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CONTACT US

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

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

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ASIA PACIFIC

Tire Chemicals Tied to Liver, Brain Toxicity: New Study

2025-05-20

Emerging contaminants from rubber tires N-(1,3-Dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD) and its oxidation product 6PPD-quinone (6PPDQ)—are raising new red flags for aquatic ecosystems. A recent study reveals that prolonged exposure to these chemicals at environmentally realistic levels disrupts lipid and carbohydrate metabolism, causes liver injury, and alters behavioral patterns in zebrafish. The research shows that 6PPD primarily accumulates in the liver, while 6PPDQ targets the brain. Both compounds downregulate PPARγ, a key regulator of metabolic function, and elevate pro-inflammatory cytokines, triggering chronic toxicity. Notably, 6PPDQ proved more damaging than its precursor, suggesting that transformation products may pose even greater risks. The findings point to a pressing need for tighter regulation and environmental surveillance of tire-derived pollutants.

N-(1,3-Dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD), an antioxidant widely used in vehicle tires, plays a critical role in preventing rubber degradation under stress. Yet, when released into the environment, it oxidizes into 6PPD-quinone (6PPDQ)—a compound now found globally in road runoff and surface waters. Prior research has linked both chemicals to developmental and systemic toxicity in aquatic organisms, but the mechanisms behind their long-term effects—particularly on liver function and neurobehavior—remain poorly defined. Zebrafish, due to their genetic similarity to humans and suitability for toxicological studies, provide a powerful model for tracing these effects. Given growing concerns, a deeper investigation into the bioaccumulation and chronic organ-specific toxicity of both 6PPD and 6PPDQ was urgently warranted.

Read More

Mirage, 20-05-25

https://www.miragenews.com/tire-chemicals-tied-to-liver-brain-toxicity-new-1462680/#google_vignette

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AMERICA

EPA Proposes Temporary Relief to Ensure Lab Compliance with Methylene Chloride Regulations under TSCA

2025-05-21

The U.S. Environmental Protection Agency (EPA) is proposing to extend various upcoming compliance dates in the final risk management rule for methylene chloride under the Toxic Substances Control Act (TSCA) in order to ensure long-term compliance with the rule's requirements. The proposal extends the Workplace Chemical Protection Program (WCPP) compliance dates for non-federal laboratories by an additional 18 months, to align with the dates allowed for federal laboratories and their contractors. EPA is issuing this proposal to address non-federal laboratories' near-term challenges with implementation of the May 2024 final rule on methylene chloride.

If finalized, this proposal would extend the following compliance dates for non-federal laboratories: for initial monitoring from May 5, 2025, to November 9, 2026; for establishing regulated areas and ensuring compliance with the Existing Chemical Exposure Limit from August 1, 2025, to February 8, 2027; and for ensuring the methods of compliance, as well as developing and implementing an exposure control plan, from October 30, 2025, to May 10, 2027.

Shortly after publishing the 2024 final rule, representatives from various laboratories using methylene chloride contacted EPA with questions and concerns including on the applicability of the rule and the requirements for WCPP compliance. Many of these laboratories, especially those associated with local governments or universities on fixed budget cycles that did not contemplate these requirements, use methylene chloride in small quantities and somewhat infrequently and are facing challenges completing the rule's initial monitoring requirements across potentially hundreds of labs in such a short timeframe. EPA's proposal would avoid disrupting important environmental monitoring and associated activities, while these non-federal labs work to comply with the rule's new requirements.

EPA will soon publish a Federal Register notice extending the compliance dates for non-federal laboratories. Upon publication of the Federal

Register notice, EPA will accept comments for 30 days via docket EPA-HQ-OPPT-2020-0465on regulations.gov.

Read More

US EPA, 21-05-25

https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-management-methylene-chloride

EPA Rolls Out Changes to Biden-Era PFAS Rules. What May Be Around the Corner?

2025-05-19

The U.S. Environmental Protection Agency (EPA) has announced major changes to two regulations concerning per- and polyfluoroalkyl substances (PFAS). The first is a revamp of Safe Drinking Water Act (SDWA) standards for certain PFAS in drinking water. The second is an update to Toxic Substances Control Act (TSCA) timelines for reporting PFAS use. As we previewed in our April 30 note, these actions are part of a multifaceted effort by the Trump EPA to update the agency's approach to PFAS issues, with likely more to come. This note provides a summary of the changes and how their implementation may proceed in light of certain congressional and judicial scrutiny.

PFAS in Drinking Water

On May 14, the EPA announced its intention to make changes to national drinking water standards regulating certain PFAS. In a press release, the EPA described plans to extend the compliance dates for two PFAS (PFOA and PFOS) but rescind regulations for four other substances pending further EPA consideration.

Read More

JDSupra, 19-05-25

https://www.jdsupra.com/legalnews/epa-rolls-out-changes-to-biden-era-pfas-9865558/

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North Carolina residents condemn EPA's PFAS regulation delay

2025-05-19

People who have been struggling to clean up decades of industrial pollution in the lower Cape Fear River basin are expressing their dismay and anger at a federal delay announced Wednesday on a crackdown on so-called forever chemicals that have fouled their drinking water.

That day, the Environmental Protection Agency announced plans to extend the timeline for water utilities to reduce the maximum safe levels for human consumption for a select group of per- and polyfluoroalkyl substances known as PFAS.

In 2024, under the Biden Administration, the EPA finalized the first-ever enforceable standards for six PFAS compounds: PFOA, PFOS, HFPO-DA (GenX), PFBS, PFNA and PFHxS. At that time, water utilities had until 2029 to comply with the new standards.

A year later, the Trump Administration's newly appointed EPA Administrator Lee Zeldin announced that the agency would uphold standards set for PFOA and PFOS — legacy PFAS that persist in the environment despite no longer being manufactured. But Zeldin also announced he would rescind and re-evaluate rules for the other four, including GenX.

Read More

NC Health News, 19-05-25

https://www.northcarolinahealthnews.org/2025/05/19/north-carolina-esidents-condemn-epas-pfas-regulation-delay/

Forever Chemicals In Your Closet? How PFAS May Be Harming Your Health

2025-05-18

In the pursuit of performance, the fashion industry has quietly adopted a class of synthetic chemicals that offer stain resistance, water repellency and durability. But the price may be higher than advertised.

Per- and polyfluoroalkyl substances, collectively known as PFAS, are increasingly found in clothing, from yoga leggings to hiking jackets and activewear. Dubbed "forever chemicals" because they don't naturally break down, PFAS persist in our environment and bodies, raising urgent

questions about their long-term effect on human and planetary health and safety.

A Glimpse Into PFAS In Clothing

Initially developed in the mid-20th century, PFAS are now ubiquitous in consumer goods, including personal care products, nonstick cookware, food packaging and water-resistant fabrics. In the apparel industry, they're often applied as coatings to make clothes repel water, oil, and dirt, which is convenient for outdoor gear and athletic wear, but at an environmentally hidden expense.

Read More

Forbes, 18-05-25

https://www.forbes.com/sites/ximenaaraya-fischel/2025/05/18/forever-chemicals-in-your-closet-how-pfas-may-be-harming-your-health/

U.S. Energy Department Slashes 47 Burdensome and Costly Regulations, Delivering First Milestone in America's Biggest Deregulatory Effort

2025-05-12

The U.S. Department of Energy (DOE) today announced the first step in the Energy Department's largest deregulatory effort in history, proposing the elimination or reduction of 47 regulations.

WASHINGTON — The U.S. Department of Energy (DOE) today announced the first step in the Energy Department's largest deregulatory effort in history, proposing the elimination or reduction of 47 regulations that are driving up costs and lowering quality of life for the American people. Once finalized, these actions will save the American people an estimated $11 billion and cut more than 125,000 words from the Code of Federal Regulations. These actions, in accordance with President Donald Trump's Executive Order, "Zero-Based Regulation to Unleash American Energy," advance President Trump's promise to restore consumer freedom, lower costs, and unleash American energy dominance.

"While it would normally take years for the Department of Energy to remove just a handful of regulations, the Trump Administration assembled a team working around the clock to reduce costs and deliver results for the American people in just over 110 days," said U.S. Secretary of Energy Chris Wright. "Thanks to President Trump's leadership, we are bringing back

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common sense -- slashing regulations meant to appease Green New Deal fantasies, restrict consumer choice and increase costs for the American people. Promises made, promises kept."

The 47 actions include the proposed elimination or modification to dozens of consumer appliance standards, regulations limiting building and energy production and unscientific DEI requirements for grant recipients. The full list of actions is available below:

1. Rescinding Requirements for Exempt External Power Supplies Under the EPS Service Parts Act of 2014
2. Streamlining Administrative Procedures with Respect to the Import and Export of Natural Gas
3. Streamlining Application for Presidential Permit Authorizing the Construction, Connection, Operation, and Maintenance of Facilities for Transmission of Electric Energy at International Boundaries
4. Rescinding Collection of Information Under the Energy Supply and Environmental Coordination Act of 1974
5. Rescinding Regulations for Loans for Minority Business Enterprises Seeking DOE Contracts and Assistance
6. Streamlining Applications for Authorization to Transmit Electric Energy to a Foreign Country
7. Rescinding the Production Incentives for Cellulosic Biofuels
8. Rescinding Reporting Requirements, Certification, Independent Verification, and DOE Review for Voluntary Greenhouse Gas Reporting

Read More

Energy.gov, 12-05-25

https://www.energy.gov/articles/energy-department-slashes-47-burdensome-and-costly-regulations-delivering-first-milestone

EUROPE

Environmental groups push back as EU considers loosening chemical regulations

2025-05-19

Environmental groups warn that the EU risks weakening its chemical safety laws as a major update to the REACH regulation looms. The groups say the proposed reforms could delay bans on harmful substances and

lower safety standards, despite growing evidence of pollution and health risks.

The European chemical industry is pushing for lower energy costs, more public subsidies, and fewer regulatory demands in REACH — the regulation that controls how chemicals are produced, used, and marketed in the EU, including personal care.

In contrast, the European Environmental Bureau (EEB) calls on the European Commission (EC) to reject the chemical industry's pressure and enforce stricter rules. The group wants the EC to speed up efforts to ban toxic chemicals, improve supply chain transparency, and commit to a toxic-free future by 2040.

The EEB is urging the EC to hold companies accountable and follow through on the goals of the European Green Deal.

These concerns were recently highlighted during a high-level meeting, where the divide between the chemical industry and civil society was pronounced. The EEB noted that three civil society groups were invited, compared to 15 industry representatives, highlighting what it sees as a clear imbalance in who gets a voice in shaping EU chemicals policy.

Alongside the EEB, the other civil society groups present were BEUC (Bureau Européen des Unions de Consommateurs), representing consumer interests across Europe, and ETUC (European Trade Union Confederation), advocating for workers' rights and trade unions.

Read More

Personal Care Insights, 19-05-25

https://www.personalcareinsights.com/news/eu-chemicals-reach-eeb-warn-against-deregulation.html

GB active substance expiry dates postponed until 2027

2025-05-19

This applies to biocidal active substance/product type combinations which expire between 1 January 2024 and 31 December 2026.

The active substance/product type combinations are able to be postponed providing a timely renewal application has been submitted and accepted.

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HSE provided information about the decision to postpone expiry datesin a previous ebulletin.

The requirements have now been met for the following active substance/product type combinations:

From 30 September 2026 to 31 January 2027

- Glutaral (glutaraldehyde) (CAS 111-30-8 EC 203-856-5) in product types 2, 3, 4, 6, 11 and 12

From 31 October 2026 to 31 January 2027

- Polyhexamethylene biguanide hydrochloride with a mean number-average molecular weight (Mn) of 1415 and a mean polydispersity (PDI) of 4.7 (PHMB (1415;4.7)) (CAS 1802181-67-4 / 32289-58-0 EC N/A) in product type 2

If you want to supply new biocidal products containing these active substances, you can still apply for GB BPR product authorisation. New products (including new trade names) must not be supplied in GB until product authorisation is granted.

HSE will provide separate updates on the renewal decisions and future expiry date postponements captured within this overall decision when relevant.

Read More

HSE, 19-05-25

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

Design and behavioural research study to create evidence-based, EU harmonised consumer waste sorting labels

2025-05-16

This Interim Report presents early results of the EU study to develop harmonised, evidence-based waste sorting labels for packaging and receptacles. The project evaluates the Nordic pictogram system and other national schemes to inform the design of an EU-wide solution that enhances consumer understanding and supports better sorting behaviours. A first prototype label has been tested through an online survey in 21 Member States (N=16,380) and participatory workshops in six countries (N=245). Findings highlight the importance of visual clarity,

intuitive icons, and consistent use of colour. Evidence shows that text is the most effective design element for improving sorting accuracy, especially when including material identifiers and clear instructions. Component pictograms significantly support the sorting of multi-material packaging. Colour improves salience for some categories, though its effect on overall accuracy is limited. Additional labels reduce salience and can distract from core sorting information. Participants expressed high motivation and confidence in their ability to sort correctly. These findings will inform a second prototype to be tested in a behavioural experiment. By combining behavioural science with participatory design, the study generates actionable insights to support future EU policy and the effective rollout of standardised labels across Europe.

Read More

European Commission, 16-05-25

https://publications.jrc.ec.europa.eu/repository/handle/JRC141556

EU Ecolabel shows the way to green procurement of paper products

2025-05-21

Public buyers can make a step towards green procurement of paper products. The two newly released Practical guides for the use of the EU Ecolabel in the green public procurement of graphic paper, and of tissue paper and tissue products are here to help.

A third set of practical guidelines is also on the horizon, this time focusing on printed paper, stationery, and printed paper carrier bags.

Public procurement: a staple in the paper market

Despite digitalisation, public sector entities still much rely on paper for official records, legal documentation, and communication. In parallel, tissue paper products such as toilet paper, paper towels and facial tissues are indispensable in the daily operations of public facilities, making their sustainable procurement important.

By choosing responsibly sourced, sustainably produced and recycled paper, public buyers can make a tangible contribution to the green transition by helping to reduce deforestation, minimise waste, and promote resource efficiency - all without necessarily increasing their expenditure.

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Why choose the EU Ecolabel?

The use of the EU Ecolabel - the official EU voluntary label for environmental excellence, with over 102.000 certified products across 25 products categories, in public procurement offers clear environmental, administrative and potential economic benefits.

Environmental: EU Ecolabel criteria are scientifically based, legally established and are third-party verified. They are developed through research and extensive stakeholder consultation. Criteria are regularly updated to reflect evolving environmental priorities and technological progress. With the EU Ecolabel certification, products are guaranteed best-in-class in terms of environmental performance, without compromising on performance!

Read More

European Commission, 21-05-25

https://environment.ec.europa.eu/news/new-practical-guides-eu-ecolabel-shows-way-green-procurement-paper-products-2025-05-21_en

INTERNATIONAL

Kazakhstan and Armenia launch SDG roadmaps on affordable and clean energy, with UNECE and ESCAP support

2025-05-14

To help accelerate their progress towards Sustainable Development Goal (SDG) 7, which aims to ensure access to affordable, reliable, sustainable and modern energy for all, SDG 7 Roadmaps for Kazakhstan and Armenia have been developed under a joint UNDA project implemented by ESCAP and UNECE.

Kazakhstan has already achieved universal access to electricity and is very close to achieving universal access to clean cooking, which stood at 97.8 per cent in 2021. It is estimated that universal access to clean cooking will be achieved by 2030 under the current policy settings. Energy efficiency improvement needs to be boosted across different sectors in order to achieve a 3.4 per cent annual improvement, which would reduce energy intensity to 4.0 MJ/USD by 2030. There is significant scope to increase the efficiency of the country's energy system. Concerted effort is needed to

improve energy efficiency across the entire economy. The power sector is heavily reliant on coal leading to substantial GHG emissions. An increase in renewable energy-based power generation is essential to reduce emissions.

The Roadmap sets out the following four key policy recommendations to help Kazakhstan achieve the SDG 7 targets:

9. Improve energy efficiency across all economic sectors;
10. Proceed with electrification of the transport sector, which will reduce emissions and improve energy security;
11. Decarbonize the power supply, which is the key to achieving net zero emissions by 2050;
12. Decarbonize the heating sector to reduce emissions and improve energy security.

Read More

UNECE, 14-05-25

https://unece.org/climate-change/news/kazakhstan-and-armenia-launch-sdg-roadmaps-affordable-and-clean-energy-unece

IFRA-IOFI-CAFFCI Collaborate to Advance Sustainability in Fragrance & Flavor Industry in China

2025-05-13

On May 13, the International Fragrance Association (IFRA), the International Organization of Flavor Industry (IOFI), and the China Fragrance, Flavor & Cosmetics Industry Association (CAFFCI) co-hosted the International Symposium on Sustainability in Shanghai, formalizing their partnership with a Memorandum of Cooperation to advance Chinese F&F industry on sustainability.

"Global science must pair with local action—listening to diverse voices ensures we balance safety, sustainability, and regional contexts for a green transition," stated Alexander Mohr, PhD, IFRA President, highlighting the progress of the IFRA-IOFI Sustainability Charter, now joined by 4 Chinese companies for the first time, committing to their effort for responsible sourcing and carbon reduction.

Dr. Yan Jiangying, Chairman of CAFFCI, emphasized: "Today, CAFFCI will jointly sign a memorandum of cooperation on the sustainable development of the F&F industry with IFRA and IOFI. CAFFCI is willing to

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work with IFRA and IOFI to translate the memorandum of cooperation into actions through a series of activities, including building an ESG service platform for the F&F industry."

Read More

IFRA, 13-05-25

https://ifrafragrance.org/news/newsroom/ifra-iofi-caffci-collaborate-to-advance-sustainability-in-fragrance-flavor-industry-in-china

How training in green skills could help turn the tide against plastic pollution

2025-05-14

Experts have long known the recipe for ending the plastic pollution crisis gripping the planet. The world, they say, must embrace a process known as circularity, which focuses on prolonging the life of plastic products and keeping plastics out of the environment.

One of the problems? Many businesses that make and use plastic cannot find workers with the technical know-how to make their operations more circular.

"In this region and many others, academic curricula are often playing catchup with environmental crises, including plastic pollution," says Juan Bello, Director and Representative of the Regional Office for Latin America and Caribbean at the United Nations Environment Programme (UNEP).

UNEP recently struck a partnership with a network of regional universities to equip students with a host of green skills, including those linked to circularity. We recently spoke with Bello about the agreement and why today's post-secondary students are key players in the global campaign against plastic pollution.

Read More

UNEP, 14-05-25

https://www.unep.org/news-and-stories/story/how-training-green-skills-could-help-turn-tide-against-plastic-pollution

From Waste to Opportunity: UNRMS and the Road to 100% Phosphogypsum Utilization

2025-05-09

The global phosphate fertilizer industry produces in excess of 230 million tonnes of phosphogypsum (PG) each year, a quantity anticipated to increase in response to the escalating demand for food production. Historically regarded as a waste, PG has now accumulated in stockpiles surpassing 6 billion tonnes, thereby presenting significant environmental and economic challenges.

The newly released 2025 International Fertilizer Association (IFA) report titled "Phosphogypsum: From Waste to Inventory " presents compelling evidence that phosphogypsum (PG) can be reclassified as a secondary raw material, exhibiting a multitude of potential applications. These analyses were undertaken with the support of the United Nations Resource Management System (UNRMS), which provides a structured framework for sustainable resource classification and reuse. As of 2024, global reuse rates of PG are approximately 35%, with countries such as Brazil and China showcasing the viability of large-scale, market-driven valorization. Presently, PG is utilised in road construction, building materials, soil conditioning, and environmental restoration initiatives. With appropriate pre-treatment and well-defined regulatory frameworks, even critical raw materials, such as rare earth elements (REE), can be effectively recovered from PG in significant quantities.

Read More

UNECE, 09-05-25

https://unece.org/circular-economy/news/waste-opportunity-unrms-and-road-100-phosphogypsum-utilization

ECHA launches revamped Classification and Labelling Inventory

2025-05-20

ECHA's redesigned C&L Inventory is now available in the Agency's new chemicals database, ECHA CHEM.

Helsinki, 20 May 2025 – The C&L Inventory includes information on more than 4 400 EU-level harmonised classifications and seven million classifications notified or included in REACH registrations. Altogether, the inventory includes data on around 350 000 substances.

The integration of classification and labelling information into ECHA CHEM follows the initial launch of the database in January 2024, which featured information on over 100 000 REACH registrations submitted by companies. The new inventory is designed to help users easily locate the classification with the highest agreement and to bring clarity on the source behind the classification information. It incorporates recent regulatory developments, such as the new CLP hazard classes and is built with stability and growth in mind.

In this first version, the classification information is accessible in a visual format per substance with complementary approaches, such as application programming interfaces (APIs), being explored in future releases.

Read More

ECHA, 20-05-25

https://echa.europa.eu/-/echa-launches-revamped-c-l-inventory#msdynttrid=1uSsn46-T6sXqqz1MlVVdCcOQPzcb74BhqvVgtkWITo

ECHA's Biocides Committee backs approval of anticoagulant rodenticides

2025-05-21

ECHA's Biocidal Products Committee (BPC) adopted eight opinions supporting the renewals and approval of anticoagulant rodenticide substances – with certain use-specific exceptions. It also adopted five opinions on Union authorisations.

Helsinki, 21 May 2025 – The BPC, in its May meeting, adopted the following opinions on active substances, supporting their renewal for product-type 14 (rodenticides):

- Brodifacoum
- Flocoumafen
- Coumatetralyl
- Chlorophacinone
- Difethialone
- Difenacoum
- Bromadiolone

Additionally, the committee supported the initial approval of Alpha-bromadiolone for the same product-type.

The BPC reviewed 11 uses for all the eight rodenticides and recommends renewing or approving these active substances for nine uses. The committee does not support their use against mice when applied by non-professionals or for permanent baiting by professional pest controllers, as safer chemical or non-chemical alternatives are available.

Furthermore, the committee adopted an opinion supporting the approval of 3-iodo-2-propynylbutylcarbamate (IPBC) for product-type 10 (construction material preservatives).

Union authorisations

The committee adopted the following five opinions on Union authorisations, supporting:

- authorisation of a biocidal product family containing Active chlorine released from hypochlorous acid for product-types 1 (human hygiene) and 3 (veterinary hygiene);
- authorisation of a biocidal product Potassium (E,E)-hexa-2,4-dienoate (Potassium Sorbate) for product-type 6 (preservatives for products during storage);
- authorisation of a biocidal product family containing Hydrogen peroxide for product-types 2 (disinfectants and algaecides not intended for direct application to humans or animals), 3 and 4 (food and feed area);
- authorisation of a biocidal product family containing Hydrogen peroxide for product-types 3 and 4; and

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- a major change of a Union authorisation of a biocidal product containing pyriproxyfen and (E)-1-(2-Chloro-1,3-thiazol-5-ylmethyl)-3-methyl-2-nitroguanidine (Clothianidin) for product-type 18.

Read More

ECHA, 21-05-25

https://echa.europa.eu/-/echa-s-biocides-committee-backs-approval-of-anticoagulant-rodenticides#msdynttrid=NMyrDlNT0af3Sq-fKC9BYqu8jvtZ1FrSlZRlMw5hp_s

Heptachlor

2023-05-12

Heptachlor, chemical formula C10H5Cl7, is an organochlorine compound that was used as an insecticide. It is one of the cyclodiene insecticides. [1] Heptachlor is a white to light tan waxy solid with a camphor-like odour. It is insoluble in water and soluble in xylene, hexane, and alcohol. [2] Heptachlor was used extensively in the past for killing insects in homes, buildings, and on food crops. These uses stopped in 1988. [3] Due to its highly stable structure, heptachlor can persist in the environment for decades. [1] It is readily converted to more potent heptachlor epoxide once it enters the environment or the body. [1,2]

USES [2,3]

- Heptachlor is a constituent of technical grade chlordane, approximately 10 percent by weight.
- Heptachlor was used as an insecticide in the United States from 1953 to 1974. In 1974, nearly all registered uses of heptachlor were cancelled.
- Heptachlor was used from 1953 to 1974 as a soil and seed treatment to protect corn, small grains, and sorghum from pests. It was also used to control ants, cutworms, maggots, termites, and other pests in agriculture and in the home.
- Its sole U.S. manufacturer voluntarily cancelled the sale of heptachlor in 1987.
- In 1988, the sale, distribution, and shipment of existing stocks of all cancelled heptachlor and chlordane products were prohibited in the United States.
- The only commercial use of heptachlor products still permitted is fire ant control in power transformers. In addition, homeowner's use of existing stocks of heptachlor-containing termite control products is also allowed.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- People whose homes were treated for termites with heptachlor may be exposed to heptachlor in the indoor air for many years after treatment.
- Workers who use heptachlor to kill fire ants or who manufacture the chemical may be exposed to it in the air or through the skin.

- Heptachlor has been detected in food, including fish, shellfish, dairy products, meat, and poultry.
- Another possible source of exposure is drinking water; heptachlor has been detected at low concentrations in drinking water wells in several states.

Routes of Exposure

- **Inhalation** – Minor route of exposure for the general population;
- **Oral** – Primary route of exposure is through the diet;
- **Dermal** – Minor route of exposure

HEALTH EFFECTS [4]

Acute Health Effects

Acute inhalation exposure to heptachlor in humans has been associated with nervous system effects in a few case studies, while gastrointestinal effects, such as nausea and vomiting, have been reported to occur following accidental ingestion of heptachlor. Effects on the liver and central nervous system have been noted in animals acutely exposed to heptachlor via the oral route. Heptachlor is considered to have high to extreme acute toxicity based on short-term oral tests in rats.

Carcinogenicity

Human studies on heptachlor exposure and cancer are inconclusive. There are several case reports describing a possible link between heptachlor exposure and leukaemia and neuroblastoma; however, insufficient information is available to confirm a causal effect. Several studies on workers exposed via inhalation to heptachlor are available; however, these are limited due to confounding factors and small sample size. Animal studies have reported liver tumours in mice exposed to heptachlor via ingestion. EPA considers heptachlor to be a probable human carcinogen (cancer-causing agent) and has classified it as a Group B2 carcinogen.

Other Effects

Heptachlor has been shown to cross the placenta to the developing foetus in humans. However, inadequate information is available to determine whether heptachlor may cause developmental or reproductive effects in humans. Animal studies have reported developmental effects, including foetal resorptions, and decreased postnatal survival, as well as

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reproductive effects such as failure of animals to reproduce, following oral exposure to heptachlor.

SAFETY

First Aid Measures [5]

- **Inhalation:** Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
- **Ingestion:** If swallowed, give large quantities of water to drink and get medical attention immediately. Never give anything by mouth to an unconscious person.
- **Skin Contact:** Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.
- **Eye Contact:** Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Personal Protective Equipment [4]

The following is a list of recommended personal protective equipment when handling heptachlor:

- **Respiratory protection:** Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN(EU).
- **Hand protection:** Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands. The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
- **Eye protection:** Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

- **Skin and body protection:** Complete suit protecting against chemicals, the type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

REGULATION

United States

The following exposure limits are for Coal Tar Pitch Volatiles:

OSHA: The United States Occupational Safety and Health Administration permissible exposure limit (PEL) for heptachlor is 0.5 milligrams per cubic metre (mg/m3) of air as an 8-hour time-weighted average (TWA) concentration. The OSHA PEL also bears a "Skin" notation, which indicates that the cutaneous route of exposure (including mucous membranes and eyes) contributes to overall exposure [29 CFR 1910.1000, Table Z-1].

NIOSH: The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for heptachlor of 0.5 mg/m3 as a TWA for up to a 10-hour workday and a 40-hour workweek. NIOSH also assigns a "Skin" notation to heptachlor. NIOSH considers heptachlor a potential occupational carcinogen [NIOSH 1992].

ACGIH: The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned heptachlor a threshold limit value (TLV) of 0.5 mg/m3 as a TWA for a normal 8-hour workday and a 40-hour workweek. The ACGIH also assigns a "Skin" notation to heptachlor. The ACGIH lists heptachlor as an animal carcinogen [ACGIH 1994, p. 22].

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AI discovers new rare-earth-free magnet at 200 times the speed of man

2024-06-12

As some entities identify new (or at least overlooked) sources to meet the growing demand for rare earth materials, others are looking toward new tools. UK deep-tech company Materials Nexus announced on Tuesday that it has designed a new rare-earth-free permanent magnet with the help of its AI platform. It says the AI-driven discovery and development process was 200 times faster than the resource-intensive manual route, bringing new hope to an electrifying world with a growing appetite for powerful magnets.

With the world moving away from internal combustion engines and gradually embracing electric mobility, the demand for compact, high-power motors is rapidly rising. By far the most popular option in the automotive industry right now is the permanent magnet motor, which powers upward of 80% of modern electric vehicles.

Materials Nexus estimates that demand for permanent magnets will grow tenfold by 2030, in the EV industry alone. And it's not just electric cars and trucks, either. Permanent magnet motors are in demand for many applications, including robotics, drones, wind turbines and HVAC equipment.

The problem is, the rare earth materials used to create the most powerful magnets and most efficient, power-dense motors – materials like neodymium and dysprosium – require damaging mining and expensive, energy-intensive processing. With its world-largest EV market, China has emerged as a leader in both mining and processing of rare earths, pulling as much as 70% of the world's rare earths out of the ground while processing closer to 90%. That gives the country monopoly-like control over the essential materials, leaving other markets exposed to supply disruptions and pricing fluctuations.

The search for alternatives is on, and some automakers and suppliers are starting to develop and incorporate magnet-free motors. Others, including Tesla, are pursuing permanent magnet designs free from rare-earth materials.

Rare-earth-free magnets certainly sound like an intriguing solution, but they can be difficult to formulate and less powerful than traditional rare-earth magnets. Niron Magnetics has developed what it calls the world's first high-performance rare-earth-free magnets, using a mix of abundantly

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available iron and nitrogen, but it's been researching and developing it for over a decade and still isn't quite ready for mass production.

Materials Nexus is letting the world know it's here to help. It believes it has just what contemporary and future magnet startups need to identify and develop rare-earth-free magnetic materials, and by substituting AI for old-fashioned trial-and-error, it believes they can do so at a pace hundreds of times faster than has been traditionally possible. It says its AI platform can identify rare-earth-free magnetic materials in a matter of days or weeks, in contrast to the years and decades it's taken in the past.

Rather than simply spout impressive numbers, Materials Nexus has already used its AI platform to identify a rare-earth-free permanent magnet it's named MagNex. The AI analyzed more than 100 million rare-earth-free material compositions before it landed on MagNex, factoring in variables such as cost, supply chain security, performance and environmental impact.

After the AI did the heavy lifting, Materials Nexus synthesized and tested MagNex with help from the Henry Royce Institute at the University of Sheffield. In three months, the company had done work that would have taken years prior to its AI system.

Furthermore, Materials Nexus says MagNex can be produced at 20% the material cost of currently available rare earth magnets, with a 70% reduction in material carbon emissions.

"We're really excited that our first interaction with Materials Nexus has yielded such a hugely positive outcome," said professor Iain Todd, metallurgy and materials processing, University of Sheffield. "The combination of Materials Nexus' approach of using AI for materials discovery and the world-class facilities we have for manufacture of advanced alloys in the Henry Royce Institute here at Sheffield has allowed a novel magnetic material to be developed with breathtaking speed."

While a brand-new rare-earth-free magnet added some serious juice to this week's announcement, it's far from the only possible use case for Material Nexus' AI. The company says the AI will be useful for all kinds of industries, helping to identify and create the next generation of cutting-edge materials driving new technologies and CO2e emissions reductions. It plans to work with industrial partners toward accelerating the discovery of viable, cost-effective and sustainable next-gen materials.

"Our platform has already attracted widespread interest for various products with applications that include semiconductors, catalysts and coatings," said Materials Nexus CEO Dr. Jonathan Bean. "I look forward to seeing the role it will play in supporting market demand for the creation of novel materials to help address increasingly pressing supply chain and environmental issues."

As do we. We also look forward to seeing if MagNex becomes a viable magnet alternative for permanent magnet motors, whether aimed at electric mobility or one of the other applications for which such motors will remain in high demand.

New Atlas, 12 June 2024

https://newatlas.com

Iron oxide 'oxygen sponge' doubles green hydrogen production efficiency by targeting atomic-level active sites

2025-05-29

As the world shifts toward sustainable energy sources, "green hydrogen"—hydrogen produced without emitting carbon—has emerged as a leading candidate for clean power. In a significant step forward, a research team has developed a new iron-based catalyst that more than doubles the conversion efficiency of thermochemical green hydrogen production.

Their findings were recently published in the journal Acta Materialia. The collaborative research team was led by Professor Hyungyu Jin from the Department of Mechanical Engineering at POSTECH and Professor Jeong Woo Han from the Department of Materials Science and Engineering at Seoul National University.

With growing concerns over fossil fuel–driven pollution and climate change, hydrogen is gaining attention as a clean energy carrier that only emits water upon combustion. Among various hydrogen production pathways, thermochemical water splitting—which uses thermal energy to split water into hydrogen and oxygen—is considered particularly promising. Central to this process is the role of metal oxides, which absorb and release oxygen in cycles, effectively acting like "oxygen sponges."

However, most conventional oxides suffer from a key limitation: they require extremely high temperatures to operate effectively due to their thermodynamic characteristics. This has hindered their commercial viability. To address this challenge, the research team developed a novel iron-poor nickel ferrite (Fe-poor $NiFe_2O_4$, or NFO).

While traditional oxides typically rely on non-stoichiometric reactions that allow relatively small oxygen absorption and release, the Fe-poor ferrite exhibits a distinct phase transformation mechanism that enables significantly greater oxygen capacity even at lower temperatures.

Experimental results showed that the novel oxides achieved a water-to-hydrogen conversion efficiency of 0.528% per gram of oxides—more than double the 0.250% benchmark set by the previous best-performing material.

What makes this study particularly noteworthy is not only the development of a high-efficiency catalyst, but also the team's success in unraveling the underlying mechanisms. Using a combination of experimental techniques and computational simulations, the researchers were able to identify, for the first time, the "structural active sites" within iron oxide materials that drive hydrogen production at the atomic level.

They further revealed that a redox swing between two types of iron sites is directly correlated with hydrogen yield—an insight that could guide the future design of even more effective catalysts.

"This study is meaningful in that it proposes an economical and sustainable hydrogen production pathway using abundant iron oxides. It also opens the door to using solar heat or industrial waste heat as energy sources for hydrogen generation," said Professor Jin.

Professor Han added, "This work is a compelling example of how experimental and computational sciences can work together to uncover fundamental principles through interdisciplinary collaboration."

Phys Org, 29 May 2025

https://phys.org

New fuel cell could enable electric aviation

2025-05-27

Batteries are nearing their limits in terms of how much power they can store for a given weight. That's a serious obstacle for energy innovation and the search for new ways to power airplanes, trains, and ships. Now, researchers at MIT and elsewhere have come up with a solution that could help electrify these transportation systems.

Instead of a battery, the new concept is a kind of fuel cell -- which is similar to a battery but can be quickly refueled rather than recharged. In this case, the fuel is liquid sodium metal, an inexpensive and widely available commodity. The other side of the cell is just ordinary air, which serves as a source of oxygen atoms. In between, a layer of solid ceramic material serves as the electrolyte, allowing sodium ions to pass freely through, and a porous air-facing electrode helps the sodium to chemically react with oxygen and produce electricity.

In a series of experiments with a prototype device, the researchers demonstrated that this cell could carry more than three times as much energy per unit of weight as the lithium-ion batteries used in virtually all electric vehicles today. Their findings are being published today in the journal Joule, in a paper by MIT doctoral students Karen Sugano, Sunil Mair, and Saahir Ganti-Agrawal; professor of materials science and engineering Yet-Ming Chiang; and five others.

"We expect people to think that this is a totally crazy idea," says Chiang, who is the Kyocera Professor of Ceramics. "If they didn't, I'd be a bit disappointed because if people don't think something is totally crazy at first, it probably isn't going to be that revolutionary."

And this technology does appear to have the potential to be quite revolutionary, he suggests. In particular, for aviation, where weight is especially crucial, such an improvement in energy density could be the breakthrough that finally makes electrically powered flight practical at significant scale.

"The threshold that you really need for realistic electric aviation is about 1,000 watt-hours per kilogram," Chiang says. Today's electric vehicle lithium-ion batteries top out at about 300 watt-hours per kilogram -- nowhere near what's needed. Even at 1,000 watt-hours per kilogram, he says, that wouldn't be enough to enable transcontinental or trans-Atlantic flights.

That's still beyond reach for any known battery chemistry, but Chiang says that getting to 1,000 watts per kilogram would be an enabling technology for regional electric aviation, which accounts for about 80 percent of domestic flights and 30 percent of the emissions from aviation.

The technology could be an enabler for other sectors as well, including marine and rail transportation. "They all require very high energy density, and they all require low cost," he says. "And that's what attracted us to sodium metal."

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A great deal of research has gone into developing lithium-air or sodium-air batteries over the last three decades, but it has been hard to make them fully rechargeable. "People have been aware of the energy density you could get with metal-air batteries for a very long time, and it's been hugely attractive, but it's just never been realized in practice," Chiang says.

By using the same basic electrochemical concept, only making it a fuel cell instead of a battery, the researchers were able to get the advantages of the high energy density in a practical form. Unlike a battery, whose materials are assembled once and sealed in a container, with a fuel cell the energy-carrying materials go in and out.

The team produced two different versions of a lab-scale prototype of the system. In one, called an H cell, two vertical glass tubes are connected by a tube across the middle, which contains a solid ceramic electrolyte material and a porous air electrode. Liquid sodium metal fills the tube on one side, and air flows through the other, providing the oxygen for the electrochemical reaction at the center, which ends up gradually consuming the sodium fuel. The other prototype uses a horizontal design, with a tray of the electrolyte material holding the liquid sodium fuel. The porous air electrode, which facilitates the reaction, is affixed to the bottom of the tray.

Tests using an air stream with a carefully controlled humidity level produced a level of nearly 1,700 watt-hours per kilogram at the level of an individual "stack," which would translate to over 1,000 watt-hours at the full system level, Chiang says.

The researchers envision that to use this system in an aircraft, fuel packs containing stacks of cells, like racks of food trays in a cafeteria, would be inserted into the fuel cells; the sodium metal inside these packs gets chemically transformed as it provides the power. A stream of its chemical byproduct is given off, and in the case of aircraft this would be emitted out the back, not unlike the exhaust from a jet engine.

But there's a very big difference: There would be no carbon dioxide emissions. Instead the emissions, consisting of sodium oxide, would actually soak up carbon dioxide from the atmosphere. This compound would quickly combine with moisture in the air to make sodium hydroxide -- a material commonly used as a drain cleaner -- which readily combines with carbon dioxide to form a solid material, sodium carbonate, which in turn forms sodium bicarbonate, otherwise known as baking soda.

"There's this natural cascade of reactions that happens when you start with sodium metal," Chiang says. "It's all spontaneous. We don't have to do anything to make it happen, we just have to fly the airplane."

As an added benefit, if the final product, the sodium bicarbonate, ends up in the ocean, it could help to de-acidify the water, countering another of the damaging effects of greenhouse gases.

Using sodium hydroxide to capture carbon dioxide has been proposed as a way of mitigating carbon emissions, but on its own, it's not an economic solution because the compound is too expensive. "But here, it's a byproduct," Chiang explains, so it's essentially free, producing environmental benefits at no cost.

Importantly, the new fuel cell is inherently safer than many other batteries, he says. Sodium metal is extremely reactive and must be well-protected. As with lithium batteries, sodium can spontaneously ignite if exposed to moisture. "Whenever you have a very high energy density battery, safety is always a concern, because if there's a rupture of the membrane that separates the two reactants, you can have a runaway reaction," Chiang says. But in this fuel cell, one side is just air, "which is dilute and limited. So you don't have two concentrated reactants right next to each other. If you're pushing for really, really high energy density, you'd rather have a fuel cell than a battery for safety reasons."

While the device so far exists only as a small, single-cell prototype, Chiang says the system should be quite straightforward to scale up to practical sizes for commercialization. Members of the research team have already formed a company, Propel Aero, to develop the technology. The company is currently housed in MIT's startup incubator, The Engine.

Producing enough sodium metal to enable widespread, full-scale global implementation of this technology should be practical, since the material has been produced at large scale before. When leaded gasoline was the norm, before it was phased out, sodium metal was used to make the tetraethyl lead used as an additive, and it was being produced in the U.S. at a capacity of 200,000 tons a year. "It reminds us that sodium metal was once produced at large scale and safely handled and distributed around the U.S.," Chiang says.

What's more, sodium primarily originates from sodium chloride, or salt, so it is abundant, widely distributed around the world, and easily extracted, unlike lithium and other materials used in today's EV batteries.

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The system they envisage would use a refillable cartridge, which would be filled with liquid sodium metal and sealed. When it's depleted, it would be returned to a refilling station and loaded with fresh sodium. Sodium melts at 98 degrees Celsius, just below the boiling point of water, so it is easy to heat to the melting point to refuel the cartridges.

Initially, the plan is to produce a brick-sized fuel cell that can deliver about 1,000 watt-hours of energy, enough to power a large drone, in order to prove the concept in a practical form that could be used for agriculture, for example. The team hopes to have such a demonstration ready within the next year.

Sugano, who conducted much of the experimental work as part of her doctoral thesis and will now work at the startup, says that a key insight was the importance of moisture in the process. As she tested the device with pure oxygen, and then with air, she found that the amount of humidity in the air was crucial to making the electrochemical reaction efficient. The humid air resulted in the sodium producing its discharge products in liquid rather than solid form, making it much easier for these to be removed by the flow of air through the system. "The key was that we can form this liquid discharge product and remove it easily, as opposed to the solid discharge that would form in dry conditions," she says.

Ganti-Agrawal notes that the team drew from a variety of different engineering subfields. For example, there has been much research on high-temperature sodium, but none with a system with controlled humidity. "We're pulling from fuel cell research in terms of designing our electrode, we're pulling from older high-temperature battery research as well as some nascent sodium-air battery research, and kind of mushing it together," which led to the "the big bump in performance" the team has achieved, he says.

The research team also included Alden Friesen, an MIT summer intern who attends Desert Mountain High School in Scottsdale, Arizona; Kailash Raman and William Woodford of Form Energy in Somerville, Massachusetts; Shashank Sripad of And Battery Aero in California, and Venkatasubramanian Viswanathan of the University of Michigan. The work was supported by ARPA-E, Breakthrough Energy Ventures, and the National Science Foundation, and used facilities at MIT.nano.

Science Daily, 27 May 2025

https://sciencedaily.com

Polymer membrane separates hydrocarbons, offering alternative to distillation

2025-05-29

A new polymer membrane for separating hydrocarbons in crude oil might one day save huge amounts of energy by removing the need for fractional distillation. The polymer is similar to reverse osmosis membranes used for desalination of seawater, making it potentially scalable to the large volumes that would be needed in industry.

Fractional distillation of crude oil consumes nearly 1% of global energy and accounts for 6% of the world's carbon emissions. In 2016 chemical engineers Ryan Lively and David Sholl at Georgia Institute of Technology in Atlanta, US, placed the isothermal separation of crude oil top of a list of 'seven chemical separations to change the world'. Lively was subsequently part of the first team to demonstrate the process in 2020, using a spirocyclic polymer. Other groups have now demonstrated it using other materials.

Reverse osmosis plants can desalinate large volumes of salt water many times faster than the world's largest refineries can fractionate similar quantities of crude oil. They achieve this using membranes produced by interfacial polymerisation. This technique, which traditionally involves dissolving the two monomers – one in water and one in an organic solvent – to form a crosslinked polymer at the interface, is therefore highly attractive for scalable production of hydrocarbon-separation membranes.

Producing polymers to separate hydrocarbons poses specific challenges, however. First, for hydrocarbons to flow through them, the materials need to be lipophilic. However, as polymers are themselves hydrocarbons, membranes that are not structurally rigid may absorb the liquids and swell, altering the pore sizes and filtration properties. 'Some of the materials worked quite well, but not really satisfactorily,' says Tae Hoon Lee, a researcher at Sungkyunkwan University in South Korea, who helped develop the new membrane during his postdoc at the Massachusetts Institute of Technology (MIT) in the US. 'That's why we started this work to develop a proper polymer membrane for organic solvent reverse osmosis while still adopting the interfacial polymerisation technique.'

The researchers designed triptycene and spirobifluorene monomers that retained their shape when solvent passed through them. To join these together, they replaced the traditional amide linkages with less polar imine linkages – each formed by reacting an amine group on

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the triptycene with an aldehyde group on the spirobifluorene. As the monomers are insoluble in water, they dissolved both of them in the organic solvent, and instead dissolved the acid catalyst needed for the reaction to occur in the aqueous phase. The resulting microporous polyimine membrane showed continuous and stable ability to separate out the components of a mixture of naphtha-, kerosene- and diesel-grade fuel with efficiency better than state-of-the-art competitors and remained stable during 7 days of operation.

The researchers now hope to develop the process further and commercialise it. 'What about the pharmaceutical industry and semiconductor industry?' says MIT's Zachary Smith, who led the project. 'There's many places where solvent separations or solvent–solute separations are needed. We're looking to optimise, to scale, and to get this out into the real world.'

Lively, who was not involved in the present work, believes that, despite the inertia of industrial chemistry, 'it is just a matter of time before a demonstration [of membrane crude oil fractionation] outside the university occurs'. He says this new idea is promising and the figures presented appear impressive, but cautions the technology is at an early stage. 'I think separating a real crude oil needs to be tested,' he says.

Chemistry World, 29 May 2025

https://chemistryworld.com

New plastic dissolves in the ocean overnight, leaving no microplastics

2025-03-27

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

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

But those same strong bonds become a problem after the useful life of a plastic product is over. That cup you used once and threw away will sit in

landfill for decades, even centuries, before it fully breaks down. And when it does, it forms microplastic pieces that are turning up in all corners of the natural world, including our own bodies, where they wreak havoc on our health in ways we're only just beginning to understand.

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

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

After screening a range of molecules, the researchers identified a particular combination that seemed to have the right properties – sodium hexametaphosphate, which is a common food additive, and monomers based on guanidinium ions, which are used in fertilizers. When these two compounds are mixed together in water, they form a viscous material that can be dried to form plastics.

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

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

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

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

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

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

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

New Atlas, 27 March 2025

https://newatlas.com

Rethinking our relationship with CO_2—greenhouse gas could lead to development of sustainable fuels

2025-05-29

The goal of carbon dioxide (CO2) hydrogenation is to turn pollution into fuel. This process transforms CO2, one of the main greenhouse gases, into chemical products and renewable fuels. One important product is methanol, a versatile compound used in everything from plastics to fuels.

Other compounds can also be produced, such as methane, which can be injected directly into natural gas pipelines. Hydrocarbons with longer chains can be produced as well and can be used as gasoline or aviation fuel. This opens up the possibility of creating so-called e-fuels, which are sustainable alternatives to traditional fossil fuels.

An international consortium, including Liane Rossi, director of the Carbon Capture and Conversion Program (CCU) of the Research Center for Greenhouse Gas Innovation (RCGI) and professor at the Institute of Chemistry of the University of São Paulo (USP), in Brazil, presents an overview of the subject in an article published in the journal Science.

"We need to rethink our relationship with carbon dioxide," argues Robert Wojcieszak, a senior researcher at the Centre National de la Recherche Scientifique in France and one of the authors of the article. "Instead of viewing it as waste, we can capture CO2 from industrial sources or even directly from the air and use it as a valuable carbon building block."

The surface of the catalytic particles captures the CO2 and hydrogen molecules, weakening the strong bonds that hold them together. This

allows the atoms to rearrange themselves and form new bonds, creating the desired products. Scientists are constantly working to develop better catalysts.

The article examined methanol as a green solution for aviation and maritime transport. The CuZnAl (CZA) catalyst has been used to produce methanol since the 1940s. It has become the industry standard due to its efficiency.

However, "when using CZA, the catalytic process has a peculiarity: it prefers a different reaction instead of directly converting CO2 into methanol. This means that it doesn't use CO2 as efficiently as we'd like," explains Andrew Beale, a professor at University College London in the United Kingdom and co-author of the article.

Another problem with CZA is aggregation. Over time, the catalytic particles clump together, which reduces their surface area and makes them less effective. Nikolaos Dimitratos, a professor at the University of Bologna in Italy, adds, "The catalysts that are initially most active [and generally contain the most copper] are also the ones that aggregate the fastest."

So although CZA is an excellent catalyst, its performance decreases over time. Scientists are searching for even better catalysts that can use CO2 more efficiently and last longer. One potential solution is hydrogenating CO2 to produce clean e-fuels for sectors that are difficult to electrify directly, such as aviation and maritime transport.

New catalysts

The article emphasizes that scientists are exploring new catalyst formulations, and those based on indium oxide are showing great potential. Recent research indicates that over 85% of these new catalysts can convert CO2 into methanol with over 50% efficiency.

"The good news is that methanol production is getting better and better," says Jingyun Je, a professor at Duquesne University in the United States. The most popular catalyst currently consists of copper, zinc oxide, manganese oxide, and a special support material called KIT-6. This catalyst can operate at a relatively low temperature (180 °C) and efficiently transform CO2 into methanol.

However, as Rossi explains, "the ultimate goal goes beyond just producing methanol, it's about building a sustainable future powered by many CO2-derived products. The key lies in the development of innovative

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catalysts. By advancing CO2 hydrogenation, we can reduce greenhouse gas emissions, especially when we use renewable energy to power the process."

However, that does not mean it is a magic solution. There are challenges and trade-offs to consider. The technology used to convert CO2, whether it comes from a factory or is captured directly from the air, and the final application of the product as a fuel can significantly impact the overall environmental footprint.

Prospects

In the article, the scientists detail the main factors influencing the activity of heterogeneous catalysts in the hydrogenation of CO2 to methanol. They highlight different strategies for increasing catalyst stability and improving their hydrogenation properties, summarizing the most significant advances of the last five years and the challenges of developing more efficient formulations. Historical and mechanistic aspects of CO2 hydrogenation are also discussed.

Although alternatives, such as palladium-indium catalysts, are being studied, costs remain a significant obstacle. Despite this challenge, advances in catalyst design and materials analysis techniques are paving the way for a cleaner energy future driven by CO2 hydrogenation.

"We still have difficulty understanding the reactions at the molecular level, and the mechanisms of catalyst deactivation, such as sintering, poisoning, and coke formation, aren't well understood," concludes Wojcieszak.

However, the scientists believe that future advances are possible. Increased computing power, particularly in the areas of artificial intelligence and quantum computing, combined with large volumes of data, will enable more precise simulations and a better understanding of catalyst behavior. Meanwhile, new real-time characterization techniques will provide more detailed knowledge about active sites and reaction mechanisms.

Phys Org, 29 May 2025

https://phys.org

Just add iron: Researchers develop a clever way to remove forever chemicals from water

2025-05-27

PFOS, also known as "forever chemicals," are synthetic compounds popular for several commercial applications like making products resistant to stains, fire, grease, soil and water. They have been used in non-stick cookware, carpets, rugs, upholstered furniture, food packaging and firefighting foams deployed at airports and military airfields. PFOS (perfluorooctane sulfonate or perfluorooctane sulfonic acid) are part of the larger class of forever chemicals called PFAS (per- and polyfluoroalkyl substances.) Both types have been linked to a variety of health issues, including liver disease, immune system malfunction, developmental issues and cancer.

Because of their widespread use, PFOS are found in soil, agricultural products and drinking water sources, presenting a health risk.

Xiaoguang Meng and Christos Christodoulatos, professors at the Department of Civil, Environmental and Ocean Engineering at Stevens Institute of Technology, and Ph.D. student Meng Ji working in their lab, wanted to identify the most efficient way to remove these toxins from the water.

Most water filters use activated carbon to remove forever chemicals and other contaminants.

Activated carbon removes PFOS through a process called adsorption, in which the PFOS molecules stick to the large, porous surface area of the carbon particles as the water flows through them.

However, in the wastewater industry, iron powder -- in scientific terms called microscale zero-valent iron or mZVI -- is also used to remove contaminants from the effluent.

"Iron powder is commonly used for water treatment and wastewater treatment, because it's cheap -- it's cheaper than activated carbon," says Meng.

They wanted to compare the adsorption potency of iron powder and activated carbon.

They found that iron powder was a better water purifier. "The iron powder was 26 times more effective than activated carbon per unit surface area," says Ji. Researchers outlined their findings in the study titled Kinetic

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and Mechanism Study of PFOS Removal by Microscale Zero-Valent Iron from Water, published in Environmental Science & Technology, an ACS (American Chemical Society) publication, on March 19, 2025.

More interestingly, the team found that even when the iron powder rusted from being in the water, its adsorption properties weren't affected much.

"The particles' surface is covered by iron oxide, but it's still very active," says Meng -- and that's surprising.

It means that the oxidized iron still contributes to PFOS removal.

The unexpected findings made the study popular with other researchers, Meng says.

Although published recently, the paper has already been viewed over 1000 times.

Meng and Ji are planning to investigate this phenomenon further. "Now we need to do more research to find out why," Meng says. "Because this is important for the development of large-scale removal technologies."

Science Daily, 27 May 2025

https://sciencedaily.com

Record-Breaking Catalyst Converts Carbon Dioxide Into Valuable Chemicals

2025-05-24

EPFL scientists have created a high-efficiency, long-lasting catalyst that converts CO_2 into industrial chemicals, offering a promising leap toward large-scale carbon recycling.

We've all heard about the urgent need to reduce carbon dioxide (CO2) emissions. But what if we could actually use this greenhouse gas instead of just fighting to get rid of it? Scientists are exploring an exciting approach called electrochemical CO2 conversion. This process transforms CO2 into valuable chemicals and fuels, offering a cleaner and more sustainable path forward for energy and industry.

The idea holds a lot of promise, but there's a major hurdle: most current methods either wear out too quickly or use too much energy, making them impractical for real-world applications.

Take low-temperature CO2 conversion, for example. It usually lasts less than 100 hours and delivers energy efficiencies of under 35 percent. Higher temperatures, between 600 and 1,000 degrees Celsius, make the process more efficient, but most existing catalysts break down under those conditions or depend on expensive materials like precious metals. To move this technology from the lab to everyday use, we need a game-changing solution, one that is durable, efficient, and affordable. Ideally, it should be able to convert CO2 into something useful, like carbon monoxide, which is widely used in industrial manufacturing.

Breakthrough from EPFL

Now, a team led by Professor Xile Hu at EPFL has crafted a new type of catalyst that promises to make this high-temperature conversion more practical and cost-effective. The catalyst could accelerate the transition towards cleaner industries by converting CO2 into usable chemicals and fuels.

The researchers developed an innovative catalyst made from a cobalt-nickel (Co-Ni) alloy encapsulated within a ceramic material called Sm2O3-doped CeO2 (SDC). The encapsulation prevents the metal from agglomerating (clumping together), a common problem that reduces catalyst effectiveness. Impressively, their catalyst operates at 90% energy efficiency, 100% product selectivity, and sustains its performance over an unprecedented 2,000 hours, far surpassing existing technologies.

To create the catalyst, first-author and EPFL postdoc Wenchao Ma, used a sol-gel method, a process that mixes metal salts with organic molecules to form tiny metal clusters encased by ceramic shells. They tested different combinations of metals, discovering that a balanced mix of cobalt and nickel delivered the best performance. Unlike traditional catalysts, which quickly degrade under intense heat, the encapsulated alloy remained stable, maintaining its efficiency even after thousands of hours of continuous operation.

Industrial Implications

The results were remarkable. The new catalyst maintained an energy efficiency of 90% at 800 degrees Celsius while converting CO2 into carbon monoxide—a valuable chemical used in industrial processes—with 100% selectivity. In simpler terms, nearly all the electricity used in the reaction directly contributed to producing the desired chemical, without wasteful side reactions.

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The breakthrough brings us closer to practical, cost-effective carbon recycling. Instead of releasing CO2 into the atmosphere, industries could reuse it, transforming waste gas into valuable products. This technology could help industries reduce their environmental footprint, saving both energy and money in the process.

The EPFL team's catalyst remained stable at industrially relevant conditions for more than 2,000 hours, a milestone that dramatically reduces operating costs. Compared to existing technologies, their approach could cut overall costs by 60% to 80%, according to the researchers' preliminary estimate.

The catalyst is a significant step towards cleaner industries. By turning CO2 into valuable products efficiently, we can envision a future where industries recycle carbon emissions as routinely as we recycle paper and plastic today. The EPFL team has filed an international patent application for the catalyst.

Sci Tech Daily, 24 May 2025

https://scitechdaily.com

MXene boosts the effectiveness of catalysts for green hydrogen production

2025-05-28

Green hydrogen is set to play an important role in the future energy system: it can be used for storing chemical energy, as a raw material for the chemical industry, and for producing climate-friendly fuels. Green hydrogen can be generated in a nearly climate-neutral manner if the energy used for electrolysis—the process of splitting water into its elements—comes from solar or wind power. However, special catalysts are needed to speed up the formation of hydrogen and oxygen at the two electrodes.

In particular, the oxygen evolution reaction is sluggish and would require significantly more energy without effective catalysts. Currently, such catalysts are made from precious metals, which are rare and expensive. For green hydrogen to be produced in the required quantities at a reasonable price, catalysts made from readily available elements are needed.

At HZB, a team led by Michelle Browne is developing sophisticated alternatives based on so-called MXenes. MXenes are flaky structures made of carbon and so-called transition metals. Catalytically active particles can adhere to the inner surfaces of MXenes, thereby enhancing their catalytic

effect. A new study in the journal Advanced Functional Materials now shows that this idea works.

The study's first author, Can Kaplan, used different variants of a vanadium carbide MXene as the basis for his research. He took the opportunity to conduct research at the laboratory of the Swedish partners at Linköping University during his Ph.D., as part of an exchange program during his Ph.D.

"There, we synthesized two MXene variants: pure V2CTX and V1.8CTx with 10% vanadium vacancies. These vanadium vacancies ensure that the internal surface area of this variant is significantly larger," explains Kaplan.

Embedding CoFe into MXene

In Browne's HZB laboratory, Kaplan developed a multi-step chemical process to embed Co0.66Fe0.34 catalyst particles into the MXene. Images taken with a scanning electron microscope show that this was successful; the pure MXenes have a pastry-like structure, but this changed significantly due to the incorporation of the cobalt-iron particles.

The team then investigated the effect of the different catalyst samples in use during electrolysis: pure iron-cobalt and mixed with one of the two MXene variants. The results were very clear: also pure iron-cobalt compound acts as a catalyst. However, when embedded in MXene, the catalytic effect increased significantly. And efficiency is further enhanced when the iron-cobalt compound is embedded in MXene with numerous vacancies.

Using in situ X-ray absorption spectroscopy at the SOLEIL synchrotron source in France, the team was able to track changes in the oxidation numbers of cobalt and iron during the electrolytic reaction.

Promising path to a new class of catalysts

"We tested these catalysts on both a laboratory scale and in a much larger electrolyzer," emphasizes Kaplan. "This makes our results really meaningful and interesting for industrial applications."

"Currently, the industry has not yet considered MXene as a carrier material for catalytically active particles on the radar," says Browne.

"We are conducting basic research here, but with clear prospects: on applications. Our results have now provided initial insights into the complex interplay between the carrier structure, the embedding of catalytically active particles and catalytic activity."

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MXene is a promising candidate for the development of innovative, highly efficient and inexpensive catalysts, Browne concludes.

Phys Org, 28 May 2025

https://phys.org

Turning Waste Into Energy: New Enzyme Revolutionizes Biofuel Production

2025-05-29

The natural protein, known as CelOCE, was developed at the Brazilian Center for Research in Energy and Materials and is ready for immediate integration into industrial processes.

Breaking down plant material into usable fuel has long been one of science's biggest energy challenges. At the heart of this process is cellulose, the most abundant renewable polymer on Earth.

While it's made entirely of glucose, its tightly packed crystalline structure, along with its entanglement with other plant components like lignin and hemicellulose, makes it incredibly tough to break down. Nature does it slowly and only with the help of complex enzyme systems.

Now, scientists from the Brazilian Center for Research in Energy and Materials (CNPEM), together with partners in Brazil and abroad, have discovered an enzyme that could transform this process. Their breakthrough enzyme has the power to unlock cellulose more efficiently than ever before. This could pave the way for large-scale production of second-generation ethanol, a clean fuel made from agricultural waste like sugarcane bagasse and corn straw. The findings were recently published in the journal Nature.

"We've identified a metalloenzyme that enhances cellulose conversion through a previously unknown mechanism of substrate binding and oxidative cleavage. This discovery establishes a new frontier in redox biochemistry for the depolymerization of plant biomass, with broad implications for biotechnology," Mário Murakami, head of the CNPEM biocatalysis and synthetic biology research group and coordinator of the study, told Agência FAPESP.

The newly discovered enzyme was named CelOCE, which stands for cellulose oxidative cleaving enzyme. It cleaves cellulose using an unprecedented mechanism, allowing other enzymes in the enzyme cocktail to continue their work and convert the fragments into sugar. "To

use a comparison, the recalcitrance of the crystalline structure of cellulose stems from a series of locks that classical enzymes cannot open. CelOCE opens these locks, allowing other enzymes to do the conversion. Its role isn't to produce the final product but to make the cellulose accessible. There's a synergy, the potentiation of the action of other enzymes by the action of CelOCE," comments Murakami.

Paradigm shift

According to the researcher, the addition of monooxygenases to the enzyme cocktail about two decades ago was the first revolution. These enzymes directly oxidize the glycosidic bonds in cellulose, facilitating the action of other enzymes. It was the first time that redox biochemistry was used as a microbial strategy to overcome the recalcitrance of cellulose biomass. And that set a paradigm. Everything that was discovered at that time was based on monooxygenases. Now, for the first time, that paradigm has been broken with the discovery of CelOCE, which is not a monooxygenase and provides a much more significant result.

"If we add a monooxygenase to the enzyme cocktail, the increase is X. If we add CelOCE, we get 2X: twice as much. We've changed the paradigm of cellulose deconstruction by the microbial route. We thought that monooxygenases were nature's only redox solution for dealing with the recalcitrance of cellulose. But we discovered that nature had also found another, even better strategy based on a minimalist structural framework that could be redesigned for other applications, such as environmental bioremediation," says Murakami.

The researcher explains that CelOCE recognizes the end of the cellulose fiber, attaches itself to it, and cleaves it oxidatively. In doing so, it disrupts the stability of the crystalline structure, making it more accessible to the classical enzymes, the glycoside hydrolases. A very important fact is that CelOCE is a dimer, consisting of two identical subunits. While one subunit "sits" on the cellulose, the other one is free and can perform a secondary oxidase activity, generating the necessary co-substrate for the biocatalytic reaction.

"This is really very innovative because monooxygenases depend on an external source of peroxide, whereas CelOCE produces its own peroxide. It's self-sufficient, a complete catalytic machine. Its quaternary structural organization makes it possible for the site that isn't engaged on cellulose to act as its peroxide generator. This is a huge advantage because peroxide is a highly reactive radical. It reacts with a lot of things. It's very difficult to control. That's why, on an industrial scale, adding peroxides to the process

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is a major technological challenge. With CelOCE, the problem is eliminated. It produces the peroxide it needs in situ," emphasizes Murakami.

A Natural Catalyst Found in Sugarcane Waste

CelOCE is a metalloenzyme: this is its exact classification because it has a copper atom embedded in its molecular structure, which itself acts as a catalytic center. It was not created in a laboratory but discovered in nature. However, to get to it, the researchers had to mobilize a formidable amount of science and equipment.

"We started with samples of soil covered with sugarcane bagasse that had been stored for decades in an area adjacent to a biorefinery in the state of São Paulo. In these samples, we identified a microbial community highly specialized in the degradation of plant biomass, using a multidisciplinary approach that included metagenomics, proteomics, carbohydrate enzymology by chromatographic, colorimetric and mass spectrometric methods, fourth-generation synchrotron-based X-ray diffraction, fluorescence and absorption spectroscopies, site-directed mutagenesis, genetic engineering of filamentous fungi using CRISPR/Cas and experiments in 65-liter and 300-liter pilot plant bioreactors. We went from biodiversity exploration to mechanism elucidation to an industrially relevant scale in a pilot plant with the possibility of immediate real-world application," says Murakami.

The researcher emphasizes that this was not a laboratory bench result that still needs to be validated before it can be used on an industrial scale. The proof of concept has already been demonstrated on a pilot scale, and the newly discovered enzyme can be immediately incorporated into the production process – which is extremely relevant for Brazil, as a major producer of biofuels, and for the world, in a context of urgent energy transition due to the climate crisis.

Brazil has the only two biorefineries in the world capable of producing biofuels from cellulose on a commercial scale. The trend is for these biorefineries to multiply here and be replicated in other countries. One of the biggest challenges so far has been the deconstruction of cellulose biomass: how to break it down and convert it into sugar. CelOCE is expected to significantly increase the efficiency of this process.

"Currently, efficiency is in the 60% to 70% range, and in some cases it can reach 80%. That means that a lot is still not being used. Any increase in yield means a lot, because we're talking about hundreds of millions of tons of waste being converted," Murakami argues. He adds that it is not just

about increasing the production of ethanol for vehicles, but also for other products, such as aviation biofuel.

Sci Tech Daily, 29 May 2025

https://scitechdaily.com

Common drug taken by millions globally is 'linked to cancer'

2025-05-29

A common over-the counter medication that's been available for decades and is taken by millions worldwide has been singled out for its possible cancer risk.

Phenazopyridine, typically sold under brand names like Pyridium or Safrel and generally available over-the-counter in pharmacies across the world, is used to relieve symptoms caused by urinary tract infections.

In Australia, the urinary analgesic is not readily available over-the-counter and generally requires a prescription from a healthcare professional.

It works by numbing the lining of the urinary tract, decreasing burning, irritation and discomfort.

But over the years, experts have warned the drug could cause cancer based on early evidence from animal studies, according to The Sun.

Study links common pain drug to cancer

After a study published in 2021, the National Institutes for Health (NIH) warned dietary exposure to phenazopyridine caused tumours in two rodent species in two different tissue sites.

Benign and malignant liver tumours were found in female mice, while benign and malignant bowel tumours were discovered in both sexes.

It was noted while animal studies don't prove a direct link between human cancer and exposure to phenazopyridine, it is "reasonably anticipated to be a human carcinogen".

Potential side effects include chest tightness, dizziness, headache, and loss of appetite, according to the Mayo Clinic.

More severe adverse reactions may include seizures, trouble breathing, and unusual bleeding or bruising.

Rita Jew, president of the Institute for Safe Medication Practices, said personally she wouldn't advise taking phenazopyridine.

She told Bloomberg: "There is no need for this drug".

In Australia, it's estimated that one in two (50 per cent) of women experience UTIs in their lifetime, and a significant number of men and children also suffer.

What is a urinary tract infection?

UTIs are usually caused by bacteria from faeces entering the urinary tract.

The bacteria enters through the tube that carries urine out of the body, known as the urethra.

Women are more susceptible due to their shorter urethra, which gives bacteria a shorter path to the bladder.

Several factors can increase your risk of UTIs, including sexual activity, certain birth control methods, and pre-existing conditions.

Hygiene practices, age, and certain medical conditions also play a role.

The most common treatment for UTIs is a short course of antibiotics.

Remedies containing a mix of methenamine and sodium salicylate are seen as an alternative to phenazopyridine.

New York-based gynaecologist Steven Goldstein, who recommends the medication to patients while they're awaiting the results of urine tests, said he was unaware of the cancer links.

"It's the first time I'm even hearing about this. I'm totally unaware," he told Bloomberg.

The Sun has reached out to the Medicines and Healthcare products Regulatory Agency on phenazopyridine and its safety as a UTI medication.

News, 29 May 2025

https://news.com.au

Microplastics could actually help us, by detecting sewage in waterway

2025-05-27

One of the worries about microplastic particle pollution is the possibility that the particles may accumulate harmful bacteria in the environment, then pass those microbes on to us. Well, that germ-grabbing capability could soon put the particles to work as sewage monitors in rivers.

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Currently, when authorities are monitoring the effluent from wastewater treatment plants, they periodically take water samples from the river downstream of those plants' outfall pipes. The samples are then analyzed in a lab, to see if they contain significant amounts of harmful bacteria associated with insufficient treatment of raw sewage.

One problem with this approach lies in the fact that even if a plant is releasing untreated sewage, it may not be doing so 24 hours a day. This means that if water samples are collected between those releases, they might not catch any of the telltale bacteria.

In order to address that problem, Dr. Luke Woodford and colleagues at Scotland's University of Stirling looked to microplastic beads.

More specifically, they looked to spherical steel-screen cages full of such beads. Batches of these round cages could be placed inside larger cube-shaped screen baskets, which would be left immersed in rivers near wastewater treatment plants.

The idea was that if harmful bacteria were to flow through those baskets at any time, some of the microbes would cling to the biofilm that would naturally form on the microbeads. When the beads were subsequently collected and analyzed, the bacteria would be detected.

For the study, the scientists utilized 2-mm-wide beads made of three different materials: polyethylene, rubber and cork. The latter was included as a control, to see how well a natural material would function. Two hundred of each type of bead were placed inside each of the spherical cages.

Two baskets full of those cages were subsequently placed up- and downstream from a treatment plant's outfall pipe in a Scottish river. Over the next 23 days, beads were regularly collected from each of the baskets and taken to a lab for analysis.

Even within just 24 hours of deployment, it was found that beads of all three materials taken from the downstream location contained significantly higher concentrations of harmful bacteria such as Escherichia coli, Klebsiella pneumoniae, Citrobacter freundii and Enterococcus. This trend continued over the entire testing period ... in fact, it got worse.

"Additional genome sequencing revealed that these bacteria contained many genes conferring antimicrobial resistance and increased virulence, further highlighting their risk to the public and the wider environment," says Woodford. "Sewage releases are increasing in the UK, posing risks to

human health, so having systems like our one in place to monitor what is being released is a key part of tackling this public health issue."

A paper on the research was recently published in the journal Water Research.

New Atlas, 27 May 2025

https://newatlas.com

Supercapacitor-assisted catalytic system strips fluorine from PTFE and PFAS at low temperatures

2025-05-29

Technology of China (USTC) of the Chinese Academy of Sciences (CAS) has developed a supercapacitor (SC)-assisted electrophotocatalysis for the efficient defluorination of the polytetrafluoroethylene (PTFE) and poly- and perfluoroalkyl substances (PFAS) at low temperatures.

They incorporated the strength of both electrochemical and photochemical energy, providing more possibilities for solving environmental problems caused by PTFE and PFAS. The study is published in Angewandte Chemie International Edition.

PTFE is widely used in various fields due to its excellent thermal and chemical stabilities. However, its high stability also makes it difficult to degrade and recycle. Commonly, high-energy consumption methods such as thermal cracking are used to treat PTFE, while defluorination degradation under low temperature conditions requires the use of strong reducing agents such as liquid alkali metals.

Photocatalysis can compensate for the shortcomings of traditional methods under mild conditions, however, the defluorination rate of PTFE is less than 5%.

Prof. Kang's team has always been dedicated to the research on the activation and cleavage of inert carbon-heteroatom bonds. Based on this research, they have developed a highly efficient photocatalytic system based on twisted carbazole structures.

CBZ6, as a photoreductant, thanks to its twisted structure, has excellent single-electron transfer capabilities, thereby achieving the cleavage and transformation of inert carbon-heteroatom bonds in stable molecules such as PTFE.

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However, in this process, due to the hydrophobic and oleophobic nature of PTFE, along with its insolubility in almost all organic solvents and high usage, the reaction system became a multi-phase reaction system mixed with various solids and liquids.

For photo-reactions, many insoluble solids reduced the permeability of light, which led to extremely high requirements for the light source and dispersion degree of the system. While this situation was unfavorable for carrying out large-scale reactions.

To address the above issues, the research team developed an electrophotocatalysis system assisted by SCs. They used electrochemical methods to generate catalytically active species, replacing the poorly soluble reducing agents in photocatalytic reactions.

By effective electron injection into the carbon–fluorine bond of PTFE, the reduction defluorination of PTFE was established under mild conditions, with the help of synergistic effects of photochemistry and electrochemistry.

The electro-photoreduction catalytic system effectively avoided excessive use of co-reductants in the standalone photocatalytic reduction system. Moreover, the scale of the reaction was further expanded from milligram level to gram level.

At the same time, this catalytic system also shows good applicability to the defluorination of other small molecules containing PFAS.

In addition, supercapacitors have fast charging speed, high working efficiency, high energy ratio, ultra-high temperature resistance, and long cycle life. Therefore, they can be used outdoors with sunlight as the light energy source to achieve the defluorination reaction of PTFE.

In this study, various testing methods including Raman spectroscopy, X-ray photoelectron spectroscopy, and Fourier transform infrared spectroscopy were employed to characterize the solid products of PTFE defluorination.

Researchers thus confirmed that there were aliphatic structures, aromatic structures, and oxygen-containing functional groups in these products. In addition, they also possess regular carbon structures (Raman G peak) and irregular carbon structures (Raman D peak).

This study provides a new perspective for solving environmental problems caused by the hard degradation of PTFE and PFAS.

Phys Org, 29 May 2025

https://phys.org

Cryo-em freezes the funk: How scientists visualized a pungent protein

2025-05-27

They say a picture is worth a thousand words.

But it takes millions of pictures to understand the intricate chemistry of an enzyme that helps break down sulfur, commonly found in fruits, vegetables, alcohol and gasoline, into the colorless gas most noted for its distinctive odor.

Most people have witnessed -- or rather smelled -- when a protein enzyme called sulfite reductase works its magic.

This enzyme catalyzes the chemical reduction of sulfite to hydrogen sulfide.

Hydrogen sulfide is the rotten egg smell that can occur when organic matter decays and is frequently associated with sewage treatment facilities and landfills.

Beth Stroupe is a professor of biological science.

But scientists have not been able to capture a visual image of the enzyme's structure until now, thus limiting their full understanding of how it works.

Florida State University Professor of Biological Science Elizabeth Stroupe and her former doctoral student Behrouz Ghazi Esfahani have solved that problem and published their work in the journal Nature Communications.

"Artificial intelligence has gotten better at predicting protein structures, but at the end of the day, it's not data," Stroupe said.

"This gives us the primary knowledge we need to better understand this kind of structure."

Stroupe and Ghazi Esfahani used an advanced technique called cryo-electron microscopy to visualize the 3D structure of this enzyme.

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Cryo-electron microscopy allows scientists to continually capture images of chemical reactions, giving them the necessary data to visualize the structure.

To the untrained eye, protein molecules look like complicated strings of chemicals, but this clear visualization of the 3D structure allows scientists to see the exact arrangement of atoms and how electron transfer occurs.

"I think of it as an octopus with four yo-yos because the molecule is particularly flexible," Stroupe said.

This work, funded by the National Science Foundation, is essential for scientists so they can learn how to control or manipulate chemical reactions, a process that is often used by drug manufacturers or industry when they develop products with these chemicals.

"There are environmental implications too," Ghazi Esfahani said.

"Some bacteria use sulfur as an energy source the way humans or other living creatures use oxygen. This allows us to understand how some of those bacteria thrive in anaerobic conditions."

This research was a big step in gaining a better understanding of how sulfite reductase works, but there are still unanswered questions about how it functions as a larger protein assembly and how similar enzymes in other organisms, like the pathogen that causes tuberculosis, which depends on sulfur to live in a human host, work. Stroupe's lab is continuing to work on that problem as well as other structural questions related to the sulfur metabolism process.

Science Daily, 27 May 2025

https://sciencedaily.com

"Self-densified" wood could give metal a run for its money

2025-03-25

While sustainably-grown wood can be an economical and eco-friendly building material, its relatively low tensile strength limits its potential applications. That could soon change, however, thanks to a new self-densifying technique for creating super-strong wood.

Individual wood fibers are made up mainly of cellulose, along with a binder material known as lignin. This mixture forms the wall of what is

essentially a long hollow tube – the fiber – which runs lengthwise within the larger piece of wood. The hollow space inside the tube is called the lumen, and it is what limits wood's strength.

A team from China's Nanjing University recently set out to address that shortcoming, by developing the new process.

It begins by boiling a block of wood in a mixture of sodium hydroxide (lye) and sodium sulfite, removing some of the lignin. That block is then immersed in a heated blend of lithium chloride salt and a solvent known as dimethylacetamide. This causes the cellulose (and remaining lignin) to swell, expanding inwards to fill the lumen.

In a final step, the processed wood is left to air-dry at room temperature for 10 hours. As it does so, it uniformly shrinks inwards from all sides, but maintains its original length.

The resulting material is claimed to exhibit "ultra-high" tensile strength, flexural strength, and impact toughness – much more so than natural wood. It even surpasses wood which has been compressed by traditional methods, in which the fibers are just mechanically flattened in one direction.

And unlike other methods of uniformly densifying wood, it doesn't require an energy-intensive hot-pressing process.

It is hoped that once the technology is developed further, self-densified wood could be used as an alternative to traditional metals in building construction and other possible applications.

A paper on the research, which was led by Dafang Huang and Jie Li, was recently published in the Journal of Bioresources and Bioproducts.

New Atlas, 25 March 2025

https://newatlas.com

'Green' ammonia powered by sunlight

2025-05-22

You've probably heard of ammonia, especially in relation to agriculture, where it's an essential component of the fertilizers that feed the crops upon which all our lives depend. But here are some numbers to paint a picture of why ammonia is so important and impactful: Just under 200 million tons of ammonia are produced yearly, and 80% of this is used for fertilizer. Also, its production accounts for around 2% of the world's entire

Ammonia is a chemical essential to many agricultural and industrial processes, but it's mode of production comes with an incredibly high energy cost. Various attempts have, and are, being made to produce ammonia more efficiently. For the first time, a group including researchers from the University of Tokyo combined atmospheric nitrogen, water and sunlight, and using two catalysts, produced sizable quantities of ammonia without a high energy cost. Their processes mirror natural processes found in plants utilizing symbiotic bacteria.

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energy consumption and correspondingly around 2% of the world's entire carbon dioxide emissions. With these things in mind, it's understandable why researchers around the world are trying to create a cleaner, more efficient means to produce ammonia.

Professor Yoshiaki Nishibayashi from the Department of Applied Chemistry at the University of Tokyo and his team have recently made significant strides in this goal. They succeeded in developing a novel catalytic system for producing ammonia from abundant molecules found on Earth, including atmospheric nitrogen and water. The key lies in a combination of two kinds of catalysts, intermediate compounds which enable or speed up reactions without contributing to the final mixture, made especially for ammonia production, and which are driven by sunlight.

"This is the first successful example of photocatalytic ammonia production using atmospheric dinitrogen as a nitrogen source and water as a proton source, that also uses visible light energy and two kinds of molecular catalysts," said Nishibayashi. "We used an iridium photocatalyst and another chemical called a tertiary phosphine which enabled photochemical activation of water molecules. The reaction efficiencies were higher than expected, compared to previous reports of visible light-driven photocatalytic ammonia formation."

The thing about chemical reactions is, they don't always happen as fast as you want, or in the way that you want. And to control the outcome, efficiency, timing and so on of a process, you need to involve additional components beyond just the raw ingredients. This is where the catalysts come in. Nishibayashi and his team utilized two catalysts for these experiments, one based on the transition metal molybdenum for the activation of dinitrogen and the other based on the transition metal iridium for the photoactivation of both tertiary phosphines and water. A third component called tertiary phosphines are also key to helping get the protons out of water molecules.

"When the iridium photocatalyst absorbs sunlight, its excited state can oxidize the tertiary phosphines. The oxidized tertiary phosphines then activate water molecules via formation of a chemical bond between the phosphine's phosphorus atom and the water, yielding protons," said Nishibayashi. "The molybdenum catalyst then enables nitrogen to bond with these protons to become ammonia. The use of water for producing dihydrogen or hydrogen atoms is one of the most important processes for achieving green ammonia production."

The team managed to produce this reaction at a scale 10 times that of previous experiments, suggesting it's ready for trials at larger scales, though there are still some issues that could improve the safety and effectiveness further. Some of the components such as the tertiary phosphines could be made using solar power or recycled from phosphine oxides. And while stable themselves, they may be toxic if ingested by people, so it would be ideal to find a responsible way to dispose of or recycle them.

"In plants, ammonia is formed by biological nitrogen fixation using cyanobacteria and is linked with photosynthesis," said Nishibayashi. "Here, the electrons for the reaction are supplied by photosynthesis and protons are derived from water. Therefore, the findings of our recent study can be regarded as a successful example of the artificial photosynthesis of ammonia."

Science Daily, 22 May 2025

https://sciencedaily.com

Artificial cell-like structures mimic self-reproduction and release polymeric spores

2025-05-29

Life on Earth possesses an exceptional ability to self-reproduce, which, even on a simple cellular level, is driven by complex biochemistry. But can self-reproduction exist in a biochemistry-free environment?

A study by researchers from Harvard University demonstrated that the answer is yes.

The researchers designed a non-biochemical system in which synthetic cell-like structures form and self-reproduce by ejecting polymeric spores.

The PNAS paper reports a one-pot reaction in which chemically active polymer protocells began their journey as a uniform mixture of molecules that usually do not self-assemble. However, when placed under green light (530 nm), they formed vesicle-like structures that grew and divided as the reaction proceeded.

Living organisms produce offspring from their own cellular material, giving rise to new, independent life forms which interact with their environment to obtain food, energy, and information needed for survival. If all goes well, the internal chemical networks of these new systems also enable them to self-reproduce, leading to future generations. As Rudolf

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Virchow, father of cellular pathology, stated in 1858, "every cell comes from a pre-existing cell."

In biochemistry-based life, even single-celled organisms like bacteria depend on a chain of well-coordinated complex chemical processes to run the life-sustaining processes and reproduction.

It is known that biochemistry is sufficient for driving self-reproduction, but is it essential? Or can we build artificial, compartmentalized chemical systems in the lab that can self-assemble and reproduce on their own?

Previous studies have shown reproduction-like behaviors such as polymerization-induced self-assembly (PISA) in micelles and vesicles. However, these processes were neither biochemistry-free nor did they demonstrate true autonomous self-reproduction.

To explore the unknown, the team designed a one-pot PISA batch reactor consisting of strictly non-biochemical molecules with an aim to synthesize amphiphiles that can self-organize, self-assemble, and self-initiate into chemically active entities.

The reaction vial included an aqueous solution of a hydrophilic polymer with a hydrophobic chain transfer agent molecule (CTA) attached to its end, along with the monomer to be polymerized and a photocatalyst in a nitrogen-filled inert environment. This mixture was then allowed to sit under green LED light for 90 minutes at 33°C.

They observed that the mixture of chemicals undergoes photo-Reversible Addition-Fragmentation Chain Transfer (RAFT) photopolymerization in water to transform the starting molecules into amphiphilic block copolymers. These block copolymers then gave rise to non-biochemical polymer vesicles or synthetic cells that displayed self-reproduction behavior via PISA.

The vesicles not only formed and sustained themselves but also released polymeric "spores" that seeded a nonlinear, exponential increase in vesicle numbers, with each new generation inheriting certain properties from their "parent" vesicles.

The behavior shown in this study mimics self-reproduction—a key feature of living systems—arising from simple chemistry without the need for complex biochemical processes.

The researchers note that the findings not only offer insights into how life might have begun but also open new possibilities for creating a wide range of abiotic, life-like systems.

Phys Org, 29 May 2025

https://phys.org

Scientists Discover Violation of 1931 Thermodynamic Principle

2025-05-29

The cell model of ion-exchange membranes reveals violations of the Onsager reciprocity principle, particularly at high electrolyte concentrations, highlighting the importance of accounting for asymmetric transport coefficients.

Ion-exchange membranes are widely used in electrochemical and separation processes, and accurate modeling of their transport properties is essential. A new study published in the journal Asymmetry demonstrates that the commonly used cell model for ion-exchange membranes violates the Onsager reciprocity principle, challenging a foundational assumption in non-equilibrium thermodynamics.

In the context of the cell model for ion-exchange membranes, it is shown that the Onsager reciprocity principle does not hold, the cross kinetic coefficients are not equal. This violation arises because the reciprocity principle is valid only for systems in which all generalized fluxes vanish when thermodynamic forces other than zero are present, as stipulated by linear irreversible thermodynamics.

The cell model simplifies the complex structure of real ion-exchange membranes by replacing randomly distributed ion-exchange resin grains with a periodic lattice. This lattice consists of identical, porous, charged spheres surrounded by concentric spherical shells filled with electrolyte, forming a structured porous medium.

To account for interactions between neighboring particles, the model imposes specific boundary conditions at the outer surface of the liquid shell. It is assumed that the gradients of external forces acting on the entire porous layer are equivalent to the local gradients within a single unit cell.

Advantages of the Cell Model Approach

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The advantage of the described approach is that all the quantities included in the equations of electrolyte transfer through a porous layer: thermodynamic fluxes and forces, can be directly measured in experiments.

When calculating the kinetic coefficients Lij of the Onsager matrix, as independent thermodynamic forces that are set during the experiment of transferring an electrolyte solution through a thin infinitely extended charged porous layer (membrane), we select gradients of pressure dp/dx, chemical dμ/dx and electrical dφ/dx potentials perpendicular to the surface of this layer.

As dependent thermodynamic parameters determined in the experiment, we take the flux densities: U—solvent (for example, water), I—mobile charges (electric current density), J—solute (density of the diffusion flux of the electrolyte).

Experimental Observations

It was shown based on experiments for heterogeneous MK-40 and homogeneous MF-4SK cation-exchange membranes that their cross coefficients differ little at small concentrations of aqueous solutions of NaCl electrolyte (up to 0.1 M).

At high concentrations, there is a significant quantitative and qualitative discrepancy between reverse osmotic L13 and capillary osmotic L31 coefficients, as well as for electrodiffusion coefficients L23 and L32. At the same time, the cross kinetic coefficients L12 (regulates electroosmosis) and L21 (regulates streaming current) practically coincide up to high values of the electrolyte concentration.

We have shown here that in the case of the cell membrane model, the Onsager reciprocity principle is violated—the matrix of kinetic coefficients is not symmetric. In this regard, it is necessary to be careful about determining the transport characteristics of membranes, which depend on the cross kinetic coefficients due to the asymmetry of the latter.

In the present paper, it is shown that the coupled cross coefficients can differ not only quantitatively, but also qualitatively. It is crucial when considering the transport characteristics of charged membranes.

Sci Tech Daily, 29 May 2025

https://scitechdaily.com

Harnessing the power of 'click chemistry' to make biomolecular labeling safe for live cells

2025-05-29

One of the longstanding challenges in chemical biology has been finding ways to directly observe biological processes at work inside living cells without disturbing the action. In order to unlock new therapies and better understand disease processes and other biological phenomena, scientists have used different methods of tracking molecular interactions inside cells in real time, a practice known as biomolecular labeling.

But current methods have limitations, creating unwanted chemical reactions or harming cells in the process. Now, a team of Northeastern University researchers think they've found a way to make biomolecular labeling safe for live cells by harnessing the power of "click chemistry," a process by which scientists generate chemical reactions to create new chemical formulas.

Sara Rouhanifard, a Northeastern assistant professor specializing in click chemistry and RNA imaging, says she and a team of research scientists created a breakthrough reagent they call "InCu-Click," a novel tool they say will help aid in drug discovery, diagnostics and biological research.

That tool is what's called a copper-chelating ligand, a chemical agent that binds to copper, thereby mitigating its toxic effects on human cells. Rouhanifard says the reagent, which she says will better enable biomolecular labeling, was the result of "an accidental finding based on a failed experiment."

"It was kind of an accident," she says.

Rouhanifard and her colleagues published the findings in Nature Communications.

Researchers in Rouhanifard's lab have been focused on one particular chemical reaction called the copper-catalyzed azide-alkyne cycloaddition (CuAAC), an early example of click chemistry that's come to have widespread application as a way of creating new complex molecules out of chemical building blocks, such as proteins, amino acids and peptides.

That Lego-like joining of molecules, called covalent conjugation, has applications in a wide variety of fields, from biomedical research to nanotechnology.

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But the CuAAC reaction, considered the bedrock of click chemistry, has never been viable for live cell research, a promising market projected to exceed $15 billion by 2027 worldwide.

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But the CuAAC reaction, considered the bedrock of click chemistry, has never been viable for live cell research, a promising market projected to exceed $15 billion by 2027 worldwide.\

"Nobody has ever been able to track biomolecules using the CuAAC reaction inside of live cells, and the reason is because copper is toxic to cells," Rouhanifard says. "You can't just put copper into cells because it will kill them."

That's where the copper-chelating ligand comes in. The reagent neutralizes the copper to such a degree as to prove safe in live cells, while still enabling the reaction to take place efficiently.

The tool also brings the necessary precision to the task: it is highly selective, meaning scientists can better isolate and study different functional groups—classes of molecules inside cells that serve a shared purpose—without compromising or harming others.

"All of these things are important," Rouhanifard says. "Live cell labeling is all about protecting the cell and doing things quickly."

Imaging techniques developed over the last century, such as widefield fluorescence, have made it possible for scientists to better identify and differentiate molecular structures of cells in microscopy.

"Usually, we're looking at cells in a snapshot," Rouhanifard says. "We're looking at something that is fixed. But molecules are dynamic. They're moving around in response to things going on in their environment, and we've been trying to find ways of visualizing that environment more readily."

Rouhanifard and her team hope to make InCu-Click available to biotech and pharmaceutical researchers and companies for widespread use. They are now focused on fine-tuning the copper-chelating ligand to get it ready for commercialization.

Rouhanifard says she hopes the advancement can translate to her ongoing research in gene expression and disease development.

"What we'd really like to achieve with this new reaction is to be able to track single molecules of RNA inside of live cells without having to genetically engineer them," Rouhanifard says.

"I want to be able to get a patient sample, for example, and be able to see how the RNA is moving around that cell, and how can I control it so that it doesn't do that in disease. The goal, essentially, is to cure human disease."

Phys Org, 29 May 2025

https://Phys.org

MIT Breakthrough Makes Carbon Capture 6x More Efficient

2025-05-24

MIT researchers have developed a powerful improvement to carbon capture tech by using nanofiltration membranes to separate key chemical ions, drastically enhancing efficiency and stability.

This clever middle step allows both capture and release phases to run more effectively, potentially cutting costs by 20% and making the process more forgiving to fluctuations. The system is not only compatible with existing infrastructure but could also pave the way for safer, greener chemistry in carbon management.

The Challenge of Efficient Carbon Capture

Removing carbon dioxide from the atmosphere is widely considered one of the most important tools for fighting climate change. But there's a frustrating catch: the chemicals that are best at pulling CO2 out of the air tend to cling to it too tightly, making it hard to release later. On the flip side, compounds that let go of CO2 easily aren't great at capturing it in the first place. It's a balancing act, and improving one part usually means weakening the other.

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Now, researchers at MIT have found a clever way to overcome this challenge. By adding a nanoscale filtering step in the middle of the carbon capture process, they've managed to boost efficiency by a factor of six, while also lowering costs by at least 20 percent. This innovation could make carbon removal significantly more practical and scalable.

The work, published in ACS Energy Letters, comes from a team including MIT doctoral students Simon Rufer, Tal Joseph, and Zara Aamer, along with mechanical engineering professor Kripa Varanasi.

Thinking Big From the Start

"We need to think about scale from the get-go when it comes to carbon capture, as making a meaningful impact requires processing gigatons of CO2," says Varanasi. "Having this mindset helps us pinpoint critical bottlenecks and design innovative solutions with real potential for impact. That's the driving force behind our work."

Traditional systems often use a chemical called hydroxide, which quickly reacts with carbon dioxide in the air to form carbonate. That carbonate is then sent into an electrochemical cell, where it reacts with acid, turning into water and releasing pure CO2. The result is a clean, concentrated stream of carbon dioxide that can be reused for making fuel or other valuable products.

However, there's a major hitch. Both the capture and release stages happen in the same water-based liquid. The capture step works best in a liquid full of hydroxide ions, while the release step needs that liquid to contain mostly carbonate ions.

"You can see how these two steps are at odds," says Varanasi. "These two systems are circulating the same sorbent back and forth. They're operating on the exact same liquid. But because they need two different types of liquids to

A Smart Three-Part System

The team's solution was to decouple the two parts of the system and introduce a third part in between. Essentially, after the hydroxide in the first step has been mostly chemically converted to carbonate, special nanofiltration membranes then separate ions in the solution based on their charge. Carbonate ions have a charge of 2, while hydroxide ions have a charge of 1. "The nanofiltration is able to separate these two pretty well," Rufer says.

operate optimally, it's impossible to operate both systems at their most efficient points."

Once separated, the hydroxide ions are fed back to the absorption side of the system, while the carbonates are sent ahead to the electrochemical release stage. That way, both ends of the system can operate at their more efficient ranges. Varanasi explains that in the electrochemical release step, protons are being added to the carbonate to cause the conversion to carbon dioxide and water, but if hydroxide ions are also present, the protons will react with those ions instead, producing just water.

"If you don't separate these hydroxides and carbonates," Rufer says, "the way the system fails is you'll add protons to hydroxide instead of carbonate, and so you'll just be making water rather than extracting carbon dioxide. That's where the efficiency is lost. Using nanofiltration to prevent this was something that we aren't aware of anyone proposing before."

Demonstrating Real-World Viability

Testing showed that the nanofiltration could separate the carbonate from the hydroxide solution with about 95 percent efficiency, validating the concept under realistic conditions, Rufer says. The next step was to assess how much of an effect this would have on the overall efficiency and economics of the process. They created a techno-economic model, incorporating electrochemical efficiency, voltage, absorption rate, capital costs, nanofiltration efficiency, and other factors.

The analysis showed that present systems cost at least $600 per ton of carbon dioxide captured, while with the nanofiltration component added, that drops to about $450 a ton. What's more, the new system is much more stable, continuing to operate at high efficiency even under variations in the ion concentrations in the solution. "In the old system without nanofiltration, you're sort of operating on a knife's edge," Rufer says; if the concentration varies even slightly in one direction or the other, efficiency drops off drastically. "But with our nanofiltration system, it kind of acts as a buffer where it becomes a lot more forgiving. You have a much broader operational regime, and you can achieve significantly lower costs."

Beyond Direct Air Capture

He adds that this approach could apply not only to the direct air capture systems they studied specifically, but also to point-source systems — which are attached directly to the emissions sources such as power plant

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emissions — or to the next stage of the process, converting captured carbon dioxide into useful products such as fuel or chemical feedstocks. Those conversion processes, he says, "are also bottlenecked in this carbonate and hydroxide tradeoff."

In addition, this technology could lead to safer alternative chemistries for carbon capture, Varanasi says. "A lot of these absorbents can at times be toxic, or damaging to the environment. By using a system like ours, you can improve the reaction rate, so you can choose chemistries that might not have the best absorption rate initially but can be improved to enable safety."

Ready for Real-World Use

Varanasi adds that "the really nice thing about this is we've been able to do this with what's commercially available," and with a system that can easily be retrofitted to existing carbon-capture installations. If the costs can be further brought down to about $200 a ton, it could be viable for widespread adoption. With ongoing work, he says, "we're confident that we'll have something that can become economically viable" and that will ultimately produce valuable, saleable products.

Rufer notes that even today, "people are buying carbon credits at a cost of over $500 per ton. So, at this cost we're projecting, it is already commercially viable in that there are some buyers who are willing to pay that price." But by bringing the price down further, that should increase the number of buyers who would consider buying the credit, he says. "It's just a question of how widespread we can make it." Recognizing this growing market demand, Varanasi says, "Our goal is to provide industry-scale, cost-effective, and reliable technologies and systems that enable them to directly meet their decarbonization targets."

Sci Tech Daily, 24 May 2025

https://scitechdaily.com

Technical Notes

MAY. 30, 2025

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

CHEMICAL EFFECTS

Elucidation of 28 day repeated oral dose induced genotoxicity potential of nickel (II) oxide nanoparticles in Wistar albino rats

Phosphate perils in marine aquaculture: Systematic toxicity assessment in turbot juveniles in cultivation

Understanding the role of endocrine disrupting chemicals as environmental obesogens in the obesity epidemic: A comprehensive overview of epidemiological studies between 2014 and 2024

ENVIRONMENTAL RESEARCH

Untargeted metabolomics offers insights into the risks of chronic exposure to mixtures of polycyclic aromatic hydrocarbons at environmentally relevant low concentrations

Occurrence and environmental risk assessment of pesticides reveal important threats to aquatic organisms in precordilleran rivers of north-central Chile

PHARMACEUTICAL/TOXICOLOGY

Molecular mechanistic approach to reveal decitabine's effect on DNMT gene modulation and its inhibitory role in heavy metal-induced proliferation in urinary bladder cancer cell line

Immunosuppressive role of benzo[a]pyrene exposure in prostate cancer progression

OCCUPATIONAL

Neonatal exposure to phthalates and their alternatives and associated thyroid disorders: Levels, potential health risks, and mechanisms

Using hair as a non-invasive matrix to assess the exposure of e-waste workers to selected heavy metals in Pakistan

Developmental exposure to echimidine induces locomotor hyperactivity in zebrafish larvae via inhibiting acetylcholinesterase activity