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Regulatory Update

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ASIA PACIFIC

China's Air Pollution Controls Sped Up Global Warming, Study Suggests

2025-04-23

Cutting lung-damaging—but planet-cooling—sulphur pollution from China's coal plants, industry, and vehicle exhaust over the past 15 to 20 years has driven much of the faster global warming seen since 2010, finds new research from Norway's CICERO climate institute.

The cleanup likely added about 0.07°C to global temperatures—possibly as little as 0.02°C or as much as 0.12°C, researchers estimate in a paper now awaiting peer review.

Prompted by public outcry against lethal levels of air pollution, China began to crack down on sulphur dioxide (SO_2) emissions in the mid-2000s, ultimately cutting them by 75%.

It was excellent news from a public health perspective, but the reductions also sped up the rate of warming, since SO_2 turns into sulphate aerosols in the atmosphere—and these aerosols help cool the Earth by reflecting sunlight away from the planet.

The cooling effect is two-fold: aerosols are highly reflective, radiating sunlight back into space, and they also encourage formation of long-lived, brighter, more reflective clouds.

While atmospheric cooling through sulphate aerosols might seem like relief, it is misleading. In their presence, the full extent of human-caused global heating was masked. Without them, it is now revealed.

"The warming was always there, we just had some artificial cooling from pollution, and in removing the pollution we are now seeing the full effect of the greenhouse gas-driven warming," lead author Bjørn Samset told the New Scientist.

Read More

Energy Mix, 23-04-25

https://www.theenergymix.com/chinas-air-pollution-controls-sped-up-global-warming-study-suggests/

India May Introduce Mandatory BIS Certification for Cosmetics: What Global Brands Need to Know

2025-04-23

India is poised to tighten quality control in its rapidly expanding beauty and personal care (BPC) market. According to a recent Economic Times report, the Indian government is considering adding cosmetics to the list of products requiring mandatory certification by the Bureau of Indian Standards (BIS). If implemented, this move will apply to both domestically manufactured and imported cosmetic products.

Why Is India Pushing for BIS Certification in Cosmetics?

India's BPC industry has experienced significant growth, expanding from USD 21 billion to USD 34 billion in recent years. With projections indicating continued expansion through 2028, India is now one of the fastest-growing cosmetic markets in the world. However, the influx of substandard, low-cost products, particularly through imports, has raised serious concerns about consumer safety and product quality.

To mitigate these risks and improve market standards, the Indian government aims to implement BIS certification as a mandatory quality assurance measure. This shift is expected to boost consumer confidence and elevate the overall competitiveness of the Indian cosmetics sector.

Read More

REACH24, 23-04-25

https://www.reach24h.com/en/news/india-may-introduce-mandatory-bis-certification-for-cosmetics.html

AMERICA

FDA asks food industry to phase out artificial dyes

2025-04-22

- The FDA on Tuesday requested the food industry to phase out petroleum-based artificial dyes used in everything from sports drinks and yogurt to candy and fruit snacks.
- The agency, alongside the Department of Health and Human Services, said food companies should voluntarily remove six synthetic dyes by the end of next year. These include Green No. 3, Red No. 40, Yellow No. 5, Yellow No. 6, Blue No. 1 and Blue No. 2. The FDA is also requesting food companies remove Red. No. 3 sooner than the 2027 requirement.
- The FDA said it will revoke authorization for synthetic food colorings Citrus Red No. 2 and Orange B "within the coming months," according to an announcement. The agency intends to encourage the use of natural alternatives among food companies and is accelerating approval of at least four natural color additives during the next few weeks.

Read More

Food Dive, 22-04-25

https://www.fooddive.com/news/rfk-food-phase-out-artificial-dyes-synthetic-colors/746071/

Canada Federal Plastics Registry

2025-03-07

The Federal Plastics Registry (FPR) collects data from companies across the plastics value chain to help monitor and track plastic from the time it is produced up to its end of life. By better tracking plastic through its full life cycle, Canada is better equipped to address plastic waste and pollution through increased transparency and sound, robust, evidence-based decision-making.

About the FPR

The FPR requires companies (including resin manufacturers, service providers, generators of waste, and producers of plastic products) to report annually on the quantity and types of plastic they manufacture, import, and place on the market. Producers of plastic products and service providers are also required to report on the quantity of plastic collected and diverted, reused, repaired, remanufactured, refurbished, recycled, processed into chemicals, composted, incinerated, and landfilled. They are also required to report on the amount of plastic waste generated on their industrial, commercial, and institutional premises.

The FPR provides Canadians, including innovators and decision-makers, with reliable data that will identify opportunities for further action to reduce plastic waste and pollution, as well as help monitor progress over time.

In Canada, the responsibility for managing waste is shared among the federal, provincial, territorial, and municipal governments. As part of their

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responsibilities, provinces and territories develop and expand extended producer-responsibility programs to make producers responsible for managing their products at their end-of-life. While extended producer responsibility plays an important role in building a circular plastics economy, reporting requirements are inconsistent across Canada due to different definitions, calculations, and indicators of success.

That's why the Canada-wide Action Plan on Zero Plastic Waste committed federal, provincial, and territorial governments to developing and maintaining Canada-wide data on how plastic moves through the economy. The FPR will help address these needs by providing accessible, consistent and robust plastic data. This information will go beyond plastic packaging and other plastic categories currently captured through domestic extended producer-responsibility programs.

Read More

Government of Canada, 07-03-25

https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/reduce-plastic-waste/federal-plastics-registry.html

The Advanced Clean Trucks rule saves lives, so why is Congress trying to axe it?

2025-04-23

Diesel trucks and other diesel-fueled equipment are significant sources of particulate matter, including fine particulate matter (PM2.5) – a dangerous air pollutant that is small enough to penetrate deep into the lungs and bloodstream. There is "no safe threshold under which exposure to ambient PM has no adverse health effects," and both short- and long-term exposure to PM2.5 lead to a variety of harmful health effects.

Short term spikes in PM2.5 are linked to increased mortality in infants, increased hospital admissions and emergency department visits for heart attacks, strokes, and chronic obstructive pulmonary disease, and increased severity of asthma attacks and hospitalization for asthma among children. The effects of long-term exposure to PM2.5 are even more severe, resulting in higher risk of premature death from heart disease, stroke, influenza, pneumonia, and lung cancer. More recent research also links long-term

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exposure to PM2.5 to death from chronic kidney disease, hypertension, and dementia.

Read More

Clean Air Task Force, 23-04-25

https://www.catf.us/2025/04/advanced-clean-trucks-rule-saves-lives-why-congress-trying-axe-it/

Trump administration pauses new mine safety regulation – here's how those rules benefit companies as well as workers

2025-04-23

President Donald Trump's administration has announced its intention to pause or reverse regulations on mine safety, saying it wants to loosen rules that constrain companies. But as a scholar of both engineering and public policy, with a focus on the risk of exposures to air pollutants and other safety issues, I have seen how safety regulations are designed to benefit not only workers but also companies and the public as a whole.

Federal laws and other regulations require that rules written by federal agencies use scientific evidence about how to minimize risk. And under an executive order signed by President Bill Clinton in 1993 that is still in effect, regulations must be evaluated to make sure they produce more economic benefit for the nation than they cost.

This is not a simple or quick process. Let's look at one rule as an example of how this plays out, and how the democratic process of scientific study, public debate and comment helps regulators arrive at a rule that balances the needs and interests of workers, companies and the public.

Read More

The Conversation, 23-04-25

https://theconversation.com/trump-administration-pauses-new-mine-safety-regulation-heres-how-those-rules-benefit-companies-as-well-as-workers-254178

Building an Environmental Regulatory System that Delivers for America

2025-04-23

The Clean Air Act. The Clean Water Act. The National Environmental Policy Act. These and most of our nation's other foundational environmental laws were passed decades ago – and they have started to show their age. The Clean Air Act, for instance, was written to cut air pollution, not to drive the whole-of-economy response that the climate crisis now warrants. The Energy Policy and Conservation Act of 1975 was designed to make cars more efficient in a pre-electric vehicle era, and now puts the Department of Transportation in the awkward position of setting fuel economy standards in an era when more and more cars don't burn gas.

Trying to manage today's problems with yesterday's laws results in government by kludge. Legacy regulatory architecture has foundered under a patchwork of legislative amendments and administrative procedures designed to bridge the gap between past needs and present realities. Meanwhile, Congressional dysfunction has made purpose-built updates exceptionally difficult to land. The Inflation Reduction Act, for example, was mostly designed to move money rather than rethink foundational statutes or regulatory processes – because those rethinks couldn't make it past the filibuster.

As the efficacy of environmental laws has waned, so has their durability. What was once a broadly shared goal – protecting Americans from environmental harm – is now a political football, with rules that whipsaw back and forth depending on who's in charge.

Read More

Federation of American Scientists, 23-04-25

https://fas.org/publication/building-an-environmental-regulatory-system-that-delivers-for-america

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EUROPE

Too little, too late: EU chemical reforms threaten to roll back public health protections

2025-04-23

The European Commission's new plan to overhaul the EU's main chemical regulation, REACH, risks undoing two decades of progress in protecting people and nature from toxic substances.

On 3 April, the Commission presented proposed changes to EU Member State representatives at the 54th CARACAL meeting, calling them a 'simplification' of EU chemicals law. However, the draft reforms would introduce more red tape, delay action on dangerous substances, and closely reflect the demands of the chemical industry lobby.

Dolores Romano, Policy Manager for Chemicals at the European Environmental Bureau (EEB), said: "The Commission's proposal is not only long overdue after decades of inaction, but also too little and in the wrong direction. The science on chemical harm has been clear for decades. Instead of finally delivering what was promised in REACH, the Commission is now proposing changes that favour industry convenience over public safety. This is a deeply worrying contradiction."

The European Commission's recent endorsement of the Antwerp Declaration, a document backed by Europe's most polluting industries, as a sign that economic interests are being prioritised over the EU's European Green Deal's Chemicals Strategy for Sustainability.

"The Commission appears willing to trade long-term public health for short-term economic gain and reduced compliance costs for chemical producers," Romano added.

One of the clearest signs of regulatory backsliding is the overlap between the Commission's proposals and the industry's 10-point plan to "simplify REACH". In recent advertising campaigns across Brussels, CEFIC claims to support the European Green Deal. But a close analysis reveals the plan is a thinly veiled deregulation agenda.

Read More

European Environmental Bureau, 23-04-25

https://eeb.org/too-little-too-late-eu-chemical-reforms-threaten-to-roll-back-public-health-protections/

PFAS: chemicals ban to apply to toys

2025-04-23

Toy manufacturers will be subject to a "limited ban on intentional use" of per- and polyfluoroalkyl substances (PFAS) in the making of their products and components, under a deal reached by EU law makers.

Earlier this month, the European Parliament and Council of Ministers announced that they had reached provisional agreement over a proposed new EU toy safety regulation.

The draft legislative text reflecting the provisional agreement is yet to be published, but the Parliament has stated that new rules banning the intended use of PFAS and "the most dangerous types of bisphenols" have been agreed on at its "insistence".

Earlier in the legislative process, MEPs adopted proposals that included provisions prohibiting use of PFAS and bisphenols in toys, components of toys or micro-structurally distinct parts of toys. Those proposals envisaged limited exceptions to the PFAS ban. Those exceptions included batteries in toys and "toy components necessary for electronic or electric functions of the toy where the substance or mixture is fully inaccessible to children", when the toy is used as it is intended or in a foreseeable way.

Whilst the exact terms of the prohibition on PFAS remain unclear, in announcing the deal the Council said the agreed text introduces "a limited ban on the intentional use of PFAS in toys". This appears to suggest a more nuanced approach to a prohibition has been agreed than the more radical ban suggested by MEPs. The Council also said there will be "exemptions for toy components necessary for electronic or electric functions of the toy where the substance or mixture is fully inaccessible to children".

Read More

Pinsent Masons, 23-04-25

https://www.pinsentmasons.com/out-law/news/pfas-chemicals-ban-toys

'Alarming' increase in levels of forever chemical TFA found in European wines

2025-04-23

Levels of a little-known forever chemical known as TFA in European wines have risen "alarmingly" in recent decades, according to analysis, prompting fears that contamination will breach a planetary boundary.

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Researchers from Pesticide Action Network Europe tested 49 bottles of commercial wine to see how TFA contamination in food and drink had progressed. They found levels of trifluoroacetic acid (TFA), a breakdown product of long-lasting Pfas chemicals that carries possible fertility risks, far above those previously measured in water.

Wines produced before 1988 showed no trace of TFA, the researchers found, but those after 2010 showed a steep rise in contamination. Organic and conventional wines showed a rise in TFA contamination, but levels in organic varieties tended to be lower.

"The wines that contained the highest concentration of TFA, on average, were also the wines we found with the highest amount of pesticide residue," said Salomé Roynel from Pesticide Action Network Europe, which has called on the European Commission and EU member states to ban Pfas pesticides.

The researchers used 10 Austrian cellar wines from as early as 1974 – before policy changes they suspect led to the widespread use of precursor chemicals to TFA – as well as 16 wines bought in Austrian supermarkets from vintages between 2021 and 2024.

Read More

The Guardian, 23-04-25

https://www.theguardian.com/environment/2025/apr/23/alarming-increase-forever-chemical-tfa-european-wines

Public consultation: new GB PPP active substance

2025-04-22

There is a call for comments on the first GB approval of a new active substance.

HSE has received a dossier from CEV SA for the following active substance/ uses:

- **Aqueous extract from the germinated seeds of sweet Lupinus albus**

Fungicide active substance for use in plant protection products against botrytis grey mould and powdery mildew on strawberry and tomato

This is the first application for approval of this substance in GB under the assimilated Regulation No 1107/2009. The assessment was performed by HSE's Chemicals Regulation Division.

Have your say

Any interested third parties are invited to comment on the content and conclusions of the Draft Assessment Report (DAR) or share any relevant information. Comments can be submitted by any member of the public or interested party.

The deadline for receiving comments is 21 June 2025.

View the consultation details and submit your response.

Read More

UK HSE, 22-04-25

https://consultations.hse.gov.uk/crd-ppp/ppp-nas-007-aqueous-sweet-lupin/

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Project to identify methodologies for biodegradation tests

2025-04-23

We have contracted Fraunhofer Gesellschaft and Technical University of Denmark to work on identifying methodologies for biodegradation tests of difficult-to-test substances that can be used for regulatory decision-making.

The outcome of the project will be used to develop guidance for the degradation testing of difficult-to-test substances.

Read More

ECHA, 23-04-25

https://echa.europa.eu/-/framework-contracts-for-scientific-and-technical-support-work-related-to-hazard-assessment-and-identification-including-regulatory-support-of-work-on-clp-dossier-and-substance-evaluation-pops-dwd-and-future-tasks-under-certain-water-protection-directives#msdynttrid=X3lcPlu0i2243RGYkGXYl-lxezgaLQ1lBxYX88gFePE

Janet's Corner

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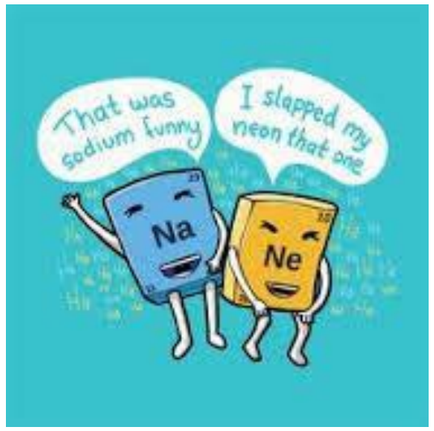
Sodium Funny

2025-05-05



https://www.pinterest.com

Hazard Alert

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Methyl Isocyanate

2025-05-05

USES [2,3]

Methyl isocyanate is used in the chemical industry to produce a number of important chemicals. It is also involved in the manufacture of synthetic rubbers, adhesives, herbicides and pesticides.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Methyl isocyanate has been found in the smoke from tobacco, so people who smoke or breathe second-hand smoke may be exposed to this compound.
- You can be exposed to methyl isocyanate by breathing or touching it at workplaces where this compound is produced or used.
- People living near facilities, which manufacture, store or use the chemical may breathe in low levels of it.

Routes of Exposure

- **Inhalation:** Inhalation is the major route of exposure to methyl isocyanate. The vapours are readily absorbed through the lungs. The odour threshold is approximately 100 to 250 times higher than the OSHA PEL-TWA (0.02 ppm). Significant exposures to methyl isocyanate occur primarily in occupational settings.
- **Skin/Eye Contact:** Direct contact with liquid or concentrated vapours of methyl isocyanate. This would not likely occur outside an occupational environment in which methyl isocyanate is stored or used.
- **Ingestion:** Although unlikely, ingestion of liquid methyl isocyanate is a possible route of exposure.

HEALTH EFFECTS [4]

Acute Health Effects

- In 1984, in Bhopal, India, an accidental Union Carbide gas leak of methyl isocyanate resulted in the deaths of more than 2,000 people and adverse health effects in greater than 170,000 survivors. Pulmonary oedema was the cause of death in most cases, with

Methyl Isocyanate (MIC) is an organic compound with the molecular formula CH3NCO. It is also known as isocyana-tomethane, methyl carbylamine, and MIC.

many deaths resulting from secondary respiratory infections such as bronchitis and bronchial pneumonia.

- Other effects noted from acute inhalation exposure to methyl isocyanate in humans are respiratory tract irritation, difficulty breathing, blindness, nausea, gastritis, sweating, fever, chills, and liver and kidney damage. Survivors continue to exhibit damage to the lungs (e.g., bronchoalveolar lesions and decreased lung function) and the eyes (e.g., loss of vision, loss of visual acuity, and cataracts).
- Animal studies have reported pulmonary oedema, upper respiratory tract irritation, respiratory lesions, and weight loss from acute inhalation exposure to methyl isocyanate.
- Acute animal tests in rats have shown methyl isocyanate to have extreme acute toxicity from inhalation exposure and high acute toxicity from oral exposure.

Carcinogenicity

- No information is available on the carcinogenic effects of methyl isocyanate in humans.
- In a study in which animals were exposed once by inhalation, no tumours were significantly associated with methyl isocyanate exposure in mice and female rats; male rats had marginally increased rates of tumours of the pancreas.
- EPA has classified methyl isocyanate as a Group D, not classifiable as to human carcinogenicity.

Other Effects

- No information is available on the chronic (long-term) effects of methyl isocyanate in humans or animals.
- EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for methyl isocyanate.
- CalEPA has calculated a chronic inhalation reference exposure level of 0.001 milligrams per cubic meter (mg/m3) based on lung and body weight effects in rats.

SAFETY

First Aid Measures [5]

Respiratory distress/asthma: If the person is experiencing difficulty in breathing, the following steps should be followed as this condition may develop rapidly into a life-threatening situation:

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- Remove the patient from the contaminated area and give them oxygen.
- If breathing has stopped, initiate artificial respiration.
- If first aid or nursing personnel are present and have received appropriate training, they may administer a bronchodilating drug such as salbutamol by nebuliser.
- Seek medical attention urgently.

Splashes of isocyanate into eyes: Gently irrigate the eyes with a continuous stream of tepid water for at least 15 minutes. If contact lenses are worn, then irrigate the eyes thoroughly for a few minutes, remove the contact lenses and then continue with further eye irrigation. Refer the patient to a doctor or hospital.

Splashes onto skin: Remove contaminated clothing. Wash skin thoroughly with soap and water. Solvents, for example, methylene chloride, should not be used to remove isocyanates or polyurethane from the skin. Clothing should not be re-used until it has been decontaminated.

Workplace Controls & Practices [4]

Where there is a likelihood of worker exposure to isocyanates, steps should be taken to minimise that exposure. A thorough examination of work practices is essential. Procedures should be adopted to ensure that workers are not exposed to an extent likely to cause adverse health effects. Control measures include, but are not limited to, the following, which are ranked in priority of their effectiveness:

- elimination/substitution and process modification;
- engineering controls;
- administrative controls; and
- use of personal protective equipment.

Personal Protective Equipment [5]

In certain circumstances, personal protection of the individual employee is necessary. Personal protective devices should be regarded as being supplementary to substitution and engineering control and should not be used in preference to them as they do nothing to eliminate the hazard. However, in some situations, minimising exposure to isocyanates by enclosure and ventilation is not possible, particularly during on-site mixing of paints, spray-painting, foaming and maintenance of machine and ventilation systems. In these situations, air-line respirators or self-

contained breathing apparatus complying with Australian Standard AS 1716 must be

used. The selection, use and maintenance of personal respiratory protective devices should be in accordance with the requirements of Australian Standard AS 1715. Organic vapour respirators with particulate pre-filters and powered, air-purifying respirators are not suitable. Personal protective equipment must be appropriately selected, individually fitted and workers trained in their correct use and maintenance. Personal protective equipment must be regularly checked and maintained to ensure that the worker is being protected. Air-line respirators or self-contained breathing apparatus complying with Australian Standard AS 1716 should be used during the clean-up of spills and the repair or clean-up of contaminated equipment and similar situations which cause emergency exposures to hazardous atmospheric concentrations of isocyanate. Eye and skin contact with isocyanates should be avoided. Particular attention should be given to personal protective equipment being resistant to isocyanates, for example, teflon, viton, nitrile rubber and some PVA gloves. Protective gloves and overalls should be worn as specified in Australian Standard AS 2161. Contaminated garments should be removed promptly and should not be re-used until they have been decontaminated.

REGULATION

United States

OSHA: The United States Occupational Safety & Health Administration has set the following Permissible Exposure Limit (PEL) for methyl isocyanate:

- General Industry: 0.02 ppm, 0.05 mg/m3 (Skin)
- Construction Industry: 0.02 ppm, 0.05 mg/m3 TWA (Skin)

ACGIH: The American Conference of Governmental Industrial Hygienists set a Threshold Limit Value (TLV) for methyl isocyanate of 0.02 ppm, 0.047 mg/m3 TWA (Skin)

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL)for methyl isocyanate of 0.02 ppm TWA (Skin)

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Opioids and Animal Sedatives Detected in Australian Wastewater

2025-04-29

University of South Australia scientists have developed a highly sensitive method to detect illegal opioids and a veterinary sedative in Australia's wastewater system, providing a vital early warning tool to public health authorities.

A new study published in Environmental Science and Pollution Research, funded by the Australian Criminal Intelligence Commission and Preventative Health SA, explains the innovative wastewater-based testing method capable of identifying trace levels of nitazenes – a class of highly potent synthetic opioids – and xylazine, an animal sedative not approved for human use.

Nitazenes are among the most dangerous opioids ever synthesised, up to 1000 times more potent than morphine. Initially developed in the 1950s but never approved for clinical use, these substances have recently emerged in the illicit drug supply worldwide. Their extreme potency poses a significant risk of overdose, often with fatal consequences.

Xylazine, commonly used in veterinary medicine, is often added to illicit opioids such as fentanyl and heroin. It complicates overdose treatment because its effects cannot be reversed with naloxone, the standard emergency antidote for opioid toxicity. Moreover, xylazine use is associated with severe health impacts including sedation, respiratory depression, hypotension, and dangerous skin ulcerations.

"This is the first time a comprehensive suite of nitazene compounds and xylazine has been monitored in Australian wastewater," says lead researcher UniSA Associate Professor Cobus Gerber.

"Our method can detect even minute levels, allowing us to track emerging threats before they escalate," he says.

Over a three-day period in August 2024, researchers analysed 180 wastewater samples from 60 sites around Australia. They identified five different nitazenes in 3–6% of all samples. Alarmingly, xylazine was detected in 26% of all samples.

"Given the potency of nitazenes and the health complications associated with xylazine, even low-level detections are a red flag," says co-first author Dr Emma Keller.

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The research team developed a laboratory method using solid phase extraction and liquid chromatography–mass spectrometry (LC-MS/MS) to concentrate and identify target compounds. The method achieved up to 1000-fold enrichment, with limits of detection well below 1 ng/L for most substances.

Crucially, the method is adaptable and can be quickly updated to detect new derivatives as they emerge – an essential capability as drug manufacturers continue to tweak chemical structures to evade legislation.

"This analytical platform enhances Australia's capacity to monitor and respond to the shifting landscape of illicit drug use," says Assoc Prof Gerber. "It complements forensic analysis and can provide near real-time data to inform public health strategies."

The results underscore the growing presence of harmful and often unsuspected substances in street-level drugs. In the United States, xylazine has already been detected in over 80% of fentanyl-containing paraphernalia and is implicated in an increasing number of overdose deaths.

"With similar patterns now being detected in Australia and nitazenes also infiltrating the stimulant market, there's an urgent need to raise awareness and strengthen harm reduction responses," Assoc Prof Gerber says.

Technology Networks, 29 April 2025

https://technologynetworks.com

Major Breakthrough: Non-Toxic Alternative to "Forever Chemicals" Discovered

2025-04-23

Scientists have developed a non-toxic alternative to harmful PFAS chemicals using carbon and hydrogen-based compounds, offering a safer solution for products that currently rely on fluorine.

An international team of scientists has developed a safer alternative to PFAS (perfluoroalkyl substances), a group of synthetic chemicals commonly used in everyday products for their water- and stain-resistant properties, but known to be harmful to both human health and the environment.

Until recently, fluorine, an essential component in PFAS, was thought to be irreplaceable due to its unique ability to create strong, water-repellent

barriers. Its exceptional performance stems from its small size and high electronegativity, which allow it to form tight, durable molecular structures.

However, researchers from the University of Bristol (UK), Hirosaki University (Japan), and Université Côte d'Azur (France) have discovered that fluorine's distinct "bulky" spatial characteristics, which help it occupy molecular space so effectively, can be mimicked using a non-toxic alternative. This breakthrough could pave the way for safer, environmentally friendly materials that perform similarly to traditional PFAS without the associated risks.

Co-lead author Professor Julian Eastoe, from the University of Bristol's School of Chemistry, said: "From fire-fighting foam to furniture, food packaging and cookware, to make-up and toilet tissue, PFAS products are everywhere. Despite the risks to human health, and the fact they don't degrade, perfluoroalkyl substances persist in the environment, finding an alternative with comparable properties has proven elusive. But after many years of intensive research, we've made a great breakthrough."

How the New Substitutes Work

The results of their discovery are published in a study, which unpacks the chemical structure of PFAS and pinpoints the characteristic 'bulkiness' they sought to replicate in a safer form. It also demonstrates how non-fluorinated components, containing only non-toxic carbon and hydrogen, could be equally effective replacements.

Prof Eastoe said: "Through extensive experimentation, it turns out these 'bulky' fragments feature in other common chemical systems like fats and fuels. So we took those principles and created modified chemicals, which have these positive attributes and are also much safer.

"Using our specialized laboratories for chemical synthesis, we substituted the fluorine in PFAS with certain groups containing only carbon and hydrogen. The whole process has taken about 10 years and the implications are very significant not least because PFAS is used in so many different products and situations."

The researchers now plan on using these principles discovered in the lab to design commercially viable versions of PFAS substitutes.

Co-author Professor Frédéric Guittard, from the Université Côte d'Azur, Nice said: "These new results are of great interest for industrial and

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academic researchers. We are now working with companies in France and China to bring these ideas to market."

Sci Tech Daily, 23 April 2025

https://website

~Chemical recycling turns used silicones into pure building blocks, promising infinite reuset

2025-04-24

A study conducted by CNRS researchers describes a new method of recycling silicone waste (caulk, sealants, gels, adhesives, cosmetics, etc.). It has the potential to significantly reduce the sector's environmental impacts.

This is the first universal recycling process that brings any type of used silicone material back to an earlier state in its life cycle where each molecule has only one silicon atom. And there is no need for the raw materials currently used to design new silicones. Moreover, since it is chemical and not mechanical recycling, the reuse of the material can be carried out infinitely.

The associated study is published in Science.

The raw material used to make silicones is naturally occurring quartz. Its constituents are decomposed using metallurgy at high temperature to obtain pure silicon. That then reacts with methyl chloride to form chlorosilanes, molecules essential to all silicone-based polymers.

These first two transformations are very energy intensive and emit CO2, the main greenhouse gas causing climate change.

Consequently, this new recycling technique would make it possible to circumvent one of the most harmful impacts of the silicone sector. Moreover, as this chemical recycling process gives direct access to (methyl)chlorosilanes, which can be separated and purified industrially, it guarantees the quality of silicone materials from recycling, and can do that infinitely without loss of properties.

At a time when key chemical elements—and the associated mineral resources—are increasingly sought after, a recycling process like this also opens up a path to easing potential tensions around the crucial quartz resource, and the resulting silicon that is one of the key components used by the electronics industry.

Together with their scientific and industrial partners, the authors continue their research, both on improving this process to make it industrially applicable, and by proposing recycling methods for other stages of silicone processing. Finally, they are also working on recycling other materials to make their use more sustainable.

Phys Org, 24 April 2025

https://phys.org

The Chemistry Trick Poised to Slash Steel's Carbon Footprint

2025-04-18

Their process, which uses saltwater and iron oxide instead of carbon-heavy blast furnaces, has been optimized to work with naturally sourced materials. By identifying low-cost, porous iron oxides that dramatically boost efficiency, the team is laying the groundwork for large-scale, eco-friendly steel production. And with help from engineers and manufacturers, they're pushing this green tech closer to the real world.

A Greener Future for Steel Production

Chemists at the University of Oregon are moving closer to a cleaner way to produce iron for steelmaking, an industry that ranks among the largest sources of carbon emissions worldwide.

Last year, UO chemist Paul Kempler and his team introduced a method for making iron using electrochemistry. The process relies on a series of chemical reactions that convert saltwater and iron oxide into pure iron metal.

In their latest study, the researchers focused on improving the process by identifying which types of iron oxides make the reaction more cost-effective, an essential step toward scaling the method for industrial use.

"We actually have a chemical principle, a sort of guiding design rule, that will teach us how to identify low-cost iron oxides that we could use in these reactors," Kempler said.

The research was published on April 9 in ACS Energy Letters.

The Global Demand for Steel

Almost 2 billion metric tons of steel were produced worldwide in 2024, used in everything from buildings to cars to infrastructure. Currently, the

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most fossil fuel-intensive part of that process is turning iron ore — the oxidized form of iron that's found in nature — into pure iron metal.

Traditionally done in blast furnaces that send carbon dioxide into the atmosphere, Kempler's team is developing a different approach to iron production.

Iron Production With a Valuable Byproduct

Their process starts with saltwater and iron oxide, which are cheap and available, and transforms them into iron metal through a series of chemical reactions. Those reactions conveniently also produce chlorine, a commercially valuable byproduct.

When Kempler and his team began developing their process a few years ago, they started with small quantities of iron oxides from chemical supply companies.

Those materials worked well in lab tests. But they didn't reflect the kind of iron-rich materials found naturally, which have much more variation in composition and structure.

Working With Earth-Derived Materials

"So then a very natural next question was: What happens if you actually try to work with something which was dug out from the earth directly, without being extra purified, extra milled, and so on?" said Ana Konovalova, who co-led the project as a postdoctoral researcher in Kempler's lab.

As the team experimented with different kinds of iron oxides, it was clear that some worked much better than others. But the researchers weren't sure what was driving the difference in the amount of iron metal they could generate from different starting materials. Was it the size of the iron oxide particles? The composition of the material? The presence or absence of specific impurities?

Testing Particle Structure and Density

Konovalova and graduate student Andrew Goldman found creative ways to test certain variables while keeping others the same.

For example, they took iron oxide powder and made it into nanoparticles. They put some of the nanoparticles through a heat treatment that made them much denser and less porous.

"It solidifies into this same secondary nanoparticle shape, but there are no more primary particles observed inside. It's essentially the same material, just in different stages," Konovalova said.

Faster Reactions, Lower Costs

In lab tests, the difference was striking: "With the really porous particles, we can make iron really quickly on a small area," Goldman said. "The dense particles just can't achieve the same rate, so we're limited in how much iron we can make per square meter of electrodes."

That's a key insight for making the process work at an industrial scale, where success often comes down to economics.

Large-scale electrochemical plants are expensive to build, and that cost scales with electrode area. To make it economically viable, the electrodes need to be able to generate enough product quickly enough to pay off the initial investment. The faster rate of reaction of the porous particles means the initial capital cost can be recouped faster, translating into a lower final cost for the iron product, ideally low enough to be competitive with conventional methods.

Surface Area Is the Secret Ingredient

The takeaway isn't that these specific nanoparticles are needed to make the electrochemical process work well, Kempler said. Rather, the study suggests that the surface area of the starting materials really matters. The porous nanoparticles had much more surface area for the reaction to take place, making the reaction run faster. Other iron oxides with a porous structure could also be cost-effective.

"The goal is to find something that's abundant, cheap and that's going to have a smaller environmental impact than the alternative," Kempler said. "We won't be satisfied if we invent something that's more damaging than the main way that we make iron today."

Collaborating to Bring Innovation to Market

To take their process beyond the lab, Kempler's lab is working with researchers in other fields. A collaboration with civil engineers at Oregon State University is helping them better understand what's needed for the product to work in real-world applications. And collaboration with an electrode manufacturing company is helping them address the logistical and scientific challenges of scaling up an electrochemical process.

Rethinking Industry With Sustainability in Mind

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"I think what this work shows is that technology can meet the needs of an industrial society without being environmentally devastating," Goldman said. "We haven't solved all the problems yet, of course, but I think it's an example that serves as a nucleation point for a different way of thinking about what solutions look like. We can continue to have industry and technology and medicine, and we can do it in a way that's clean — and that's awesome!"

Sci Tech Daily, 18 April 2025

https://scitechdaily.com

Rapid lithium extraction eliminates use of acid and high heat, scientists report

2025-04-30

Lightweight lithium metal is a heavy-hitting critical mineral, serving as the key ingredient in the rechargeable batteries that power phones, laptops, electric vehicles and more. As ubiquitous as lithium is in modern technology, extracting the metal is complex and expensive. A new method, developed by researchers at Penn State and recently granted patent rights, enables high-efficiency lithium extraction -- in minutes, not hours -- using low temperatures and simple water-based leaching.

"Lithium powers the technologies that define our modern lives -- from smartphones to electric vehicles -- and has applications in grid energy storage, ceramics, glass, lubricants, and even medical and nuclear technologies," said Mohammad Rezaee, the Centennial Career Development Professor in Mining Engineering at Penn State, who led the team that published their approach in Chemical Engineering Journal. "But its extraction must also be environmentally Australia, Chile and China lead the world in lithium supplies, exporting to countries competing in increasingly advanced technologies that depend on the mineral. Chile and Argentina are responsible for 97% of lithium exports to the United States, which imports more than twice what it can extract from domestic resources despite housing millions of metric tons of lithium deposits. The issue is the time, financial cost and environmental impact of extracting lithium from the rocks where it naturally occurs, according to Rezaee.

Rezaee and his research group members, Chandima Hevapathiranage and Shihua Han, who are pursuing doctoral degrees in energy and mineral engineering, with the mining and mineral process engineering option, at Penn State, have a solution, though. With far less energy consumption and

fewer harsh chemicals than traditional methods, their acid-free approach can extract more than 99% of a rock's available lithium in minutes, compared to the hours of conventional extraction that produces roughly 96% of the available lithium.

"What makes this approach especially promising is its compatibility with existing industrial infrastructure," Rezaee said, explaining that the new process is designed with scalability and practicality in mind, and it does not require extreme heat or the use of acids. "It uses common materials like sodium hydroxide -- a common compound used in making soap and found in many household cleaners -- and water, and it operates at much lower temperatures than traditional techniques. That makes it not just cleaner and faster, but easier to implement at scale."

Conventional lithium extraction involves either coaxing rock ores into giving up the metal or evaporating ponds of lithium-rich brine. Evaporation requires significant amounts of water and takes too long to match industry demands. Directly extracting lithium from mined rocks is quicker than brine evaporation but involves heating the minerals to incredibly high temperatures of 1,110 degrees Celsius -- 2,300 degrees Fahrenheit -- and maintaining the temperature for two hours. This makes the lithium mineral porous and prepares the lithium to separate from the rock. In the next step, the porous mineral is treated with sulfuric acid and heated to 482 degrees Fahrenheit for two hours. Known as sulfuric acid baking, this step eventually dissolves much of the lithium. The resulting acidic lithium solution is then treated to neutralize the acid and purify the metal.responsible. Our research shows that we can extract lithium, and other critical minerals, more efficiently while drastically reducing energy use, greenhouse gas emissions and waste that's difficult to manage or dispose of."

"Each step of the conventional method, especially the high-temperature treatment, emits a substantial amount of carbon dioxide," Rezaee said, explaining that the sulfuric acid also poses environmental concerns and leaves hazardous byproducts. "The process requires significant equipment investment and has challenges for temperature control and energy recovery. Impurities lead to lithium loss, and the acidic lithium solution requires significant chemical consumption to become basic for final extraction."

When Rezaee and his team first considered improving this process, they realized they could eliminate the need for phase transformation -- the

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extreme heating and sulfuric acid baking that loosens lithium ions from the mineral.

"We used thermodynamic modeling to understand how the lithium-bearing minerals might interact with different chemical agents, and then validated those predictions through laboratory experiments," Rezaee said. "We found that mixing the lithium-containing mineral, called spodumene, with sodium hydroxide, at relatively low temperatures converts the mineral into lithium-bearing water-soluble phases."

They also investigated the use of microwave heating for this low temperature reaction -- similar to heating food in a microwave rather than an oven -- to cut the processing time to just minutes.

This reaction produces lithium sodium silicate, a compound that dissolves readily in room-temperature water. When water is added, the lithium leaches out in about a minute. Because the resulting solution is already basic, meaning non-acidic, it also eliminates the need for the chemical additions that conventional lithium extraction requires to shift from acidic to basic. The researchers can immediately add a compound that solidifies the lithium so that it can be easily collected.

According to Rezaee, the process can also work to extract lithium and two other critical minerals -- rubidium and cesium, which are used in electronics, quantum computing, solar panels, atomic clocks, satellite navigation systems, batteries and even as a rocket propellant -- from lepidolite, another rock ore. It can also extract lithium from clay sources. The team is now working toward scaling up their approach and refining the process for industrial application.

The Penn State College of Earth and Mineral Sciences supported this work through the George H. Deike, Jr. Research Award.

Science Daily, 30 April 2025

https://sciencedaily.com

Electrosynthesis of urea from flue gas achieves high efficiency with no ammonia byproducts

2025-05-02

Urea, with the formula CO(NH2)2, is a chemical compound that is widely used in a range of sectors, including manufacturing, agriculture and various industries. Conventionally, this compound is produced via a two-

step process that entails the synthesis of ammonia from nitrogen (N_2) and its subsequent reaction with carbon dioxide (CO_2).

This reaction occurs at high temperatures and under high pressure, leading to the formation of a compound called ammonium carbamate. This compound is then decomposed at lower pressures, which ultimately produces urea and water.

Traditional processes for producing urea are very energy intensive, meaning that to produce desired amounts of urea they consume a lot of electrical power. Over the past few years, some engineers have thus been trying to devise more energy-efficient strategies to synthesize urea.

One possible approach could be to directly synthesize urea from CO_2 and N_2 using electrolyzers, devices that utilize electricity to facilitate desired chemical reactions. So far, the use of these devices to synthesize urea has proved difficult, as unsought side reactions within the devices often produce other compounds instead.

Researchers at Sun Yat-Sen University in China recently introduced a new strategy to synthesize pure urea from pre-treated flue gas, a waste gas emitted from industrial processes, in a proton-limited environment attained using an electrolyzer that integrates a solid-state electrolyte. Their paper, published in Nature Nanotechnology, could open new valuable opportunities for the energy-efficient production of urea on a large scale.

"The electrosynthesis of pure urea via the co-reduction of CO2 and N2 remains challenging," wrote Yan-Chen Liu, Jia-Run Huang and their colleagues in their paper. "We show that a proton-limited environment established in an electrolyzer equipped with a porous solid-state electrolyte, devoid of an aqueous electrolyte, can suppress the hydrogen evolution reaction and excessive hydrogenation of N2 to ammonia.

"This can instead be conducive to the C–N coupling of *CO2 with *NHNH (the intermediate from the semi-hydrogenation of N2), thereby facilitating the production of urea."

The new strategy to synthesize urea introduced by this research team primarily relies on the creation of a proton-limited environment, a condition in which hydrogen ions (i.e., protons) are scarce. This condition was successfully realized using an electrolyzer that contains a porous solid-state electrolyte.

"By using nanosheets of an ultrathin two-dimensional metal–azolate framework with cyclic heterotrimetal clusters as catalyst, the Faradaic efficiency of urea production from pretreated flue gas (which contains mainly 85% N2 and 15% CO2) is as high as 65.5%, and no ammonia and other liquid products were generated," wrote Liu, Huang and their colleagues.

"At a low cell voltage of 2.0 V, the current can reach 100 mA, and the urea production rate is as high as 5.07 g gcat−1 h−1 or 84.4 mmol gcat−1 h−1. Notably, it can continuously produce 6.2 wt% pure urea aqueous solution for at least 30 h, and about 1.24 g pure urea solid was obtained."

In the team's initial experiments, their strategy enabled the continuous production of high-purity urea with no ammonia byproducts, while consuming less energy than conventional urea synthesis approaches. In the future, it could be tested further and implemented on a large scale, potentially enabling the greener and cost-effective production of urea on a large scale.

"The use of pretreated flue gas as a direct feedstock significantly reduces input costs, and the high reaction rate and selectivity contribute to a reduction in system scale and operational costs," wrote the researchers.

Phys Org, 2 May 2025

https://phys.org

Dust in the system -- How Saharan storms threaten Europe's solar power future

2025-05-02

As Europe increases its reliance on solar energy to meet climate and energy security targets, a growing atmospheric phenomenon is complicating the path forward: Saharan dust. New research presented at the European Geosciences Union General Assembly (EGU25) shows that mineral dust carried on the wind from North Africa is not only reducing photovoltaic (PV) electricity generation across Europe but also making it harder to predict. In their presentation at EGU25, The shadow of the wind: photovoltaic power generation under Europe's dusty skies, Dr. György Varga and collaborators from Hungarian and European institutions reveal how dust-laden skies disrupt PV performance and challenge existing forecasting models. Their work, grounded in field data from more than 46 Saharan dust events between 2019 and 2023, spans both Central Europe (Hungary) and Southern Europe (Portugal, Spain, France, Italy, and Greece).

The Sahara releases billions of tonnes of fine dust into the atmosphere every year, and tens of millions of tonnes reach European skies.

These particles scatter and absorb sunlight, reduce irradiance at the surface, and can even promote cloud formation -- all of which degrade PV output.

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Science Daily, 2 May 2025

https://sciencedaily.com

Dimethyl sulfide signature may not indicate extraterrestrial life

2025-05-01

Belief in alien life, having been forever devoid of any empirical basis pro or con, has been free to enjoy cycles of fashion. When both traditional astronomy and Christian theology placed the Earth at the centre of the cosmos, few imagined the stars and planets as anything other than the unchanging celestial backdrop to life in this vale of tears. But 'A Man that is of Copernicus's Opinion', in the evaluation of Christiaan Huygens in the late 17th century, 'cannot but sometimes have a fancy that it's not improbable that the rest of the Planets have… their Inhabitants too'.

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Huygens' casual acceptance of extraterrestrial life remained the norm at least until HG Wells warned of its hazards, and even in 1952 the Astronomer Royal Harold Spencer Jones was happy to tell us that 'it is almost certain that there is some form of vegetation on Mars.'

When the Viking lander missions of the 1970s revealed a sterile Martian landscape, scientific opinion reverted to the notion that we are a lone oasis of life in the solar system and possibly in the wider cosmos. Some still consider the origin of life on Earth to have been an extremely rare and improbable event on potentially habitable worlds. But probably a more common view, now that we know how abundant extrasolar and even somewhat Earthlike planets are, is that life of some kind might be fairly widespread in the universe, but that intelligent life – the sort that we purport to be – could be very rare.

Hard steps

One argument for that view came from cosmologist Brandon Carter, who in 1983 pointed out a peculiar coincidence whereby the timescale for humans to evolve – around 4.6 billion years – is of the same order of magnitude as the span over which our planet will be habitable at all: in around 5 billion years' time the Earth will be fried by the ageing, swollen Sun before it wanes into a white dwarf.1 Carter inferred that it would normally take much longer for intelligent life to appear on a planet like ours, and that we are the result of one or two rare and improbable events required for such evolution: 'hard steps' that usually preclude advanced, intelligent life but which will happen here and there throughout the cosmos. In this view, we're either alone or nearly so.

Carter's hard-steps model has recently been challenged by a team who argue that the late arrival of humans need not imply our improbability, but might rather reflect the fact that the environmental conditions needed for big, complex life forms like us – not least, an oxygen-rich atmosphere to support our energy-hungry cells – can't evolve quickly from the inhospitable setting of the Hadean (Earth's oldest geologic eon).2

All this context adds intrigue to the recent claim by a team of astronomers at the University of Cambridge, UK, to have detected a potential 'biosignature' – a compound that, on Earth, has only a biogenic natural source – on an extrasolar planet called K2-18b, 2.6 times the diameter of Earth and orbiting a red-dwarf star 124 light years away.3 They report the spectral signature of dimethyl sulfide (DMS) in K2-18b's atmosphere, based on measurements by the James Webb Space Telescope (JWST). The team

made the same claim more tentatively two years ago from data collected by a different JWST instrument.4

Uncertainty

The most credulous (or most sensationalist) media sources reported this claim as a likely ('99.7% certainty') detection of alien life. Many experts were more sceptical. For one thing, the DMS detection itself may not be as convincing as the authors claim. They said there is only a 0.3% chance of the signal being mere noise, but others have questioned that number.

On Earth, DMS in the atmosphere is produced by marine plankton, and the Cambridge team says the compound has been considered a 'robust biosignature' for planets like K2-18b, which is thought to have an ocean beneath an atmosphere rich in hydrogen. But an abiotic source of DMS has been reported from photochemical reactions involving hydrogen sulfide and methane.5 Some planetary scientists argue that it seems unlikely any putative biosignature gas in a planetary atmosphere can be considered compelling evidence for life, given how little we know about the geological conditions of any extrasolar planet.

All the same, it's interesting to contemplate what a world with DMS-generating microbes might imply. On Earth, these are relatively recent: the metabolic pathway leading to DMS is thought to have appeared only around 250 million years ago.6 So it's a fairly sophisticated bit of biochemistry. Such life might then be supposed already to have completed some of Carter's hard steps – in which case they wouldn't look so hard after all.

Chemistry World, 1 May 2025

https://chemistryworld.com

Bomb residue study opens the door for stronger evidence in criminal cases

2025-05-01

Scientists have for the first time provided insight into how bomb residue transfers to the hands of suspects, which could lead to stronger evidence in court.

The study, which was led by a team from King's College London and published in the journal Science & Justice, investigated how explosive materials commonly found in pipe bombs and improvised explosive

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devices (IEDs) transferred to the palms and fingers of individuals who handled them.

The researchers learned that the amount that was handled and the unique characteristics of the handler were important determining factors. Surprisingly, the brand or type of material appeared not to be a decisive influencing factor.

The study is the first of its kind to explore how contextual factors influence explosive material residue transfer to hands, and could be used to help forensic experts in cases involving explosive materials.

Lead author, Dr. Matteo Gallidabino, lecturer in forensic chemistry at King's College London, said, "These findings could mark a breakthrough in forensic investigations into individuals who are suspected of handling explosive materials. Currently, forensic experts can identify the presence of explosive material-related molecules on hands, but interpretation rarely goes deeper than that because of a lack of contextual data.

"This study is a first step towards understanding how a range of contextual factors influence how residue is transferred. Developing this understanding is critical if we want forensic evidence to truly be helpful in understanding what happened in a case.

"The results provide a foundation that can help experts better interpret residue in cases involving the use of energetic materials, such as terrorist attacks, leading to stronger and more reliable conclusions in court."

Often used in the construction of IEDs, smokeless powders (SLPs) are a common and easily available material. In some countries, they can be bought over the counter by people seeking to manually load their own gun cartridges. The powder residues can be detected by hand swabs applied to suspects following a bombing incident.

Currently, analysts primarily focus on determining whether explosive-related molecules are present, and when possible, what type of explosive was involved. However, due to a lack of data on background levels and persistence of powder, as well as secondary transfer—by way of actions such as shaking hands or touching surfaces—assessment of whether a suspect actually handled an explosive remains limited.

The research team conducted controlled experiments where volunteers handled different SLP samples containing common additives—namely diphenylamine (DPA), dibutyl phthalate (DBP) and ethyl centralite (EC).

The volunteers were instructed to wash their hands thoroughly with soap and water before rubbing samples of SLP between their palms for 30 seconds. They were then asked to clap their hands to dislodge loose particles. This was followed by swabs being rubbed on their hands to collect a sample.

The researchers then used a streamlined "filter and shoot" method—a simple and fast sample preparation technique used in analytical chemistry—that was optimized for the experiment, before analyzing the samples using gas chromatography-mass spectrometry.

The results showed that the quantity transferred to hands ranged from in the billionths to in the millionths of a gram. DBP was the most concentrated additive in all SLP samples, followed by DPA and EC—a pattern also seen in the hand residues.

However, the specific concentrations of these additives which varied across SLPs were not mirrored in the hand residues. The researchers were surprised by this finding, indicating that the type or brand of SLP is not a key influencing factor.

The unique characteristics of the handler also influenced residue transfer. These included physical characteristics—such as skin properties, and behaviors—such as how the powder was handled and the force applied. While not directly measurable, these factors caused the final amount transferred to differ from person to person. In addition, the amount of SLP found on the hands correlated with the total mass of SLP handled.

The results indicate the importance of taking contextual factors into account when investigating explosive residue traces in real cases.

The study also introduces a faster and more robust sampling method—the optimized filter and shoot technique—that could be used for future research studies.

Dr. Gallidabino calls for future research to look at a wider range of chemical substances associated with explosives, as well as to study the related retention and persistence of SLP traces on hands.

Phys Org, 1 May 2025

https://phys.org

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Rare earth element extraction bolstered by new research

2025-04-30

A more efficient and environmentally friendly approach to extracting rare earth elements that power everything from electric vehicle batteries to smartphones could increase domestic supply and decrease reliance on costly imports.

This new method, developed by researchers at The University of Texas at Austin, allows for separating and extracting these in-demand elements where it's not possible today, opening up new avenues for gathering rare earth elements amid global trade tensions.

"Rare earth elements are the backbone of advanced technologies, but their extraction and purification are energy intensive and extremely difficult to implement at the scales required," said Manish Kumar, professor in the Cockrell School of Engineering's Fariborz Maseeh Department of Civil, Architectural and Environmental Engineering and the McKetta Department of Chemical Engineering. "Our work aims to change that, inspired by the natural world."

The research was recently published in ACS Nano. The researchers developed artificial membrane channels -- tiny pores embedded in membranes -- that mimic the selective transport mechanisms of transport proteins found in biological systems. These channels are the roadways used by different ions to travel between cells.

Each channel is different, letting only ions with certain characteristics through while keeping others out. That selectivity is critical to many biological processes, including how our brains think.

The researchers' artificial channels use a modified version of a structure called pillararene to enhance their ability to bind and block specific common ions while transporting specific rare earth ions. The result is a system that can selectively transport middle rare earth elements, such as europium (Eu^3) and terbium (Tb^3), while excluding other ions like potassium, sodium, and calcium.

"Nature has perfected the art of selective transport through biological membranes," said Venkat Ganesan, professor in the McKetta Department of Chemical Engineering and one of the research leaders. "These artificial channels are like tiny gatekeepers, allowing only the desired ions to pass through."

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Rare earth elements are split into several classes (light, middle and heavy), each with different properties that make them ideal for specific applications. Middle elements are used in lighting and displays, including TVs, and as magnets in green energy technologies, such as wind turbines and electric vehicle batteries.

The U.S. Department of Energy and the European Commission have identified several middle elements, including europium and terbium, as critical materials at risk of supply disruption. With demand for these elements expected to grow by over 2,600% by 2035, finding sustainable ways to extract and recycle them is more urgent than ever.

Science Daily, 30 April 2025

https://sciencedaily.com

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Curiosities

Actinide bonding could be tweaked by adjusting oxidation states

2025-05-02

The final piece of the jigsaw puzzle of how actinides bond with ligands through phi bonds has been identified, with its control via oxidation states paving the way for advances in f-block catalysis and quantum computing.

The actinide series includes the heaviest elements that occur naturally on Earth, and how they bond with ligands is essential to understand, both in terms of fundamental chemistry and in solving problems in the nuclear industry. However, their radioactivity and the complexity of working with these elements makes it difficult to confirm theoretical predictions.

The gargantuan size of these atoms also means they behave differently. Bonds are described based on the symmetry of their atomic orbitals; sigma bonds have no 'nodal planes', pi bonds have one and delta bonds, found in the transition metals, have two. The f-orbitals, such as those found in the actinides, have three nodal planes, forming rare, and still mysterious, phi bonds.

To help expand our understanding of the far end of the periodic table, a group of researchers led by Ping Yang at Los Alamos National Laboratory, US, used theoretical modelling to predict how these phi bonds behave. Building on previous work and knowledge of actinide structures, the team looked at actinide–ligand bonding across the entire series, and three different oxidation states, to see how these phi-interactions occurred. The team's results showed that, simply by varying the oxidation state of the actinide, they could change the strength of phi bonding's 'head-to-head' interaction: essentially providing an easy way to tweak how the actinide behaves.

This discovery could allow researchers to fine-tune actinide bonding, with potentially huge implications for the entire f-block, explains Yang. 'This control enables the rational design of ligands with enhanced selectivity for actinides over lanthanides, particularly challenging for minor actinides like americium and curium, offering a powerful strategy to improve separation efficiency in nuclear fuel recycling.'

The group's findings could also inform the design of better redox-active catalysts, and even control of electronic states, allowing f-block elements and their high angular momentum to be used in quantum computing, she suggests.

Conrad Goodwin, an actinide researcher at the University of Manchester, UK, praised the work as 'a trove of data, which I am sure will be extremely valuable for the community', likening it to the contributions made by former American Chemical Society president Bruce Bursten in terms of potential impact. 'It's a beautiful piece of fundamental theoretical actinide science,' he adds. 'This type of theoretical investigation is hugely important as it provides real, testable experimental targets for the synthetic community to explore.'

Chemistry World, 5 May 2025

https://chemistryworld.com

'Like asbestos': Carbon fibre ban rattles car industry

2025-04-16

A proposal to outlaw the use of carbon fibre in cars on health and safety grounds rocked the car industry this week.

The lightweight material, comprised of thin carbon filaments weaved together and held in resin, has become a staple of the automotive industry as an alternative to traditional matter such as metal and plastic.

But there are concerns surrounding how carbon can be broken down and recycled at the end of a car's life.

A Japanese study published in 2019 found that "generation of carbon fibre dust during the recycling process is a serious issue". A second study published in Germany in 2019 urged further analysis of the effect of carbon fibre recycling on human health, saying that "in order to predict and manage health risks of the large variety of existing carbon fibre materials, the understanding … must be urgently improved".

The Asia Nikkei reported that the European Union was set to amend laws surrounding the end of life for vehicles, outlining how cars should be dismantled and recycled.

Draft legislation created this year put carbon fibre on a list alongside hazardous materials such as lead that should be used sparingly in vehicle production, and phased out altogether in the future.

Legislators were concerned that wirelike carbon filaments could cause respiratory problems for people involved in cutting, crushing, and dismantling carbon fibre pieces in years to come.

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It presented a similar problem to asbestos, a building material originally praised for its water and fire-resistant properties, that poses a risk to health when disturbed.

Lighter and stronger than alternative material, carbon is used for many different elements in new cars.

It's easy to spot as decorative trim – often on a car's spoiler, or in the cabin.

Some performance cars, such as the BMW M3, offer carbon fibre seats, as they are lighter and stronger than standard seats, offering improved performance as well as aesthetic appeal.

More than a few models, including the Toyota GR Yaris and Corolla, use carbon fibre instead of steel in the roof to help lower a car's centre of gravity, improving performance.

Porsche uses it for many elements of the 911 GT3 RS, including the interior's safety cage and anti-roll bars in the suspension.

A handful of high-end cars, including Chevrolet's Corvette Z06, the Ferrari 296 GTS, Range Rover Sport and Bentley Continental, offer customers the option of lightweight wheels made from carbon fibre in a bid to improve performance and handling.

More exotic machines such as the Lamborghini Revuelto and McLaren 750S have carbon at the core of their chassis, instead of steel or aluminium.

Following initial reports surrounding concerns about how carbon can be recycled, the EU amended its draft legislation to remove carbon from its list of hazardous substances.

Even so, car makers are already looking for sustainable alternatives to the material.

Porsche and BMW have replaced carbon fibre bodywork in some race cars with elements made from plant-based fibre such as hemp and flax.

The sustainable bodywork, found in cars such as the BMW M4 GT4 and Porsche Cayman GT4 RS Clubsport, is made from layers of plant fibre woven together in a similar fashion to a straw basket or jute rug, then suspended in resin and pressed into moulds that create complex shapes.

Expect to see more sustainable alternatives to carbon hit the road in years to come.

News, 16 April 2025

https://news.com.au

Fungus-based material could offer a sustainable concrete alternative

2025-04-21

Among the many things we could do to reduce strain on the environment is find greener ways of constructing buildings. You see, cement production accounts for 8% of CO2 emissions worldwide – and a lot of that goes towards making concrete.

It's a difficult problem to solve, because doing so will require us to find eco-friendly materials that are as strong as concrete and need little maintenance. That's why scientists have been looking into engineered living materials (ELMs) which incorporate organisms like bacteria with non-living components to offer unique properties along with structural benefits – and less reliance on cement as a binder.\

A team of engineers from Montana State University has developed a building material using the root-like mycelium network of a fungus, along with specially selected bacteria.

This hybrid material overcomes two of the major challenges associated with ELMs. Firstly, the materials typically only survive a few days or weeks in less-than-optimal conditions, and then lose their unique properties. Secondly, the way that minerals (such as calcium carbonate) are deposited onto the mycelium structure usually can't be controlled to have the kind of internal geometry that would make the material strong and durable.

The researchers went with a fungus called N. crassa that exhibits rapid mycelial growth, as well as a property called Microbially Induced Carbonate Precipitation (MICP) where it can turn loose sand or soil into something strong like cement.

They also introduced a bacterium, S. pasteurii, which we've previously seen being used to repair bricks made from lunar soil for use on the moon, and to fix potholes here on Earth. This is a biomineralizing bacterium, which means it can create solid minerals.

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Montana State's Asst. Prof. Chelsea Heveran, who authored the study that appeared in the journal Cell Reports Physical Science, explained the other big benefit of going with the mycelium from N. crassa. "We learned that fungal scaffolds are quite useful for controlling the internal architecture of the material," she said. "We created internal geometries that looked like cortical bone, but moving forward, we could potentially construct other geometries too."

That means it's possible to create structural complexity within materials using this system for enhanced strength and stiffness.

It's the first time that fungal mycelium has been tested as a scaffold for biomineralized ELM production.The choice of fungus allowed the researchers to test its viability as a living component in an ELM over a long period of time, both as a system for MICP as well as one to support self-repairing S. pasteurii.

The team found that the microorganisms in the scaffold remained alive and metabolically active for a minimum of four weeks. That's longer than many other candidates for ELMs, and it could be the key to creating a strong and long-lasting building material that has useful properties like self-repair.

To that end, the researchers plan to try coaxing the cells to live on for longer periods, and determine ways to manufacture them at scale.

If the researchers are successful, they could have a viable complement to traditional concrete. Of course, they'll have to tackle the biggest hurdles in challenging concrete as a building material, which include the higher cost of an ELM, the ability to make it as easily available so it can sourced and stored on demand, and suitable for a range of construction projects.

Source: Cell Reports Physical Science

New Atlas, 21 April 2025

https://newatlas.com

Childhood Exposure to Bacterial Toxin May Trigger Early-Onset of Colorectal Cancer

2025-04-24

In an effort to explain a modern medical mystery, an international team of researchers led by the University of California San Diego has identified

a potential microbial culprit behind the alarming rise in early-onset colorectal cancer: a bacterial toxin called colibactin.

Produced by certain strains of Escherichia coli that reside in the colon and rectum, colibactin is a toxin capable of altering DNA. Now, scientists report that exposure to colibactin in early childhood imprints a distinct genetic signature on the DNA of colon cells—one that may increase the risk of developing colorectal cancer before the age of 50.

The new study, published on April 23 in Nature, analyzed 981 colorectal cancer genomes from patients with both early- and late-onset disease across 11 countries with varying colorectal cancer risk levels. The findings show that colibactin leaves behind specific patterns of DNA mutations that were 3.3 times more common in early-onset cases (specifically in adults under 40) than in those diagnosed after the age of 70. These mutation patterns were also particularly prevalent in countries with high incidence of early-onset cases.

"These mutation patterns are a kind of historical record in the genome, and they point to early-life exposure to colibactin as a driving force behind early-onset disease," said study senior author Ludmil Alexandrov, professor in the Shu Chien-Gene Lay Department of Bioengineering and the Department of Cellular and Molecular Medicine at UC San Diego, who is also a member of UC San Diego Moores Cancer Center and Deputy Director of Sanford Stem Cell Fitness and Space Medicine Center.

Although previous studies—including earlier work from Alexandrov's lab— have identified colibactin-related mutations in roughly 10 to 15 percent of all colorectal cancer cases, those studies either focused on late-onset cases or did not distinguish between early- and late-onset disease. This latest study is the first to demonstrate a substantial enrichment of colibactin-related mutations specifically in early-onset cases.

The implications are sobering. Once considered a disease of older adults, colorectal cancer is now on the rise among young people in at least 27 countries. Its incidence in adults under 50 has roughly doubled every decade for the past 20 years. If current trends continue, colorectal cancer is projected to become the leading cause of cancer-related death among young adults by 2030.

Until now, the reasons behind this surge have remained unknown. Young adults diagnosed with colorectal cancer often have no family history of the disease and few known risk factors such as obesity or hypertension. That

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has fueled speculation about potential hidden environmental or microbial exposures—something this new study directly investigates.

"When we started this project, we weren't planning to focus on early-onset colorectal cancer," said study co-first author Marcos Díaz-Gay, a former postdoctoral researcher in Alexandrov's lab. "Our original goal was to examine global patterns of colorectal cancer to understand why some countries have much higher rates than others. But as we dug into the data, one of the most interesting and striking findings was how frequently colibactin-related mutations appeared in the early-onset cases."

According to the team's analysis, colibactin's damaging effects begin early. By molecularly timing each mutational signature identified in this study, the researchers demonstrate that colibactin-associated mutations arise early in tumor development, consistent with prior studies showing that such mutations occur within the first 10 years of life. The study also reveals that colibactin-related mutations account for approximately 15% of what are known as APC driver mutations—some of the earliest genetic alterations that directly promote cancer development—in colorectal cancer.

"If someone acquires one of these driver mutations by the time they're 10 years old," Alexandrov explained, "they could be decades ahead of schedule for developing colorectal cancer, getting it at age 40 instead of 60."

In other words, colibactin-producing bacteria may be silently colonizing children's colons, initiating molecular changes in their DNA, and potentially setting the stage for colorectal cancer long before any symptoms arise.

Alexandrov cautioned that while their findings provide strong support for this hypothesis, further research is necessary to establish causality.

Building on past breakthroughs

This work—part of Cancer Grand Challenges team Mutographs, funded by Cancer Research UK—is the latest milestone in a growing body of research that Alexandrov, Díaz-Gay and colleagues have been advancing over the past several years. Their specialty lies in decoding patterns of DNA mutations caused by environmental exposures—such as UV radiation and bacterial toxins—and lifestyle behaviors like smoking and drinking. Each factor leaves a distinct genetic fingerprint in the genome, a unique mutational signature that can help pinpoint the origins of certain cancers.

As part of a long-term collaboration between UC San Diego, the International Agency for Research on Cancer (France), and the Wellcome Sanger Institute (UK), enabled by Cancer Grand Challenges funding, team Mutographs has elucidated the mutational processes underlying esophageal, kidney, and head and neck cancers worldwide. This most recent result on colorectal cancer further expands the global understanding of cancer etiology through mutational signature analysis.

By systematically cataloging these mutational patterns across thousands of cancer genomes, the researchers have been working to identify new causes of cancer that had previously flown under the radar.

"Not every environmental factor or behavior we study leaves a mark on our genome," said Alexandrov. "But we've found that colibactin is one of those that can. In this case, its genetic imprint appears to be strongly associated with colorectal cancers in young adults.

The team's approach—using genomic detective work to uncover hidden causes of cancer—demonstrates the power of fundamental scientific research. But unfortunately, the future of this work is in peril.

Although the research has been supported in large part by programs in the UK such as Cancer Research UK via Cancer Grand Challenges, a substantial portion of the team's funding has come from the U.S. National Institutes of Health (NIH). With the NIH now facing proposed budget cuts, critical projects like this one could be at risk.

"If NIH funding cuts impact our ability to do this work, that will be, in my opinion, a substantial hit to cancer research not just in the U.S., but globally," said Alexandrov. "Our funding has allowed us to collaborate with cancer researchers around the world, collecting and analyzing large datasets from patient samples in multiple countries. That kind of scale is what makes discoveries like this possible."

Ongoing work

Continued support is especially important for the next phase of their research, as it raises a host of new questions. How are children being exposed to colibactin-producing bacteria, and what can be done to prevent or mitigate that exposure? Are certain environments, diets or lifestyle behaviors more conducive to colibactin production? How can people find out if they already have these mutations?

The team is investigating several hypotheses while also further examining the correlation between colibactin and the risk of early-onset colorectal

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cancer. In addition, they are exploring whether the use of probiotics could safely eliminate harmful bacterial strains. They are also developing early detection tests that analyze stool samples for colibactin-related mutations.

But these efforts will require resources.

"To further investigate our hypotheses and develop safe, ethical interventions, we're going to need tens of millions of dollars," said Alexandrov. "This research has important implications for the future health of children globally. Without adequate support, it will be difficult to fully understand and address the issue.

In the meantime, the team is continuing its global search for cancer-linked mutational signatures. In the recent Nature study, the team also found that colorectal cancers from specific countries—particularly Argentina, Brazil, Colombia, Russia and Thailand—showed an increase in certain mutational signatures. This suggests that local environmental exposures may also contribute to cancer risk.

"It's possible that different countries have different unknown causes," said Díaz-Gay, who is launching a new phase of the study in his newly established lab at the Spanish National Cancer Research Center (CNIO) in Madrid, Spain. "That could open up the potential for targeted, region-specific prevention strategies."

Alexandrov noted a broader implication of the research: that many cancers may originate from environmental or microbial exposures in early life, long before diagnosis.

"This reshapes how we think about cancer," he said. "It might not be just about what happens in adulthood—cancer could potentially be influenced by events in early life, perhaps even the first few years. Sustained investment in this type of research will be critical in the global effort to prevent and treat cancer before it's too late."

Technology Networks, 24 April 2025

https://technologynetwroks.com

Innovative synthesis technique unlocks new class of planar organometallic compounds

2025-05-03

With six Nobel Prizes in the category, organometallic chemistry has been a widely explored field since the 1950s. Yet, the discovery of new classes of organometallic compounds remains a rare occurrence.

A team of researchers from China and the U.S. decided to change that by identifying a new class of organometallic compounds—three new metal-centered planar annulene frameworks.

Annulenes are cyclic hydrocarbons that contain the maximum number of alternating carbon–carbon single and double bonds possible, with a general formula CnHn for even numbers of n or CnHn + 1 for odd numbers of n. The annulenes presented in this study were made up of 15 carbon atoms bonded to one atom of the transition metal osmium, at the center.

The new compounds were reported in Nature.

The mid-20th century saw the rise of a new field of chemistry called organometallics, kickstarted by the discovery of ferrocene—a compound consisting of two five-carbon annulene rings sandwiching a central iron atom. In most organometallic compounds, a metal is π-coordinated where it sits above or below the plane of the flat annulene anions.

Over the years, many such out-of-plane complexes have been synthesized, significantly influencing bonding theory and finding diverse applications in scientific and industrial processes thanks to their unique useful catalytic, electrochemical, and magnetic properties.

However, not many in-plane metal-annulene complexes where the metal atom sits inside the ring and forms a σ (sigma) bond with the carbon atoms rather than π bonds, have been reported.

Synthesizing such complexes has proven far more challenging due to several factors: restrictions due to smaller annulene anions not having a large enough central cavity to accommodate a metal atom, larger annulenes deviating from planarity because of their flexible structures and the need to break strong carbon–hydrogen bonds and replacing them with carbon–metal bonds.

The new study overcomes the synthetic obstacles to in-plane metallo-annulenes through targeted molecular design and a clever synthetic

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route. Instead of trying to insert a metal into an annulene, the researchers built an annulene framework around a metal center.

The synthesis was carried out in multiple steps, starting with a molecular precursor containing a reactive osmium–carbon triple bond and then assembling carbon–carbon bonds around the metal atom via cycloaddition reaction. This led to the formation of in-plane [15]annulene metal complexes, containing five fused rings joined through the central osmium bis-phosphine moiety.

The most symmetrical molecule designed in the study was a metallo-annulene made up of five connected five-membered aromatic rings. Using this as the parent structure, the researchers derived iodinated, chlorinated and nitrated version of the in-plane metallo-annulenes. They also found that the phosphine ligands of the parent moiety can be swapped out, offering a versatile platform for newer derivatives.

The researchers highlight that the high stability of the metal-centered planar annulenes and their ability to be functionalized position them as promising building blocks for materials science.

Phys Org, 3 May 2025

https://phys.org

Common Plastic Chemical Linked to Heart Disease Deaths

2025-04-29

Daily exposure to certain chemicals could be linked to the more than 356,000 global deaths from heart disease.

Daily exposure to certain chemicals used to make plastic household items could be linked to the more than 356,000 global deaths from heart disease that occurred in 2018 alone, a new analysis of population surveys shows.

Although the chemicals, called phthalates, are in widespread use globally, the Middle East, South Asia, East Asia and the Pacific bore a much larger share of the death toll than others – about three-fourths of the total.

For decades, experts have connected health problems to exposure to certain phthalates found in cosmetics, detergents, solvents, plastic pipes, bug repellants and other products. These chemicals break down into microscopic particles and are ingested and studies have linked such

exposure to an increased risk of conditions ranging from obesity and diabetes to fertility issues and cancer.

Led by researchers at NYU Langone Health, the current study focused on a kind of phthalate called di-2-ethylhexyl phthalate (DEHP), which is used to make food containers, medical equipment, and other plastic items softer and more flexible. Exposure has been shown in other studies to prompt an overactive immune response (inflammation) in the heart's arteries, which over time is associated with increased risk of heart attack or stroke. In their new analysis, the authors estimated that DEHP exposure contributed to 356,238 deaths, or more than 13 percent of all global mortality from heart disease in 2018 among men and women ages 55 through 64.

"By highlighting the connection between phthalates and a leading cause of death across the world, our findings add to the vast body of evidence that these chemicals present a tremendous danger to human health," said study lead author Sara Hyman, BS, an associate research scientist at NYU Grossman School of Medicine.

In a past study from 2021, the research team tied phthalates to more than 50,000 premature deaths each year, mostly from heart disease, among older Americans. Their latest investigation is believed to be the first global estimate to date of cardiovascular mortality—or indeed any health outcome—resulting from exposure to the chemicals, said Hyman, who is also a graduate student at NYU School of Global Public Health.

A report on the findings was published online April 29 in the journal Lancet eBioMedicine.

For the research, the team used health and environmental data from dozens of population surveys to estimate DEHP exposure across 200 countries and territories. The information included urine samples containing chemical breakdown products left by the plastic additive. Mortality data was obtained from the Institute for Health Metrics and Evaluation, a research group in the United States that collects medical information worldwide to identify trends in public health.

Among the key findings, the study showed that losses in the combined region of East Asia and the Middle East and the combined region of East Asia and the Pacific accounted, respectively, for about 42 percent and 32 percent of the mortality from heart disease linked to DEHP. Specifically, India had the highest death count, at 103,587 deaths, followed by China and Indonesia. The larger heart death risks in these populations held true

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even after the researchers adjusted their statistical analysis to take into account population size within the studied age group.

A possible explanation, the authors say, is that these countries face higher rates of exposure to the chemicals, possibly because they are undergoing a boom in plastic production but with fewer manufacturing restrictions than other regions.

"There is a clear disparity in which parts of the world bear the brunt of heightened heart risks from phthalates," said study senior author Leonardo Trasande, MD, MPP. "Our results underscore the urgent need for global regulations to reduce exposure to these toxins, especially in areas most affected by rapid industrialization and plastic consumption," added Dr. Trasande, the Jim G. Hendrick, MD, Professor of Pediatrics at NYU Grossman School of Medicine.

Dr. Trasande, who is also a professor in the Department of Population Health, cautions that the analysis was not designed to establish that DEHP directly or alone caused heart disease and that higher death risks did not take into account other types of phthalates. Nor did it include mortality among those in other age groups. As a result, the overall death toll from heart disease connected to these chemicals is likely much higher, he says.

Dr. Trasande says that the researchers next plan to track how reductions in phthalate exposure may, over time, affect global mortality rates, as well as to expand the study to other health concerns posed by the chemicals, such as preterm birth. Dr. Trasande also serves as director of NYU Grossman School of Medicine's Division of Environmental Pediatrics and the Center for the Investigation of Environmental Hazards.

Funding for the study was provided by National Institutes of Health grant P2CES033423. Further study funding was provided by Beyond Petrochemicals.

Dr. Trasande has received support for travel or meetings from the Endocrine Society, the World Health Organization, the United Nations Environment Programme, Japan's Environment and Health Ministries, and the American Academy of Pediatrics. He has also received royalties and licenses from Houghton Mifflin Harcourt, Audible, Paidós, and Kobunsha, and has served in leadership or fiduciary roles at Beautycounter, Ahimsa, Grassroots Environmental Education, and Footprint. None of these activities were related to the current study. The terms and conditions of all of these relationships are being managed by NYU Langone Health.

In addition to Hyman and Dr. Trasande, other NYU Langone researchers involved in the study are Jonathan Acevedo, MPH and Chiara Giannarelli, MD, PhD.

Technology Networks, 29 April 2025

https://technologynetworks.com

Iron-fortified lumber could be a greener alternative to steel beams

2025-04-29

Although lumber does show promise as a renewable alternative to structural materials such as steel and concrete, it still tends to be a bit weaker than those substances. Scientists have now set about addressing that shortcoming, by strengthening wood with added iron.

Led by Asst. Prof. Vivian Merk, a team of researchers at Florida Atlantic University (FAU) started out with cubes of untreated red oak hardwood. Red oak – along with hardwoods like maple, cherry and walnut – is an example of what's known as ring-porous wood. In a nutshell, this means that it utilizes large ring-shaped internal vessels to draw water up from the tree's roots to its leaves.

The scientists proceeded to mix ferric nitrate with potassium hydroxide, creating a hard iron oxide mineral called nanocrystalline ferrihydrite, which occurs naturally in soil and water. Utilizing a vacuum impregnation process, nanoparticles of that ferrihydrite were drawn into the wood and deposited inside of its individual cell walls.

This action served to strengthen those walls, thus increasing the stiffness and hardness of the wood by 260.5% and 127%, respectively. That said, when the modified red oak wood did bend or break, it did so in a manner much like that of unmodified test samples. This is likely due to the fact that although the wood's cell walls had been strengthened, the bonds between the cells had not.

Importantly, the addition of the ferrihydrite nanoparticles increased the weight of the wood by only a small amount. Additionally, because the particles are nontoxic, they shouldn't pose a threat to the environment when the wood is eventually discarded or recycled.

"Our researchers are laying the groundwork for a new generation of bio-based materials that have the potential to replace traditional materials like

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steel and concrete in structural applications," says Dr. Stella Batalama, dean of FAU's College of Engineering and Computer Science.

"The impact of this work reaches far beyond the field of engineering – it contributes to global efforts to reduce carbon emissions, cut down on waste, and embrace sustainable, nature-inspired solutions for everything from buildings to large-scale infrastructure."

A paper on the research – which also involved scientists from the University of Miami and Oak Ridge National Laboratory – was recently published in the journal ACS Applied Materials and Interfaces.

In a previous study, a team at Georgia Tech determined that impregnating wood with different types of metal oxide additionally helped keep it from rotting.

Source: Florida Atlantic University

New Atlas, 29 April 2025

https://newatlas.com

New catalyst allows asymmetric radical reactions using an engineered ligand

2025-05-01

A team of chemists at Southern University of Science and Technology, working with a colleague from Zhejiang University, both in China, has engineered a metal–ligand complex that incorporates a reactive pocket to pre-organize prochiral substrates. Their paper is published in the journal Science.

Carbon radicals are being used as an intermediate in a variety of synthetic transformations. Because they have just one electron, they tend to be highly reactive, allowing for speedy reactions with little energy release.

Unfortunately, when working with prochiral substrates, where three different groups are attached to a single radical center, the ability to control the reaction becomes untenable. Prior research has shown that the underlying cause of these difficulties lies with the differences inherent in the alkyl group, where non-stereoselective reactions tend to dominate.

To overcome such problems, the team developed a metal–ligand complex with a pocket that allows a reaction to pre-organize the substrates. As a reaction begins, the researchers note, the smaller parts of a molecule

become wedged into the tighter, inner parts of the ligand, forcing the larger parts to an outer region. This allows reactions occurring in the pocket to be localized. The team added features around the edges of the pocket to direct nonbonding interactions that occurred during the main reaction.

The idea, the team notes, is to hold the prochiral radical in place so a reaction can take place by itself and then allow subsequent reactions to take place in the outer part of the ligand, but still on the same side, resulting in the production of a single enantiomer.

When designing the ligand, the researchers were focused on finding a way to conduct asymmetric amination reactions using well-known, copper-based chemistry to form α-chiral alkyl amines.

Testing of their ligand showed it could accommodate both photocatalytic and thermal radical processes and that it could be used with a host of functional groups. During testing, the team produced more than 50 amines, clearly demonstrating the utility and versatility of their approach.

Phys Org, 1 May 2025

https://phys.org

Body of article

website, date

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One timed-release capsule could replace taking multiple pills

2025-05-01

Managing complex medication schedules could soon become as simple as taking a single capsule each day. Engineers at the University of California San Diego have developed a capsule that can be packed with multiple medications and release them at designated times throughout the day.

The advance, published in Matter, could help improve medication adherence and health outcomes by eliminating the need for patients to remember taking multiple drugs or doses at various times each day. It could potentially reduce the risk of missed doses or accidental overdoses.

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"We want to simplify medication management with a single capsule that is smart enough to deliver the right drug at the right dose at the right time," said study first author Amal Abbas, who recently earned her Ph.D. in chemical engineering at the UC San Diego Jacobs School of Engineering. She spearheaded this work with Joseph Wang, a professor in the Aiiso Yufeng Li Family Department of Chemical and Nano Engineering at UC San Diego.

Seeing its potential benefits to patients as well as their caregivers, Abbas is launching a startup company to accelerate the development and commercialization of the capsule.

Inside the capsule, multiple medications are packed in separate compartments. Each is designed to release its contents at a predetermined time. The medications are separated by barriers made of a lactose and maltose matrix embedded with a pH-responsive polymer. This polymer shields the medications from stomach acid but dissolves in a more alkaline environment.

By adjusting the density of this polymer, researchers can control how long it takes for each barrier to dissolve, ensuring that medications are released at precisely timed intervals.

The capsule's outer shell consists of a body and cap made from vegetable cellulose. The capsule's main body, where the medication compartments are housed, is protected by a pH-responsive polymer. The cap, which is unprotected, dissolves as soon as it lands in the stomach, which initiates the release of the first drug.

Timing isn't the capsule's only clever feature. The researchers also incorporated microscopic magnesium particles that function as tiny stirrers and last for a short time inside the body. They react with stomach acid to generate a stream of hydrogen bubbles—this movement stirs the capsule's contents and makes the drug easier to dissolve, which is especially useful for medications that require rapid uptake, such as pain relievers, cardiovascular drugs or emergency treatments.

The magnesium particles serve another function: they neutralize stomach acid, which temporarily creates a localized alkaline environment. This helps dissolve the pH-responsive polymer barriers to initiate release of the next drugs in line.

"This innovative daily capsule approach ensures day-long full compliance towards improved patient outcomes," said Wang.

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Wang's research group has pioneered the use of microsized particles such as these—which they've dubbed microrobots—for therapeutic purposes. They were the first to translate microrobots into living animal models, demonstrating their potential in treating a range of conditions, including lung infections and diseases that require intensive care. Their experience with microrobots laid the foundation for incorporating similar technology into the timed-release capsule.

All materials used to make the capsule are FDA approved. "This will help ensure an easy translation to market," said Abbas.

As a proof of concept, the researchers packed a capsule with three doses of levodopa, a medication for Parkinson's disease. Each dose was color-coded with food dye—yellow, green and red—to visually track its release in simulated stomach conditions.

The first dose, which was housed in a compartment containing magnesium stirrers, was designed for rapid release. The second and third doses, housed in compartments without the stirrers, were released at intermediate and slow rates, respectively. The experiment successfully demonstrated that the capsule could deliver drugs in distinct phases.

The team chose a Parkinson's disease medication as a test case for their capsule since it needs to be taken consistently every few hours to keep symptoms under control. "This timed release of multiple doses could really help patients with Parkinson's disease," said Abbas.

"If the drug level dips too low, patients will experience tremors and other motor symptoms. But if we can keep that level steady, we can also help keep a patient's movement stable. Our capsule has the potential to ensure this stability throughout the day—so patients don't have to worry about timing every dose perfectly."

Abbas also sees potential in using this capsule for combination therapies. Cardiovascular disease, for example, often requires patients to take a combination of aspirin, beta blockers and cholesterol-lowering drugs—each with its own dosing schedule.

By tailoring the capsule's compartments to release these medications in a precisely timed sequence, patients could receive their aspirin in the morning, their beta blocker in the afternoon, and their cholesterol medication at night—all from a single capsule. This approach could ensure that each drug is delivered when it is most effective, potentially reducing side effects and optimizing therapeutic benefits.

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OCCUPATIONAL

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