CHEMWATCH

Bulletin Board

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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

'Nervous and rushed': Massive Fukushima plant cleanup work involves high radiation and stress

2025-03-11

The Fukushima Daiichi nuclear power plant's radiation levels have significantly dropped since the cataclysmic meltdown in Japan 14 years ago. Workers walk around in many areas wearing only surgical masks and regular clothes.

It's a different story for those who enter the reactor buildings, including the three damaged in the 2011 earthquake and tsunami. They must use maximum protection — full facemasks with filters, multi-layered gloves and socks, shoe covers, hooded hazmat coveralls and a waterproof jacket, and a helmet.

As workers remove melted fuel debris from the reactors in a monumental nuclear cleanup effort that could take more than a century, they are facing both huge amounts of psychological stress and dangerous levels of radiation.

The Associated Press, which recently visited the plant for a tour and interviews, takes a closer look.

Read More

AP, 11-03-25

https://apnews.com/article/japan-fukushima-plant-radiation-safety-4efe204a48f952137cac5a44b41f93ae

Survey of Metals in Apple Juice and Other Apple Products

2025-03-04

In 2023, FSANZ managed a survey measuring levels of various metal contaminants in apple juice and other apple products. The samples were collected in all Australian states and territories in 2021 and 2022 as part of a previous national Patulin survey.

What was tested?

Most of the sampled products were apple juice, including not from concentrate, reconstituted and freshly squeezed varieties. Several solid

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apple products including infant foods, apple puree, apple sauce, canned apple, and dried apple were also included in the survey.

All samples were analysed for metal contaminants including total arsenic, cadmium, lead and mercury. Samples with detectable concentrations of arsenic were re-analysed for inorganic arsenic. The levels of tin were investigated in two canned apple samples.

What was found?

The survey found that metal concentrations in apple juice and other apple products were very low. Most samples (82%) had no detectable levels of any of the analysed metals. Lead was detected in 12 of 71 (17%) samples. Arsenic (total) was detected in 2 of 71 (3%) samples. Tin was detected in 2 of 2 (100%) canned apple samples. Inorganic arsenic, cadmium and mercury were not detected in any samples.

All metal concentrations were below the relevant Australian Maximum Levels (MLs) in the Food Standards Code, or other relevant country specific and international regulatory limits. This indicates metal levels in the sampled apple juices and other apple products are as low as reasonably achievable. On that basis, FSANZ concluded that there are no public health and safety concerns for Australian consumers.

What happens next?

Information from the survey will support a comprehensive FSANZ assessment of overall dietary exposure to metals from a broad range of foods as part of the 28th Australian Total Diet Study (for which sampling occurred across 2024).

FSANZ will continue to monitor levels of metals in the Australian food supply to ensure levels are kept low and safe.

- **File**

Survey of Metals in Apple Juice and Other Apple Products - Survey Report

- **File**

Survey of Metals in Apple Juice and Other Apple Products - Appendix 1 - Analytical Results

Read More

FSANZ, 04-03-25

https://www.foodstandards.gov.au/publications/survey-metals-apple-juice-and-other-apple-products

AMERICA

Flexible Regulation of Product Distribution in Cyclohexane Cracking Catalyzed by Acid–Base Bifunctional Catalyst

2025-03-04

Conversion of crude oil to chemicals is a developing trend in the petroleum industry. Cycloalkanes are main components of crude oil, especially in intermediate- or naphthene-based oil; however, converting cycloalkanes into high-value chemicals, especially light olefins, remains a challenge. In this study, HIM-5 zeolite, with strong Brønsted acidity, small pores, and a large-cavity structure, was proposed as the active material for cyclohexane (a model compound for cycloalkanes) cracking. The external surface of HIM-5 was modified with phosphorus (P) to reduce the acid strength, efficiently improving the catalytic lifetime. To regulate product distribution, an acid–base bifunctional catalyst composed of calcium aluminate (CA) and the most stable zeolite, 1.0P-CIM, was prepared. As the 1.0P-CIM content decreased, the acid amount exhibited an obvious decreasing tendency, while the base amount exhibited the opposite trend. The average light olefins yield over the bifunctional catalysts varied from 11.9–27.8%, while the average BTX (benzene, toluene, xylene) yield was from 31.4–41.6%. Specifically, the light olefins yield in the catalytic system containing 30 wt % zeolite was the highest (27.8%), with an increase of 15.9% compared with that in the 1.0P-CIM system, and the total yield of light olefins and BTX reached the maximum (59.2%). In situ spectroscopic analysis illustrated that CA could activate the reactant, promote ring-opening, and inhibit side reactions such as hydrogen transfer, leading to increased light olefins yield, while the strong acidity of the bifunctional catalyst, when CA content was low, would facilitate BTX formation. Therefore, product distribution could be flexibly adjusted in cyclohexane cracking by changing the acid or base amount in the bifunctional catalyst.

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ACS, 04-03-25

https://pubs.acs.org/doi/10.1021/acscatal.4c06815

5 U.S. States Where Drinking Water Quality is Falling Below Standards

2025-03-05

We all rely on clean, safe drinking water for our health and well-being. Imagine turning on the tap and wondering if the water is safe for your family to drink. This is a reality for millions of Americans living in these states. Unfortunately, recent reports indicate that access to quality drinking water is a growing concern in many parts of the United States. Here's a closer look at 14 U.S. States Where Drinking Water Quality is Falling Below Standards, according to a 2023 Environmental Protection Agency (EPA) report:

California

The Golden State faces a multi-pronged water challenge. Aging infrastructure, drought conditions (leading to reliance on groundwater sources that are more prone to contaminants), and agricultural runoff all contribute to potential contaminants in drinking water. A 2020 study by the Environmental Working Group (EWG) found that 31 million Californians live in areas with detectable levels of nitrates in their drinking water, which can be harmful to infants.

Read More

AOL, 05-03-25

https://www.aol.com/5-u-states-where-drinking-143206068.html

EPA Extends Comment Period on Draft TSCA Risk Evaluation for DCHP

2025-03-11

The U.S. Environmental Protection Agency (EPA) announced on March 7, 2025, that it is extending the comment period on the draft risk evaluation for dicyclohexyl phthalate (DCHP) under the Toxic Substances Control Act (TSCA). EPA released the risk evaluation for DCHP on January 7, 2025, with a comment period that closed March 10, 2025. EPA states that it will soon publish a Federal Register notice extending the public comment period for

an additional 60 days. Upon publication of the Federal Register notice, EPA will accept public comments until May 9, 2025.

According to EPA's January 6, 2025, press release announcing the availability of the draft risk evaluation, DCHP is used primarily as a plasticizer or stabilizing agent in polyvinyl chloride (PVC) products and in adhesives, sealants, paints, coatings, rubbers, and other applications. EPA preliminarily determined that DCHP presents an unreasonable risk of injury to human health for workers. EPA states that nine conditions of use (COU) significantly contribute to the unreasonable risk to workers. The draft risk evaluation preliminarily shows that DCHP does not pose unreasonable risk to the environment, the general population, or consumers. EPA notes that there are other uses of DCHP that are generally excluded from TSCA's definition of chemical substance, such as food contact materials, and EPA did not evaluate risk associated with these uses.

Read More

B&C, 11-03-25

https://www.lawbc.com/epa-extends-comment-period-on-draft-tsca-risk-evaluation-for-dchp/

HHS Secretary RFK Jr. orders FDA to close food ingredients loophole

2025-03-10

Health and Human Services Secretary Robert F. Kennedy Jr. ordered the Food and Drug Administration on Monday to revise its rule allowing food companies to "self-affirm" that its ingredients are safe.

"For far too long, ingredient manufacturers and sponsors have exploited a loophole that has allowed new ingredients and chemicals, often with unknown safety data, to be introduced into the U.S. food supply without notification to the FDA or the public," said Secretary Kennedy.

"Eliminating this loophole will provide transparency to consumers, help get our nation's food supply back on track by ensuring that ingredients being introduced into foods are safe, and ultimately Make America Healthy Again," Kennedy added.

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Read More

UPI, 10-03-25

https://www.upi.com/Top_News/US/2025/03/10/health-secretary-Robert-F-Kennedy-Jr-food-ingredients/2981741652056/

Two federal food safety panels get disbanded, worrying advocates

2025-03-10

USDA quietly terminated the committees, whose work included studying pathogens linked to foodborne illnesses.

Two federal committees tasked with advising policymakers on food safety have been disbanded as part of the administration's cost-cutting and government-shrinking goals, according to advocates and one committee member.

The elimination of the panels, whose members included experts from academia, industry and nonprofits, has raised alarms among some food-safety advocates, who point to large-scale outbreaks in recent years as a reason for needing even more attention and modern science around the issue.

Read More

The Washington Post, 10-03-25

https://www.washingtonpost.com/food/2025/03/10/food-safety-advisory-committees-disbanded-usda/

Trump's next climate move: Show global warming benefits humanity

2025-03-10

President Donald Trump has long rejected climate science.

Now, his administration is grappling with how to assemble a body of federal climate research to show a warming world is benefiting humanity.

The claims would be highly misleading and ignore decades of scientific research that shows climate change will have increasingly dire effects.

But a federal report downplaying or denying the threat of climate change would become a cornerstone of Trump's efforts to end or weaken climate

regulations while expanding executive authority. It also would mark an escalation of Trump's own climate disinformation from rhetoric to federal action.

The Trump assault on climate science has begun in earnest. In its first weeks, the Trump administration fired climate scientists and removed climate-related government web pages while Cabinet officials made false climate claims.

When EPA Administrator Lee Zeldin recommended in February that the White House attempt to reverse the endangerment finding — which requires EPA to regulate greenhouse gas emissions — he may have kick-started a process to produce a government report intended to tear down climate rules.

Read More

E&E New, 10-03-25

https://www.eenews.net/articles/trumps-next-climate-move-show-global-warming-benefits-humanity/

Improving TSCA Existing Chemical Reviews

2025-03-11

Congress intended for TSCA reforms to ensure a substance does not pose unreasonable risks to human health or the environment, all while supporting innovation and protecting American jobs. Congress envisioned reforming TSCA would make it the model for sound, risk-based chemical management across the globe.

Learn more at: https://www.americanchemistry.com/better-policy-regulation/chemical-management/toxic-substances-control-act-tsca/resources/improving-tsca-existing-chemical-reviews

Read More

American Chemistry Council, 11-03-25

https://www.americanchemistry.com/better-policy-regulation/chemical-management/toxic-substances-control-act-tsca/resources/improving-tsca-existing-chemical-reviews

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EUROPE

HSE inspections of schools to assess the management of asbestos

2025-03-13

HSE is continuing to inspect schools across Great Britain to assess how well they are managing the risks from asbestos.

The findings of our 2023 to 2024 inspections show that most schools are complying with their legal duties and have effective systems in place to manage and monitor the condition of asbestos-containing materials (ACMs).

However, there are some common areas where schools continue to require improvements. Most of these relate to failings in their management systems and include key findings that schools should:

- ensure staff and organisations have clear roles and responsibilities for managing asbestos and have deputies or contingency plans in place to cover for absences
- check that when contractors tender for work that there is a permit-to-work or similar safe system of work in place
- have clear asbestos management plans including how information is provided to emergency services who attend site
- include photographs of ACMs in their asbestos registers to assist with identifying their locations and condition
- check that in-house staff carrying out maintenance work on or near asbestos have a method statement, also known as a plan of work
- provide appropriate asbestos training for in-house staff and ensure that external contractors are appropriately trained

Similar issues were identified in our 2022 to 2023 inspection report into the management of asbestos in schools. Schools may want to consider these findings to ensure that their management arrangements remain effective and that common areas of improvement identified during these visits have been addressed.

HSE is carrying out further inspections to schools across Great Britain in 2025 to 2026.

HSE's Asbestos – Your Duty campaign provides additional free resources to support dutyholders with the legal duty to manage asbestos in buildings.

Read More

HSE, 13-03-25

https://www.hse.gov.uk/education/asbestos.htm

Remarks by Commissioner Roswall at the press conference on the results of the second Zero Pollution Monitoring and Outlook and fourth Clean Air Outlook reports

2025-03-03

Mercury pollution in the air seeps back in our soil and water. But also many other forms of pollution affect people's health. Excessive noise pollution from traffic increases the chances of strokes and heart disease. Microplastic pollution is a problem. Babies are increasingly exposed to the risk of microplastics even before they are born. And pollution from forever chemicals like PFAS also poses growing risks. So we have social, environmental and economic reasons to move to a world without pollution by 2050. This is only one generation away. We need to progress fast.

The European Commission has already taken action on health for citizens. A lot of work has been done. Since 2016, we have updated air pollution targets for 2030. In 2022, we proposed new rules to improve air quality and better protect EU citizens. And this is important not only for human health, but also for businesses. They need a clean environment, too.

To take stock, we are presenting two reports today: The Zero Pollution Monitoring and Outlook report and the Clean Air Outlook report. We are also launching a new digital tool, the Zero Pollution Dashboard. This dashboard is the very first time that we launch an online tool with up-to-date information about pollution that zooms in on European regions and cities. For example, you can compare the region where you are from with other regions in your country. This will offer transparency to citizens, scientists, policy makers and businesses alike.

I mentioned the two reports that are published today. The findings are clear. The good news is that we are overall heading in the right direction. Air quality has improved. Pesticide use has decreased. Antimicrobial use is

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also decreasing. And for the first time we are recording a decline in plastic litter on our beaches. That is all encouraging.

Read More

EU Monitoring, 03-03-25

https://ieu-monitoring.com/editorial/zero-pollution-monitoring-and-clean-air-outlook-remarks-by-eu-commissioner-roswall/546050?utm_source=ieu-portal

INTERNATIONAL

Majority of the world's population breathes dirty air, report says

2025-03-11

Most of the world has dirty air, with just 17% of cities globally meeting air pollution guidelines, a report Tuesday found.

Switzerland-based air quality monitoring database IQAir analyzed data from 40,000 air quality monitoring stations in 138 countries and found that Chad, Congo, Bangladesh, Pakistan and India had the dirtiest air. India had six of the nine most polluted cities with the industrial town of Byrnihat in northeastern India the worst.

Experts said the real amount of air pollution might be far greater as many parts of the world lack the monitoring needed for more accurate data. In Africa, for example, there is only one monitoring station for every 3.7 million people.

Read More

AP, 11-03-25

https://apnews.com/article/air-pollution-climate-change-asia-diseases-cancer-lungs-dc623f24dfab652ef06eca51cd4211e8

New format for list numbers

2025-03-13

Each substance registered or notified under REACH or CLP needs an identifier. If a substance is not identified by an EC number and has not been previously notified or registered, REACH-IT assigns a new list number to the substance.

We will update the list number format around early summer 2025as numbers in the current format are soon running out. The new format will keep the current length, but will change from numeric to alphanumeric.

- Example of the current format: 100-000-1.
- Example of the new format: A00-001-5.

Companies may need to take action to adapt their recording systems outside REACH-IT to accommodate the new format. List numbers assigned before the format change will not be affected.

Read More

ECHA, 13-03-25

https://echa.europa.eu/about-ec-and-list-numbers

Topics page on cyclosiloxanes D4, D5, D6

2025-03-13

Have a look at our new topical page on cyclosiloxanes D4, D5, D6. It provides information on their properties, uses and related concerns as well as an overview on what the EU is doing to regulate them.

Read More

ECHA, 13-03-25

https://echa.europa.eu/hot-topics/cyclosiloxanes

New Approach Methods (NAMs) for human health hazard assessment

2025-03-13

Researchers and scientists from regulatory agencies in Europe, Singapore, Canada and the US have developed new methods to predict hazards of chemicals with limited toxicity testing data.

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For the recently published case study, data was generated and interpreted for 200 substances using methods including in silicoand in vitroNAMs. The presented approach may reduce animal testing in the future by using NAMs for assessing hazards to human health. Regulatory scientists can use it to consider:

- what is needed for building a test battery to address more complex toxicological endpoints;
- what is the current performance of such approach;
- what are the realistic expectations regarding optimal performance; and
- what are the deficiencies of the current approach.

The study was carried out under the Accelerating the Pace of Chemical Risk Assessment (APCRA), which is a consortium for international research and regulatory scientists.

Read More

ECHA, 13-03-25

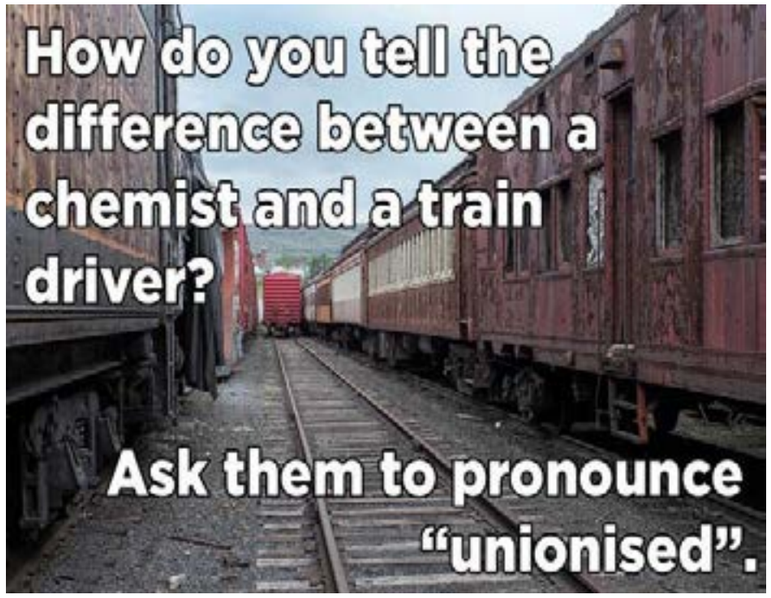
https://academic.oup.com/toxsci/advance-article-abstract/doi/10.1093/toxsci/kfaf019/8023380

Janet's Corner

MAR. 21, 2025

Difference Between Train Drivers and Chemists

2025-03-21



https://www.buzzfeed.com

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Hazard Alert

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Lead

2025-03-21

USES [2,3]

Lead and lead alloys are commonly found in pipes, storage batteries, weights, shot and ammunition, cable covers, and sheets used to shield us from radiation. The largest use for lead is in storage batteries in cars and other vehicles. Lead compounds are used as a pigment in paints, dyes, and ceramic glazes and in caulk. The amount of lead used in these products has been reduced in recent years to minimise lead's harmful effect on people and animals. Tetraethyl lead and tetramethyl lead were once used in the United States as gasoline additives to increase octane rating. However, their use was phased out in the United States in the 1980s, and lead was banned for use in gasoline for motor vehicles beginning January 1, 1996. Tetraethyl lead may still be used in gasoline for off-road vehicles and airplanes. It is also still used in a number of developing countries. Lead used in ammunition, which is the largest non-battery end-use, has remained fairly constant in recent years. However, even the use of lead in bullets and shot as well as in fishing sinkers is being reduced because of its harm to the environment.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- **Industry sources:** Mining and metal manufacturing are the largest sources of lead emissions in Australia. Water supply, sewerage and draining surfaces, oil and gas extraction and electricity supply can also emit lead. Lead is also emitted as a result of coal mining, cement, lime, plaster and concrete product manufacture, ceramic product manufacturing, transport equipment manufacturing, iron and steel manufacturing, petroleum and coal product manufacturing. Other manufacturing industries where lead may be used include: beverages and malt, paper and paper products, glass and glass products, fabricated and structural metal products, motor vehicles and parts, wood products, ceramic products, food and beverage products, textile, yarn and woven fabrics.
- **Diffuse sources:** Paved roads, windblown dust, burning fuels or wildfires, solid and liquid fuel combustion, lawn mowing and barbeques (from burning fuel) are all capable of causing emissions of lead.

Lead is a chemical element in the carbon group with symbol Pb and atomic number 82. Lead is a soft and malleable metal, which is regarded as a heavy metal. Metallic lead has a bluish-white colour after being freshly cut, but it soon tarnishes to a dull greyish colour when exposed to air. Lead has a shiny chrome-silver lustre when it is melted into a liquid. [1] Lead is found in the earth's crust. However, it is rarely found naturally as a metal. It is usually found combined with two or more other elements to form lead compounds. Metallic lead is resistant to corrosion (i.e., not easily attacked by air or water). When

- **Natural sources:** Lead and compounds occurs naturally in the earth's crust in rocks and soil.
- **Transport sources:** Lead emissions may be present from the vehicle exhaust of cars, aeroplanes, railway operations and from recreational and commercial shipping or boating.
- **Consumer products:** Lead and compounds are used in a range of applications. Lead is used in the production of batteries, ammunition, metal products (solder and pipes) and devices to shield X-rays. Lead was present in petroleum, paints and ceramic products, caulking and pipe solder, however due to health concerns, it is now prohibited to include lead in these products.

Routes of Exposure

- **Ingestion:** Lead exposure in the general population occurs primarily through ingestion.
- Inhalation may be the major contributor for workers in lead-related occupations. Almost all inhaled lead is absorbed into the body, whereas from 20% to 70% of ingested lead is absorbed. Since leaded gasoline additives were phased out beginning in the 1970s, and control measures were implemented in industries, which have reduced air emissions, inhalation is no longer the major exposure pathway for the general population.
- **Dermal:** Dermal exposure plays a role for exposure to organic lead among workers, but is not considered a significant pathway for the general population. Organic lead may be absorbed directly through the skin. Dermal exposure is most likely among people who work with lead.
- **Endogenous Exposure:** Endogenous exposure to lead may contribute significantly to an individual's current blood lead level, and of particular risk to the developing foetus. Once absorbed into the body, lead may be stored for long periods in mineralising tissue (i.e., teeth and bones). The stored lead may be released again into the bloodstream, especially in times of calcium stress (e.g., pregnancy, lactation, osteoporosis), or calcium deficiency.

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HEALTH EFFECTS [4]

Carcinogenicity

- Human studies are inconclusive regarding lead exposure and an increased cancer risk. Animal studies have reported kidney tumours in rats and mice exposed to lead via the oral route.
- EPA has considered lead to be a probable human carcinogen, and, under more recent assessment guidelines, it would likely be classified as likely to be carcinogenic to humans.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.
- **Skin Contact:** Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.
- **Inhalation:** If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
- **Ingestion:** Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Workplace Controls & Practices [4]

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

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling lead:
Safety glasses;

- Lab coat;

- Dust respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves

Personal Protection in Case of a Large Spill:
Splash goggles;

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

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REGULATION

United States

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA Permissible Exposure Limit (PEL) - General Industry See 29 CFR 1910.1025 Note: OSHA considers "lead" to mean elemental lead, all inorganic lead compounds, and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds. Note: Large nonferrous foundries (20+ employees) are required to achieve the PEL of 0.05 mg/m³ by means of engineering and work practice controls. Small nonferrous foundries (<20 employees) are required to achieve an 8-hour TWA of 0.075 mg/m³ by such controls.	0.05 mg/m³ TWA 0.03 mg/m³ Action Level	HE3	Nephrotoxicity
		HE5	Reproductive hazards
		HE7	Cumulative neurologic effects
		HE12	Cumulative blood effects

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA PEL - Construction Industry See 29 CFR 1926.62	0.05 mg/m³ TWA 0.03 mg/m³ Action Level	HE3	Constipation, nausea, pallor
		HE5	Reproductive risks
		HE7	Nervous irritability, hyperactivity, anxiety, insomnia, headache, weakness, numbness, dizziness
OSHA PEL - Shipyard Employment See 29 CFR 1915.1025	0.05 mg/m³ TWA 0.03 mg/m³ Action Level	HE3	Nephropathy, loss of kidney function, increased blood pressure
		HE5	Reduced sperm count and male sterility
		HE7	Subclinical and clinical peripheral neuropathy (muscle weakness, pain, and paralysis of extremities)
		HE12	Disruption of hemesynthesis, anaemia

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Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) See Appendix C Note: NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts such as lead soaps but excluding lead arsenate).	0.05 mg/m³ TWA Air concentrations should be maintained so that worker blood lead remains less than 0.06 mg Pb/100 g of whole blood	HE5	Reproductive toxicity, nephrotoxicity, cardiovascular toxicity, gastrointestinal toxicity
		HE7	Neurotoxicity
		HE12	Hematologic toxicity
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2001)	0.05 mg/m³ TWA A3; BEI	HE3	Cardiovascular toxicity, hypertension, cerebrovascular disease, nephrotoxicity
		HE5	Reproductive toxicity
		HE7	Neurologic and neurobehavioral toxicity
		HE12	Blood dyscrasias
CAL/OSHA PELs (See also Section 5198)	0.05 mg/m³ Lead (metallic and inorganic compounds), dust and fume, (as Pb)	HE3	Cardiovascular toxicity, hypertension, cerebrovascular disease, nephrotoxicity
		HE5	Reproductive toxicity
		HE7	Neurologic and neurobehavioral toxicity

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4. http://www.atsdr.cdc.gov/tfacts13.pdf
5. http://www.atsdr.cdc.gov/csem/csem.asp?csem=7&po=6
6. http://www.epa.gov/ttn/atw/hlthef/lead.html
7. http://www.sciencelab.com/msds.php?msdsId=9927204
8. https://www.osha.gov/dts/chemicalsampling/data/CH_249110.html

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Novel hydrogen bonding strategy yields high-birefringence crystals for optics

2025-03-20

Birefringent crystalline materials are essential in advanced optical technologies such as isolators and modulators due to their ability to manipulate light polarization. However, designing high-performance birefringent materials with a birefringence value ($\Delta n > 0.3$) is challenging. Achieving superior optical anisotropy requires identifying functional groups with strong polarizability anisotropy and optimizing their arrangement in the crystal lattice.

To address this challenge, researchers from the Xinjiang Technical Institute of Physics and Chemistry (XTIPC) of the Chinese Academy of Sciences have developed a novel design strategy to enhance optical anisotropy in low-dimensional structures. This approach involves modulating intralayer hydrogen bonding and optimizing anionic frameworks.

Using this method, the researchers synthesized a series of two-aminopyrazine-based birefringent crystals, four of which demonstrated exceptional birefringence values of 0.489, 0.490, 0.594, and 0.658 at 546 nm. The work is published in the journal Materials Horizons.

The significant improvement in birefringence was attributed to structural dimensional transitions and the propensity of protonated two-aminopyrazine groups to form low-dimensional frameworks under the influence of hydrogen bonding. Specifically, intralayer [N–H···O], [O–H···N], and [N–H···F] hydrogen bonds facilitated the coplanar alignment ($\theta = 0°$) of birefringent-active units, resulting in enhanced in-plane optical anisotropy.

Theoretical calculations further supported these findings, revealing that sequential anionic substitutions induced variations in optical polarizability, thereby optimizing the linear optical properties of the materials.

This study not only introduces a new birefringent functional group but also provides a theoretical and experimental framework for designing and synthesizing high-birefringence compounds within low-dimensional structures.

Phys Org, 20 March 2025

https://phys.org

Wearable Sensor Detects Plant Stress Before It's Visible

2025-03-19

Plants send distress signals when under attack from pests, drought, or disease, but these signals are often invisible to the naked eye. Now, scientists have developed a tiny, wearable sensor that attaches to plant leaves and detects stress before visible damage occurs.

By measuring hydrogen peroxide levels—an early biochemical warning—this patch helps farmers and gardeners respond swiftly, improving plant health and crop yields. Best of all, it provides real-time results in under a minute at an affordable cost.

Enhancing Plant Health with Wearable Sensors

Environmental factors like pests, drought, extreme temperatures, and infections can put significant stress on plants, creating challenges for both home gardeners and farmers. Detecting this stress early – before leaves begin to discolor, wilt, or wither – is crucial for effective intervention.

Now, researchers reporting today (March 19) in ACS Sensors have developed a wearable patch that attaches directly to plant leaves, allowing growers to monitor plant health in real-time. This electrochemical sensor detects hydrogen peroxide, a key distress signal plants produce when under stress.

When a plant experiences stress, its normal biochemical processes become disrupted, triggering the production of hydrogen peroxide. This molecule not only signals distress but also helps activate the plant's defense mechanisms. Identifying these chemical changes early allows growers to respond quickly, minimizing damage and improving crop yields, even in harsh conditions.

However, most existing methods for detecting hydrogen peroxide are complex, requiring leaf samples, multiple processing steps, or external detectors that rely on fluorescence – an approach often complicated by chlorophyll interference. Previous research on plant-wearable devices has focused on monitoring leaf water content as an indicator of health, but Liang Dong and his team sought a more direct approach. They developed a self-contained patch that rapidly and accurately detects hydrogen peroxide levels in living plants, offering a simpler and more effective way to monitor plant stress.

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Innovative Patch Design for Early Detection

To build a patch that sticks to the underside of leaves, the researchers created an array of microscopic plastic needles across a flexible base. Onto this patterned surface they coated a chitosan-based hydrogel mixture that converted small changes in hydrogen peroxide into measurable differences in electrical current. The mixture contained an enzyme that reacted with hydrogen peroxide to produce electrons and reduced graphene oxide to conduct those electrons through the sensor.

Real-World Testing on Crops

The researchers tested their patches on live, healthy soybean and tobacco plants and compared them to stressed bacteria-infected plants. They found:

- For both crops infected with the bacterial pathogen Pseudomonas syringae pv. tomato DC3000, the sensor produced more electrical current on stressed leaves than on healthy ones, and the current levels were directly related to the amount of hydrogen peroxide present.
- The sensor's measurement of hydrogen peroxide was accurate and confirmed by conventional lab analyses.
- After about 1 minute, the patches measured hydrogen peroxide in the leaves at significantly lower levels than those previously reported from needle-like sensors for live plants.
- Patches could be reused nine times before the microscopic needles lost their form.

A Game-Changer for Farmers

The new strategy provides information that could help growers efficiently make decisions about their crops. "We can achieve direct measurements in under a minute for less than a dollar per test," says Dong. "This breakthrough will significantly streamline analysis, making it practical for farmers to use our patch sensor for real-time disease crop monitoring."

And the researchers are excited to continue moving the research forward. "Our next step is to refine the technology and enhance its reusability," concludes Dong.

Sci Tech Daily, 19 March 2025

https://scitechdaily.com

Producing nuclear fusion fuel is banned in the US for being too toxic, but these researchers found an alternative

2025-03-20

Lithium-6 is essential for producing nuclear fusion fuel, but isolating it from the much more common isotope, lithium-7, usually requires liquid mercury, which is extremely toxic. Now, researchers have developed a mercury-free method to isolate lithium-6 that is as effective as the conventional method. The new method is presented March 20 in the Cell Press journal Chem.

"This is a step towards addressing a major roadblock to nuclear energy," says chemist and senior author Sarbajit Banerjee of ETH Zürich and Texas A&M University. "Lithium-6 is a critical material for the renaissance of nuclear energy, and this method could represent a viable approach to isotope separation."

The conventional method used to isolate lithium-6, called the COLEX process, involves liquid mercury and has been banned in the United States since 1963 due to pollution concerns. Since then, almost all lithium-6 used in US research has relied on a diminishing stockpile maintained at Oak Ridge National Laboratory in Tennessee. Having a safe method of isolating lithium-6 will be key to unlocking nuclear fusion as a sustainable energy source.

The researchers stumbled upon their method of isolating lithium-6 isolation while developing membranes for cleaning "produced water" -- groundwater that is brought to the surface during oil and gas drilling and that must be cleaned before it can be pumped back underground. They noticed that their cleaning membrane captured disproportionate quantities of lithium in the water.

"We saw that we could extract lithium quite selectively given that there was a lot more salt than lithium present in the water," says Banerjee. "That led us to wonder whether this material might also have some selectivity for the 6-lithium isotope."

The membrane's lithium-binding properties are due to a material called zeta-vanadium oxide (ζ-V_2O_5), a lab-synthesized inorganic compound that contains a framework of tunnels running in a single dimension.

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"Zeta-V_2O_5 has some pretty incredible properties -- it's an amazing battery material, and now we're finding that it can trap lithium very selectively, even with isotopic selectivity," says Banerjee.

To test whether the material could separate lithium-6 from lithium-7, the team set up an electrochemical cell with a zeta-V_2O_5 cathode. When they pumped an aqueous solution containing lithium ions through the cell while applying a voltage, the positively charged lithium ions were drawn towards the negatively charged zeta-V_2O_5 matrix and into its tunnels. Because lithium-6 and lithium-7 ions move differently, the zeta-V_2O_5 tunnels preferentially captured lithium-6 ions while the more mobile lithium-7 ions escaped capture.

"Lithium-6 ions stick a lot stronger to the tunnels, which is the mechanism of selectivity," says co-first author Andrew Ezazi of Texas A&M. "If you think of the bonds between V_2O_5 and lithium as a spring, you can imagine that lithium-7 is heavier and more likely to break that bond, whereas lithium-6, because it's lighter, reverberates less and makes a tighter bond."

As lithium ions are integrated into the zeta-V_2O_5, the compound gradually changes color from bright yellow to dark olive green, which enables the degree of lithium isolation to be easily monitored.

The team shows that a single electrochemical cycle enriched lithium-6 by 5.7%. To obtain fusion-grade lithium, which requires a minimum of 30% lithium-6, the process needs to be repeated 25 times, and 90% lithium-6 can be obtained in about 45 sequential cycles.

"This level of enrichment is very competitive with the COLEX process, without the mercury," says Ezazi.

"Of course, we're not doing industrial production yet, and there are some engineering problems to overcome in terms of how to design the flow loop, but within a bunch of flow cycles, you can get fusion-grade lithium for quite cheap," says Banerjee.

The researchers say that their results suggest that materials like zeta-V_2O_5 could be used to isolate other substances, for example, to separate radioactive from non-radioactive isotopes.

Now, the team is taking steps to scale their method up to an industrial level.

"I think there's a lot of interest in nuclear fusion as the ultimate solution for clean energy," says Banerjee. "We're hoping to get some support to build this into a practicable solution."

Science Daily, 20 March 2025

https://sciencedaily.com

Scientists discover new inhibitors of inflammation-related enzyme

2025-03-19

Using computational tools and virtual screening, researchers at the Center for Redox Processes in Biomedicine (Redoxoma) have identified new inhibitors of the enzyme human 15-lipoxygenase-2 (h15-LOX-2). This protein plays an important role in inflammatory and metabolic processes and contributes to cellular homeostasis.

The discovery, described in the Journal of Medicinal Chemistry, could open up new avenues for investigating the biological and pathological functions of the enzyme and provide promising candidates for the development of new drugs.

"Although h15-LOX-2 is a potential biological target, it's scarcely been explored for this purpose. Our work contributes to new inhibitors that have structural diversity among themselves and with respect to inhibitors already described in the literature. What's more, they have similar drug properties according to predictions based on computational models," says Lucas Gasparello Viviani, first author of the article.

The enzyme h15-LOX-2 belongs to the family of lipoxygenases (LOXs), enzymes that catalyze the oxidation of polyunsaturated fatty acids to form specific hydroperoxides. In humans, six LOX isoforms have specialized roles in different tissues, regulating processes such as inflammation, cell proliferation and regulation of the intracellular redox state. h15-LOX-2 is predominantly expressed in macrophages, skin, cornea, lung and prostate, where it catalyzes the conversion of arachidonic acid into a compound that significantly influences inflammatory and cellular responses.

"In the inflammatory cascade, h15-LOX-2 is one of the few enzymes capable of acting on complex lipids. It can oxidize membranes and cholesterol esters, whereas most lipoxygenases act on free fatty acids. We also chose to study this enzyme because of its particularities in terms of enzymatic activity," comments Miyamoto.

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Experimental validation

Virtual screening is a technique that uses computational methods to select compounds with potential biological activity from large databases. In this study, the researchers started with a database of 8 million compounds that had been pre-filtered for drug-like properties, taking into account factors such as absorption, distribution, metabolism, excretion and toxicity. They then applied sequential filters based on different methodological approaches to simplify the process.

"A very important point of this work was the use of a filter based on molecular shape similarity as a first step, based on the idea that there's shape complementarity between a low molecular mass compound—such as the inhibitor—and its binding site on the target protein. One advantage of this method is that even compounds that share the same shape can have different structures.

"Since one of our goals was to select compounds that were structurally different from existing inhibitors, this step was fundamental to the success of our approach," explained Viviani.

The specific physiological roles of h15-LOX-2 are still under investigation. The enzyme is involved in the biosynthesis of inflammatory lipid mediators and in the formation of atherosclerotic plaques. Studies indicate that the expression of the enzyme is significantly higher in atherosclerotic lesions of the human carotid artery compared to healthy arteries. In addition, evidence suggests a possible link between h15-LOX-2 and the development of certain cancers.

Moreover, h15-LOX-2 and other LOX enzymes may be involved in ferroptosis, a form of iron-dependent cell death associated with lipid peroxidation. In this case, inhibition of the enzyme may be beneficial.

The enzyme may also be involved in the regulation of cellular senescence in epithelial cells and may play a role in cholesterol homeostasis in macrophages, as described in recent studies.

Next steps

The researchers now plan to propose structural modifications to the identified compounds in order to increase their inhibitory potency.

"Another goal is to improve some physicochemical properties, such as solubility in aqueous media, which could favor their pharmacokinetic properties," says Viviani.

Miyamoto stressed that more testing is needed, saying, "In addition to improving efficiency, the inhibitors need to be tested in cells and animal models to confirm that they reach the target enzyme and work as intended."

Phys Org, 19 March 2025

https://phys.org

Weak Forces, Super Materials: The Breakthrough Changing Material Science

2025-03-18

A team from Kyoto University has developed novel three-dimensional van der Waals frameworks that showcase exceptional stability and porosity.

These materials, suitable for applications like gas storage and carbon capture, overturn previous beliefs about the limitations of van der Waals forces and offer a scalable, recyclable solution in material engineering.

Groundbreaking Advancements in Materials Science

Researchers at Kyoto University have made a major breakthrough in materials science by developing the first-ever three-dimensional van der Waals open frameworks (WaaFs). This discovery challenges the long-standing belief that van der Waals forces are too weak to support stable open-framework materials, proving instead that they can create highly porous and durable structures.

Challenging Old Assumptions

Published today (March 18) in Nature Chemistry, the study introduces a method that uses octahedral metal-organic polyhedra (MOPs) as building blocks to form WaaFs. These frameworks are remarkably stable, highly porous, and can be reversibly assembled, making them ideal for applications in gas storage, separation, and catalysis. Despite previous doubts about the strength of van der Waals interactions, WaaFs demonstrate robust three-dimensional structures that remain intact at temperatures up to 593 K and boast surface areas exceeding 2,000 m2/g, making them efficient for industrial use.

High Stability and Industrial Potential

A key advantage of WaaFs is their ability to be disassembled and reassembled in solution, enabling scalable production and recyclability.

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Their adjustable porosity and strong chemical stability make them highly promising for applications such as gas storage, carbon capture, water harvesting, and catalytic processes.

Expert Insights on the Future of WaaFs

Professor Shuhei Furukawa of Kyoto University's Institute for Integrated Cell-Material Sciences (iCeMS) emphasized the broader impact of this breakthrough, stating, "Our research challenges the long-standing assumption that van der Waals forces are too weak to construct stable frameworks. Through careful supramolecular design, we have demonstrated that these interactions can be harnessed to create robust and highly porous materials with practical applications."

Mr. Shun Tokuda, lead researcher of the study, added, "This discovery redefines the design principles of porous materials, showcasing a new approach to material engineering that enables both scalability and recyclability. WaaFs offer an innovative solution for gas separation, storage, and beyond."

Sci Tech Daily, 18 March 2025

https://scitechdaily.com

Cations found to be culprit behind degraded platinum electrodes

2025-03-19

Electrochemical devices like batteries and fuel cells help power our modern lives. These devices traditionally contain a liquid electrolyte sandwiched between solid electrodes, and can generate electricity through chemical reactions, or alternatively, can undergo chemical reactions when subjected to an electrical current.

A rechargeable battery is a classic example of an electrochemical device that has both these functions. It is important to understand how electrochemical devices degrade during use if we want to increase their durability. However, the decay of the solid metal electrodes in electrochemical devices is poorly understood.

Now, a collaboration between Japanese, Korean, and American researchers is addressing this knowledge gap by investigating the degradation behavior of electrodes made of platinum—a stable noble metal like gold and silver—in different electrolyte solutions.

The researchers measured the degradation of platinum electrodes in electrolytes containing different cations, which are atoms with positive charges, from the same group of the periodic table (lithium, sodium, potassium, and cesium). Their results revealed that the cation identity affected platinum degradation: larger cations suppressed platinum dissolution compared with that in systems with smaller cations.

"We monitored platinum dissolution in real time," says lead author Haesol Kim. "Our results revealed that platinum leaching decreased as the atomic number (and size) of the cation increased. That is, electrode degradation is influenced by a cation effect."

Intrigued by this effect, the researchers conducted further experiments and computer simulations to identify the origin of this behavior.

"Our computational simulations indicated that the hydroxide ions near the platinum electrode strongly affected platinum leaching," explains senior author Chang Hyuck Choi. "Hydroxide ions promoted the diffusion of platinum ions into the bulk electrolyte by weakening the force for platinum redeposition on the electrode surface."

The negatively charged hydroxide ions acted as a shield around the positively charged platinum ions, helping them to move away from the electrode surface. But how did this relate to the cation effect?

The cations in the electrolyte influenced the concentration of hydroxide ions near the platinum electrode surface. Cations with higher acidity provided a higher hydroxide ion concentration near the platinum surface than cations with lower acidity. In the investigated cation series, the smaller cations had higher acidity than the larger cations. As a result, platinum electrode degradation was accelerated in the presence of smaller cations.

The finding that electrode stability is directly affected by the type of cations in the electrolyte is an exciting finding and will give researchers an area to focus on in their quest to create the durable electrochemical devices needed to power the future.

Phys Org, 19 March 2025

https://phys.org

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New carbon-negative material could make concrete and cement more sustainable

2024-03-19

Using seawater, electricity and carbon dioxide (CO2), Northwestern University scientists have developed a new carbon-negative building material.

As Earth's climate continues to warm, researchers around the globe are exploring ways to capture CO2 from the air and store it deep underground. While this approach has multiple climate benefits, it does not maximize the value of the enormous amounts of atmospheric CO2.

Now, Northwestern's new strategy addresses this challenge by locking away CO2 permanently and turning it into valuable materials, which can be used to manufacture concrete, cement, plaster and paint. The process to generate the carbon-negative materials also releases hydrogen gas -- a clean fuel with various applications, including transportation.

The study will be published on March 19 in the journal Advanced Sustainable Systems.

"We have developed a new approach that allows us to use seawater to create carbon-negative construction materials," said Northwestern's Alessandro Rotta Loria, who led the study. "Cement, concrete, paint and plasters are customarily composed of or derived from calcium- and magnesium-based minerals, which are often sourced from aggregates -- what we call sand. Currently, sand is sourced through mining from mountains, riverbeds, coasts and the ocean floor. In collaboration with Cemex, we have devised an alternative approach to source sand -- not by digging into the Earth but by harnessing electricity and CO2 to grow sand-like materials in seawater."

Rotta Loria is the Louis Berger Assistant Professor of Civil and Environmental Engineering at Northwestern's McCormick School of Engineering. Jeffrey Lopez, an assistant professor of chemical and biological engineering at McCormick, served as a key coauthor on the study. Co-advised by Rotta Loria and Lopez, other Northwestern contributors include Nishu Devi, a postdoctoral fellow and lead author; Xiaohui Gong and Daiki Shoji, Ph.D. students; and Amy Wagner, former graduate student. The study also benefited from the contributions of key representatives from the Global R&D department of Cemex, a global building materials company dedicated to sustainable construction. This work is part of a broader collaboration between Northwestern and Cemex.

Seashell-inspired science

The new study builds on previous work from Rotta Loria's lab to store CO2 long term in concrete and to electrify seawater to cement marine soils. Now, he leverages insights from those two projects by injecting CO2while applying electricity to seawater in the lab.

"Our research group tries to harness electricity to innovate construction and industrial processes," Rotta Loria said. "We also like to use seawater because it's a naturally abundant resource. It's not scarce like fresh water."

To generate the carbon-negative material, the researchers started by inserting electrodes into seawater and applying an electric current. The low electrical current split water molecules into hydrogen gas and hydroxide ions. While leaving the electric current on, the researchers bubbled CO2 gas through seawater. This process changed the chemical composition of the water, increasing the concentration of bicarbonate ions.

Finally, the hydroxide ions and bicarbonate ions reacted with other dissolved ions, such as calcium and magnesium, that occur naturally in seawater. The reaction produced solid minerals, including calcium carbonate and magnesium hydroxide. Calcium carbonate directly acts as a carbon sink, while magnesium hydroxide sequesters carbon through further interactions with CO2.

Rotta Loria likens the process to the technique coral and mollusks use to form their shells, which harnesses metabolic energy to convert dissolved ions into calcium carbonate. But, instead of metabolic energy, the researchers applied electrical energy to initiate the process and boosted mineralization with the injection of CO2.

Dual discoveries

Through experimentation, the researchers made two significant discoveries. Not only could they grow these minerals into sand, but they also were able to change the composition of these materials by controlling experimental factors, including the voltage and current of electricity, the flow rate, timing and duration of CO2injection, and the flow rate, timing and duration of seawater recirculation in the reactor.

Depending on the conditions, the resulting substances are flakier and more porous or denser and harder -- but always primarily composed of calcium carbonate and/or magnesium hydroxide. Researchers can grow the materials around an electrode or directly in solution.

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"We showed that when we generate these materials, we can fully control their properties, such as the chemical composition, size, shape and porosity," Rotta Loria said. "That gives us some flexibility to develop materials suited to different applications."

These materials could be used in concrete as a substitute for sand and/or gravel -- a crucial ingredient that accounts for 60-70% of this ubiquitous building material. Or they could be used to manufacture cement, plaster and paint -- all essential finishes in the built environment.

Storing carbon in structures

Depending on the ratio of minerals, the material can hold over half its weight in CO2. With a composition of half calcium carbonate and half magnesium hydroxide, for example, 1 metric ton of the material has the capacity to store over one-half a metric ton of CO2. Rotta Loria also says the material -- if used to replace sand or powder -- would not weaken the strength of concrete or cement.

Rotta Loria envisions industry could apply the technique in highly scalable, modular reactors -- not directly into the ocean -- to avoid disturbing ecosystems and sea life.

"This approach would enable full control of the chemistry of the water sources and water effluent, which would be reinjected into open seawater only after adequate treatment and environmental verifications," he said.

Responsible for 8% of global CO2 emissions, the cement industry is the world's fourth-largest carbon emitter, according to the World Economic Forum. When combined with concrete production, this figure is even higher. Rotta Loria foresees putting some of that CO2 back into concrete and cement to make more sustainable materials for construction and manufacturing.

"We could create a circularity where we sequester CO2 right at the source," Rotta Loria said. "And, if the concrete and cement plants are located on shorelines, we could use the ocean right next to them to feed dedicated reactors where CO2 is transformed through clean electricity into materials that can be used for myriad applications in the construction industry. Then, those materials would truly become carbon sinks."

Science Daily, 19 March 2025

https://sciencedaily.com

World's first long-life sodium-ion power bank launched

2025-03-18

Japanese hardware brand Elecom has just launched what it claims is the world's first power bank to feature a sodium-ion battery inside. It promises significantly longer cycle life than traditional lithium-ion batteries, as well as the ability to operate in extremely hot and cold climes.

On the outside, the affectionately named DE-C55L-9000 looks similar to the vast majority of power banks on the market, with a rounded brick shape housing its 9,000-mAh battery, a 45-W USB Type-C and an 18-W Type-A port, and charging indicator LEDs.

What's more interesting than the rest is the tech inside. A sodium-ion battery is pretty similar to a lithium-ion battery in terms of how it works and how it's constructed – but it uses cheaper and more abundantly available sodium for the cathode material, and sodium salts instead of lithium salts for the electrolyte.

That means you don't need to mine as many valuable metals like lithium, cobalt, and copper to make these batteries. Elecom's power bank also works safely at temperatures ranging from -30 °F (-34 °C) to 122 °F (50 °C), which means it could be a good choice for people working in difficult conditions outdoors. And due to the properties of the batteries' materials, they pose a far lower risk of catching on fire.

The other big draw with this tech is that it has a much longer cycle life – the number of times it can be charged and discharged before the cell's energy density drops – than lithium-ion batteries. Elecom says its power bank is good for 5,000 charge cycles, compared to lithium-ion's usual range 500 to 1,000 cycles.

This is cool to see, because it's one of the first major commercially available sodium-ion products on the market. This battery tech has been in the works since the 1970s, and it potentially presents a lower cost per kWh than lithium-ion. Plus, it not only works the same way as lithium-ion batteries, but can also be manufactured similarly too – so producing more of these won't require substantial tooling costs.

Sodium-ion batteries can also be shipped at zero volts – in stable and inactive state, if you will – which means they can be transported with a far lower risk of fires.

What's more, it could reduce our dependence on harmful mining operations to extract the metals needed for lithium-ion batteries, like

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cobalt, copper, and graphite. Sodium is abundantly available in sea salt, as well as in the crust of the earth.

Now, back to that power bank. Elecom's portable puck costs 9,980 JPY (US$67) in Japan, and is available in limited quantities. That's actually a fair bit more expensive than two comparable 10,000-mAh power banks from Anker that I looked at, which will set you back by about $16 - $24. This one is also heavier at 12.3 oz (350 g) than Anker's offerings (7.5 oz - 8.6 oz/212 g - 244 g).

That's likely due to the fact that sodium-ion cells have a lower energy density than lithium-ion. It's one of the limitations holding sodium-ion from being widely adopted in EVs, though some low-range vehicles are expected to use this tech in the near future. Sodium-ion batteries are currently being developed for use in stationary storage applications like power backup.

So yeah, this is an expensive power bank that won't wow you with performance, but it could last you up to 13 years even if you juice it up every day. It also represents a sign of things to come in future battery technology for everything from phones to cars.

New Atlas, 2025-03-18

https://newatlas.com

Velvet worm slime: Reversible liquid-to-fiber transformation inspires sustainable materials

2025-03-19

A new discovery about the slime ejected by velvet worms could revolutionize sustainable material design, according to a study by McGill University researchers. Their findings outline how a naturally occurring protein structure, conserved across species from Australia, Singapore and Barbados over nearly 400 million years of evolution, enables the slime's transformation from liquid to fiber and back again. It's a discovery that could inspire next-generation recyclable bioplastics.

"Nature has already figured out a way to make materials that are both s5trong and recyclable," said Matthew Harrington, a chemistry professor and Canada Research Chair in green chemistry, who led the study. "By decoding the molecular structure of velvet worm slime, we're now one step closer to replicating that efficiency for the materials we use every day."

Velvet worms, small caterpillar-like creatures found in humid forests of the southern hemisphere, use their slime to capture prey. When ejected, the slime rapidly hardens into fibers as strong as nylon. The slime dissolves in water and can be reconstituted into new fibers. Until now, the molecular mechanism behind this reversibility remained a mystery.

Using protein sequencing and AI-driven structure prediction (AlphaFold, the 2024 Nobel Prize-winning tool), Harrington's team identified previously unknown proteins in the slime that function similarly to cell receptors in the immune system. The researchers believe the receptor proteins function to link large structural proteins during fiber formation. By comparing two subgroups of velvet worms that separated nearly 380 million years ago, the researchers demonstrated the evolutionary significance and functional relevance of this protein.

A blueprint for recyclable materials

Traditional plastics and synthetic fibers are typically made using petroleum-based precursors and require energy-intensive processes to manufacture and recycle, often involving heat or chemical treatments. The velvet worm, however, uses simple mechanical forces—pulling and stretching—to generate strong, durable fibers from biorenewable precursors, which can later be dissolved and reused without harmful byproducts.

"Obviously, a plastic bottle that dissolves in water would have limited use, but by adjusting the chemistry of this binding mechanism, we can get around this issue," said Harrington.

The study was co-authored by researchers from McGill University and Nanyang Technological University (NTU) in Singapore. The team's next challenge will be to experimentally verify the binding interactions and explore whether the principle can be adapted for engineered materials.

Phys Org, 19 March 2025

https://phys.org

Researchers develop chainmail integrated-electrode for highly efficient hydrogen sulfide electrolysis

2025-03-20

Hydrogen sulfide (H2S), a toxic and corrosive byproduct of fossil fuel extraction, poses significant environmental and industrial challenges. While the conventional Claus process converts H2S into elemental sulfur,

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it fails to recover hydrogen gas, missing an opportunity for sustainable energy production.

Electrocatalytic H2S decomposition offers a promising strategy to simultaneously eliminating pollutants and producing green hydrogen. However, the acidic nature of H2S deactivates non-precious metal catalysts and degrades electrode structures, making it difficult to achieve both high efficiency and long-term stability.

In a study published in Angewandte Chemie International Edition, a research group led by Prof. Deng Dehui and Assoc. Prof. Cui Xiaoju from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences has developed a dual-level chainmail integrated-electrode that enables highly efficient hydrogen production via H2S electrolysis.

Researchers designed a graphene encapsulating nickel foam (Ni@NC foam) electrode with a dual-level chainmail structure, enhancing both catalytic activity and durability.

This electrode achieved an industrial-scale current density exceeding 1 A/cm2 at 1.12 V versus the reversible hydrogen electrode, which is five times higher than commercial nickel foam electrodes. The Ni@NC foam electrode remained stable for over 300 hours, demonstrating a lifespan at least ten times longer than commercial nickel foam electrodes.

In a simulated natural gas desulfurization test, the chainmail integrated-electrode completely oxidized and removed 20% H2S at the anode, producing sulfur powder simultaneously. Meanwhile, high-purity hydrogen was collected at the cathode. Compared with conventional water electrolysis, the system reduced energy consumption by 43% at the current density of 200 mA/cm2, offering a more sustainable approach to hydrogen production.

"Our study provides an efficient, low-energy solution for natural gas purification and opens up the potential of converting H2S into valuable hydrogen fuel for industrial applications," said Prof. Deng.

Phys Org, 20 March 2025

https://phys.org

Cement sand substitute made directly from seawater, electricity and CO2

2025-03-19

This strange white paste might not look like much, but it might help solve the sand shortage, while making the cement manufacturing process capture carbon dioxide instead of emitting it. Scientists at Northwestern University grew this stuff out of seawater, electricity and CO2.

Concrete is the most widely used artificial material on the planet – which is a shame, because making it also happens to be one of the most polluting processes. Worse still, at a global scale it requires huge amounts of sand, which is getting harder (financially and environmentally) to mine from coasts, seafloors and riverbeds.

An unassuming new material from Northwestern could help solve both problems. Composed of calcium carbonate and magnesium hydroxide in different ratios, it's pretty simple to make – just take some seawater, zap it with electricity and bubble some CO2 through it.

The whole process is similar to how corals and mollusks build their shells, according to the team.

If you really want to get your thinking cap on, here's how they do it: two electrodes in the tank emit a low electrical current that splits the water molecules into hydrogen gas and hydroxide ions. When CO2 gas is added, the chemical composition of the water changes, increasing levels of bicarbonate ions. These hydroxide and bicarbonate ions react with other natural ions in seawater, producing solid minerals that gather at the electrodes.

The end result is a versatile white material that not only stores carbon, but can stand in for sand or gravel in cement, and also forms a foundational powder for other building materials like plaster and paint.

Intriguingly, the researchers found the material could be tweaked by adjusting the flow rate, timing and duration of the CO2 and seawater, and the voltage and current of the electricity.

"We showed that when we generate these materials, we can fully control their properties, such as the chemical composition, size, shape and porosity," said Alessandro Rotta Loria, lead author of the study. "That gives us some flexibility to develop materials suited to different applications."

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This process is far greener than the usual method of making these building materials. Not only does it reduce the need to strip mine huge quantities of sand from the natural environment, but the only gaseous byproduct is hydrogen, which can itself be captured for use as clean fuel. The CO2 used to make the material could even come from emissions from regular cement production, in which case the process could make regular cement greener as a byproduct.

"We could create a circularity where we sequester CO2 right at the source," Rotta Loria said. "And, if the concrete and cement plants are located on shorelines, we could use the ocean right next to them to feed dedicated reactors where CO2 is transformed through clean electricity into materials that can be used for myriad applications in the construction industry. Then, those materials would truly become carbon sinks."

Seawater, electricity and carbon dioxide... These are not rare or expensive input items. Naturally, this process needs to prove itself at industrial scale, on commercial timelines, and survive the close scrutiny of the bean counters, but it sure looks to us like an innovation with impressive potential.

If this engineered carbon-capturing sand substitute proves cheaper than schlepping actual sand around at scale, it could make a meaningful contribution to decarbonization – but by itself, it won't produce entirely green cement. It's the next stage – where the sand is ground up with limestone and heated up north of 1,400°C (1,670 °K) in a kiln – that produces the lion's share of carbon emissions.

The research was published in the journal Advanced Sustainable Systems.

New Atlas, 2025-03-19

https://newatlas.com

Optimized CBD Formula Could Improve Epilepsy Treatments

2025-03-20

Scientists at the University of South Australia have come up with an innovative solution to improve the effectiveness of cannabidiol to treat epilepsy, multiple sclerosis and other neurodegenerative diseases.

Cannabidiol (CBD) is a non-psychoactive compound found in the cannabis plant. It is widely prescribed for its analgesic, anti-inflammatory and

neuroprotective properties, but its clinical applications to date have been limited by its poor water solubility and absorption in the human body.

By developing a phospholipid complex – a class of lipids (fats) that contain phosphorus – UniSA researchers have increased the solubility of cannabidiol by up to six times and improved its absorption in the gastrointestinal tract.

Lead researcher Professor Sanjay Garg says the breakthrough, reported in the International Journal of Molecular Sciences, means that patients could experience more consistent and effective results with lower doses of oral CBD medications.

Currently, only a small fraction of orally ingested CBD reaches the bloodstream, limiting its therapeutic effects.

"For this reason, a number of different formulations have been explored, including the production of synthetic CBD, self-emulsifying delivery systems, and encapsulating CBD in gelatine matrix pellets, but all of them have only resulted in minor improvements in bioavailability," Prof Garg says.

His research team identified the optimal phospholipid composition to form nanosized CBD-PLC particles. Compared to pure CBD, the phospholipid complex improved dissolution rates from 0% to 67.1% within three hours, demonstrating a significant enhancement in drug release.

In cellular uptake studies, CBD-PLC exhibited 32.7% higher permeability than unmodified CBD, ensuring greater absorption through the intestinal wall.

Another critical advantage of this new delivery system is its stability. Traditional CBD formulations degrade over time when exposed to heat, light or oxygen, reducing potency and shelf life.

However, testing over 12 months showed that CBD-PLC retained its performance under varied storage conditions, making it a more reliable option for pharmaceutical applications.

The study's first author, UniSA PhD candidate Thabata Muta, says the discovery has significant implications for the future of CBD-based therapeutics.

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"Improved bioavailability means that lower doses can achieve the same therapeutic effect, potentially reducing side effects and making treatment more cost effective," Thabata says.

The research team believes that this innovation could be applied beyond CBD, providing a blueprint for enhancing the absorption of other poorly water-soluble drugs.

With the global CBD market projected to grow from USD 7.59 billion in 2023 to USD 202.45 billion by 2032, the findings of this study come at a crucial time, according to the study authors.

The team is now exploring opportunities for commercialisation and clinical trials to validate their new formulation.

Technology Networks, 20 March 2025

https://technologynetworks.com

Japanese plant yields compounds that exhibit strong anti-HIV activity

2025-03-20

Researchers have discovered that Daphne pseudomezereum (commonly known as Onishibari) contains a substance inhibiting replication of human immunodeficiency virus (HIV). The plants were cultivated at the Medicinal Plant Garden of the Faculty of Pharmaceutical Sciences, Toho University. This finding is expected to lead to the discovery of drug seeds for novel drugs with superior anti-HIV activity.

A paper reporting this study was published in the journal Phytochemistry. The research group was led by Professor Wei Li from the Department of Pharmacognosy, Faculty of Pharmaceutical Sciences, Toho University, in collaboration with the Duke University Medical Center in the United States.

The Thymelaeaceae family consists of over 53 genera and 800 species distributed worldwide, except in polar and desert regions. These plants contain diterpenoids, which exhibit significant biological activities, including anticancer, anti-HIV, and analgesic effects.

D. pseudomezereum is a deciduous shrub of the Thymelaeaceae family found in Japan, China, and Korea. Its bark has been traditionally used in medicine to treat chronic skin diseases and rheumatism due to its anti-inflammatory properties. Additionally, this fiber-rich bark has been utilized as an additive in Japanese paper production.

In the study, a research group isolated 10 daphnane diterpenoids, including three previously undescribed compounds, from the fruits of D. pseudomezereum. Among the isolated compounds, three exhibited potent anti-HIV activity, with EC50 values around 1 nM and cytotoxicity at IC50 > 5 μM.

The findings of this study not only underscore the promising anti-HIV potential of daphnane diterpenoids but also provide a foundation for future research aimed at optimizing their activity through strategic structural modifications.

Phys Org, 20 March 2025

https://phys.org

This Tiny Discovery Could Change How We Store Energy and Filter Gases

2025-03-19

A groundbreaking study has introduced DNL-17, a newly synthesized aluminophosphate molecular sieve with a unique porous structure.

Researchers leveraged advanced 3D electron diffraction to reveal its intricate crystallographic details and discovered a novel structure-directing mechanism. This advancement paves the way for enhanced molecular sieve design with promising industrial applications.

Unlocking the Potential of Aluminophosphate Molecular Sieves

Aluminophosphate (AlPO) molecular sieves are crystalline, microporous materials composed of alternating PO4 and AlO4 tetrahedra. These structures create well-organized channels and cage-like frameworks.

Small-pore AlPO molecular sieves with three-dimensional (3D) channel systems have significant potential for selective adsorption and energy storage. However, synthesizing these materials and determining their precise crystallographic structures remains a challenge.

A Breakthrough in Synthesis: Introducing DNL-17

In a study published in the Journal of the American Chemical Society, a research team led by Prof. Peng Guo and Prof. Zhongmin Liu from the Dalian Institute of Chemical Physics at the Chinese Academy of Sciences successfully synthesized a novel small-pore AlPO molecular sieve, named

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DNL-17. They achieved this using a flexible diquaternary ammonium compound as an organic structure-directing agent (OSDA).

Researchers used cutting-edge 3D electron diffraction (ED) technology to directly determine the complex crystallographic structure of DNL-17. This new member of the ABC-6 family features 3D 8 * 8 * 8-ring pores and a framework structure containing four characteristic cages (d6r, can, eri, and cha), with a distinct 24-layer stacking sequence along the c axis (AABAACAABBCBBABBCCACCBCC).

A Unique Structure-Directing Effect

In addition, researchers identified a unique structure-directing effect in which the flexible OSDAs adopt various conformations to stabilize different cages during crystallization. They demonstrated that DNL-17 shows promise for selective adsorption in the separation of n-butane and isobutane.

"This study demonstrates that OSDAs can construct novel AlPO MSs through different conformations, paving the way for the design and synthesis of new molecular sieves," said Prof. Guo.

Sci Tech Daily, 19 March 2025

https://scitechdaily.com

Nanomaterials Used To Measure a Nuclear Reaction That Occurs in Neutron Star Collisions

2025-03-20

Physicists have measured a nuclear reaction that can occur in neutron star collisions, providing direct experimental data for a process that had previously only been theorised. The study, led by the University of Surrey, provides new insight into how the universe's heaviest elements are forged – and could even drive advancements in nuclear reactor physics.

Working in collaboration with the University of York, the University of Seville, and TRIUMF, Canada's national particle accelerator centre, the breakthrough marks the first-ever measurement of a weak -process reaction cross-section using a radioactive ion beam, in this case studying the 94Sr(α,n)97Zr reaction. This is where a radioactive form of strontium (strontium-94) absorbs an alpha particle (a helium nucleus), then emits a neutron and transforms into zirconium-97.

The study has been published as an Editors Suggestion in Physical Review Letters.

Dr Matthew Williams, lead author of the study from the University of Surrey, said: "The weak -process plays a crucial role in the formation of heavy elements, which astronomers have observed in ancient stars – celestial fossils that carry the chemical fingerprints of perhaps only one prior cataclysmic event, like a supernovae or neutron star merger. Until now, our understanding of how these elements form has relied on theoretical predictions, but this experiment provides the first real-world data to test those models that involve radioactive nuclei."

The experiment was enabled by the use of novel helium targets. Since helium is a noble gas, meaning it is neither reactive nor solid, researchers at the University of Seville developed an innovative nano-material target, embedding helium inside ultra-thin silicon films to form billions of microscopic helium bubbles, each only a few 10s of nanometres across.

Using TRIUMF's advanced radioactive ion beam technology, the team accelerated short-lived strontium-94 isotopes into these targets, allowing them to measure the nuclear reaction under conditions similar to those found in extreme cosmic environments.

Dr Williams said: "This is a major achievement for astrophysics and nuclear physics, and the first-time nanomaterials have been used in this way, opening exciting new possibilities for nuclear research."

"Beyond astrophysics, understanding how radioactive nuclei behave is crucial for improving nuclear reactor design. These types of nuclei are constantly produced in nuclear reactors, but until recently, studying their reactions has been extremely difficult. Reactor physics depends on this kind of data to predict how often components need replacing, how long they'll last and how to design more efficient, modern systems."

The next phase of research will apply the findings to astrophysical models, helping scientists to better understand the origins of the heaviest known elements. As researchers continue to explore these processes, their work could deepen our understanding of both the extreme physics of neutron star collisions and practical applications in nuclear technology.

Technology Networks, 20 March 2025

https://technologynetworks.com

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Kakhovka dam attack exposed 'toxic time bomb' of heavy metal pollution

2025-03-18

The destruction of the Kakhovka dam in Russian-occupied southern Ukraine exposed large quantities of heavy metals that pose a 'largely overlooked' threat to surrounding ecosystems. Researchers who analysed pollution associated with the dam's destruction say that the protection of dams in military zones should be a priority concern given the potential long-term impact on both people and the environment.

The Kakhovka dam, located upstream of the city of Kherson on the Dnipro river, collapsed in June 2023 following a suspected explosion. The extensive flooding along the lower Dnipro River that followed resulted in thousands of people being evacuated from their homes and the deaths of at least 58 people.

While the economic and societal impacts of the dam's collapse have been widely reported, assessments of the long-term environmental effects and threats to human health have been hindered by ongoing combat in the area.

Now, researchers have combined field surveys, remote sensing data and hydrodynamic modelling with insights from dam removal practices, flood hazard assessment and analysis of ecosystem reestablishment, to understand the scale of the catastrophe. The team also outlines possible approaches for reestablishing the damaged ecosystem.

'When the disaster happened a lot of scientists were giving different opinions, and also a lot of myths emerged about what was happening there,' explains Oleksandra Shumilova, a river scientist based at the Leibniz Institute of Freshwater Ecology and Inland Fisheries in Berlin, Germany, who led the project. 'The aim of our [research] was to [carry out] a scientifically based, comprehensive assessment of what was happening.'

The researchers found that destruction of the dam had resulted in substantial erosion, loss of vegetation, habitat destruction and the death of large quantities of fish and other organisms.

In addition, they revealed that before the dam collapsed, large quantities of pollutants from industrial and agricultural sources – including heavy metals, nitrogen and phosphorus – had accumulated in a thick layer of sediment settled on the bottom of the reservoir.

The team's models suggest that when the dam was breached, two waves produced a surge of water both up- and downstream, rapidly draining the reservoir and exposing as much as 1.7km3 of polluted sediment. The researchers estimate that this sediment contains up to 83,300 tonnes of highly toxic heavy metals, which they describe as a 'toxic time bomb'.

Less than 1% of the pollution has likely been released into the surrounding areas so far, mostly from upstream of the dam, the researchers say. However, surface runoff during rainfall events and seasonal floods, such as those occurring in March 2024, will continue to mobilise the pollutants. Shumilova says that the threats posed by the release of these heavy metals – both ecological and to human health – have been overlooked.

'There are different discussions going on but there is no mention of this issue at all,' says Shumilova. 'People argue that this area should be left to be colonised by vegetation, no one talks about how this vegetation will accumulate heavy metals, how it can pass through the foodweb [and] how it can affect human health.'

Overall, the researchers predict that reestablishment equivalent to 80% of an undammed ecosystem could be expected within five years and that biodiversity of the river environment will start to increase within two. They note that the heavy metal pollution could be mitigated by bioremediation methods – using plants to absorb the pollutants – and propose building two 15-kilometer-long barriers along the Dnipro to limit the spread.

'Shumilova [and her colleagues] provide an unusually high-fidelity view of the environmental impacts of war,' says Joshua Daskin, an expert on the impacts of war on the environment, who serves as director of conservation at the Archbold Biological Station in Florida, US.

'Scientists, very understandably, don't often work in the hottest conflict zones, making it hard to measure wars' effects. The Kakhovka dam example, though, is just one case of the widespread decline in ecological conditions during and after wars and other periods of bureaucratic instability,' he adds. 'Government activities may be redirected from ecological concerns to military priorities during a conflict, and NGOs may be forced to withdraw program staff for safety reasons – both with often-negative impacts on wildlife and human communities.'

Chemistry World, 18 March 2025

https://chemistryworld.com

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Peptide screening reveals irreversible inhibitors for cancer's 'undruggable' cJun protein

2025-03-20

For the first time, scientists have identified promising drug candidates that bind irreversibly with a notoriously undruggable cancer protein target, permanently blocking it.

Transcription factors are proteins that act as master switches of gene activity and play a key role in cancer development. Attempts over the years to design small molecule drugs that block them have been largely unsuccessful, so in recent years scientists have explored using peptides—small protein fragments—to block these undruggable targets.

Now, researchers from the University of Bath have for the first time detailed an approach to discover peptides that bind selectively and irreversibly within cells, permanently blocking a transcription factor that drives cancer known as cJun.

The team, publishing in the journal Advanced Science, used a new drug discovery screening platform technology, called the Transcription Block Survival (TBS) assay, which tests a huge number of peptides to switch off transcription factors that drive cancer.

Their previous work identified reversible inhibitors of cJun, but this latest work builds on that by discovering peptides that bind selectively and irreversibly within cells, permanently blocking cJun action.

The transcription factor cJun has two identical halves, which bind on either side of the DNA strand to alter gene expression.

It can become overactive in cancer, driving uncontrolled cell growth, so the researchers designed a peptide inhibitor that binds to one half of cJun, stopping it from forming pairs and attaching to the DNA.

Once they had made a peptide that bound to the transcription factor, the researchers modified it to bind irreversibly.

Dr. Andy Brennan, first author of the study and Research Fellow at the University of Bath's Department of Life Sciences, said, "The inhibitor works a bit like a harpoon that fires across to the target and won't let go—it grips the cJun tightly and stops it from binding to the DNA.

"We'd previously identified reversible inhibitors but this is the first time we've managed to block a transcription factor irreversibly with a peptide inhibitor."

For the Transcription Block Survival assay, researchers inserted binding sites for cJun into an essential gene in cells grown in the lab. As cJun binds to the gene, it prevents it working and the cell dies. In contrast, if cJun is blocked by the peptide inhibitor, the gene activity is restored and the cell survives.

Jody Mason, CSO of Revolver Therapeutics and Professor of Biochemistry in the University of Bath's Department of Life Sciences, said, "Many drug candidates that are effective in vitro turn out to be toxic or don't penetrate cancer cells at all.

"However, our platform screens for peptide activity directly in the cell, overcoming many common challenges faced by drugs based on small molecules or antibodies.

"The screen checks the activity of the inhibitor in a real cell environment which includes proteases and other proteins that can sometimes interfere with peptide activity, while also checking toxicity.

"We hope this technology can in the future uncover other promising drug candidates for previously 'undruggable' targets."

Having proven cell permeability and activity in cancer cells, as well as target selectivity, the researchers now need to show the inhibitors work in preclinical cancer models.

Phys Org, 20 March 2025

https://phys.org

New material for efficient separation of Deuterium at elevated Temperatures

2025-03-19

A novel porous material capable of separating deuterium (D2) from hydrogen (H2) at a temperature of 120 K has been introduced. Notably, this temperature exceeds the liquefaction point of natural gas, thus facilitating large-scale industrial applications. This advancement presents an attractive pathway for the economical production of D2 by leveraging the existing infrastructure of liquefied natural gas (LNG) production pipelines. The research conducted by Ulsan National Institute of Science

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& Technology (UNIST), Korea, Helmholtz-Zentrum Berlin, Heinz Maier Leibnitz Zentrum (MLZ), and Soongsil University, Korea, has been published in Nature Communications.

Deuterium, a stable isotope of hydrogen, plays a critical role in enhancing the durability and luminous efficiency of semiconductors and display devices, as well as serving as a fusion fuel in energy production. However, the increasing demand for D2 presents challenges in its production, primarily due to the need to separate from hydrogen through a cryogenic distillation process conducted at temperatures as low as 20 K (-253°C). While research has explored the use of metal-organic frameworks (MOFs) for D2 separation, their efficiency diminishes significantly at elevated temperatures.

In this study, the research team presented a copper-based zeolite imidazolate framework (Cu-ZIF-gis), which shows exceptional D2 separation performance, even at 120 K (-153). While typical MOFs operate effectively at around 23 K (-250), their performance decreases sharply as temperatures approach 77 K (-196). However, the newly developed Cu-based MOF demonstrates a significant advantage in maintaining its effectiveness at higher temperatures.

For the first time, the research team identified that the superior performance of this material results from the increased expansion of its lattice as the temperature rises. At cryogenic temperatures, the pores of the developed MOF are smaller than H2 molecules, thereby inhibiting their passage. However, as the temperature increases, the lattice expands, leading to an increase in pore size. This enlargement facilitates the passage of gases through the pores, thereby enabling the separation of H2 and D2 via the quantum sieving effect, wherein heavier molecules traverse the pores more efficiently at lower temperatures.

Confirmatory in-situ X-ray diffraction (XRD) and quasi-elastic neutron scattering (QENS) experiments, conducted at the Institut Laue-Langevin (ILL) in Grenoble, France, by the joint team from UNIST, HZB and MLZ, confirmed the expansion of the lattice framework with increasing temperature, as well as the difference in isotope diffusivity even at elevated temperatures. Additionally, the analysis from the Thermal Desorption Spectroscopy (TDS) experiments indicated stable D2 separation at elevated temperatures.

Professor Oh remarked, "The reported material exhibits markedly lower energy consumption and enhanced separation efficiency compared to most traditional methods, which operate at extremely low temperatures."

Dr. Jitae Park further noted, "These findings can be applied to develop sustainable isotope separation technologies using existing LNG cryogenic infrastructure, underscoring its potential industrial impact."

Dr. Margarita Russina highlighted the crucial role of QENS in this study, stating: "With QENS, we can directly probe the molecular motion of H2 and D2 in MOFs, gaining key insights into their diffusion behavior and interactions with porous materials. The observed stronger confinement of D2 compared to H_2, a strictly nanoscale phenomenon, leads to remarkable effects on macroscopic properties, forming the basis for the development of a new generation of materials for more efficient isotope separation."

The research team, jointly led by Professor Hyunchul Oh from the Department of Chemistry at UNIST, Professor Jaheon Kim from Soongsil University, Dr. Jitae Park from Heinz Maier Leibnitz Zentrum (MLZ) at Technical University of Munich (TUM), and Dr. Margarita Russina from Helmholtz-Zentrum Berlin für Materialien und Energie (HZB) in Berlin, Germany announced this advancement on March 19, 2025. The study also involved Minji Jung, Jaewoo Park, and Raeesh Muhammad from the Department of Chemistry at UNIST, who served as co-first authors. The findings of this research have been published in Nature Communications on February 27, 2025. This study was supported by the National Research Foundation (NRF) of Korea and the Ministry of Science and ICT (MSIT), and the Institut Laue-Langevin (ILL) in Grenoble, France for the allocation of beam time.

Science Daily, 19 March 2025

https://sciencedaily.com

Peptide screening reveals irreversible inhibitors for cancer's 'undruggable' cJun protein

2025-03-20

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Now, researchers from the University of Bath have for the first time detailed an approach to discover peptides that bind selectively and irreversibly within cells, permanently blocking a transcription factor that drives cancer known as cJun.

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Phys Org, 20 March 2025

https://phys.org

Recycled cements drive down emissions without slacking on strength

2025-03-20

Giving a second life to construction materials after demolition, engineers at the University of São Paulo and Princeton have developed an approach for recycling cement waste into a sustainable, low-carbon alternative that is comparable in performance to the industry standard.

In addition to lowering the carbon intensity of the cement and concrete industry, the process could enable new uses for construction and demolition waste, of which concrete is a significant component. In 2018 in the United States, the total amount of construction and demolition waste was more than twice that of household waste.

"Construction waste typically ends up either in a landfill, or, if it's recycled, will be used in low-grade applications such as in pavements or in soils," said research leader Sérgio Angulo, a professor of Civil and Urban Construction Engineering at the University of São Paulo. "It's exciting to show that we can, in fact, recycle this recovered cement waste into a high-quality application."

In their paper, published in ACS Sustainable Chemistry & Engineering, the researchers demonstrated that mixtures containing up to 80% of this recycled cement were just as strong as conventional Portland cement by itself while generating a fraction of the carbon emissions. Portland

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cement is the most common binder used to create concrete, but its high carbon intensity is the main reason the cement and concrete industry is responsible for around 8% of global emissions.

If fully realized and deployed in coordination with other emerging technologies that replace cement, the researchers estimated that emissions from the cement industry could be cut by up to 61%. The estimated reductions blow past the 9% emissions cuts that the Global Cement and Concrete Association projected to be possible with so-called clinker replacement approaches.

"The leap forward here is that you can now get short- and long-term properties that are essentially the same as Portland cement by itself with a low-carbon alternative overwhelmingly composed of recycled materials," said co-author Claire White, a professor of civil and environmental engineering and the Andlinger Center for Energy and the Environment.

A comparison of recycled cement by itself (left), ordinary Portland cement (middle), and the researchers' optimized blend of recycled cement and finely ground Portland cement (right), before the addition of water. The optimized cement blend demonstrates similar water requirements, strength gain, and workability to ordinary Portland cement while generating a fraction of the carbon emissions. (Photo courtesy of first author Mateus Zanovello, a Ph.D. student working with Angulo at the University of São Paulo).

Enabling circular cements

At the core of the recycling approach is heat.

After pulverizing or crushing concrete into a fine powder -- the researchers estimated that of the five gigatons of concrete waste produced annually, around one gigaton of this powder could be recovered by the industry -- the team heated it to 500 °C. This temperature was high enough to dehydrate the cement powder and restore its properties as a binder but low enough to prevent the decomposition of carbonate components in the material, which would lead to additional carbon dioxide emissions.

While this 'thermoactivated' cement could be used on its own to make concrete, the researchers found that its high surface area and water demand during the mixing process led to a final material with high porosity and diminished strength. But by combining the recycled cement with small amounts of finely ground Portland cement or limestone, the

resulting cement binder demonstrated strength gains and workability on par with industry standards.

The strength gain occurs because the finely ground Portland cement or limestone fills the pores in the recycled cement with a material other than water, reducing the overall water demand and even forming new products after the mixing process, called hydration products, that increase the material's strength.

"Previously, if you only used thermoactivated recycled cement, it didn't perform well enough to be an acceptable replacement," White said. "But by lowering the surface area and optimizing the packing of particles in the material's microstructure, we get something that behaves quite comparably to Portland cement."

A comparison of recycled cement by itself (left), ordinary Portland cement (middle), and the researchers' optimized blend of recycled cement and finely ground Portland cement (right), after the addition of water. (Photo courtesy of Mateus Zanovello).

Since the process repurposes construction waste, the researchers said the process could move the world toward a more circular carbon economy while generating fewer carbon emissions than other emerging low-carbon cement alternatives. In the paper, for instance, the team estimates their cement emits between 198 to 320 kilograms of carbon dioxide per metric ton, up to 40% fewer emissions than a commercially available low-carbon alternative known as limestone calcined clay cement (LC3).

"With this technology, you could imagine cities becoming much more circular than today," Angulo said. "Materials from demolished infrastructure can be directly used in new building projects."

Despite such benefits, Angulo and White noted several technological, economic, and policy hurdles to the technology's wide-scale deployment.

For instance, they explained that scaling the recycled cement would require a better approach for sorting and processing demolition waste, one that considers circularity rather than the landfill. The technology would also be most practical in mature cities with a reliable supply of aging building stock instead of rapidly developing areas with primarily new buildings.

Lastly, building codes developed when Portland cement was the dominant binder for concrete production would need to be updated, moving away from 'recipe-based' standards that specify certain cement compositions to

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ones that instead focus on performance-based requirements. Angulo said that several countries in Europe and Latin America have already begun to adopt such performance-based standards, which could permit the use of not just the recycled cements he studies but also a wide array of low-carbon alternatives.

"In Brazil, we are already beginning to implement performance-based standards for non-structural building envelopes and floors," said Angulo. "Updating construction codes is important for allowing innovation in the building sector."

Laying the foundations for an ongoing collaboration

The work on recycled cements results from a collaboration formed when Angulo came to Princeton as a visiting researcher in White's group for a year, beginning in 2023.

Both researchers said that the collaboration -- which has been ongoing even after Angulo's return to Brazil -- unlocked new research capabilities and perspectives that have improved their groups' work.

For Angulo, tapping into White's expertise in characterization techniques such as total X-ray scattering has helped him to better understand the driving mechanisms behind the materials he studies. For example, White and Angulo performed experiments during Angulo's visit that will help them better understand how the atomic structure of the material changes as it undergoes thermal activation. This will help them answer questions about the durability of the recycled cement over multiple cycles of use and whether it is truly a 'circular' material.

For White, the collaboration allowed her to work on a class of cements that she had previously never studied, despite her extensive background in low-carbon concrete. Even beyond the recycled cement project, White said that Angulo's visit provided her group with a totally new perspective on many of their projects, even those that appear far-removed from the world of recycled cements.

"This collaboration has had benefits in both directions," White said. "Sergio's brought his domain knowledge, my group has brought our expertise in advanced characterization techniques, and together, we've been able to tackle some of the biggest challenges about this material."

Science Daily, 20 March 2025

https://sciencedaily.com

Technical Notes

MAR. 21, 2025

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

CHEMICAL EFFECTS

Nickel-based nanomaterials: a comprehensive analysis of risk assessment, toxicity mechanisms, and future strategies for health risk prevention

Prediction of acute toxicity of organic contaminants to fish: Model development and a novel approach to identify reactive substructures

Ammonia-rich sediment: Practical issues about embryotoxicity as endpoint supporting challenges in dredging activities

ENVIRONMENTAL RESEARCH

Environmental low-dose nanosized carbon black exposure aggravates lung fibrosis-induced by radiation in vivo and in vitro

PHARMACEUTICAL/TOXICOLOGY

Maternal di(2-ethylhexyl) phthalate exposure increases the risk of congenital heart disease in mice offspring

Exploring the Activation of the Keap1-Nrf2-ARE Pathway by PAHs in Children's Toys

Dissociation-dependent kinetics and distinct pathways for direct photolysis and •OH/SO4•- radical dominated photodegradation of ionizable antiviral drugs in aquatic systems

Fractional exhaled nitric oxide (FeNO) among elementary school children in Stockholm: Associations with asthma, allergies, and home and school environment

OCCUPATIONAL

Long-term exposure to low-level crystalline silica and risk assessment of silicosis: a cohort study

Gender-specific effects of prenatal polystyrene nanoparticle exposure on offspring lung development