CHEMWATCH

Bulletin Board

Contents

MAR. 07, 2025

(click on page numbers for links)

REGULATORY UPDATE

ASIA PACIFIC

Information requirements for assessment certificate applications of ‘designated fluorinated chemicals’ 4
Outcome of public consultation on the 2025 Categorisation Guidelines 5
Correction of chemical names - 18 February 2025 6

AMERICA

States move to cement PFAS protections amid fears of federal rollbacks 7
Trump’s PFAS rule rollback: What does it mean for litigation? 9
Colorado tackling air pollution in vulnerable neighborhoods by regulating 5 air toxics 9

EUROPE

GB mandatory classification and labelling (GB MCL) decision and updated GB MCL list (published 15 February 2025) 10
Silica in stone working – new guidance for installers of stone worktops 11
France to Ban ‘Forever Chemicals’ in Cosmetics Under New Environmental Bill 11
ANSES proposes classifying resorcinol as an endocrine disruptor in the European CLP Regulation 12

REACH UPDATE

Save the date: Workshop to discuss the roadmap to phase out animal testing 14
ECHA updates annual evaluation statistics 14
Consultation on ethanol as a candidate for substitution 14

JANET’S CORNER

I Wish for Grants 16

HAZARD ALERT

2-Nitropropane 17

CONTACT US

subscribers@chemwatch.net
tel +61 3 9572 4700
fax +61 3 9572 4777

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

Contents

GOSSIP

A mix of amazement, pure joy and relief': chemists reflect on their Eureka moments....24
Salt-based catalysts enable selective production of mirror-image molecules....26
New Research Exposes Shocking Health Risks of Chemicals Found in Popular Everyday Products....27
Scientists unravel the spiraling secrets of magnetic materials for next-generation electronics....29
Sustainable smart polymers change color and self-repair when damaged....30
High-Density, Ultra-Stable Batteries Advance Renewable Energy Storage32
Breakthrough tool to enhance precision in cold-temperature cancer surgery....33
Aluminum's surprising stability in alkaline environments enhances hydrogen production....35
Forever chemical' hotspots revealed to include RAF bases and airports....36

CURIOSITIES

Clearest ever picture of worms' surface chemistry deepens evolutionary understanding....38
Natural alternative to Ozempic brings results without side effects....39
This Food Packaging "Significantly" Produces Microplastics in Urine, Says New Research....41
Machine learning reveals hidden complexities in palladium oxidation, sheds light on catalyst behavior....43
Converting CO2 Into Fuel With the Help of Battery Waste....44
Squid are some of nature's best camouflagers. Researchers have a new explanation for why....46
Single-qubit sensing puts new spin on quantum materials discovery....48
99% Efficient and Dirt Cheap – Is This the Holy Grail of Hydrogen?....50
Harnessing heat: Metal-organic frameworks enable efficient hydrogen peroxide production....52
Wax Melt Compounds Can Form Potentially Toxic Particles....54

Contents

TECHNICAL NOTES

(Note: Open your Web Browser and click on Heading to link to section)...56
CHEMICAL EFFECTS....56
ENVIRONMENTAL RESEARCH....56
PHARMACEUTICAL/TOXICOLOGY....56
OCCUPATIONAL....56

ASIA PACIFIC

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

2025-02-28

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?

Why are we consulting?

The full set of information requirements for assessment certificate applications for designated fluorinated chemicals are not currently in the application form in AICIS Business Services. They are also not available on the AICIS website. Instead, the website directs potential applicants to contact us for guidance about the information needed for their application. This has led to requirements being communicated to an applicant as an information request after a certificate application has been submitted.

Before improving transparency by adding the requirements to the application form and publishing them, we would like your feedback about whether an applicant will be able to clearly understand them.

Read More

AICIS, 28-02-25

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

Outcome of public consultation on the 2025 Categorisation Guidelines

2025-02-28

Summary of outcome

Between 24 October and 5 December 2024, we asked for your feedback on changes to the AICIS Industrial Chemicals Categorisation Guidelines (the Guidelines) for 2025 and a proposal to annually update the Guidelines with set timeframes.

We received 5 submissions, which mostly supported the proposals. After considering the feedback, we will implement all the original proposals without change. These are described below. You can read the full details in last year's consultation.

2025 Industrial Chemicals Categorisation Guidelines

- The next Guidelines will be issued in September 2025.
- An extra 116 entries will be added to the 'list of chemicals with high hazards for categorisation' (the list) based on updates to external sources, plus another 4 AICIS-assessed chemicals.
- No chemicals will be added to part 6 of the Guidelines. This means introducers do not need to check any additional esters and salts of chemicals on the list.

The 2025 Guidelines will also include editorial changes such as fixed footnotes and minor text changes in some sections to improve clarity.

Annual updates to the Guidelines

- An updated version of the Guidelines will be issued in September each year to coincide with the AICIS registration cycle.

- The updated version will include changes that have been consulted on publicly. All stakeholder feedback will be considered before deciding on the final changes.
- The public consultation period on proposed changes to the Guidelines will start in September-October of the year before the updated Guidelines come into effect. This will include a public notice about any chemicals that will be added to the list due to updates to external sources.
- The finalised changes to the Guidelines will be announced 6 months in advance each year (February-March) to give introducers time to transition.

Read More

AICIS, 28-02-25

https://www.industrialchemicals.gov.au/consultations/outcome-public-consultation-2025-categorisation-guidelines

Correction of chemical names - 18 February 2025

2025-02-18

We have updated the names of the following chemicals in the Australian Inventory of Industrial Chemicals (Inventory) to the Chemical Abstracts Service (CAS) name. These corrections do not change the identity of the chemical substances themselves.

For details of their Inventory listings, search our Inventory.

These amendments are in accordance with section 85 of the Industrial Chemicals Act 2019.

Previous Chemical Name	Chemical name as varied	CAS number	Listing varied on	Reason the listing was varied
Propanal,	Propanal, 2,3-dihydroxy-	56-82-6	9 February 2025	CAS updated the chemical name
Butanamide, 2,4-dihydroxy-	Butanamide, 2,4-dihydroxy-	81-13-0	9 February 2025	CAS updated the chemical name
Butanedioic acid, 2,3-dihydroxy-[R-(R*,R*)]-	Butanedioic acid, 2,3-dihydroxy-(2R,3R)-	87-69-4	9 February 2025	CAS updated the chemical name
Hexanedioic acid, bis[2-(2-	Hexanedioic acid,	141-17-3	9 February 2025	CAS updated the chemical name
		141-22-0	9 February 2025	CAS updated the chemical name
		141-24-2	9 February 2025	CAS updated the chemical name
		141-27-5	9 February 2025	CAS updated the chemical name
Hexanedioic acid, diethyl ester	Hexanedioic acid, 1,6-diethyl ester	141-28-6	9 February 2025	CAS updated the chemical name
urea	Urea, hydrochloride (1:1)	506-89-8	9 February 2025	CAS updated the chemical name

Read More

AICIS, 18-02-25

https://www.industrialchemicals.gov.au/news-and-notices/correction-chemical-names-18-february-2025

AMERICA

States move to cement PFAS protections amid fears of federal rollbacks

2025-02-21

Concerns are growing about the fate of a Biden-era rule to limit toxic PFAS chemicals in drinking water, with some states moving to introduce laws that would lock in place PFAS protections that could survive any potential rollback by the Trump Administration.

California introduced legislation on Wednesday that would direct the State Water Resources Control Board to adopt regulations at least as protective as those in the federal rule. If California's bill passes, it will require state regulators to set new regulations by January 1, 2026 that would mirror the Biden Administration rule that set a limit on per- and polyfluoroalkyl substances (PFAS) in drinking water.

The legislation specifically calls for adopting the requirements in place on a federal level as of the day prior to President Donald Trump's January 20th inauguration.

"We think there's a case here for folks to act with urgency given the developments in Washington, given the threat to public health and public safety that these chemicals pose," Assemblymember Jesse Gabriel (D-CA), who introduced the bill, said on a February 19 press call. "We are going to do this so we can protect our communities irrespective of what happens at the federal level."

Lawmakers in multiple other states are making similar moves, including in Pennsylvania, Maine and Connecticut.

"It's not unreasonable to be concerned that there would be a rollback of these policies here," said Steve Hvozdovich, Pennsylvania Campaigns Director for the group Clean Water Action. "I think the quicker we can move the better."

California's push for protections

The proposed California law– Assembly Bill 794– is supported by public health and environmental groups that include the American College of Obstetricians and Gynecologists, California Environmental Voters, the Sierra Club, Clean Water Action, and the Environmental Working Group.

The measure covers the same six PFAS chemicals as those in the national drinking water regulation finalized by the US Environmental Protection Agency (EPA) last April, and would set limits at the same levels, including 4 parts per trillion (ppt) for perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), which have been linked to cancer in humans by an international research group.

Read More

The New Lede, 21-02-25

https://www.thenewlede.org/2025/02/states-move-to-cement-pfas-protections-amid-fears-of-federal-rollbacks/

Trump's PFAS rule rollback: What does it mean for litigation?

2025-02-21

Last month, the Trump administration said a rule establishing limits for PFAS chemicals in drinking water will no longer be going into effect.

PFAS, also known as "forever chemicals," have been linked to cancers, childhood development problems, reduced fertility and other health issues. Studies have found at least 97 percent of Americans have PFAS in their system.

PFAS-related lawsuits and insurance claims have been on the rise in recent years. Last year, in the largest class action settlement of 2024, 3M agreed to pay $10.3 billion after being sued by public water providers for polluting drinking water with PFAS.

We spoke with Jamie Sanders, a partner with the law firm Clyde & Co., about what the rule change could mean going forward.

Read More

PropertyCasualty360, 21-02-25

https://www.propertycasualty360.com/2025/02/21/trumps-pfas-rule-rollback-what-does-it-mean-for-litigation/?slreturn=20250224-14634

Colorado tackling air pollution in vulnerable neighborhoods by regulating 5 air toxics

2025-02-27

The Globeville, Elyria-Swansea and Commerce City communities in metro Denver are choked by air pollution from nearby highways, an oil refinery and a Superfund site.

While these neighborhoods have long suffered from air pollution, they're not the only ones in Colorado.

Now, Colorado is taking a major step to protect people from air pollutants that cause cancer or other major health problems, called "air toxics." For the first time, the state is developing its own state-level air toxic health standards, naming the "priority" chemicals: benzene, ethylene oxide, formaldehyde, hexavalent chromium compounds and hydrogen sulfide.

Read More

Colorado Biz, 27-02-25

https://coloradobiz.com/commentary-colorado-tackling-air-pollution-in-vulnerable-neighborhoods-by-regulating-5-air-toxics/

EUROPE

GB mandatory classification and labelling (GB MCL) decision and updated GB MCL list (published 15 February 2025)

2025-02-27

Ministers acting on behalf of the Secretary of State, with the consent of Scottish and Welsh Ministers, have made a decision regarding the GB MCL of 46 chemical substances.

The ministerial decision is an administrative process of updating the GB MCL list with new and revised GB MCLs.

Summaries of these GB MCLs have now been published in the GB CLP publication table, together with the entry into force date (15 February 2025) and the compliance date (15 August 2026).

The reasons for the decision were the identification of the intrinsic hazards of the 46 substances resulting from the scientific and technical assessment of the available information (as set out in the Agency Technical Reports), with no significant impacts being identified by the impact and policy assessments, as set out in the Agency Opinions.

The GB MCL list, which contains the legally binding mandatory classification and labelling of substances, has also been updated with these new or revised GB MCLs.

More information on the new GB MCL system is available on the HSE website.

Read More

HSE, 27-02-25

https://www.hse.gov.uk/chemical-classification/classification/mcl-list.htm

Silica in stone working – new guidance for installers of stone worktops

2025-02-27

HSE has worked with the industry to create guidance that will help protect worktop installers.

Stone workers are at risk of exposure to airborne particles of stone dust containing respirable crystalline silica (RCS) when processing stone, including engineered stone, by cutting, chiselling and polishing.

The guidance explains what employers and workers need to do to stay safe from stone dust and covers 3 main areas:

- competent staff and effective processes
- pre-installation actions
- on-site installation actions

Read HSE's detailed guidance: Installing stone worktops: protect against harmful natural or artificial stone dust.

Our Work Right campaign website has further resources and important safety advice.

Read More

HSE, 27-02-25

https://www.hse.gov.uk/stonemasonry/installing-stone-worktops.htm

France to Ban 'Forever Chemicals' in Cosmetics Under New Environmental Bill

2025-02-25

French lawmakers are poised to pass legislation prohibiting the manufacture and sale of products containing perfluorinated alkylated substances (PFAS), including cosmetics. If approved, the law would come into force on January 1, 2026, placing France at the forefront of PFAS restrictions in the European Union.

- PFAS, often called 'forever chemicals,' are notorious for their persistence in water, soil, and the human body.
- The bill specifies a ban on cosmetics, ski waxes, and various textiles with PFAS content, while allowing certain industrial uses deemed essential.

- Kitchen utensils, initially included in the proposal, were excluded in the revised version.
- A separate measure introduces a tax on manufacturers responsible for PFAS emissions, adhering to the 'polluter pays' principle.
- The legislation was refined by France's Senate in May and is expected to pass with minimal changes.

Read More

Global Cosmetics News, 25-02-25

https://www.globalcosmeticsnews.com/france-to-ban-forever-chemicals-in-cosmetics-under-new-environmental-bill/

ANSES proposes classifying resorcinol as an endocrine disruptor in the European CLP Regulation

2025-02-14

After having shown that resorcinol affects thyroid function, with harmful effects, the Agency is putting forward a proposal to classify this substance as an endocrine disruptor for human health. This was made possible by the recent creation of this hazard class in the CLP Regulation (the European Regulation on classification, labelling and packaging). Since 20 January 2025, the scientific dossier has been available for public consultation on the website of the European Chemicals Agency (ECHA), for comments or provision of additional information on this substance.

Resorcinol is a substance used in the manufacture of tyres, rubber products, adhesives and industrial resins. It is also used in certain cosmetic and hygiene products (hair dyes, mascara for professional use), as an antioxidant in food products such as shrimp, and as an antiseptic in certain medicines.

In 2020, ECHA's Member State Committee (MSC) recognised that this substance met the definition of an endocrine disruptor . However, there was no consensus on identifying it as a substance of very high concern within the meaning of the REACH Regulation. The recent inclusion of endocrine disruption in the CLP Regulation provides another way of taking action, by proposing its classification as an endocrine disruptor for human health and giving regulatory recognition to its hazard properties.

Read More

ANSES, 14-02-25

https://www.anses.fr/en/content/anses-proposes-classifying-resorcinol-endocrine-disruptor-european-clp-regulation

Save the date: Workshop to discuss the roadmap to phase out animal testing

2025-02-27

On 16-17 June 2025, the European Commission and ECHA will jointly organise a third workshop to discuss elements of the roadmap to phase out animal testing for chemical safety assessments. The purpose is to present proposed recommendations of the roadmap for stakeholder consultation.

Contribute to this important discussion by joining us at ECHA or remotely.

You can register until 15 May 2025 to attend this free-of-charge event at our premises in Helsinki. No registration is needed if you follow the workshop’s plenary sessions online.

Read More

ECHA, 27-02-25

https://echa.europa.eu/news

ECHA updates annual evaluation statistics

2025-02-26

Since 2009, ECHA has evaluated 15 500 REACH registrations. The checks ensure that companies provide reliable information on the hazards of chemicals to support chemical safety in the European Union. Based on the evaluations, the Agency has updated its recommendations to registrants on how to improve their registration dossiers.

Read More

ECHA, 26-02-25

https://echa.europa.eu/news

Consultation on ethanol as a candidate for substitution

2025-02-27

We have launched a consultation to find potential safer alternatives to:

- ethanol (EC 200-578-6, CAS 64-17-5) for product-types 1, 2 and 4.

Have your say until 28 April 2025.

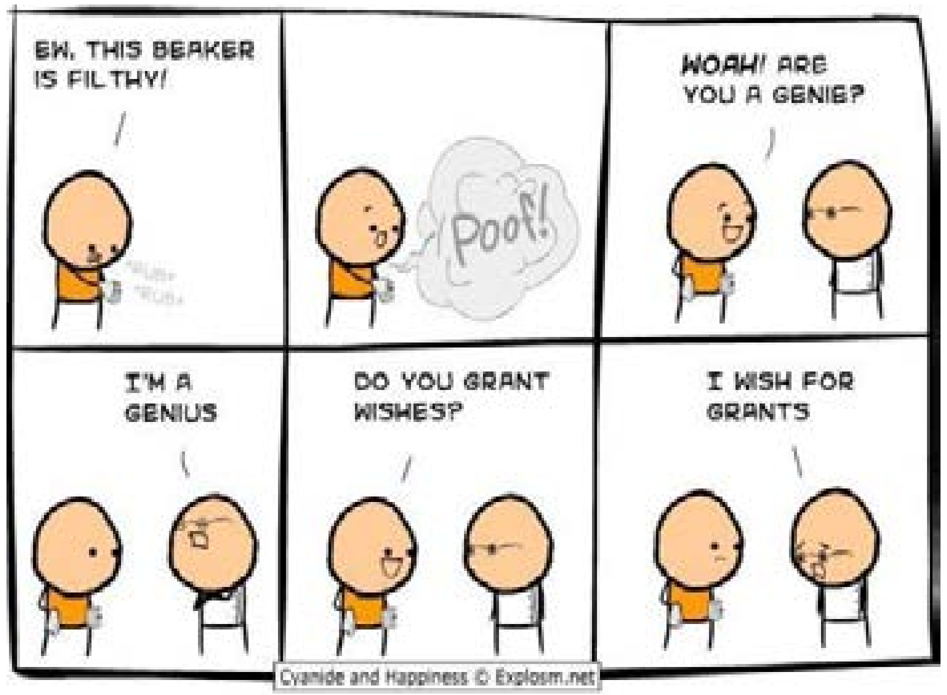
Read More

ECHA, 27-02-25

https://echa.europa.eu/current-candidates-for-substitution-and-derogations-conditions/-/substance-rev/79301/

I Wish for Grants

2025-03-07



Explosm.net

2-Nitropropane

2025-03-07

USES [2,3]

2-Nitropropane is used principally as a solvent and chemical intermediate. As a solvent, it is used in inks, paints, adhesives, varnishes, polymers, and synthetic materials. It is used as a solvent or co-solvent with many resins, and these solvent-resin mixtures are used as coatings, including coatings for beverage cans. 2-Nitropropane is a feedstock for the manufacture of 2-nitro-2-methyl-1-propanol and 2-amino-2-methyl-1-propanol. It is also used as a component of explosives and rocket propellants and as an additive in fuels for internal combustion engines for hobbyists and for racing cars.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

For the general population, daily intake of 2-nitropropane has been estimated at 50 to 100 mg, which includes exposure due to its use as a solvent for beverage-can coatings, film-laminating adhesives, and printing inks for food packaging (3 ng) and from vegetable oils (30 ng). Cigarette smokers receive an additional exposure of 1.2 µg per cigarette. Potential occupational exposure to 2-nitropropane occurs during its manufacture, formulation, and use in industrial construction and maintenance, printing, highway maintenance, and food packaging. Air concentrations of up to 6,000 mg/m3 have been measured in workplaces.

Routes of Exposure

The main routes of exposure to 2-nitropropane are:

- Inhalation
- Ingestion
- Dermal contact
- Eye Contact

2-Nitropropane is clear, colourless liquid with a slightly fruity odour that has the chemical formula $CH3CH(NO2)CH3$. It is flammable and stable under normal conditions and is slightly soluble in water and miscible in numerous solvents including most aromatic hydrocarbons, esthers, ketones, and ethers. [1,2]

HEALTH EFFECTS [4]

Acute Health Effects

Severe liver damage, as well as some kidney damage, has been observed in workers fatally poisoned from acute inhalation exposure to high concentrations of 2-nitropropane. Tests involving acute exposure of rats and mice have demonstrated 2-nitropropane to have moderate to high acute toxicity from inhalation and moderate acute toxicity from oral exposure.

Carcinogenicity

In one epidemiology study, there were no trends indicating increased carcinogenic risk from exposure to 2-nitropropane in humans. In one animal study, multiple hepatocellular carcinomas were observed in rats. EPA has classified 2-nitropropane as a Group B2, probable human carcinogen. EPA has calculated a provisional inhalation unit risk factor of 0.0027 (µg/m3)-1.

Other Effects

No information is available on the reproductive or developmental effects of 2-nitropropane in humans. One animal study has reported foetal toxicity (delayed foetal heart development) following injection of 2-nitropropane in rats.

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. WARM water MUST be used. Get medical attention if irritation occurs.
- **Skin Contact:** Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.
- **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]

Engineering Controls

- Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of 2-nitropropane vapours below their respective threshold limit value.
- Ensure that eyewash stations and safety showers are proximal to the workstation location.

Personal Protective Equipment [5]

Gloves and Clothing

- Avoid skin contact with phenanthrene.
- Wear personal protective equipment made from material which can not be permeated or degraded by this substance.
- The recommended glove materials are Nitrile, Neoprene and Barrier® for Coal Tar Extract.
- The recommended protective clothing material for solid phenanthrene is Tyvek®, or the equivalent.
- All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection

- Wear eye protection with side shields or goggles.
- If additional protection is needed for the entire face, use in combination with a face shield. A face shield should not be used without another type of eye protection.

Respiratory Protection

- Where the potential exists for exposure over 0.1 mg/m3, use a NIOSH approved respirator with an organic vapour cartridge and particulate

N, R or P100 prefilters. Increased protection is obtained from full facepiece powered-air purifying respirators.

- Leave the area immediately if:
- While wearing a filter or cartridge respirator you can smell, taste, or otherwise detect phenanthrene,
- While wearing particulate filters abnormal resistance to breathing is experienced, or
- Eye irritation occurs while wearing a full facepiece respirator. Check to make sure the respirator-to-face seal is still good. If it is, replace the filter or cartridge. If the seal is no longer good, you may need a new respirator.
- Consider all potential sources of exposure in your workplace. You may need a combination of filters, prefilters or cartridges to protect against different forms of a chemical (such as vapour and mist) or against a mixture of chemicals.
- Where the potential exists for exposure over 1 mg/m3, use a NIOSH approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus or an emergency escape air cylinder.

REGULATION

United States

OSHA: The United States Occupational Safety and Health Administration has established the following Permissible Exposure Limits (PEL)for 2-nitropropane:

- General Industry: 25 ppm, 90 mg/m3
- Construction Industry: 25 ppm, 90 mg/m3 TWA

ACGIH: The American Conference of Governmental Industrial Hygienists has established a Threshold Limit Value (TLV) of 10 ppm, 36 mg/m3 Time Weighted Average; Appendix A3 (Confirmed Animal Carcinogen with Unknown Relevance to Humans)

NIOSH: The National Institute for Occupational Safety and Health (NIOSH) has set the following Recommended Exposure Limit (REL): Potential Carcinogen, Lowest Feasible Concentration

REFERENCES

1. http://toxipedia.org/display/toxipedia/2-Nitropropane
2. http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/Nitropropane.pdf
3. http://www.cdc.gov/niosh/docs/81-123/pdfs/0460.pdf
4. http://www.epa.gov/ttn/atw/hlthef/nitropro.html
5. http://www.sciencelab.com/msds.php?msdsId=9926285
6. https://www.osha.gov/dts/chemicalsampling/data/CH_257900.html
7. http://www.safeworkaustralia.gov.au/sites/swa/about/Publications/Documents/772/Workplace-exposure-standards-for-airborne-contaminants.docx

Incineration Could Safely Destroy PFAS-Contaminated Materials

2025-03-03

An Australian-led team of international scientists have shown how per- and polyfluoroalkyl substances (PFAS) can be safely destroyed by burning them.

Theirs is the first study to trace the entire chain of chemical reactions as PFAS break down during incineration.

Global concern around PFAS contamination is mounting because these “forever chemicals” persist and accumulate in the environment, causing significant harm to human and animal health.

There is currently a moratorium on burning PFAS in the United States, and regulatory uncertainty elsewhere.

This is because improper incineration does not completely destroy them, and risks spreading them further through the air. It also creates harmful greenhouse gas emissions.

Now, researchers from Australia’s national science agency, CSIRO, the University of Newcastle, Colorado State University and the National Synchrotron Radiation Laboratory in Hefei, China, have defined a pathway for PFAS to be destroyed safely and completely, inside a hazardous waste incinerator.

CSIRO Environmental Chemist and study co-author, Dr Wenchao Lu, explained how the interdisciplinary team studied a common type of PFAS called perfluorohexanoic acid.

“There are over 15,000 types of PFAS, but all of them share a strong fluorocarbon chain which doesn’t break down naturally,” Dr Lu said.

“This is what makes them so persistent in our environments.”

Some of the chemicals formed during PFAS incineration exist for just 1 millisecond: shorter than a housefly’s wing flap. But identifying these intermediary molecules is crucial to determining what harmful products are formed throughout the process.

Researchers ionised then detected the different molecules created as the PFAS was burned. Using specialised equipment at the National Synchrotron Radiation Laboratory, the researchers detected the short-lived molecules, created as the PFAS burned.

“By taking ‘snapshots’ of the chemical reactions as they occur, we can see what intermediaries or harmful free radicals form inside the incinerator,” Dr Lu said.

“These chemicals had been hypothesised, but never actually detected.”

Co-author from the University of Newcastle, Professor Eric Kennedy, said their results shed light on how PFAS can be safely destroyed at high temperatures.

“This study has identified intermediary molecules that are critical for us to ensure the PFAS molecule is completely destroyed, and to ensure no harmful byproducts are formed,” he said.

Co-author from Colorado State University, Professor Anthony Rappé, said: “This international team effort is illustrative of the collaborative environmental work that CSIRO leads.”

The ultimate goal of incinerating PFAS is a process called ‘mineralisation’. This converts the strong fluorocarbon chains into inorganic compounds like calcium fluoride, carbon dioxide, carbon monoxide, and water.

These byproducts can, in turn, be captured at the source and transformed into reusable materials such as industrial chemicals, concrete, fertilisers and fuels.

While further research is needed, these insights offer a promising option for destroying PFAS safely, and for good.

PFAS occur in a range of consumer, industrial, and commercial products, such as non-stick food packaging and cookware, and legacy firefighting foams.

The chemicals can leach into soils and groundwater, travel long distances, and do not fully break down naturally, giving them their moniker of “forever chemicals”.

Technology Networks, 3 March 2025

https://technologynetworks.com

A mix of amazement, pure joy and relief': chemists reflect on their Eureka moments

2025-03-05

Every scientist has either had, or hopes to have, a Eureka moment at least once in their career. Historically, these lightbulb or 'aha' moments, happen in a variety of different ways – from breakthroughs that took years of careful investigation to those that happened seemingly by accident.

How Eureka moments manifest was something Jeffrey Seeman, a chemist and historian of science at the University of Richmond, and Judy Wu, a physical organic chemist at the University of Houston, were keen to explore. They wanted to focus on the 'human side of chemistry' and the emotions that accompany revelatory discoveries. To this end, they conducted interviews with 18 chemists from a variety of disciplines.

Seeman and Wu concluded that at least two characteristics were shared by all of the interviewees. First, each reported an awareness of a discontinuity in their knowledge – from unknowing to knowing – and second, that once the proverbial light bulb had lit up, their research goals became clearer and challenges were easier to surmount.

The different ways a Eureka moment can arise

The path of an 'aha' moment can differ greatly from one discovery to the next. Some Eureka moments start with quiet and careful observation while others come about because an individual has the courage to stand up and question existing understanding.

In many cases, however, breakthroughs require the person to go through periods of discomfort, uncertainty and ambiguity and, very often, failure.

Following the interviews, Seeman and Wu sorted the Eureka moments by their shared characteristics. For this they used the three categories defined in a 2007 paper called 'The Cha-Cha-Cha Theory of Scientific Discovery': charge, challenge and chance.2 Although, in their concluding remarks, they said their work had suggested there was maybe a fourth: curiosity.

Charge: Solving specific and obvious problems, often dealing with a societal need'

Such a specific and obvious problem might be taking aim at a huge societal issue like cancer and setting out to cure it. However, while the problem might be clear, often the way to solve it is not. Famous examples of charge discoveries, according to Koshland, are Issac Newton's discovery of gravity in 1666, which came about while he tried to solve the problem of understanding the movement of the stars, the Earth and the sun. Another is Gregor Mendel's discovery regarding the laws of heredity, which he worked out while trying to understand the problem of why offspring look like their parents.

Challenge: Solving long-standing scientific puzzles or incongruities'

These discoveries happen as a response to an accumulation of facts or concepts that are unexplained by or incongruous with scientific theories of the time. In the case of these Eureka moments, the discovery may identify anomalies and also come up with a solution. Famous examples of a challenge breakthrough include Frederick August Kekulé's dream of the structure of benzene in 1865 and James Watson and Francis Crick's discovery of base pairing in the DNA double helix in 1953.

Chance: 'Making happy and unexpected discoveries by accident'

These may be described as serendipitous and are used to describe an instance of a chance event that a 'ready mind' recognises as important and then passes on to other scientists. A famous example is Alexander Fleming's discovery of penicillin in 1928 after he noticed that mould growing on a petri dish prevented bacteria from growing. Roy Joseph Plunkett's invention of Teflon in 1938 was also a chance breakthrough that came about while he was researching new chlorofluorocarbon refrigerants.

Can you increase your chances of having a Eureka moment?

Following the interviews, Seeman and Wu observed that it may be possible to cultivate your environment to make Eureka moments more likely. They came up with the following pointers:

- Recognise the importance of stepping back, taking breaks and allowing time for ideas to develop; this is a marathon, not a sprint!
- Make space in your schedule for spontaneous moments to occur – such as a chance conversation or inconsistent data, which could spark a new idea
- Search for connections from unrelated information, even casual remarks
- Embrace discomfort, uncertainty and even failure in your work

- Being an outsider to a field does not necessarily mean you cannot have a breakthrough.

Chemistry World, 5 March 2025

https://chemistryworld.com

Salt-based catalysts enable selective production of mirror-image molecules

2025-03-06

A research team based in Bochum and Mülheim is using a new type of salt to specifically produce one of two possible mirror-image molecules.

In scenarios where two mirror-image molecules are possible, special catalysts are required to produce only the desired one. A research team from the Ruhr Explores Solvation RESOLV Cluster of Excellence at Ruhr University Bochum, Germany, and the Max-Planck-Institut für Kohlenforschung in Mülheim, Germany, is using salts that control the desired reaction via halogen bonds.

Going forward, the salts can be adapted to different reactions as a modular system. The team headed by Professor Stefan Huber and Professor Benjamin List published their findings in the Journal of the American Chemical Society on March, 3, 2025.

A molecule and its twin

There are certain molecules that exist twice, so to speak: as themselves and as their mirror image. “These so-called chiral molecules demonstrate a handedness of sorts,” explains Huber. Despite sharing many similarities, they have very different properties, for example, in terms of their biological effectiveness. When used as a component of medicines, for example, the original molecule can have the desired effect, while its mirror image can cause adverse effects. This is why the aim is usually to produce only one variant of the molecule.

To this end, the team from Bochum and Mülheim adopted a novel approach. Their aim was to produce a molecule with interesting properties for medical application. The researchers used salts as catalysts in which both components (cation and anion) play an important role: The cation sets the reaction in motion via halogen bonds.

“Halogen bonds are weak bonds formed between the cation and the substrate,” explains Dominik Reinhard, Ph.D. student from Bochum. For its part, the anion, produced by the Mülheim researchers, ensures the correct handedness of the resultant molecule.

“The salt is introduced to the relevant substrates in a compatible solvent. The concerted action of the salt components then ensures the desired reaction, during which only the molecule with the desired handedness is formed,” explains Reinhard.

“What makes this approach so attractive is that, by using salts, we’ve created a modular system,” points out Huber. By combining a wide range of different cations and anions, the researchers can thus create different salts and, consequently, catalyze different reactions going forward.

Phys Org, 6 March 2025

https://phys.org

New Research Exposes Shocking Health Risks of Chemicals Found in Popular Everyday Products

2025-03-04

Everyday products contain unregulated toxic chemicals.

For years, the scientific community has assumed that polymers—large molecules—are too big to migrate from products into the human body and therefore pose no health risks. As a result, polymers have largely remained unregulated and are exempt from major toxic substance laws, such as the U.S. Toxic Substances Control Act and the E.U.’s REACH regulation. However, a groundbreaking peer-reviewed study published in Nature Sustainability reveals that certain polymers used as flame retardants can degrade into smaller, harmful chemicals.

“Our study suggests polymers can act as a trojan horse for toxic chemicals,” said Da Chen, senior author and scientist at Jinan University in China. “They are added to products as inert large molecules, but over time they can degrade, exposing us to their harmful breakdown products.”

The researchers tested two polymeric brominated flame retardants (polyBFRs) that were developed as “non-toxic” alternatives to banned flame retardants. They found that both polyBFRs broke down into dozens of types of smaller molecules. Toxicity testing of these smaller molecules in zebrafish showed significant potential for causing mitochondrial dysfunction and developmental and cardiovascular harm.

Environmental Contamination and Human Exposure

The scientists went on to search for these polymer break-down products in the environment and, further raising alarm, detected them in soil, air, and dust. The levels were highest near electronic waste recycling facilities and lessened moving away from the facilities. These results confirm that the use of polyBFRs in electronics leads to the release of toxic breakdown products into the environment with potential for human and wildlife exposure and harm.

“Widespread use of these polyBFRs in electronics may result in exposures when these products are manufactured, when they’re in our homes, and when they’re discarded or recycled,” said Miriam Diamond, co-author and professor at the University of Toronto. “Since it is suspected that production volumes are very high (the chemical industry does not disclose the volumes), the potential for pollution—and resulting serious harm to people and wildlife— greatly concerns me.”

Industry Claims vs. Scientific Evidence

The chemical producers and their trade groups promote polyBFRs as environmentally friendly and non-hazardous substitutes for banned monomeric flame retardants (e.g., hexabromocyclododecane and decabromodiphenyl ether) to meet flammability standards for electronics, building materials, and vehicles. However, real-world fire safety benefits for many of these standards have not been demonstrated.

The study also has implications for other types of polymers used in consumer products such as per- and polyfluoroalkyl substances (PFAS). PFAS polymers have been put into textiles including children’s uniforms, food packaging, and cosmetics to name a few uses. Similar to this study, previous research has shown that fluorinated polymers contain numerous impurities and release smaller toxic molecules. Although the producers of PFAS argue that fluorinated polymers should be exempt from regulation, scientists maintain that fluorinated polymers are members of the class of PFAS and that the use of the whole class of PFAS should be avoided.

“To escape regulation, flame retardant, and PFAS producers are increasingly pivoting to polymers for use in everyday products,” said Arlene Blum, co-author and Executive Director of the Green Science Policy Institute. “As a result, problematic polymers emit toxic small molecules from products we touch, sit on, wear, and keep in our homes. Regulators

need to close this loophole to protect consumers—especially children—from the possibility of serious chemical harm.”

Sci Tech Daily, 4 March 2025

https://scitechdaily.com

Scientists unravel the spiraling secrets of magnetic materials for next-generation electronics

2025-03-04

Deep within certain magnetic molecules, atoms arrange their spins in a spiral pattern, forming structures called chiral helimagnets. These helical spin patterns have intrigued researchers for years due to their potential for powering next-generation electronics. But decoding their properties has remained a mystery -- until now.

Researchers at the University of California San Diego have developed a new computational approach to accurately model and predict these complex spin structures using quantum mechanics calculations.

Their work was published on Feb. 19 in Advanced Functional Materials.

“The helical spin structures in two-dimensional layered materials have been experimentally observed for over 40 years. It has been a longstanding challenge to predict them with precision,” said Kesong Yang, professor in the Aiiso Yufeng Li Family Department of Chemical and Nano Engineering at the UC San Diego Jacobs School of Engineering and senior author of the study.

“The helical period in the layered compound extends up to 48 nanometers, making it extremely difficult to accurately calculate all the electron and spin interactions at this scale.”

In this approach, researchers calculated how the total energy of a chiral helimagnet changes as the spin rotation shifts between successive layers of atoms.

By applying first-principles quantum mechanics calculations, they were able to map out the critical features of these spiraling structures.

“Rather than modeling the entire system at a large length scale, we chose to focus on how spin rotation affects the total energy of the system,” said study first author Yun Chen, a nanoengineering Ph.D. student in Yang’s group.

"By using a small supercell and designing optimized spin configurations, we were able to obtain highly accurate results."

They tested their approach on a group of chiral helimagnets containing chromium, a metal known for its magnetic properties.

The team successfully predicted three key parameters: the helix wavevector, which describes how tightly the spins spiral; the helix period, or the length of one complete spiral turn; and the critical magnetic field, the strength of an external field needed to alter the helimagnet's structure.

"This is exciting because we can now precisely model these complex spin structures using quantum mechanics calculations, opening new opportunities for designing better materials," said Yang.

This work was partially supported by the American Chemical Society Petroleum Research Fund under award number 65212-ND10. This work used the Expanse cluster at the San Diego Supercomputer Center at UC San Diego through allocation DMR160045 from the Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support (ACCESS) program, which is supported by the National Science Foundation (NSF).

Science Daily, 4 March 2025

https://sciencedaily.com

Sustainable smart polymers change color and self-repair when damaged

2025-03-06

Plastics, which are polymeric materials composed of long chains of small molecules called monomers, are widely used in everyday life and industry due to their lightweight, good strength and flexibility. However, with approximately 52 million tons of plastic waste generated annually, plastic pollution has become a major environmental concern.

To address this issue, research efforts have focused on developing sustainable polymeric materials. Unfortunately, most materials developed so far suffer from complex synthesis processes or difficulties in separating them from other polymers during waste disposal.

To overcome these limitations, a research team led by Dr. Tae Ann Kim of the Convergence Research Center for Solutions to Electromagnetic Interference in Future-mobility (SEIF) at Korea Institute of Science and Technology (KIST) has developed a new polymeric material with self-healing capabilities and high recyclability.

The findings are published in the journal Advanced Functional Materials.

The team designed a unique pentagonal ring-structured molecule that can not only be freely converted between monomers and polymers but also facilitates dynamic covalent exchange reactions in response to heat, light, and mechanical forces. This molecule enables creating polymeric materials with a wide range of properties, as flexible as a rubber band or as rigid as a glass bottle.

The newly developed polymer is easy to manage, as it exhibits fluorescence at damaged sites, enabling real-time damage detection, and self-heals when exposed to heat and light. Upon disposal, this material can selectively depolymerize into its monomers, even when mixed with conventional plastics.

The recovered monomers can then be used to regenerate polymers that retain their original properties. These features present an innovative solution for enhancing both sustainability and recyclability of polymeric materials.

Beyond its recyclability, this material dynamically changes its thermal, mechanical, and optical properties in response to heat, light, and mechanical forces.

When used as a protective coating, it demonstrates outstanding performance, with a hardness of up to three times and an elastic modulus more than two times higher than conventional epoxy coatings. Additionally, exposure to ultraviolet light strengthens molecular interactions, enabling the material to fix specific shapes.

This shape memory capability opens up potential applications in smart clothing, wearable devices, and advanced robotics.

With its high mechanical strength, damage resistance, self-healing, damage detection, and selective recyclability, this polymeric material presents a promising solution to reduce economic costs associated with sorting and processing mixed plastic waste.

Furthermore, by replacing industrial coatings with this eco-friendly alternative, the maintenance costs of coating can be significantly reduced while mitigating environmental pollution.

Dr. Tae Ann Kim, a principal researcher of the Soft Materials Research Group, emphasized, “This research introduces a new approach to designing materials with autonomous functionalities, such as damage detection and self-healing, while overcoming the thermal and mechanical limitations of recyclable plastics derived from pentagonal ring monomers.

“We are striving to pioneer the market for eco-friendly functional coatings that require minimal maintenance and generate no waste.”

Phys Org, 6 March 2025

https://phys.org

High-Density, Ultra-Stable Batteries Advance Renewable Energy Storage

2025-03-04

Researchers developed a high-solubility pyrene tetraone derivative (PTO-PTS) that enhances AOFB energy density and stability. This monomer enables reversible four-electron storage, achieving 90 Ah/L and maintaining 100% capacity retention after 5,200 cycles.

Aqueous organic flow batteries (AOFBs) are a promising technology for integrating renewable energy and enhancing electricity grid storage, thanks to their inherent safety and the availability of naturally abundant, synthetically tunable organic redox-active molecules (ORAMs). However, their commercial viability is limited by challenges such as low energy density, poor stability at high concentrations, and high synthesis costs.

To advance stationary energy storage, it is crucial to develop ORAMs that combine high energy density with long-term cycling stability. Increasing the number of electron transfers per molecule can enhance energy density and lower electrolyte costs without increasing concentration. However, multi-electron transfer ORAMs often struggle with a trade-off between stability and solubility, posing a key challenge for their practical application.

Breakthrough in High-Solubility ORAMs

In a study published in the Journal of the American Chemical Society, a research team led by Prof. Xianfeng Li and Prof. Changkun Zhang from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) developed a high-water-soluble pyrene tetraone derivative that greatly enhances the energy density of AOFBs while maintaining high-temperature stability.

Researchers designed an asymmetrical pyrene-4,5,9,10-tetraone-1-sulfonate (PTO-PTS) monomer via a coupling oxidation-sulfonation reaction. This innovative monomer could reversibly store four electrons, offering a high theoretical electron concentration of 4.0 M, as well as an ultra-stable intermediate semiquinone free radical. When applied to AOFBs, this monomer achieved an ultra-high volumetric capacity of approximately 90 Ah/L. The AOFBs maintained nearly 100% capacity retention after 5,200 cycles in the air, demonstrating great potential for large-scale energy storage.

Key Structural Advantages of PTO-PTS

Besides, researchers found that the extended conjugated structure of the pyrene tetraone cores facilitated reversible four-electron transfer through enolization tautomerism. Introducing a single sulfonic acid group into the core decreased the molecular planarity, and enhanced the regional charge density and hydrogen bonding with water molecules, thereby improving solubility in aqueous electrolytes.

Furthermore, the monomer stabilized the intermediate semiquinone free radical through effective delocalization of the conjugated structure and ordered π-π stacking during the redox process, contributing to excellent stability in air and high temperatures.

AOFBs incorporating the pyrene tetraone derivative achieved an energy density of 60 Wh/L. Both symmetric and full cells exhibited no obvious capacity decay after thousands of cycles at 60 °C, indicating good cycling stability (about 1,500 hours) and promising performance over a broad temperature range (10 to 60 °C).

Sci Tech Daily, 4 March 2025

https://scitechdaily.com

Breakthrough tool to enhance precision in cold-temperature cancer surgery

2025-03-03

Researchers at NYU Abu Dhabi (NYUAD) have developed an innovative tool that enhances surgeons’ ability to detect and remove cancer cells during cryosurgery, a procedure that uses extreme cold to destroy tumors. This breakthrough technology involves a specialized nanoscale material that illuminates cancer cells under freezing conditions, making them easier to distinguish from healthy tissue and improving surgical precision.

Detailed in the study "Freezing-Activated Covalent Organic Frameworks for Precise Fluorescence Cryo-Imaging of Cancer Tissue" in the journal of the American Chemical Society, the Trabolsi research group at NYUAD designed a unique nanoscale Covalent Organic Framework (nTG-DFP-COF) that responds to extreme cold by increasing its fluorescence.

This makes it possible to clearly differentiate between cancerous and healthy tissues during surgery.

The material, prepared by Gobinda Das, Ph.D., a researcher in the Trabolsi Research Group at NYUAD, is engineered to be biocompatible and low in toxicity, ensuring it interacts safely within the body.

Importantly, it maintains its fluorescent properties even in the presence of ice crystals inside cells, allowing real-time monitoring during cryosurgery.

This advancement not only improves the accuracy and safety of cryosurgical procedures -- helping surgeons preserve more healthy tissue while removing cancer cells -- but also combines diagnostic and treatment functions into one platform.

This could reduce the need for repeat surgeries and speed up patient recovery.

Fluorescence imaging, a non-invasive technique that uses light-sensitive dyes to highlight tumors, has gained traction for its ability to provide real-time insights during surgery.

However, its use in cryosurgery has remained largely unexplored until now.

"We believe this is a transformative tool that could revolutionize cancer surgery," said Farah Benyettou, Ph.D., a research scientist in the Trabolsi Research Group at NYU Abu Dhabi.

"By making tumor removal more precise, this technology has the potential to reduce additional surgeries and accelerate patient recovery. It's a major step forward in treating aggressive, hard-to-target cancers."

"This breakthrough bridges the gap between imaging and therapy, providing surgeons with a real-time tool to visualize and remove cancer with unprecedented precision," said Ali Trabolsi, Professor of Chemistry and principal investigator of the Trabolsi Research Group at NYU Abu Dhabi. "By integrating fluorescence imaging with cryosurgery, we are

pushing the boundaries of cancer treatment and offering new hope for patients with difficult-to-treat tumors."

Science Daily, 3 March 2025

https://sciencedaily.com

Aluminum's surprising stability in alkaline environments enhances hydrogen production

2025-03-06

Aluminum (Al) is a material considered susceptible to corrosion, but it could become key to core technology in producing clean hydrogen energy. A POSTECH research team succeeded in dramatically improving the performance of hydrogen production catalysts using this unstable metal.

The research is published in the journal ACS Catalysis.

Hydrogen is being spotlighted as a clean energy source that could replace fossil fuels. In particular, research on alkaline water electrolysis using alkaline solution as an electrolyte is being actively conducted, as it is cost-effective and suitable for mass production.

Water electrolysis requires a catalyst that accelerates two important reactions. One of them is the hydrogen evolution reaction (HER), which produces hydrogen gas (H_2) by combining hydrogen ions (H^+) and electrons. The other is the oxygen evolution reaction (OER), which produces oxygen gas (O_2) as hydroxyl ions (OH^-) lose electrons. Nickel-iron (Ni-Fe) is a catalyst mainly used in the oxygen production reaction; however, it has had difficulties in commercializing due to its lack of activity and durability.

The research team solved the problem using aluminum. Aluminum is generally known to be easily corroded in alkaline environments, but the research team overcame the problem by designing it to form a stable structure on the surface of an electrode. As a result, aluminum efficiently controlled the existing catalytic electron structure without corrosion, accelerating the oxygen production reaction.

Experiments conducted in an alkaline water electrolysis cell showed that the nickel-iron-aluminum (Ni-Fe-Al) catalyst improved performance by approximately 50% compared to existing catalysts. The research team confirmed that the aluminum catalyst maintained high current density even at low voltage. Additionally, it was proven to be applicable in a large-scale hydrogen production process, as it maintained excellent stability in long-term operation.

Professor Yong-Tae Kim, the leader of this research, said, "This research broke the stereotypes of existing catalyst designs. By using this innovative approach of utilizing aluminum, we were able to drastically improve the performance of catalysts used in a hydrogen production system. I expect this research will substantially advance the hydrogen economy age and become a new milestone in eco-friendly energy technology."

Phys Org, 6 March 2025

https://phys.org

Forever chemical' hotspots revealed to include RAF bases and airports

2025-01-15

RAF bases, airports and fire stations are amongst the biggest hotspots of "forever chemical" pollution, an Environment Agency report has revealed.

Linked to serious health issues, these toxic substances are commonplace in the UK, and virtually indestructible.

Technically called PFAS or PFOS, forever chemicals are a family of more than 10,000 human-made substances. They are only manufactured by a relatively small number of companies, but are widely used in everyday products and processes.

Forever chemicals can be found in non-stick pans, pizza boxes, cosmetics, waterproof fabric, greaseproof paper, and certain carpets and flooring, and are used for their resistant properties.

Documents from the Ministry of Defence (MoD) show that some of the highest concentrations of the chemicals can be found in RAF bases across the UK. Groundwater samples from RAF Benson in South Oxfordshire have been recorded as high as 7,700 nanograms a litre (ng/l). The maximum allowable level for drinking water in England is 100ng/l.

Similar levels have been recorded in Lincolnshire at RAF Coningsby and RAF Waddington, which is located in a drinking water supply zone. Anglian Water samples also show that chemicals from RAF Mildenhall in Suffolk could be contaminating nearby drinking water sources.

A former RAF base in Duxford is another hotspot, with over 1,000 homes nearby in South Cambridgeshire supplied with water from an aquifer containing high levels of PFAS. This is likely due to pollution from firefighting foams used at the base, which is now owned by the Imperial War Museum. Cambridge Water has apologised but says the contamination would not have reached customers because the water was blended with another source.

An MoD spokesperson said: "Ensuring the safety of our staff, personnel and the public is our number one priority and that's why we are complying with the relevant legislation and regulations. As understanding of these chemicals has changed, we have responded accordingly. We have prioritised a programme of investigation of our sites, which has been agreed with the Environment Agency."

Fire stations are also among some of the most PFAS-contaminated hotspots. At the Angus firefighting foam plant and training centre in Bentham, North Yorkshire, PFAS from firefighting foams have polluted the groundwater, causing the town to become the most contaminated in the UK.

Angus Fire says it has ceased its production and is working with the Environment Agency to tackle the issue. The company may yet face legal action from residents.

Heathrow Airport is another contamination hotspot, with high levels of groundwater contamination and both rivers adjacent to the site failing their chemical status test for PFOS. The airport says it has been monitoring the chemicals since 2011, has invested £30m in combatting the issue, and has ceased using firefighting foams containing PFAS and PFOS.

However, the number of PFAS hotspots across Europe is increasing, an investigation by The Forever Lobbying Project has found. These include most landfills, airports, sewage areas, and manufacturers and industrial users of PFAS in the UK.

Independent, 15 January 2025

https://independent.co.uk

Clearest ever picture of worms' surface chemistry deepens evolutionary understanding

2025-03-04

The surface chemistry of two worm species has been found to play a crucial role in their interaction with the environment and each other. This work provides the clearest picture yet of the surface chemistry of these worms and could help combat parasitic infections.

Scientists from the University of Nottingham used an advanced mass spectrometry imaging system – 3D-OrbiSIMS – to examine the nematodes Caenorhabditis elegans and Pristionchus pacificus and characterise their complex surface chemistry. The species studied don't have eyes and ears, so the team was interested in learning how they interact with other systems and organisms. These worms were selected because they represent distinct evolutionary lineages with different ecological adaptations.

P. pacificus exhibits predatory behaviour allowing the researchers to explore how surface chemistry influences predator–prey interactions. 'These little worms, they go from egg to adult in three days … the amount of data you can generate and the amount of research that you can do in such a short life cycle … offers a model for studying lipid signalling in human tissue,' explains lead researcher Veeren Chauhan. Millions of years of evolution separate humans and worms, yet humans share around 70% of their genes with these worms making them an ideal model for human biology. Despite C. elegans being one of the most studied, well-established genetic models, the full chemical composition of the organism's surface has remained largely unexplored.

This gap in knowledge is largely due to limitations in the tools to accurately capture and interpret the chemistry. The state-of-the-art 3D-OrbiSIMS instrument enables a level of analysis not seen before in biological cells and tissues, making it a powerful tool for chemical imaging. 'The 3D OrbiSIMS uses argon gas clusters to bombard a surface,' explains Chauhan, and this acts as a sputtering beam for depth profiling. 'We studied the first top 50nm of nematode cuticles [which] are then put into the detector [which is] extremely high mass and high spatial resolution.' The worms' surface chemistry was also studied during the species' development, enabling the team to track molecular changes in detail and how they influence their interaction with each other.

The team found that the worms' surfaces were made up of lipids and that the surface chemistry of both worm species changed over time. Comparing the lipid profiles of the worms' surfaces revealed that the two species were developmentally dynamic and species-specific – the two species have distinct surface lipid profiles, which may reflect the divergent evolutionary pressures they face. Chauhan notes that their most important observation was made after modifying lipid compositions in C. elegans by removing the daf-22 gene. Following this change, the sightless and earless P. pacificus worms 'selectively predate on animals or show more tendency to predate on animals that don't have these surface lipids'. This discovery is a significant step in understanding their biology – lipid surfaces may influence chemical communication pathways between species and modifying the lipid composition in C. elegans increases susceptibility to predation by P. pacificus.

'The most interesting [finding] was the evolutionary implications,' says Ann Corsi, a biologist at the Catholic University of America. 'After altering the lipid composition in the [C. elegans] larvae, they found that P. pacificus were more predatory … it makes sense that C. elegans have evolved to be more resistant to P. pacificus.' This suggests that surface lipids may have a protective role beyond structural integrity.

'We've only scratched the surface,' says Chauhan of the highly sensitive mass spec technique, adding that further analysis of nematodes is currently underway. This new knowledge also opens new areas of scientific discovery. 'With this new technique … if we understand how [worms] sense when a human is present … we can then prevent [parasitic worm] infections,' he says. Corsi says that the research might also help prevent crop damage caused by nematodes and agrees that 'there's a lot of pathways and phenomena in worms [with a] potential connection with humans'.

Chemistry World, 4 March 2025

https://chemistryworld.com

Natural alternative to Ozempic brings results without side effects

2025-03-06

After screening 20,000 protein-encoding genes in the human body, Stanford researchers have identified a naturally occurring molecule that works like semaglutide, most popularly known as Ozempic, to put the brakes on appetite and weight gain.

Since its release in the United States in 2017, the injectable drug Ozempic has not only helped thousands lose weight, but it's also been shown to have a wide range of other health-boosting effects. It has shown promise in fighting alcohol addiction; relieving knee pain from osteoarthritis; reducing the risk of kidney failure and death in some type 2 diabetics; and temper the negative effects being overweight has on the heart.

Despite all its promise, however, Ozempic does come with a range of side effects. These can range from relatively mild symptoms like nausea, diarrhea and dizziness to more serious effects like gallbladder disease, hypoglycemia, and pancreatitis. The drug has even been linked to suicidal ideation and up to a sevenfold increase in a rare form of blindness known as an "eye stroke."

So, researchers led by a team at Stanford Medicine set out to see if they could find a natural alternative to semaglutide that would deliver its weight-loss benefits while reducing or eliminating its side effects. To do so, they focused on prohormones, biologically inert protein molecules that become active when they are chopped up into smaller parts called peptides by other protein molecules. Some of these peptides function as hormones in the body.

The researchers developed an algorithm called Peptide Predictor that analyzed thousands of genes that encode prohormones, and more specifically looked at the sites where each could be carved up by the action of outside proteins. This led them to find a small peptide named BRP which consists of only 12 amino acids yet increased the action of neuronal cells in the brain tenfold over controls. Developing a drug that only works in the brain, they reasoned, would be an improvement over Ozempic, which works throughout the whole body.

"The receptors targeted by semaglutide are found in the brain but also in the gut, pancreas and other tissues," said study co-author and assistant professor of pathology Katrin Svensson. "That's why Ozempic has widespread effects including slowing the movement of food through the digestive tract and lowering blood sugar levels. In contrast, BRP appears to act specifically in the hypothalamus, which controls appetite and metabolism."

The researchers then conducted tests of BRP on both mice and minipigs, whose systems more closely mimic that of humans than rodents. They found that one injection of BRP reduced food intake in both species by up to 50% during the following four hours. In obese mice, a daily injection of BRP for 14 days caused the rodents to lose an average of three grams (about 0.1 oz) due primarily to fat loss, and to demonstrate better glucose and insulin tolerance.

They also did not see any side effects of BRP after observing the animals' water intake, fecal production, movements or behaviors that would be associated with anxiety.

Svensson has now co-founded a company with the intention of moving to human clinical trials of BRP, and she and her team are now studying ways to extend the duration of its effects in the body. This would make it easier to dose if it does prove to be an effective weight-loss solution for humans.

"The lack of effective drugs to treat obesity in humans has been a problem for decades," Svensson said, speaking on the success of BRP in the animals. "Nothing we've tested before has compared to semaglutide's ability to decrease appetite and body weight. We are very eager to learn if it is safe and effective in humans."

The research has been published in the journal Nature.

Source: Stanford University

New Atlas, 6 March 2025

https://newatlas.com

This Food Packaging "Significantly" Produces Microplastics in Urine, Says New Research

2025-08-05

Toxicology researchers evaluated three categories of groceries to find that a "widely used" type is disrupting major body systems.

Maybe you've heard about the increasing research that's suggesting too much exposure to polyfluoroalkyl substances, or PFAS, could increase cancer risk and disrupt hormonal harmony. Meanwhile, another substance used in plastic packaging, bisphenol A or BPA, has been linked to high blood pressure, type 2 diabetes and heart disease, according to the Mayo Clinic.

BPA is used in items like reusable water bottles, as well as food containers in the freezer aisle and heat-and-eat kiosks around the market. Without following a few important steps, those quick, convenient options may come with a price, says a team of researchers in Turkey who compared the BPA exposure and health effects between fresh, canned and ready-to-eat meals.

The randomized, controlled, single-blinded July 2024 study published in Nutrients followed 48 healthy university students between the ages of 18 and 30. The study was led by researchers in Turkey who specialize in the study of toxicology, pharmacology, and public health.

Study participants were randomly assigned to eat either fresh, canned or plastic-packaged ready-to-eat meals over a four-day period. On the first and second days, they were given a series of rules to follow to limit their plastic exposure:

- Avoid "meals prepared outside the home, canned food and beverages, frozen meals, plastic-packaged food, water from polycarbonate bottles, food stored in plastic containers or use plastic containers in microwave ovens."
- Not to eat any food or beverage other than water after 10 p.m.
- Fast for at least eight hours.
- Avoid any physical activity beyond their typical routine.
- Only consume processed products packaged in glass containers or in "low-density polyethylene plastic containers" like those you might buy milk or orange juice in.
- Avoid coffee or only use a French press or ceramic dripper instead of a plastic coffee machine.

The researchers took urine samples and a 24-hour "food consumption record" to ensure participants complied with these requirements.

On the third and fourth days of the study, participants' heart rate and blood pressure readings were taken before they received their meal assignment for the day. Urine samples, heart rate and blood pressure readings were taken two, four and six hours after eating the meal.

The researchers found that the study participants who ate ready-to-eat meals had "significantly increased urine BPA concentrations" compared to the other two groups. The authors cited past research which suggested this can have implications for the liver, in addition to the hormone-disrupting effects on the thyroid and issues with other important health functions.

Another observation was that those who ate the fresh meals appeared to clear out evidence of plastics from their system via urine two hours faster than the ready-to-eat group.

Eating ready-to-eat meals was also associated with higher blood pressure and pulse pressure, or the difference between the upper and lower numbers of your blood pressure, according to the Cleveland Clinic, as well as decreased diastolic blood pressure and heart rate.

The participants who ate canned food saw higher blood pressure values, which may speak to the constricting effect of sodium on the blood vessels.

These findings may be one more reason to slow down and take a few moments to prepare something fresh or at least be sure to remove your food from its plastic packaging before you warm it—and minimize those prepared, processed foods.

For the convenience of frozen foods, look for microwavable meals that come in compostable containers. Increasingly, manufacturers of prepared foods with higher-quality ingredients are utilizing these eco- and human-friendly methods.

The Healthy, 5 August 2024

https://thehealthy.com

Machine learning reveals hidden complexities in palladium oxidation, sheds light on catalyst behavior

2025-03-06

Researchers at the Fritz Haber Institute have developed the Automatic Process Explorer (APE), an approach that enhances our understanding of atomic and molecular processes. By dynamically refining simulations, APE has uncovered unexpected complexities in the oxidation of palladium (Pd) surfaces, offering new insights into catalyst behavior. The study is published in the journal Physical Review Letters.

Kinetic Monte Carlo (kMC) simulations are essential for studying the long-term evolution of atomic and molecular processes. They are widely used in fields like surface catalysis, where reactions on material surfaces are crucial for developing efficient catalysts that accelerate reactions in energy production and pollution control. Traditional kMC simulations rely on predefined inputs, which can limit their ability to capture complex atomic movements. This is where the Automatic Process Explorer (APE) comes in.

Developed by the Theory Department at the Fritz Haber Institute, APE overcomes biases in traditional kMC simulations by dynamically updating the list of processes based on the system's current state. This approach encourages exploration of new structures, promoting diversity and efficiency in structural exploration. APE separates process exploration from kMC simulations, using fuzzy machine-learning classification to identify distinct atomic environments. This allows for a broader exploration of potential atomic movements.

By integrating APE with machine-learned interatomic potentials (MLIPs), researchers applied it to the early-stage oxidation of palladium surfaces, a key system in pollution control. When applied to the early-stage oxidation of a palladium surface, a key material used in catalytic converters for cars to reduce emissions, APE uncovered nearly 3,000 processes, far exceeding the capabilities of traditional kMC simulations. These findings reveal complex atomic motions and restructuring processes that occur on timescales similar to molecular processes in catalysis.

The APE methodology provides a detailed understanding of Pd surface restructuring during oxidation, revealing complexities previously unseen. This research enhances our knowledge of nanostructure evolution and its role in surface catalysis. By improving the efficiency of catalysts, these insights have the potential to significantly impact energy production and environmental protection, contributing to cleaner technologies and more sustainable industrial processes.

Phys Org, 6 March 2025

https://phys.org

Converting CO2 Into Fuel With the Help of Battery Waste

2025-03-05

Battery waste is a serious environmental problem: it contains substances that pose a threat to both human health and ecosystems. At the same time, however, they also contain valuable materials such as nickel, which we need – for example, for the production of new batteries. Better recycling methods for batteries are therefore urgently required.

At TU Wien, it has now been possible to develop a process that can be used to recover nickel from spent nickel-metal hydride batteries. But that's not all: from this battery waste and used aluminium foil, such as that used in the kitchen, it was possible to produce a nanocatalyst that converts CO2

into valuable methane. In this way, one can reduce the waste problem on the one hand and at the same time obtain a climate-neutral fuel.

Battery recycling: Important for the environment and economy

"Modern batteries, such as nickel-metal hydride (Ni-MH) and lithium-ion batteries, consist of different components, which makes recycling and recovery processes technologically challenging," says Prof. Günther Rupprechter from the Institute of Materials Chemistry at TU Wien, head of the research project. "Improper disposal can lead to chemical leaks, fires, and pollution."

The recovery of nickel from spent Ni-MH batteries is also highly important economically: In the EU, waste batteries and scrap from battery production could provide around 16% of the nickel needed by 2030, which is enough to equip 1.3 to 2.4 million electric vehicles (EVs) annually.

Despite this potential, current recycling capacity in the EU and the UK is only about one-tenth of what is needed by 2030. Investments in recycling infrastructure are therefore necessary.

Upcycling: From waste recycling to CO2 capture

"Recycling is an important step, but even greater impact can be achieved by upcycling nickel into catalysts capable of producing fuels," says Dr. Qaisar Maqbool, first author of the study.

The team extracted nickel from used Ni-MH batteries and recovered alumina from used aluminium foil. These materials were then converted into a high-performance nanocatalyst in an environmentally friendly way – using green chemistry methods.

"Our nanocatalyst consists of 92-96% aluminium oxide and 4-8% nickel, which is optimal for converting the greenhouse gas CO2 together with hydrogen into methane," explains Günther Rupprechter. The process requires neither high pressure nor high temperatures, the catalyst works at atmospheric pressure and an easily achievable temperature of 250°C.

From greenhouse gas to clean energy

This provides a method for converting CO2 into a valuable fuel in a climate-neutral way: Methane plays an important role as an energy source in industry, for example. "Now we want to investigate how this process can be scaled up for technological applications," says Prof. Günther Rupprechter. "We believe that this approach can transform sustainable fuel production. Our approach shows a solution to the climate problem – and in a way that also helps to solve a pressing waste problem."

Upcycled material can also be recycled

Many catalysts deactivate over time – because the catalyst changes structurally at some point or becomes less effective due to the accumulation of coke (carbon). Such a deactivation was not detected in the study. Nevertheless, it was important to the team to think in closed cycles and to consider how the catalyst itself can also be recycled.

"To close the sustainability loop, you can recycle the spent catalysts back into their original precursors to be reused," says Dr. Qaisar Maqbool. This ensures that the entire process remains environmentally friendly, and the amount of waste is minimized.

Technology Networks, 5 March 2025

https://technologynetworks.com

Squid are some of nature's best camouflagers. Researchers have a new explanation for why

2025-03-06

Nature is full of masters of disguise. From the chameleon to arctic hare, natural camouflage is a common yet powerful way to survive in the wild. But one animal might surprise you with its camouflage capabilities: the squid.

Capable of changing color within the blink of an eye, squid, along with their cephalopod relatives octopi and cuttlefish, have used their natural camouflage to survive since the age of the dinosaurs. However, scientists still know very little about how it all works.

Leila Deravi aims to change that.

An associate professor of chemistry and chemical biology at Northeastern University, Deravi's recently published paper in the Journal of Materials Chemistry C sheds new light on how squid use organs that essentially function as organic solar cells to help power their camouflage abilities. Deravi says it's a breakthrough in how humans understand these "super-charged animals," one that could impact how we humans interact with the world.

Deravi has long been fascinated by cephalopods, particularly squid. Her Biomaterials Design Group at Northeastern is focused on investigating how these animals camouflage, with the aim of using those natural mechanisms to create new biomaterials.

More recently, her lab has been looking at one specific part of squid biology— chromatophores—which is where the latest discovery was made.

Chromatophores are pigmented organs that sit all over the squid's skin. They have muscle fibers on the outside that are filled with neurons, allowing the animal to neuromuscularly open and control these pigment sacks based on what's in their environment.

Together with iridophores, which act as a kind of photo filter, adding greens and blues to the chromatophores' reds, yellows and browns, they give squid the ability to change color within hundreds of milliseconds, distributing the color all over their body.

"To have something sense the colors around it and distribute [them] within hundreds of milliseconds is really insane," Deravi says. "It's not something that's easy to do, especially in a living system that's under water."

It has been commonly understood that chromatophores are a kind of colorant that operate similar to pixels in a TV display, but Deravi found that they are much more. Her latest research reveals that chromatophores are light sensors that help power squid and their natural camouflage.

"It can see whatever light is on the outside and convert that light into energy and then harvest that energy to help distribute camouflage," Deravi says.

To test this idea, Deravi and her team built a squid-powered solar cell. They used conductive glass, semiconductors, electrolytes and the chromatophores' pigmented nanoparticles taken from dissected squid to create a circuit. By focusing solar simulated light on the glass, they activated the circuit and measured how much energy it was putting out.

"We found that the more granules you put into there, the higher the photocurrent response is," Deravi says. "It's a direct indication that the pieces of the chromatophore are actually converting the light from the sun's simulated light to the voltage, which can complete the circuit and then be harvested, potentially, for a power supply in the animal."

The discovery marks the first time anyone has made a connection between the chromatophores in a cephalopod and their ability to generate current.

Uncovering the secrets behind how cephalopods camouflage has a number of applications for humans. Deravi's lab has already used its findings to design wearable UV sensors that can help prevent skin cancer and produce more environmentally and human-friendly sunscreen, as Deravi has done with her startup, Seaspire.

What's particularly remarkable, she says, is how efficient this biological system is. Squid are able to change color and distribute that change over their entire body while under water, using very little energy.

Understanding more about how squid use their organic solar cells could help a burgeoning field like wearable electronics where size, weight and power distribution are constant concerns. The squid might be the key to developing a truly "living digital skin," she says.

"If you think about fully wearable stuff, you just have to think about how to make it the most energetically favorable in order to be fully interactive with the surroundings," Deravi says. "We're trying to tap into what the blueprint is that the animal uses to do this and how that correlates to adapting to the environment as well."

Phys Org, 6 March 2025

https://phys.org

Single-qubit sensing puts new spin on quantum materials discovery

2025-03-05

Working at nanoscale dimensions, billionths of a meter in size, a team of scientists led by the Department of Energy's Oak Ridge National Laboratory revealed a new way to measure high-speed fluctuations in magnetic materials. Knowledge obtained by these new measurements, published in Nano Letters, could be used to advance technologies ranging from traditional computing to the emerging field of quantum computing.

Many materials undergo phase transitions characterized by temperature-dependent stepwise changes of important fundamental properties. Understanding materials' behavior near a critical transition temperature is key to developing new technologies that take advantage of unique physical properties. In this study, the team used a nanoscale quantum sensor to measure spin fluctuations near a phase transition in a magnetic thin film. Thin films with magnetic properties at room temperature are essential for data storage, sensors and electronic devices because their magnetic properties can be precisely controlled and manipulated.

The team used a specialized instrument called a scanning nitrogen-vacancy center microscope at the Center for Nanophase Materials Sciences, a DOE Office of Science user facility at ORNL. A nitrogen-vacancy center is an atomic-scale defect in diamond where a nitrogen atom takes the place of a carbon atom, and a neighboring carbon atom is missing, creating a special configuration of quantum spin states. In a nitrogen-vacancy center microscope, the defect reacts to static and fluctuating magnetic fields, allowing scientists to detect signals on a single spin level to examine nanoscale structures.

"The nitrogen-vacancy center functions as both a quantum bit, or qubit, and a highly sensitive sensor that we moved around on top of the thin film to measure temperature-dependent changes in magnetic properties and spin fluctuations that cannot be measured any other way," said ORNL's Ben Lawrie, a research scientist in ORNL's Materials Science and Technology Division.

Spin fluctuations are observed when the magnetic properties of a material governed by the spin orientation keep changing direction rather than staying fixed. The team measured the spin fluctuations as the thin film went through a phase transition between different magnetic states that was induced by changing the sample temperature.

These measurements revealed how local changes in spin fluctuations are linked together globally near phase transitions. This nanoscale understanding of interacting spins could lead to new spin-based information-processing technologies and deeper insights into wide classes of quantum materials.

"Advances in spintronics will improve digital storage and computing efficiency. Meanwhile, spin-based quantum computing offers the tantalizing promise of classically inaccessible simulation if we can learn to control interactions between spins and their environment," Lawrie said.

This type of research bridges ORNL's capabilities in quantum information and condensed matter physics. "If we can use today's generation of quantum resources to gain new understanding of classical and quantum states in materials, that will help us to design new quantum devices with applications in networking, sensing and computing," Lawrie said.

The DOE Basic Energy Sciences program funded this research.

Science Daily, 5 March 2025

https://sciencedaily.com

99% Efficient and Dirt Cheap – Is This the Holy Grail of Hydrogen?

2025-03-05

A breakthrough in renewable energy research has led to the development of a cost-effective and highly efficient iron-based catalyst for water oxidation.

This innovation mimics natural photosynthesis while overcoming the limitations of expensive metal catalysts. The newly developed polymerized iron complex, poly-Fe5-PCz, boasts exceptional stability and near-perfect Faradaic efficiency, making it a game-changer for hydrogen production. By leveraging abundant materials, the study paves the way for scalable, sustainable energy solutions that could transform clean energy storage and industrial hydrogen generation.

Harnessing Water Oxidation for Renewable Energy

Water oxidation is a key process in renewable energy, particularly for hydrogen production and artificial photosynthesis. By splitting water into oxygen and hydrogen, it offers a clean and sustainable energy source. However, replicating the efficiency and stability of natural photosynthesis in artificial catalysts — especially in water-based environments — remains a major challenge. While catalysts made from rare metals like ruthenium are highly effective, their high cost and limited supply make them impractical for large-scale applications.

To overcome this, a research team led by Professor Mio Kondo from the Institute of Science Tokyo (Science Tokyo), Japan, developed a more sustainable and affordable catalytic system using widely available metals. Their study, published today (March 5) in Nature Communications, presents a promising alternative for advancing clean energy technology.

Introducing the Pentanuclear Iron Catalyst

The study introduces a novel pentanuclear iron complex, Fe5-PCz(ClO_4)$_3$, which possesses a multinuclear-complex-based catalytically active site and precursor moieties for charge transfer sites. Kondo explains, "By electrochemically polymerizing this multinuclear iron complex, we create a polymer-based material that enhances electrocatalytic activity and long-term stability. This approach combines the benefits of natural systems with the flexibility of artificial catalysts, paving the way for sustainable energy solutions."

Synthesizing and Characterizing the Catalyst

The researchers synthesized the Fe5-PCz(ClO_4)$_3$ complex using organic reactions like bromination, nucleophilic substitution, Suzuki coupling reactions, and subsequent complexation reactions. The synthesized complex was characterized by mass spectrometry, elemental analysis, and single-crystal X-ray structural analysis.

The researchers then modified glassy carbon and indium tin oxide electrodes by polymerizing Fe5-PCz using cyclic voltammetry and controlled potential electrolysis to afford a polymer-based catalyst, poly-Fe5-PCz.

The charge transfer ability and electrocatalytic performance of poly-Fe5-PCz were evaluated through electrochemical impedance spectroscopy and oxygen evolution reaction (OER) experiments with oxygen production quantified by gas chromatography, respectively.

Outstanding Performance and Stability

The results were highly promising. Kondo explains, "Poly-Fe5-PCz achieved up to 99% Faradaic efficiency in aqueous media, meaning nearly all the applied current contributed to the OER. The system also exhibited superior robustness and a reaction rate under rigorous testing conditions compared to relevant systems.

Additionally, poly-Fe5-PCz demonstrated enhanced energy storage potential and improved electrode compatibility, making it suitable for a wide range of renewable energy applications." Its high stability was further confirmed by long-term controlled potential experiments, a key advantage for hydrogen production and energy storage technologies.

Implications for Sustainable Energy

The study's findings have significant implications for sustainable energy. The use of iron — an abundant, non-toxic metal — ensures the system is both eco-friendly and cost-effective, offering a viable alternative to precious metal-based catalysts. Its stability under operational conditions addresses a major challenge in artificial catalytic systems, where long-term catalyst degradation often limits performance. Moreover, the system's performance in aqueous environments makes it suitable for applications in water splitting.

Toward Scalable Hydrogen Production

"Optimizing poly-Fe5-PCz synthesis and scalability could further enhance its performance, paving the way for industrial-scale hydrogen production and energy storage. Our study opens new possibilities for integrating the system into broader energy technologies, paving the way to a more sustainable future," concludes Kondo.

SciTechDaily, 5 March 2025

https://scitechdaily.com

Harnessing heat: Metal-organic frameworks enable efficient hydrogen peroxide production

2025-03-06

Researchers have developed metal-organic frameworks (MOFs) that efficiently produce hydrogen peroxide (H2O2) using small temperature differences, offering a sustainable approach to chemical production.

In a study published in Science Advances, researchers have unveiled a novel application of MOFs as highly efficient thermocatalysts for hydrogen peroxide (H2O2) production.

This innovative approach capitalizes on subtle temperature gradients to drive the synthesis of H2O2, offering a sustainable, energy-efficient alternative to conventional industrial methods that are often costly, resource-intensive, and environmentally harmful.

H2O2 is a critical chemical widely used as a disinfectant, bleaching agent, and oxidizer in a broad range of industrial and medical applications. However, conventional production processes rely on the energy-intensive anthraquinone oxidation method, which involves multiple steps, harsh reaction conditions, and significant chemical waste.

The newly developed MOF-based thermocatalysts present a revolutionary solution by efficiently utilizing small thermal variations to facilitate the controlled conversion of oxygen (O2) in water into H2O2 under mild conditions.

MOFs are a class of porous crystalline materials composed of metal ions coordinated to organic ligands, forming highly ordered structures with tunable catalytic properties.

In this study, the researchers engineered highly active MOFs capable of harnessing low-grade thermal energy to selectively activate oxygen molecules in water, triggering a catalytic reaction that produces H2O2 without external energy input or aggressive reaction environments.

This advancement not only enhances energy efficiency but also significantly reduces the carbon footprint and chemical waste associated with H2O2 production, making it an environmentally friendly alternative.

Experimental results demonstrated that these MOF-based thermocatalysts exhibit exceptional efficiency, stability, and selectivity in H2O2 generation. By leveraging minor temperature differences, the MOFs consistently catalyzed the conversion of O_2 in water to H2O2, offering a scalable and decentralized production approach that could transform the global supply chain of this essential chemical.

The implications of this breakthrough extend beyond just hydrogen peroxide production. This technology holds immense potential in environmental remediation, green chemistry, and sustainable manufacturing.

The ability to generate H2O2 efficiently using widely available, low-cost thermal energy sources could pave the way for on-site, decentralized production systems, significantly reducing dependency on large-scale industrial facilities and the associated transportation costs and emissions.

"Our discovery showcases the remarkable versatility of metal-organic frameworks in catalysis and opens exciting new avenues for sustainable chemical production," says Prof. Zong-Hong Lin and Prof. Dun-Yen Kang.

"By harnessing small temperature differences, we can efficiently produce hydrogen peroxide, providing an eco-friendly and energy-saving alternative to conventional industrial methods."

This study not only highlights the emerging role of MOFs in energy conversion and catalytic chemical synthesis but also underscores the crucial need for developing next-generation functional materials that align with global sustainability goals.

By leveraging advanced material design and thermally driven catalysis, this research sets a new benchmark for environmentally responsible chemical production, offering a promising pathway toward a cleaner and more sustainable future.

Phys Org, 6 March 2025

https://phys.org

Wax Melt Compounds Can Form Potentially Toxic Particles

2025-02-24

As traditional candles burn, they can contribute to indoor air pollution by emitting volatile compounds and smoke, which may pose inhalation risks. Scented wax melts are often marketed as safer alternatives to candles because they're flame- and smoke-free. But in a study in ACS' Environmental Science & Technology Letters, researchers describe how aroma compounds released from the melted wax can react with ozone in indoor air to form potentially toxic particles.

Previous research has shown that scented wax melts emit more airborne scent compounds than traditional candles. The direct heating of the wax maximizes its surface area, thereby releasing more fragrance – such as volatile organic compounds (VOCs) made of hydrocarbons – into the air. Researchers know that these chemicals can react with other compounds in the air to form nanometer-wide particles, which have been linked to negative health effects when inhaled. However, the potential for nanoparticle formation during wax-melt use was unknown. So, Nusrat Jung, Brandon Boor and colleagues set out to investigate this process using wax melts in a full-scale house model that mimicked a typical residential house.

The researchers conducted experiments on 15 commercially available wax melts, both unscented and scented (e.g., lemon, papaya, tangerine and peppermint), in the model house. They first established a baseline of indoor air pollutants and then switched on the wax warmer for about 2 hours. During and after this period, the researchers continuously sampled the air a few yards (meters) away from the wax melts and found airborne nanoparticles, between 1 and 100 nanometers wide, at levels that were comparable to previously reported levels for traditional, combustion-based candles. These particles could pose an inhalation risk because they are small enough to pass through respiratory tissues and enter the bloodstream, say the researchers.

Additionally, using literature data, the team calculated that a person could inhale similar amounts of nanoparticles from wax melts as from traditional candles and gas stoves. Previous studies have found exposure to high levels of nanoparticles in indoor air can be linked to health risks like decreased cognitive function and increased prevalence of childhood asthma.

In the experiments, the main VOCs emitted from the wax melts were terpenes, such as monoterpenes and monoterpenoids. The researchers identified that the airborne terpenes reacted with ozone and formed sticky compounds, which aggregated into nanoscale particles. However, after warming an unscented wax melt, the team observed no terpene emissions or nanoparticle formation, which suggests that these aroma compounds contribute to nanoparticle formation.

The researchers say this study challenges the perception that scented wax melts are a safer alternative to combustion-based candles; however, they emphasize that more toxicology research is needed on the risks of breathing in nanoparticles formed from wax melts.

Technology Networks, 24 February 2025

https://technologynetworks.com

CHEMWATCH

Bulletin Board

Technical Notes

MAR. 07, 2025

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

CHEMICAL EFFECTS

Olive oil wastewater: a comprehensive review on examination of toxicity, valorization strategies, composition, and modern management approaches

ENVIRONMENTAL RESEARCH

Development of Methods for the Early Detection of Chemical Hazard and the Prevention of Pre-disease, Focusing on Environment, Food, and Health

Appraisal of potential toxic elements pollution, sources apportionment, and health risks in groundwater from a coastal area of SE China

Unraveling fate of sulfonamide antibiotics in sandy loam soil and water of India and environmental risk assessment

PHARMACEUTICAL/TOXICOLOGY

Hematological Parameters and Mercury Exposure in Children Living Along Gold-Mining-Impacted Rivers in the Mojana Region, Colombia

Perfluorooctanoic acid increases serum cholesterol in a PPARα-dependent manner in female mice

Per- and polyfluoroalkyl substances in environment and potential health impacts: Sources, remediation treatment and management, policy guidelines, destructive technologies, and techno-economic analysis

OCCUPATIONAL

Higher PFOS Exposure Associated with Higher SHBG in Third Trimester. The Odense Child Cohort

Metabolomic machine learning predictor for arsenic-associated hypertension risk in male workers

Effect of 1-nitropyrene exposure on the biological behavior of trophoblast cells