have a reputation for being very sticky, and in this case are made of chitosan,

which is a biodegradable biopolymer derived from seafood-industry shellfish waste.

One off-center section of each microcleaner pellet is infused with a small amount of a plant-based oil called eugenol. That oil decreases the surface tension on one side of the pellet, thus propelling it sideways as it sinks into the water. As the pellet moves through the water, any microplastic particles it encounters get stuck to its soft dendritic colloid particles.

The fun doesn't stop there, however.

Each microcleaner additionally contains particles of magnesium, plus it's coated in a layer of water-soluble eco-friendly gelatin.

As long as that coating remains intact, the pellet continues to slowly sink. Once the gelatin dissolves enough to allow water to reach the magnesium, however, the magnesium reacts with the water, forming air bubbles. Those attached bubbles cause the microcleaner pellet to float to the surface, carrying its microplastic payload with it.

Lab tests have shown that the pellets can swim around underwater for up to 30 minutes before rising to the surface, where they collectively form a scum. That scum can then be skimmed off the surface for disposal, although Velev does state that the chitosan could be reclaimed from the substance and used to create more microcleaners.

A paper on the research was recently published in the journal Advanced Functional Materials.

New Atlas, 28 March 2025

https://newatlas.com

Remediation Technique Turns PFAS Waste Into Graphene

2025-04-01

The graphene produced should offset the costs of remediation, the researchers say.

Rice University researchers have developed an innovative solution to a pressing environmental challenge: removing and destroying per- and polyfluoroalkyl substances (PFAS), commonly called "forever chemicals." A study led by James Tour, the T.T. and W.F. Chao Professor of Chemistry and professor of materials science and nanoengineering, and graduate

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student Phelecia Scotland unveils a method that not only eliminates PFAS from water systems but also transforms waste into high-value graphene, offering a cost-effective and sustainable approach to environmental remediation. This research was published March 31 in Nature Water.

PFAS are synthetic compounds in various consumer products, valued for their heat, water and oil resistance. However, their chemical stability has made them persistent in the environment, contaminating water supplies and posing significant health risks, including cancer and immune system disruptions. Traditional methods of PFAS disposal are costly, energy-intensive and often generate secondary pollutants, prompting the need for innovative solutions that are more efficient and environmentally friendly.

"Our method doesn't just destroy these hazardous chemicals; it turns waste into something of value," Tour said. "By upcycling the spent carbon into graphene, we've created a process that's not only environmentally beneficial but also economically viable, helping to offset the costs of remediation."

The research team's process employs flash joule heating (FJH) to tackle these challenges. By combining granular activated carbon (GAC) saturated with PFAS and mineralizing agents like sodium or calcium salts, the researchers applied a high voltage to generate temperatures exceeding 3,000 degrees Celsius in under one second. The intense heat breaks down the strong carbon-fluorine bonds in PFAS, converting them into inert, nontoxic fluoride salts. Simultaneously, the GAC is upcycled into graphene, a valuable material used in industries ranging from electronics to construction.

The research results yielded more than 96% defluorination efficiency and 99.98% removal of perfluorooctanoic acid (PFOA), one of the most common PFAS pollutants. Analytical tests confirmed that the reaction produced undetectable amounts of harmful volatile organic fluorides, a common byproduct of other PFAS treatments. The method also eliminates the secondary waste associated with traditional disposal methods such as incineration or adding spent carbon to landfills.

"This dual-purpose approach is a game changer," Scotland said. "It transforms waste into a resource while providing a scalable, cost-effective solution to an urgent environmental issue."

The implications of this research extend beyond PFOA and perfluorooctane sulfonic acid, the two most studied PFAS; it even works on

the most recalcitrant PFAS type, Teflon R. The high temperatures achieved during FJH suggest that this method could degrade a wide range of PFAS compounds, paving the way for broader water treatment and waste management applications. The FJH process can also be tailored to produce other valuable carbon-based materials, including carbon nanotubes and nanodiamonds, further enhancing its versatility and economic appeal.

"With its promise of zero net cost, scalability and environmental benefits, our method represents a step forward in the fight against forever chemicals," Scotland said. "As concerns over PFAS contamination continue to grow, this breakthrough offers hope for safeguarding water quality and protecting public health worldwide."

Technology Networks, 1 April 2025

https://technologynetworks.com

Foie gras made without force-feeding thanks to molecular mimicry

2025-03-25

Scientists have replicated the luxurious mouthfeel of foie gras using the liver and fat of ducks reared and slaughtered normally, avoiding the controversial techniques involved in traditional production

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

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

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

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

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

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

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

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

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

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

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

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

New Scientist, 25 March 2025

https://newscientist.com

Flame Retardant Polymers Act As Trojan Horse for Toxic Small Chemicals

2025-03-13

Polymer flame retardants, originally developed as a "non-toxic" alternative to banned chemicals, may be harboring a dangerous risk of their own, a new study suggests.

New analysis of two polymeric brominated flame retardant compounds has shown that, as they degrade in the environment, these long polymer molecules can break down into dozens of smaller, potentially more dangerous compounds. The study also found traces of these breakdown products in environmental samples taken from near electronic waste recycling facilities and demonstrated the toxicity of these compounds in a zebrafish embryo model.

The researchers say their study, published in Nature Sustainability, highlights the need for increased scrutiny and regulation on the environmental effects of polymer compounds.

Investigating polymer breakdown products

Non-polymeric brominated flame retardants (BFRs) are a class of relatively small molecules that were used for years as a popular additive to electronics or furniture items to reduce their flammability. At the turn of the century, these BFRs began to be phased out of production and use after studies linked the compounds to endocrine and thyroid dysfunction.

In subsequent years, polymeric flame retardants (polyBFRs) have become an increasingly popular replacement for BFRs, as their long polymer chain molecules were generally thought to be too large to migrate out of products and into the environment. As a result, these polymer compounds have largely evaded scrutiny from regulating bodies.

"The producers of flame retardants have increasingly stopped making the monomers, which are regulated, and stuck together a lot of monomers to make a big polymer and say, 'it's fine,'" study co-author Dr. Arlene Blum, founder and executive director of the Green Science Policy Institute, told Technology Networks. "We think it's really important that the polymers also have to have scrutiny and regulation before they are used."

In a bit to provide this extra scrutiny, the study authors conducted experiments on two typical polyBFRs that are known to be in use – a tetrabromobisphenol A (TBBPA) epoxy and a TBBPA-based polycarbonate.

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These TBBPA-based polymers were subjected to various photolytic, microbial and ball milling degradation experiments to simulate the sorts of environmental conditions that they might be exposed to during e-waste recycling. The identification of any breakdown products was done using a novel non-targeted screening algorithm named BrMiner, which was developed by the study authors from Jinan University and the East China University of Science and Technology.

"BrMiner is developed to screen for and identify bromine-containing compounds based on high resolution mass spectrometer (HRMS) analysis. It is employed to identify specific compounds related to tetrabromobisphenol A-based polymers in this study, but can also be used to identify other types of Br-containing compounds," lead study author Da Chen, a professor in the Jinan University College of Environment and Climate, told Technology Networks.

"BrMiner can automatically generate a list of candidates with characteristic fragment ions, predicted number of bromine atoms and simulated molecular formulas from raw HRMS data, based on the algorithms of isotopologue distribution simulation and similarity scores between measured and simulated isotopologue distributions," he explained.

The team's analysis successfully identified a total of 76 breakdown products generated by the exposure of polyTBBPAs to environment-like conditions.

Toxic breakdown products found near e-waste recycling facilities

After having identified that polyBFRs can produce dozens of unique breakdown products during e-waste handling-like conditions, the team set out to confirm whether these products might already be present in the environment around recycling facilities.

Soil, dust and particulate matter samples were taken from various locations across China, including from the immediate vicinity of e-waste recycling facilities, their general surroundings (up to 50 kilometers away) and unconnected urban regions more than 100 kilometers away from a recycling facility.

"The samples with the highest abundances and most complex composition of breakdown products were taken from electronic waste recycling sites, indicating the use of polymeric BFRs in electronic products," Chen said. "The environmental abundances declined along with the distance from the e-waste sites."

Having found real-world examples of these breakdown products, the team then moved on to conducting toxicity tests to evaluate their potential risks.

"The zebrafish model is commonly employed to study the toxic effects of environmental chemicals," Chen explained. "Zebrafish embryos can be used to systematically investigate adverse effects and key events from one cell to organogenesis stages, while meeting the replacement, reduction and refinement principles of animal research."

Ultimately, 9 out of 15 developmental toxicity end points were significantly affected by at least one of the tested breakdown products. This included abnormalities in the brain, heartbeat and locomotor activity, as well as a curved spine and decreased body length. The researchers believe that these effects could be a result of mitochondrial dysfunction – an effect that TBBPA monomers are known to have.

The push for polymer regulation

The researchers believe that these results highlight an important association between polymeric flame retardants and potential environmental health risks. In light of these findings, they conclude that the use of these compounds should be subject to more assessment and regulation.

"The real problem is that small molecules are subject to a lot of testing and regulation and have to go through a lot of hoops to get used. But polymers do not have [similar] regulation, either in the EU or US," Blum said. "You need a body of science, but I think this paper is unique in that it went beyond just showing the breakdown [of polyTBBPAs], to showing it in the environment and then showing the toxicity of the breakdown products. So it's a big step."

Technology Networks, 13 March 2025

https://technologynetworks.com

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