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ASIA PACIFIC

Cosmetics

2024-05-06

Cosmetics containing hazardous substances must meet the requirements of the standards for this group of products.

If you are importing or manufacturing cosmetic products, you must meet the conditions of the Cosmetic Products Group Standard.

The group standard includes a list of substances that cannot be used, as well as rules around quantities, labelling, packaging, and storage.

Read the Cosmetics Products Group Standard 2020 as amended in January 2024 (PDF, 7.2MB)

Cosmetics includes soap, shampoo, toothpaste, shaving products, deodorant, perfume, hair dye, insect repellent, sunscreen, self-tanning products, lipstick, and make-up such as foundation and eye shadow.

See Schedule 3 in the Group Standard for our definition of cosmetic and the explanatory note for more examples of what is considered a cosmetic in Aotearoa New Zealand.

Read More

NZ EPA, 06-05-24

https://www.epa.govt.nz/hazardous-substances/rules-notices-and-how-to-comply/specific-substance-guidance/cosmetics/

2023 Interim Review of the List of Deemed Disease in Australia report

2024-05-13

Safe Work Australia has published the 2023 Interim Review of the List of Deemed Disease in Australia report and a revised List of Deemed Diseases in Australia and Supporting Guidance Material.

The interim review was limited to considering the latest scientific evidence on COVID-19, cancers related to firefighter work, Japanese encephalitis, and other veterinarian diseases.

Based on the review findings, the List of Deemed Diseases in Australia has been updated to include malignant mesothelioma and bladder cancer related to firefighting and to remove COVID-19.

For more information, see the Safe Work Australia website.

Read More

Safe Work Australia, 13-05-24

https://www.safeworkaustralia.gov.au/doc/2023-interim-review-list-deemed-disease-australia-report

New model WHS Regulations will help protect workers from silicosis

2024-05-17

On Friday 10 May, WHS ministers agreed to 2 sets of amendments to the model WHS Regulations, which will help protect workers from silicosis, a lung disease caused by exposure to respirable crystalline silica.

These amendments give effect to the engineered stone ban from 1 July 2024 and provide stronger regulation of all materials containing crystalline silica from 1 September 2024. The first set of amendments to the model WHS Regulations includes 2 new national frameworks relating to the implementation of the engineered stone ban, one for notifying a WHS regulator about permitted work with legacy engineered stone and the other for applications for exemptions for certain types of engineered stone, from 1 July 2024. The second set of amendments will give effect to stronger regulation of all materials containing crystalline silica, from 1 September 2024.

Individual jurisdictions must make the amendments within their respective work health and safety laws to implement the ban in their jurisdiction from 1 July 2024 and the stronger regulation of all materials containing crystalline silica from 1 September 2024.

Learn more about the ban on our new look engineered stone ban website that provides everything you need to know about the ban in one place. Key features include an overarching timeline, overview of jurisdictional transitional arrangements, links to jurisdiction-specific resources, and frequently asked questions.

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We are currently developing guidance to support PCBUs understand how the amendments to the model WHS Regulations will affect them.

Read the meeting Communique published by the Department of Employment and Workplace Relations for more information about the meeting of WHS ministers.

APVMA to review industry fees and levies

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has met with key stakeholders to discuss the upcoming review of our cost recovery structure, including our fees and levies.

APVMA Acting CEO Dr Melissa McEwen met with industry stakeholders to open consultation and hear their perspectives.

"The APVMA is nearly 100% cost recovered, meaning we rely on fees and levies to fund our operations. Adequate fees from industry ensure the smooth operation of the APVMA, without unduly impacting the Australian taxpayer. I look forward to engaging with industry and community representatives in good faith on our fee structure," Dr McEwen said.

"We work tirelessly to ensure that Australia can have confidence in the safety of our agricultural sector. The APVMA has not increased our fees since 2020, and costs have risen significantly due to biosecurity incursions and inflation."

The APVMA is the independent regulator responsible for assessing and registering agricultural and veterinary chemicals. As an internationally trusted regulator we play a critical role in managing plant and animal pests and diseases. The APVMA uses a scientific, evidence-based approach and aligns our regulatory efforts with the risks posed by each product or chemical.

Read More

APVMA, 17-05-24

https://www.apvma.gov.au/about/access-information-held-apvma

AMERICA

Washington adopts rule to decrease methane emissions from landfills

2024-05-13

A new Washington regulation will help reduce emissions of methane, a potent greenhouse gas, from municipal solid waste landfills in the state.

Methane has more than 80 times the global warming potential of carbon dioxide over a 20-year period and is responsible for more than 25% of the temperature impacts coming from climate change today. In landfills, methane is produced by the decomposition of food, vegetation, and other organic materials.

Reducing landfill methane emissions is part of a suite of climate policies Washington has been implementing to meet a state commitment to reduce greenhouse gas emissions by 95% below 1990 levels by 2050.

Ecology estimates the new regulation will prevent the equivalent of about 1.6 million metric tons of carbon dioxide from escaping into the atmosphere every year, based on 20-year climate impacts for methane.

"Methane emissions are the second-largest contributor to climate change after carbon dioxide, and landfills are a significant source of this gas," said Laura Watson, director of the Washington Department of Ecology. "Along with this new rule designed to limit methane emissions at landfills, we are working hard to reduce the amount of food waste and other organic material we throw away, so we can stop the problem before it starts."

Read More

US State of Washington Department of Ecology, 13-05-24

https://ecology.wa.gov/about-us/who-we-are/news/2024-news-stories/new-rule-to-decrease-landfill-methane-emissions

Fire fighters in three cities begin to transition to PFAS-free gear

2024-05-16

San Francisco is the latest municipality to start phasing out fire fighter gear containing PFAS after its Board of Supervisors unanimously passed an ordinance declaring personal protective equipment must be PFAS-free by June 30, 2026.

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Local 798 and the San Francisco Firefighter Cancer Prevention Foundation (SFFCPF) were quick to contact the city administration and advocate for the change after the IAFF and the Metropolitan Fire Chiefs Association issued a joint advisory on the dangers of PFAS in fire fighter gear. The advisory urged IAFF Locals to lobby for PFAS-free gear as soon as possible to reduce cancer risk.

"Eliminating cancer from the fire service starts with removing this toxic bunker gear from use," said General President Edward Kelly. "As alternatives are tested and brought to market, all levels of government must ensure that our fire fighters are equipped with carcinogen-free gear."

Adam Wood, who serves as Local 798 secretary and SFFCPF Vice President, said the Board of Supervisors immediately supported the issue.

"When we began pushing for the creation of this ordinance, we held a rally in front of City Hall and laid old turnout gear on the steps. We wanted to call attention to the dangers of wearing gear containing a known carcinogen," Wood said. "The Board of Supervisors immediately understood that replacing both sets of gear was the right thing to do."

The cost is expected to be more than $10 million, and the city is making significant progress toward fully funding the change. Nearly $2 million has been earmarked in the budget to replace older gear and the city has been awarded a $2.3 million FEMA grant to purchase new gear.

Local 798 officials also believe they are closer to a day with PFAS-free gear because members have been participating in the IAFF's field test survey of new products. Several manufacturers have recently incorporated a non-fluorinated moisture barrier, along with a PFAS-free repellent outer shell coating, a crucial step in removing PFAS from all three levels of fire fighter gear.

Read More

International Association of Fire Fighters, 16-05-24

https://www.iaff.org/news/fire-fighters-in-three-cities-begin-to-transition-to-pfas-free-gear/

House Reps. Introduce Bipartisan Legislation To Ban Toxic Chemicals From Cosmetics And Personal Care Products

2024-05-10

Two House lawmakers introduced bipartisan legislation to ban toxic chemicals from cosmetics and personal care products.

Representatives Anna Paulina Luna (R- Fla.) and Yadira Caraveo (D- Colo.) unveiled the No Toxic Chemicals in Cosmetics Act on Friday. It aims to amend the Federal Food, Drug, and Cosmetic Act to declare cosmetics and sunscreens containing parabens as adulterated.

"The parabens lurking in our products is causing a lot of damage. They're in our sunscreens, our lotions, makeup especially, and yet we're doing nothing about it, which is completely outrageous," Luna said in a YouTube video.

Luna continued explaining how cosmetics and personal care products containing dangerous chemicals are being marketed and sold to Americans with little to zero regulation.

Caraveo, a physician, said that she's concerned about the potentially harmful parabens, which can cause skin cancer, hormonal disruption, and even birth defects.

"The dire reality is that nearly every adult in the U.S. displays traces of paraben contamination," Caraveo wrote.

Representative Troy Nehls (R- Texas) also joined the bipartisan duo as an original co-sponsor of the bill, citing his support as a father of three daughters.

"It is extremely concerning that our country has not taken action to protect consumers from harmful chemicals like parabens, which are found in cosmetic products," Nehls wrote.

In recent years, researchers have sounded the alarm about cancer-causing or potentially toxic chemicals found in a variety of products, including sunscreen, dry shampoo, and deodorant.

Experts believe this explains the rise of consumer demand for "clean" products that are free from parabens, sulfates, phthalates, among other chemicals.

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Read More

OAN, 10-05-24

https://www.oann.com/newsroom/house-reps-introduce-bipartisan-legislation-to-ban-toxic-chemicals-from-cosmetics-and-personal-care-products/

EUROPE

Expert analysis: EU Commission's communication on Essential Use

2024-05-06

First of all, the communication that the EU Commission published last week was long-awaited. According to the Chemical Strategy for Sustainability, it should've come already two-three years ago. But the wait has not been in vain.

The Commission's communication on the concept of Essential Use recalls important commitments of the Chemical Strategy and clarifies both the need to phase out the most harmful substances and the fact that no use can be considered essential if alternatives are available.

Positive takeaways

The focus on preventing harm from the most harmful substances is crystal clear, leaving no room for misinterpretations — let's start with that. This is hugely important.

So is the fact that the Commission uses adequate terminology when trying to come to grips with the concept. Essential use ultimately boils down to the fundamental question: "When is it justified to use the most harmful substances". The communication is spot-on in here.

Read More

Chemsec, 06-05-24

https://chemsec.org/expert-analysis-eu-commissions-communication-on-essential-use/

DG SANTE updates on FCM regulation and BPA restriction

2024-05-17

On May 6 – 7, 2024, the European Commission's working group on food contact materials (FCMs) reconvened to present the status of the FCM regulation revision and the ban on the use of bisphenol A (BPA) and other hazardous bisphenols in FCMs. The working group is hosted by the directorate general for health DG SANTE.

DG SANTE officials indicated that a study to determine the definition of sustainable FCMs should be completed by February 2025. The study was originally scheduled for publication in mid to late 2024 with the policy impact assessment and public consultation in early 2025 (FPF reported). Preliminary results seem to agree that FCMs are unsustainable and that "plastics (a large share of which is used in food packaging) alone undermine all planetary boundaries," according to the presentation slides.

Concerning the BPA restriction, the Commission is requesting final remarks and comments from Member States by May 17, 2024. The restriction encompasses a "ban on use of BPA as a monomer or other starting substance in the manufacture of FCM and placing on market of FCMs made using BPA", as well as the use of other bisphenols that are carcinogenic, mutagenic, toxic to reproduction, or endocrine disrupting (FPF reported and here). Should the regulation be approved by Member States, it will be transmitted to the European Parliament and Council on July 10, 2024.

Read More

FPF, 17-05-24

https://www.foodpackagingforum.org/news/dg-sante-updates-on-fcm-regulation-and-bpa-restriction

INTERNATIONAL

F-gases unveiled as primary contributors to the PFAS pollution crisis

2024-05-16

Imagine you're inside a steel factory, and a highly advanced cybernetic organism from the future is moving towards you on a mission to kill you.

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It's been chasing you for days, but you've managed to escape it narrowly every time. With every second, it is inching closer. If you let this robot get to you, the planet will be ruled by its evil robot friends in the future. You're out of ideas. What do you do?

Sorry, we don't have a clue what you should do. But we know what not to do. You should not do like John Connor and company in Terminator 2 and cover the whole friggin' place in halon gas – that's a massive source of f-gas emissions!

Sure, you might save humanity from a future without evil robots, but you would instead have a heavily polluted planet.

But wait a minute. That last part has actually already happened.

Due to the abundant use of f-gases in most of the world's heating and cooling systems, such as your heat pump, refrigerator, car's air conditioner, or – as in the case of Terminator 2 – a factory fire suppressant system, our planet now faces several challenges, such as ozone depletion and PFAS pollution. Leaving the ozone layer aside for now and looking at the PFAS part of f-gases, the annual emissions from this use sit at a whopping 63 per cent. That's right – f-gas emissions are responsible for over half of all PFAS pollution – every year.

The annual volumes of PFAS in the form of f-gases are similar; 59 per cent of* all PFAS goes towards this end. How can this be?

Read More

Chemsec, 16-05-24

https://chemsec.org/f-gases-unveiled-as-primary-contributors-to-the-pfas-pollution-crisis/

2023 Report of National and ECHA Helpdesks Activities

2024-05-07

This report summarises the activities of the national helpdesks1 (hereinafter NHDs) and the ECHA helpdesks during the year 2023, providing a good picture of the scale and scope of the HelpNet activities.

The HelpNet2 is a network that brings together representatives of the European Commission ECHA, national BPR, CLP, and REACH helpdesks, candidate/third countries and industry observers3.

The purpose of HelpNet is to enhance cooperation between its members on matters of mutual interest, in particular through information exchange, cooperation and mutual support, and in accordance with their respective mandates.

Each year, the national BPR, CLP and REACH helpdesks report to ECHA on their activities, workload, internal organisation, customers' support and cooperation with ECHA and within the network. The HelpNet Secretariat collected the reported information covering activities of the NHDs in 2023 through a web-based survey4 over the period December 2023 to February 2024. In 2023, the National Helpdesks (NHDs) addressed nearly 45 000 inquiries, while the European Chemicals Agency (ECHA) Helpdesk handled over 9 210 questions, encompassing regulatory and IT tool-related queries. For the first time, NHDs and the ECHA Helpdesk identified 'hot topics', reflecting newly emerging themes or questions generating high interest or requiring specific discussions.

Despite a decrease in queries since the peak in 2020, the BPR remained the regulation generating the highest number of inquiries for the NHDs. Similarly, REACH continued to dominate ECHA's inquiries, notably in registration and communication in the supply chain areas. A notable trend in 2023 was the rising interest in restrictions, with inquiries focusing on new and proposed restrictions of broad scope. Although the number of CLP inquiries decreased overall, questions related to Annex VIII and Poison Centre Notification (PCN) duties persisted.

Most NHDs reported stable resource allocation, with an average response time of just over six days. In collaboration with the HelpNet members, ECHA increased cooperation through various channels, including 26 meetings, regulatory workshops, and video conferences.

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The main activities and new initiatives of the network are presented in a dedicated section of this report (see section 5. Cooperation between the National Helpdesks and ECHA).

Read More

ECHA, 07-05-24

https://echa.europa.eu/documents/10162/17071/nhd_activities_2023_en.pdf

UK REACH - PFAS firefighting foams - Call for evidence

2024-05-16

We are gathering information and evidence relating to firefighting foams which contain per- and polyfluoroalkyl substances (PFAS).

In the first instance, we would like stakeholders to identify themselves as willing to engage in further dialogue with the Agency throughout the restrictions process. In particular, we would like to hear from stakeholders with relevant information on PFAS (or alternatives) in firefighting foams, especially information specific to Great Britain.

Regarding relevant information, we are interested in all aspects of firefighting foams, especially those that include PFAS. This includes but is not limited to:

- **Manufacture of firefighting foams:** substances used, process, quantities
- **Import of firefighting foam products of all types:** quantities, suppliers
- **Use:** quantities, sector of use, frequency, storage on site, products used
- **Alternatives to PFAS in firefighting foams:** availability, cost, performance in comparison to PFAS-containing foams, barriers to switching
- **Hazardous properties:** safety data sheets, new studies on intrinsic properties and exposure, recommended risk management measures
- **Environmental fate:** what happens to the foam after it is used, where does it go?
- **Waste:** disposal requirements, recycling opportunities, remediation
-

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- **Standards:** including product specific legislation, performance, certification

Read More

HSE UK, 16-05-24

https://consultations.hse.gov.uk/crd-reach/pfas-fire-fighting-foams/

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Janet's Corner

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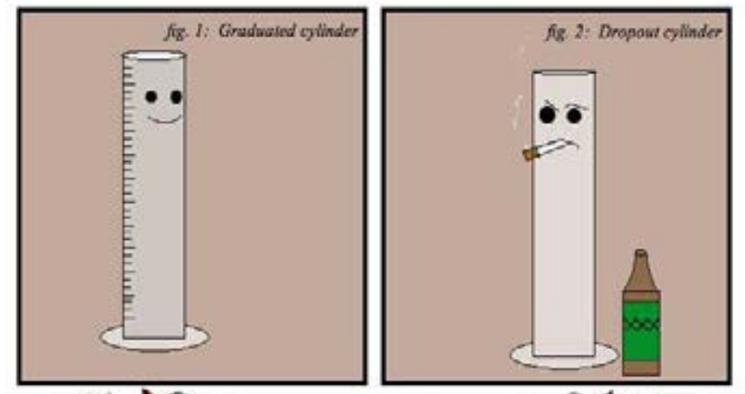
The Cylinders

2024-05-27



https://2damnfunny.com/

Styrene

2024-05-27

Pure styrene is a colourless to yellowish oily liquid that evaporates easily and has a sweet smell. It is often mixed with other substances that give it a sharp smell. It is flammable. [1,2]

USES [2,3]

When it is linked together in long chains, or polymerised, styrene is used predominantly in the production of polystyrene plastics and resins, such as in insulation or in the fabrication of fibreglass boats; most styrene products contain a residue of unlinked styrene. Styrene is also used to make rubber, and as an intermediate in the synthesis of materials used for ion exchange resins and to produce copolymers such as styrene-acrylonitrile, acrylonitrile-butadiene-styrene, and styrene-butadiene rubber.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- **Industry sources:** Styrene will be emitted to air from industrial process that use or manufacture the material or where it is formed as a by-product.
- **Diffuse sources:** Styrene is present in combustion products such as cigarette smoke.
- **Natural sources:** Low levels of styrene occur naturally in a variety of foods, such as fruits, vegetables, nuts, beverages, and meats.
- **Transport sources:** Styrene is present in car exhaust.
- **Consumer products:** Products produced from styrene include packaging, electrical and thermal insulation, fibreglass, pipes, car parts, drinking cups and other food-use items, and carpet backing.

Routes of Exposure

The routes of exposure to styrene are through:

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

Styrene, also known as ethenylbenzene, vinylbenzene, and phenylethene, is an organic compound with the molecular formula C8H8.[1]

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HEALTH EFFECTS [4]

Acute Health Effects

The following acute (short-term) health effects may occur immediately or shortly after exposure to phenanthrene:

- Acute exposure to styrene in humans results in respiratory effects, such as mucous membrane irritation, eye irritation, and gastrointestinal effects.
- Tests involving acute exposure of rats and mice have shown styrene to have low to moderate toxicity by inhalation and oral exposure.

Carcinogenicity

- Several epidemiologic studies suggest that there may be an association between styrene exposure and an increased risk of leukaemia and lymphoma. However, the evidence is inconclusive due to multiple chemical exposures and inadequate information on the levels and duration of exposure.
- Animal cancer studies have produced variable results and provide limited evidence for carcinogenicity.
- IARC has classified styrene as a Group 2B, possibly carcinogenic to humans.
- Styrene oxide is a reactive metabolite of styrene and shows positive carcinogenic results in oral exposure bioassays. Styrene oxide has been detected in workers exposed to styrene. IARC has classified this metabolite as a Group 2A, probable human carcinogen.
- EPA does not have a carcinogen classification for styrene; the chemical currently is undergoing an EPA Integrated Risk Information System (IRIS) review to establish such a classification.

Other Effects

- Phenanthrene may cause a skin allergy. If allergy develops, very low future exposure can cause itching and a skin rash.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids

open. Cold water may be used. Do not use an eye ointment. Seek medical attention.

- **Skin Contact:** After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.
- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** Allow the victim to rest in a well-ventilated area. Seek immediate medical attention.
- **Ingestion:** Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Workplace Controls & Practices [4]

Control measures include:

- The following engineering controls should be provided when handling styrene:
- Exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value.
- Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protective Equipment [5]

The following personal protective equipment should be used when handling styrene:

- Splash goggles;
- Lab coat;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves.

Personal Protective Equipment in Case of a Large Spill:

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

REGULATION

United States

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA Permissible Exposure Limit (PEL) – General Industry See 29 CFR 1910.1000 Table Z-2 (See also ANSI Z37.15-1969)	100 ppm TWA 200 ppm Ceiling Exception to ceiling value: 600 ppm (peak), for a single time period up to 5 minutes for any 3 hours	HE7	Central nervous system depression
		HE11	Irritation of the lungs
		HE15	Eye, nose, and skin irritation
OSHA PEL – Construction Industry See 29 CFR 1926.55 Appendix A	100 ppm (420 mg/m³) Ceiling	HE7	Central nervous system depression
		HE11	Irritation of the lungs
		HE15	Eye, nose, and skin irritation
OSHA PEL – Shipyard Employment See 29 CFR 1915.1000 Table Z-Shipyards	100 ppm (420 mg/m³) TWA	HE7	Central nervous system depression
		HE11	Irritation of the lungs
		HE15	Eye, nose, and skin irritation

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)	50 ppm (215 mg/m³) TWA 100 ppm (425 mg/m³) STEL	HE2	Mutagenic effects, including cytogenic changes
		HE7	Central nervous system depression
		HE8	Narcosis
		HE15	Eye, nose, throat, and skin irritation
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2001) (Listed under Styrene, Monomer)	20 ppm TWA 40 ppm STEL A4; BEI	HE2	Chromosomal abnormalities in peripheral lymphocytes
		HE7	Central nervous system depression; peripheral nervous system impairment; optic and otoneurologic impairment
		HE15	Irritation of eyes, mucous membranes, upper respiratory system, and skin
CAL/OSHA PELs	50 ppm (215 mg/m³) TWA 500 ppm Ceiling 100 ppm (425 mg/m³) STEL Skin		

References

1. http://en.wikipedia.org/wiki/Styrene
2. http://www.npi.gov.au/resource/styrene-ethenylbenzene
3. http://www.cdc.gov/niosh/npg/npgd0571.html
4. http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=420&tid=74

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5. http://www.epa.gov/ttn/atw/hlthef/styrene.html
6. http://www.sciencelab.com/msds.php?msdsId=9925112
7. https://www.osha.gov/dts/chemicalsampling/data/CH_268200.html

Scientists Determine Properties of Extremely Rare Element: Promethium

2024-05-22

Discovered in 1945 at Clinton Laboratories, promethium is a lanthanide element with symbol Pm and atomic number 61.

It is named after the mythological Titan who delivered fire to humans and whose name symbolizes human striving.

Some of its properties have remained elusive despite the rare earth element's use in medical studies and long-lived nuclear batteries.

"The whole idea was to explore this very rare element to gain new knowledge," said Dr. Alex Ivanov, a researcher at Oak Ridge National Laboratory.

Dr. Ivanov and his colleagues prepared a chemical complex of promethium, which enabled its characterization in solution for the first time.

Thus, they exposed the secrets of this element in a series of meticulous experiments.

"Because it has no stable isotopes, promethium was the last lanthanide to be discovered and has been the most difficult to study," said Dr. Ilja Popovs, also from Oak Ridge National Laboratory.

"There are thousands of publications on lanthanides' chemistry without promethium. That was a glaring gap for all of science," said Dr. Santa Jansone-Popova, also from Oak Ridge National Laboratory.

"Scientists have to assume most of its properties. Now we can actually measure some of them."

The researchers bound, or chelated, radioactive promethium with special organic molecules called diglycolamide ligands.

Then, using X-ray spectroscopy, they determined the properties of the complex, including the length of the promethium chemical bond with neighboring atoms — a first for science and a longstanding missing piece to the periodic table of elements.

Unlike other rare earth elements, only minute quantities of synthetic promethium are available because it has no stable isotopes.

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For the study, the scientists produced the isotope promethium-147, with a half-life of 2.62 years, in sufficient quantities and at a high enough purity to study its chemical properties.

Notably, they provided the first demonstration of a feature of lanthanide contraction in solution for the whole lanthanide series, including promethium, atomic number 61.

Lanthanide contraction is a phenomenon in which elements with atomic numbers between 57 and 71 are smaller than expected.

As the atomic numbers of these lanthanides increase, the radii of their ions decrease.

This contraction creates distinctive chemical and electronic properties because the same charge is limited to a shrinking space.

The authors got a clear promethium signal, which enabled them to better define the shape of the trend — across the series.

"It's really astonishing from a scientific viewpoint. I was struck once we had all the data," Dr. Ivanov said.

"The contraction of this chemical bond accelerates along this atomic series, but after promethium, it considerably slows down."

"This is an important landmark in understanding the chemical bonding properties of these elements and their structural changes along the periodic table."

"The achievement will, among other things, ease the difficult job of separating these valuable elements," Dr. Jansone-Popova said.

"Our team has long worked on separations for the whole series of lanthanides, but promethium was the last puzzle piece. It was quite challenging."

"You cannot utilize all these lanthanides as a mixture in modern advanced technologies, because first you need to separate them."

"This is where the contraction becomes very important; it basically allows us to separate them, which is still quite a difficult task."

"Anything that we would call a modern marvel of technology would include, in one shape or another, these rare earth elements," Dr. Popovs said.

"We are adding the missing link."

The team's paper appears today in the journal Nature.

Science News, 22 May 2024

https://sci.news

Scientists say they can make zero-emission cement

2024-05-25

Researchers on Wednesday said they were a step closer to solving one of the trickiest problems in tackling climate change—how to keep making cement despite its enormous carbon footprint.

In a world first, engineers from Britain's University of Cambridge have shown that cement can be recycled without the same steep cost to the environment as making it from scratch.

Cement binds concrete together but the whitish powder is highly carbon-intensive to produce, with the sector generating more than triple the emissions of global air travel.

Demand for concrete—already the most widely used construction material on Earth—is soaring, but the notoriously polluting industry has struggled to produce it in a less harmful way to the climate.

The team at Cambridge believes it has a solution, pioneering a method that tweaks an existing process for steel manufacturing to produce recycled cement without the associated CO2 pollution.

This discovery, published in the journal Nature, could provoke "an absolutely massive change" by providing low-cost and low-emission cement at scale, said Julian Allwood, who co-authored the research.

"It is an extremely exciting project... I think it's going to have a huge impact," said Allwood, an expert on industrial emissions and key contributor to reports from the UN's scientific panel on climate change.

To produce cement, the basic ingredient in concrete, limestone must be fired in kilns at very high temperatures usually achieved by burning fossil fuels like coal.

On top of that, limestone produces significant additional CO2 when heated.

'Bright hope'

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The cement industry alone accounts for nearly eight percent of human-caused CO2 emissions—more than any country except China and the United States.

Some 14 billion cubic meters of concrete are cast every year, according to industry figures, and more still will be needed as economies and cities grow in future.

The International Energy Agency says that if emissions from the cement industry continue to increase, a pledge of carbon neutrality by 2050 will almost certainly remain out of reach.

Many efforts to produce low-carbon or so-called "green cement" are too expensive or difficult to deploy at scale, rely on unproven technologies, or don't come near zero emissions.

The Cambridge researchers approached the problem by looking at an industry that was already well established—steel recycling, which uses electric-powered furnaces to produce the alloy.

They substituted a key ingredient in that process with old cement sourced from demolished buildings, Allwood said.

Instead of waste being produced, the end result was recycled cement ready for use in concrete, bypassing the emissions-heavy process of superheating limestone in kilns.

This method—which has a patent pending—was "a very low disruption innovation" requiring little change or additional cost on the part of business, Allwood said.

If powered by renewable energy, he said, these furnaces could hope to produce zero-emission concrete at scale.

"Once the electricity has no emissions, then our process would have no emissions," Allwood said.

Countries could not hope to bring CO2 emissions to zero by 2050—the key pledge of the Paris climate agreement—using concrete as it exists today, he added.

"This is the big bright hope, I think," Allwood said.

Phys Org, 25 May 2024

https://phys.org

Playing with plastic toy building bricks creates microplastic and nanoplastic pollution

2024-05-21

It's one of the most popular and creative toys around, but playing with plastic building bricks could create something much less desirable in households and childcare settings: large amounts of micro- and nanoplastic particles. While it remains unknown whether such plastic particles pose any risk to health, the findings add yet another source of emerging indoor pollutants and the researchers recommend caution to avoid inhaling or swallowing them.

It's widely known that micro- and nanoplastics are ubiquitous in the environment, originating from all sorts of plastic materials we touch and use every day from food packaging and plastic cookware, to carpets, clothes and children's toys. However, there are still big gaps in our understanding of the origins and fate of these tiny particles and, until now, nobody had explored toy building bricks as a potential source of them.

'My research interest is in environmental pollutants and remediation and my daughter likes toy building bricks very much,' says Cheng Fang who led the work at the University of Newcastle in Australia. 'I play with her and so I wondered if there might be some concerns from an emerging contamination point of view.'

To find out, Cheng's team opened fresh packets of plastic bricks, selected 50 different kinds and assembled and disassembled each of them 10 times. Before and after images were taken with a scanning electron microscope (SEM), which revealed that a small number of particles were initially present due to the manufacturing process but their abundance was far greater following simulated play.

The images suggest that friction from repeatedly connecting and disconnecting bricks generated scratches and scuffs where micro- and nano-sized particles formed, predominantly at the tip of the interlocking studs, as well as along their length and inside the stud receptacles. Combining the SEM images with statistical analysis, the team estimated the number of particles generated, finding that every square millimetre of the blocks under clicking and unclicking stress were producing thousands of microparticles and hundreds of thousands of nanoparticles (smaller than 20μm).

Raman spectroscopy, coupled with an algorithm, helped to identify which polymers the particles were made from based on their molecular spectral signatures. The algorithm enhanced the signal-to-noise ratio in the Raman spectra by making the peaks stand out from background noise, which was crucial in order to get meaningful readings of the nano-sized particles.

Results showed that the particles were either ABS (acrylonitrile butadiene styrene) or polycarbonate, both used to make toy building bricks, including Lego. While these are deemed to be safe and non-toxic plastics, some studies have found that fumes and fine particles of ABS produced by 3D printing could be toxic. However, whether micro- and nano-sized particles from toys such as building blocks pose a health risk if inhaled or ingested remains an open question.

'That we are generating microplastics from plastic play blocks is not unexpected,' says pollution expert Fay Couceiro, who leads the University of Portsmouth's microplastic research group in the UK. 'What is interesting in this work are the methods for nanoplastic estimation.' She explains that nanoparticles are usually too small for traditional spectroscopy methods to detect. 'While there is still further work to do validating the method, such as ensuring there is no background interference, it is a promising line of investigation for future nanoplastic work.'

Cheng agrees that finding so many particles wasn't surprising. He highlights that the toxicity of microplastics and nanoplastics in our daily lives is still unknown and needs to be investigated. In the meantime, he recommends that when children play with plastic bricks they are always supervised by an adult to minimise the exposure risk. 'During play, do not eat, suck fingers or drink,' he explains. 'After play, I recommend hand washing.'

'Unfortunately, plastic surrounds us and our children,' says Couceiro. She suggests that putting these results in a wider context is important. 'How do the numbers of micro- and nanoplastics released from building blocks compare to other sources and what is their risk to human health? To understand where best to enact legislation, we need a full understanding of all the sources of microplastics and nanoplastics, and to understand their fate.'

Chemistry World, 21 May 2024

https://chemistryworld.com

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‘Most Delicious Poison’ explores how toxins rule our world

2024-11-20

After his father’s unexpected death from alcohol use disorder in 2017, evolutionary biologist Noah Whiteman undertook a journey to understand how nature’s toxins affect the world. The result is his debut book, Most Delicious Poison: The Story of Nature’s Toxins — From Spices to Vices.

The book weeds through chemistry, evolution and world history to explore the origins of toxins and how humans have co-opted them for everything from medicines to spices to pesticides. “The chemicals in these products of nature are not a sideshow — they are the main event,” Whiteman writes, “and we’ve unwittingly stolen them from a war raging all around us.”

That tussle, part of what Charles Darwin called the “war of nature,” is the innovative ways plants and animals continuously evolve traits that one-up their predators or competitors. Many of the chemicals that we stock in our cabinets and pharmacies, for instance, originated in plants as deterrents against insects snacking on them, Whiteman points out. These chemicals act on our brains and bodies thanks to the surprising neurological similarities between insects and humans.

Whiteman, who studies how insects adapt to plant toxins, is a knowledgeable tour guide through this greenhouse of poisons and cures. And it is a greenhouse. Though people put some animal-made toxins to use, the plant derivatives steal the show.

Chrysanthemums with their insecticidal compound, pyrethrin, make an appearance in the book, as do terpenoid-wafting pines, calming chamomile and morphine-like water lilies. To tame the tangle of chemicals and their interactions, Whiteman dedicates each chapter to a couple of toxin classes and lays out their source in the natural world, their chemical mechanisms and historical context for their use by people.

Take tannins. They show up in a wide array of plants, including oaks, tea plants and grapes. Whiteman muses that these chemical compounds may protect plants by inhibiting the ability of microbes and herbivores to absorb nutrients. Tannins also bind to salivary proteins, resulting in the “rough, dry puckering sensation” that many people enjoy while sipping a glass of Cabernet Sauvignon. Humans have also long put the protein-binding properties of tannins to use in tanning animal hides for leather. For nearly 1,500 years, Europe and then its colonies

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relied on ink manufactured from tannin-rich oak galls for drafting important documents, including the Magna Carta and the Declaration of Independence.

Perhaps the most important role of toxins in the human world can be found in our pantries and medicine cabinets. Whiteman focuses on pharmacological heavyweights such as the antimalarial drug quinine, derived from the bark of the cinchona tree, and salicylates, such as aspirin and oil of wintergreen. Curare, cocaine and scopolamine demonstrate how we’ve wrangled these alkaloids into anesthetics. It’s one of many instances where Whiteman nods to Indigenous communities around the world that have been repeatedly exploited or gone uncompensated for their medicinal discoveries.

“It is no wonder that many countries in Latin America and elsewhere in the global tropics now have biopiracy laws that strictly regulate the export of natural products,” Whiteman notes.

Whiteman closes by examining how medieval Europe’s lust for spices catapulted the world into five centuries of geopolitical upheaval. The Columbian exchange, the Opium Wars and the founding of the East India Company are all pit stops along Whiteman’s exploration of how the pursuit of all things psychoactive and medicinal fueled European colonialism. The lasting consequences, Whiteman argues, include infringement on Indigenous rights, global biodiversity loss and the climate crisis.

The opioid epidemic and alcohol use disorder also loom large in the book. Here, Whiteman’s assertion that our use of toxins “walk[s] a knife’s edge between healing and harm” is loudest. His father haunts many of the personal anecdotes sprinkled throughout the 304-page read. Whether he’s recalling the toxicology report from his father’s autopsy or noting his family’s fondness for black pepper, Whiteman explores grief as much as he does science: “My attempt to grasp why [my father] died allowed me to identify and then draw together the many ways that nature’s toxins affect the world.”

Personal and well-researched, Most Delicious Poison has wide appeal, in part, as Whiteman points out, because indulging in nature’s toxins “is an essential part of what it means to be human.” So go ahead. Pour a cup of

herbal tea, add some drops of lavender oil to the diffuser and enjoy this mind-bending read.

Science News, 20 November 2023

https://sciencenews.org

New study offers a cleaner path for controlling water, transforming greenhouse gases

2024-05-24

Scientists looking to convert carbon dioxide into clean fuels and useful chemicals often make hydrogen gas and carbonates as unwanted byproducts. A new paper from the UChicago Pritzker School of Molecular Engineering has found a cleaner path.

Carbon dioxide is the greenhouse gas, singlehandedly responsible for 78% of the change in energy balance in Earth's atmosphere between 1990 and 2022.

A byproduct of burning fossil fuels, carbon dioxide enters the atmosphere from car exhaust and coal-fired power plants. Even some renewable energy resources produce a small amount of carbon dioxide, although at a tiny fraction of the amount coal and natural gas create.

At its core, this molecule is just an arrangement of one carbon and two oxygen atoms that can be reorganized through a process called electrochemical carbon dioxide reduction (CO2R) into clean fuels and useful chemicals. But the process is often done at a loss, with competing processes pulling the atoms in unwanted directions that create unwanted byproducts.

In a paper published today in Nature Catalysis, researchers from the UChicago Pritzker School of Molecular Engineering's Amanchukwu Lab outlined a way to manipulate water molecules to make CO2R more efficient, with the ultimate goal of creating a clean energy loop.

Through their new method, the team was able to perform CO2R with nearly 100% efficiency under mildly acidic conditions, using either gold or zinc as catalysts.

"Imagine we can have green electricity from solar and wind, and then use this electricity to convert any carbon dioxide back into fuels," said PME Ph.D. candidate Reggie Gomes, first author of the new paper.

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Competing with HER

Electrochemically disassembling a molecule is like the break shot in a game of pool. The previous arrangement disappears and the balls scatter across the table, coming to rest in new combinations—not always the ones the player intended.

Similarly, researchers performing CO2R use electricity and water to break up and rearrange the harmful greenhouse gas. This sends atoms of carbon and oxygen from the carbon dioxide caroming across the table with hydrogen atoms from the water.

If it works as intended, the atoms form other, more desirable molecules that can be used as fuels or chemicals.

But as the atoms scatter, stable pairings of two hydrogen atoms often form, a process called the hydrogen evolution reaction (HER). This makes CO2R less efficient, as energy and atoms that become hydrogen gas can't be part of the molecules the scientists were trying to create.

Even in small quantities of water, CO2R is always competing with HER.

The Amanchukwu Lab—which is most notable for its battery research—applied insights from aqueous batteries to the problem, hypothesizing that controlling the water with organic solvents could provide a solution.

All that glitters

Both CO2R and HER rely on water as a proton donor. Using organic solvents and acid additives, the team was able to tune the water behavior, finding the sweet spot where it donated the right amount of protons to create the intended molecules, not the hydrogen gas and other unwanted materials like carbonates.

"In general chemistry we learn that carbon dioxide reacts with hydroxide to form carbonate. That's undesired because it depletes the molecule we want to valorize," said Neubauer Family Assistant Professor of Molecular Engineering Chibueze Amanchukwu.

Many of the most-effective ways to perform CO2R rely on precious metals.

"Platinum, silver, gold—for research purposes, they're great catalysts," Gomes said. "They're very stable materials. But when you're thinking about industrial applications, they become cost-prohibitive."

By engineering the electrolyte, the new method can get similar results using cheaper, more abundant materials.

"Right now, the best way to do this electrochemically at room temperature is to use precious metals. Gold and silver can suppress the hydrogen evolution reaction a little bit," Amanchukwu said. "Because of our discovery, we can now use an earth-abundant metal, zinc, because we now have a separate way to control water."

Phys Org, 24 May 2024

https://phys.org

Spiky stainless steel and copper delivers one-two punch to bacteria

2024-05-22

To help combat the rise of antibiotic-resistant bacteria, researchers have been experimenting for years with drug-free methods to blast disease-causing bugs. A new type of stainless steel does exactly that, in a convenient and affordable way.

According to a global survey described in the journal Nature, in 2019 alone, antibiotic-resistant bacteria killed more people than HIV/AIDS or malaria. The superbugs were implicated in nearly five million deaths, directly causing over 1.27 million fatalities. A report from the UN's Environment Programme says that the WHO lists antimicrobial resistance (AMR) as one of the top 10 global threats to health, and that by 2050, up to 10 million additional deaths could be caused by bugs that have evolved to avoid our drugs. That would be on par with the number of global deaths from cancer in 2020.

Understandably concerned about numbers like these, researchers from Georgia Tech set out to attack AMR mechanically instead of chemically. In particular, they sought to combat Gram-negative bacteria such as E. coli, cholera, and salmonella because they contain a protective capsule that makes them particularly good at fighting back against traditional antibiotics.

"Killing Gram-positive bacteria without chemicals is comparatively easy but tackling Gram-negative bacteria poses a significant challenge, due to their thick, multilayered cell membrane," said Anuja Tripathi, the study's lead author. "And if these bacteria persist on surfaces, they can grow

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rapidly. I aimed to develop an antibiotic-free bactericidal surface effective against Gram-negative and Gram-positive bacteria."

Using an electrochemical process, Tripathi's team etched the surface of stainless steel to create thousands of tiny microspikes. They then bonded copper ions to the surface of the steel, again using electrochemistry. The result is a material that blasts AMR bugs two ways. The spikes shred their protective outer membranes, and the copper – which has been known for its antibacterial qualities since ancient Egyptian times – further degrades their cellular membranes.

In tests, the steel and copper material reduced Gram-negative E. coli by 97% and led to a 99% reduction in Gram-positive Staphylococcus epidermis bacteria. The material was shown to achieve these results in only 30 minutes.

The fact that the new material only contains a very thin layer of copper means it sidesteps the high cost of the material, thus keeping the new steel/copper combo affordable. And because it shreds bacteria with its spikes, it should keep the bugs from evolving the means to escape death, as they can do with chemical treatment methods.

This is not the first time we've seen materials that use mechanical methods to shred resistant bacteria. This year alone, we've reported on a spiky titanium material inspired by dragonfly wings that shreds a common respiratory virus, and spikes on a nanocrystal that spin up under light to dice up bacteria. The Georgia Tech study takes things a step further with the addition of copper and, based on the dire warnings of health agencies regarding AMR, can we really have enough ways to fight the attack of the superbugs?

The research has been published in the journal, Small.

New Atlas, 22 May 2024

https://newatlas.com

Synthetic Antibiotics Could Improve Treatment of "Superbugs"

2024-05-07

Antimicrobial resistance (AMR) is an increasing cause for concern, with "superbugs" causing over 2.8 million infections in the United States each year. In a study published in the European Journal of Medicinal Chemistry, researchers from the University of Liverpool set out to synthesize highly

potent analogs of an antibiotic called teixobactin to improve treatments for drug-resistant infections.

Technology Networks spoke to Dr. Ishwar Singh, a reader in pharmacology and therapeutics at the University of Liverpool and co-author of the study, to learn more about the challenges of drug-resistant infections, the discovery of teixobactin and the benefits of synthetic antibodies.

Kate Robinson (KR): How critical is finding a solution to antibiotic resistance?

Ishwar Singh (IS): Nearly 5 million people sadly lose their lives due to antibiotic resistance-associated infections per year, and millions more live with treatment failure. Therefore, developing innovative antibiotics to tackle resistant bacterial infections is important.

To address this challenge, we aspire to bring new hope to improve and save lives globally by refreshing the antibiotic development pipeline with innovative antibiotics, such as new classes of antibiotics that attack bacteria on multiple fronts.

KR: How are drug-resistant infections affecting the population?

IS: Antimicrobial resistance is labeled a silent pandemic, impacting the population globally. Without action, 10 million people are predicted to succumb to drug-resistant infections each year by 2050, according to the AMR review commissioned by the UK Government in 2014. There are real people behind these numbers.

KR: What is teixobactin and how was it discovered?

IS: Teixobactin is an antibiotic that was discovered in a screen of uncultured bacteria in 2015, and it has been described as a "game changer" in the fight against antimicrobial resistance, given its ability to kill bacteria without detectable resistance, which is associated with its ability to attack bacteria on multiple fronts. It was isolated from soil bacteria that use teixobactin as a chemical weapon to kill other soil bacteria.

KR: Why was a synthetic version of teixobactin produced, and how was this done?

IS: It is important to understand why we need a synthetic version of teixobactin. Drug development has a high attrition rate due to stringent safety and efficacy requirements. A single natural teixobactin is unlikely to reach the clinic due to all these challenges. Therefore, a library of molecules is desirable, however, this is not a viable option for natural

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teixobactin due to several bottlenecks. Its synthesis is challenging and gives low yields, and it needs a prohibitively expensive and cationic amino acid building block for high potency against multi-drug–resistant bacterial pathogens.

We have simplified the teixobactin molecule by swapping out certain amino acids to reduce the cost and automated the process, speeding up a single coupling step from 30 hours to 10 minutes in high yields. We use commercially available low-cost alternatives, and the cost has been reduced by more than 2000 times, while the efficacy and safety of the molecule has been improved.

Our simplified teixobactins successfully eradicated methicillin-resistant Staphylococcus aureus (MRSA) in mice and were found to accumulate at sites of infection in amounts greater than that required to kill such "superbugs". We have also demonstrated the scalability at the gram scale, and producing at a larger scale, such as the kilo scale, is possible. All these are important requirements to develop viable antibiotics to address the silent pandemic globally.

KR: Do these analogs have any benefits over the natural molecules?

IS: We have a powerful modular platform based on our disruptive designs, which do not follow the literature.

Our platform enables synthetic diversity to select or deselect properties and edit the molecules to impact potency and other desirable drug-like qualities that are not accessible through natural teixobactin.

KR: How do you envision teixobactin molecules will be used in a clinical setting?

IS: Our goal is to have a number of viable drugs from our modular synthetic teixobactin platform, which can be used as a "last line of defense" against superbugs to improve and save millions of lives currently lost due to antibiotic resistance-associated infections. Importantly, our synthetic teixobactins killed a wide range of resistant bacteria, such as MRSA taken from human patients, where current antibiotics fail. Moreover, synthetic teixobactins are also stable at room temperature; a cold chain is not required. Therefore, they have the potential to tackle resistant bacterial infections in diverse clinical settings around the world.

Technology Networks, 7 May 2024

https://technologynetworks.com

Harvard Scientists Discover Quantum Order in Chemical Chaos

2024-05-26

Zoom in on a chemical reaction to the quantum level and you'll notice that particles behave like waves that can ripple and collide. Scientists have long sought to understand quantum coherence, the ability of particles to maintain phase relationships and exist in multiple states simultaneously; this is akin to all parts of a wave being synchronized. It has been an open question whether quantum coherence can persist through a chemical reaction where bonds dynamically break and form.

Now, for the first time, a team of Harvard scientists has demonstrated the survival of quantum coherence in a chemical reaction involving ultracold molecules. These findings highlight the potential of harnessing chemical reactions for future applications in quantum information science.

Experimental Breakthrough

"I am extremely proud of our work investigating a very fundamental property of a chemical reaction where we really didn't know what the result would be," said senior co-author Kang-Kuen Ni, Theodore William Richards Professor of Chemistry and Professor of Physics. "It was really gratifying to do an experiment to find out what Mother Nature tells us."

In the paper, published in Science, the researchers detailed how they studied a specific atom-exchange chemical reaction in an ultra-cold environment involving 40K87Rb bialkali molecules, where two potassium-rubidium (KRb) molecules react to form potassium (K2) and rubidium (Rb2) products. The team prepared the initial nuclear spins in KRb molecules in an entangled state by manipulating magnetic fields and then examined the outcome with specialized tools. In the ultra-cold environment, the Ni Lab was able to track the nuclear spin degrees of freedom and to observe the intricate quantum dynamics underlying the reaction process and outcome.

Research Team and Techniques

The work was undertaken by several members of Ni's Lab, including Yi-Xiang Liu, Lingbang Zhu, Jeshurun Luke, J.J. Arfor Houwman, Mark C. Babin, and Ming-Guang Hu.

Utilizing laser cooling and magnetic trapping, the team was able to cool their molecules to just a fraction of a degree above Absolute Zero. In this ultracold environment, of just 500 nanoKelvin, molecules slow down,

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enabling scientists to isolate, manipulate, and detect individual quantum states with remarkable precision. This control facilitates the observation of quantum effects such as superposition, entanglement, and coherence, which play fundamental roles in the behavior of molecules and chemical reactions.

Findings and Implications

By employing sophisticated techniques, including coincidence detection where the researchers can pick out the exact pairs of reaction products from individual reaction events, the researchers were able to map and describe the reaction products with precision. Previously, they observed the partitioning of energy between the rotational and translational motion of the product molecules to be chaotic [Nature 593, 379-384 (2021)]. Therefore, it is surprising to find quantum order in the form of coherence in the same underlying reaction dynamics, this time in the nuclear spin degree of freedom.

The results revealed that quantum coherence was preserved within the nuclear spin degree of freedom throughout the reaction. The survival of coherence implied that the product molecules, K2 and Rb2, were in an entangled state, inheriting the entanglement from the reactants. Furthermore, by deliberately inducing decoherence in the reactants, the researchers demonstrated control over the reaction product distribution.

Future Prospects

Going forward, Ni hopes to rigorously prove that the product molecules were entangled, and she is optimistic that quantum coherence can persist in non-ultracold environments.

"We believe the result is general and not necessarily limited to low temperatures and could happen in more warm and wet conditions," Ni said. "That means there is a mechanism for chemical reactions that we just didn't know about before."

First co-author and graduate student Lingbang Zhu sees the experiment as an opportunity to expand people's understanding of chemical reactions in general.

"We are probing phenomena that are possibly occurring in nature," Zhu said. "We can try to broaden our concept to other chemical reactions. Although the electronic structure of KRb might be different, the idea of

interference in reactions could be generalized to other chemical systems as well."

ci Tech Daily, 26 May 2024

https://scitechdaily.com

Diamonds grown at normal pressure in just 15 minutes

2024-05-24

Diamonds are famously formed under high pressure and temperature, which is partly why they're so valuable. But now, scientists have created diamonds in a lab under regular pressure in just 15 minutes.

Diamonds are basically just plain old carbon that's been put under immense pressure and temperature, causing the atoms to crystallize into a particular structure. On Earth, the only place with the right natural conditions is deep in the mantle, hundreds of miles down. Only later are they brought closer to the surface, hitching rides in volcanic eruptions, which makes them pretty rare. Couple that with some of the most insidious marketing in history, and you've got a highly sought-after little rock.

Scientists have been growing diamonds in labs for decades, but it usually still needs those extreme conditions – almost 50,000 atmospheres of pressure, and temperatures of about 1,500 °C (2,732 °F). But a new technique has now produced diamonds under normal pressure levels and cooler temperatures.

The new method, developed by a team from the Institute for Basic Science (IBS) and the Ulsan National Institute of Science and Technology (UNIST) in South Korea, synthesizes diamonds using a liquid metal alloy of gallium, iron, nickel and silicon. In a 9-L (2.4-gal) tank, this metal mix is exposed to methane and hydrogen gas at a temperature of 1,025 °C (1,877 °F). After 15 minutes, the gas is purged from the system, and a diamond film will have formed on the bottom. This can be detached easily and used for studies or put straight to work.

Usually, synthetic diamond techniques need "seed particles" for the first carbon atoms to latch onto and form a diamond around. But in this case, the trace amounts of silicon in the liquid metal seem to help the carbon atoms form clusters. The end result is a very pure diamond. The other metals can be switched in and out, but it seems that silicon is essential to the process.

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The researchers now plan to investigate other liquid metal alloys and gases, and even solid carbons, for how well they might be able to make diamonds. While it's not likely we'll be wearing diamonds grown in liquid metal vats any time soon, they could find use in industrial applications first.

The research was published in the journal Nature.

New Atlas, 24 May 2024

https://newatlas.com

Carbon dioxide, the main culprit of global warming, reborn as an antioxidant substance

2024-05-24

A research team led by Dr. Lee Soo Youn at the Gwangju Clean Energy Research Center of the Korea Institute of Energy Research (KIER) has successfully converted carbon dioxide, the main culprit of global warming, into carotenoids, which possess antioxidant and anticancer effects. The findings were published in ChemSusChem.

According to the International Energy Agency, global energy-related carbon dioxide emissions reached a record high of 37.4 billion tons in 2023, an increase of 1.1% from the previous year. The country is also facing climate change due to carbon dioxide emissions, as evidenced by experiencing the hottest April on record this year.

To address this issue, carbon dioxide conversion technologies are being developed globally. The technology to convert carbon dioxide into high-value chemicals such as ethylene and propylene is emerging as a key technology for achieving carbon neutrality, as it not only reduces carbon emissions but also produces products that can be utilized in various industries.

Recently, microbial electrosynthesis (MES) technology for producing chemicals has been gaining attention as a promising method for carbon dioxide conversion. MES typically involves creating an electrolyte solution with water containing microorganisms and dissolving carbon dioxide into the electrolyte, which the microorganisms then use as nutrients.

However, in room temperature and normal pressure conditions where microorganisms grow, the amount of carbon dioxide that dissolves in water is very low, leading to a shortage of nutrients for the

microorganisms and resulting in low productivity of the final converted substances.

To address this issue, the research team dissolved the carbon dioxide absorbent monoethanolamine (C2H7NO) in the electrolyte to increase the amount of carbon dioxide available for the microorganisms (Rhodobacter sphaeroides). This approach increased the consumption of carbon dioxide by the microorganisms, thereby enhancing their energy production, growth, and metabolic activities, which in turn improved the production efficiency of the converted substances.

The research team also expanded the range of conversion products. While conventional microbial electrosynthesis technology produces substances with low carbon numbers, such as butanol and ethanol, due to low carbon dioxide concentrations, the team's technology can produce carotenoids with higher carbon numbers.

Carotenoids, known for their anti-aging effects on cells and used in cosmetics and supplements, are traditionally produced through microbial fermentation. However, issues with safety and raw material supply have limited production. Additionally, since carotenoids are composed of 40 carbon atoms, microorganisms must consume large amounts of carbon dioxide to produce them.

By using a high concentration of carbon dioxide, the research team improved productivity by about four times compared to existing technologies, enabling the production of carotenoids through microbial electrosynthesis.

Dr. Lee Soo Youn, the senior researcher, stated, "This research presents a new approach to converting carbon dioxide into high-value substances through microbial electrosynthesis. As an eco-friendly and highly potential 'platform chemical' technology in the bioenergy and biochemistry fields, it will contribute to achieving carbon neutrality by reducing and recycling greenhouse gases."

Phys Org, 24 May 2024

https://phys.org

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Every human testicle contained microplastics in a new study

2024-05-20

Harmful microplastics aren't only detectable in lungs, bloodstreams, and placenta—they can be found in human testicles, as well, according to a study published in the journal Toxicological Sciences.

After obtaining 23 postmortem human testes and 47 pet dog testes from veterinary neuterings, researchers used a process called pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS), heating samples to the point of decomposition. What remained was then separated and examined for the presence of microplastics using highly sensitive equipment.

The results were extremely troubling. All of the surveyed testes—canine and human—contained measurable amounts of microplastic material. Although researchers noted "significant inter-individual variability" across their sources, the human testicles averaged almost three times higher plastic concentration levels than the dogs—330 micrograms-per-gram versus 123 micrograms-per-gram. They also identified 12 separate varieties of microplastics in the testicles, with polyethylene (used to make plastic bottles and bags) being the most common.

"At the beginning, I doubted whether microplastics could penetrate the reproductive system," study co-author Xiaozhong Yu said during a recent interview with The Guardian. "When I first received the results for dogs I was surprised. I was even more surprised when I received the results for humans."

Researchers say these new findings may further support a current theory that microplastics are contributing to the global decline in overall sperm counts. PVC, for example, was also detected in the testes, and has been linked to spermatogenesis interference and endocrine issues. While the full extent of microplastics' health effects aren't known yet, evidence strongly indicates the particles can raise the risk of heart attacks and strokes, among other complications like tissue inflammation.

The age range for human samples came from males between the ages of 16 and 88, but the team voiced specific concerns about the younger generations, given the decades' long rise in the amount of plastic pollution generated around the world. It's unsettling news, but given microplastics

are now found bottom of the ocean and atop Mount Everest, it probably shouldn't be surprising that they also reside in far more personal places.

Popular Science, 20 May 2024

https://popsci.com

Can We Mitigate the Toxicity of Common Silver Nanoparticles?

2024-05-13

Silver has long been used to thwart the spread of illness and in recent years silver nanoparticles have been incorporated into products ranging from sanitizers, odor-resistant clothes and washing machines to makeup, food packaging and sports equipment.

Nanoparticles are tiny pieces of material ranging in size from one- to 100-billionths of a meter. In addition to their antimicrobial properties, silver nanoparticles are industrially important as catalysts and in electronics applications.

Despite their ubiquity, little is known about their environmental toxicity or how it might be mitigated.

Researchers at Oregon State University have taken a key step toward closing the knowledge gap with a study that indicates the particles' shape and surface chemistry play key roles in how they affect aquatic ecosystems.

The findings, published in Nanomaterials, are important because they suggest silver nanoparticles can be produced in formats that preserve their beneficial properties while limiting environmentally negative ones.

Scientists led by Marilyn Rampersad Mackiewicz and Stacey L. Harper assessed how spherical and triangular-shaped silver nanoparticles with five different surface chemistries affected their uptake and toxicity in a laboratory microcosm of bacteria, algae, Daphnia and embryonic zebrafish.

Daphnia are tiny crustaceans, and zebrafish are a small freshwater species that go from a cell to a swimming fish in about five days.

Zebrafish are particularly useful for studying the development and genetics of vertebrates, including the effects of environmental contaminants and pharmaceuticals on early embryonic development.

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They share a remarkable similarity to humans at the molecular, genetic and cellular levels; embryonic zebrafish are of special interest because in addition to developing quickly, they are transparent and can be easily maintained in small amounts of water.

The authors note that hundreds of tons of silver nanoparticles are produced every year for commercial uses, meaning it's inevitable some will end up in aquatic environments.

"Silver nanoparticles are not regulated by the Food and Drug Administration and not much is known about their toxicity except for the free silver ions that can result from surface oxidation of the nanoparticles," said Mackiewicz, assistant professor of chemistry.

"Free silver ions are known to be toxic and in this paper we found a way to study the toxicity of silver nanoparticles and how they impact the environment irrespective of poisonous silver ions."

Mackiewicz, Harper and collaborators in the OSU colleges of Science, Engineering and Agricultural Sciences found silver nanoparticles negatively affect some species but not others.

"For example, there is a decrease in bacterial and Daphnia growth, and the size and shape of the particles can contribute to that, but the nanoparticles didn't affect zebrafish," she said. "And nanoparticles coated in lipids, organic compounds found in many natural oils and waxes, did not release significant amounts of silver ions – but they exhibited the greatest toxicity to Daphnia magna, the most sensitive species in the microcosm."

Overall, Mackiewicz said, the study showed that silver nanoparticles' shape and surface chemistry can be manipulated to achieve specific objectives necessary for better understanding and mitigating the risks associated with silver nanoparticles. A related study awaiting publication, she added, shows that small, spherical nanoparticles are more toxic than triangles or cubes.

Nanoparticles are the latest format, Mackiewicz notes, for an element that throughout history has been used to restrict the spread of human disease via incorporation into items used in everyday life. Its earliest recorded use for therapeutic purposes dates back 3,500 years.

During the Middle Ages, wealthy families used so many silver vessels, plates and other products that they developed bluish skin discolorations

known as argyria, a condition believed to have led to the term "blue blood" as a description for members of the aristocracy.

Technology Networks, 13 May 2024

https://technologynetworks.com

Meet the microplastome

2024-05-22

Earlier this year, the -ome family of terms gained a new member. Researchers advocating for a more holistic approach to microplastic research proposed the term microplastome to signify 'the entirety of various plastic particles (<5mm), and their associated matters such as chemicals and microbes, found within a sample, and its overall environmental and toxicological impacts'.1 It joins the genome, proteome, microbiome, transcriptome, exposome and other research domains that unpick complex biological systems by considering them as collective entities of molecules and interactions.

Big data is central to such concepts. But as our recent feature explains, detecting, measuring and characterising micro- and nanoplastics is challenging. Notably, nanoplastics' tiny size limits their identification with optical microscopy and spectroscopic techniques, and their reactive surfaces can complicate analysis by adsorbing other pollutants. What's more, transitioning from investigating pristine samples in simple matrices to real-life samples in complex matrices is never simple.

Speaking of real-life, research we covered yesterday involves the kind of plastic building bricks that many children – and adults – I know enjoy playing with. It showed that repeatedly assembling and disassembling these blocks, which are typically made from acrylonitrile butadiene styrene, generated thousands to hundreds of thousands of particles per mm2.

Without better understanding micro- and nanoplastics impact on ecosystems and human health it's impossible to say quite how concerned we should be about such findings. That's not to say that toxicity research isn't being done; the body of knowledge is expanding at speed but for the community to establish its authority it needs to agree on terminology, standards, reference materials and best practices. Without internationally agreed definitions of what constitutes micro- and nanoplastic, for example, then it's impossible to reproduce and compare data. Only then will it be taken as seriously as it should be.

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What we are sure about is that micro- and nanoplastic pollution is abundant, persistent and complex. But studying one material, species or ecosystem at a time risks ignoring important interconnections. Now's the time to adopt a systems-thinking approach and embrace the microplastome.

Chemistry World, 22 May 2024

https://chemistryworld.com

Sustainable, high-performance paper coating material could reduce microplastic pollution

2024-05-22

Plastic pollution presents a global challenge that must be solved. In particular, packaging accounts for 30–50% of the total plastic consumption. While paper packaging is eco-friendly, it lacks crucial functionalities like moisture resistance and strength. Traditional coating materials exacerbate plastic pollution, prompting the need for sustainable alternatives.

Polyethylene (PE) and ethylene vinyl alcohol (EVOH) are typically used as coating materials to improve the low barrier properties of paper packaging, but these substances do not decompose and worsen microplastic pollution when disposed of in the natural environment.

In response to this problem, packaging materials made from bio-based substances and biodegradable plastics have been developed, but in most cases, as the packaging performance improves, the biodegradability diminishes rapidly.

A joint research team led by Professor Jaewook Myung of the Department of Civil and Environmental Engineering, Professor Hanseul Yang of the Department of Life Sciences, and Professor Jongcheol Seo of the Department of Packaging and Logistics at Yonsei University tackled the challenge of balancing packaging performance and sustainability. They successfully developed a sustainable, marine biodegradable, high-performance paper coating material.

The team utilized boric acid-crosslinked poly(vinyl alcohol) (PVA), a biodegradable plastic, to coat the paper, thereby enhancing its biodegradability, barrier properties, and strength. The resulting coated paper exhibited superior performance compared to conventional plastics,

with excellent barrier properties and physical strength, even in humid conditions.

The team also conducted an in-depth examination of biodegradation and biocompatibility to systematically evaluate the sustainability of the newly developed coated paper. Biodegradation was assessed by simulating the marine environment, known for its challenging biodegradability conditions.

The team employed a respiratory system-based bioreactor to measure the degree of carbon mineralization into carbon dioxide. After 111 days of biodegradation, it was found that the coated papers achieved 59–82% biodegradation depending on the coating component.

The phenomenon in which marine bacteria are decomposing the coating material was captured through a scanning electron microscope. In addition, in vitro biocompatibility was confirmed through human embryonic kidney and mouse embryonic fibroblast cells, as well as high in-vivo biocompatibility of the coated paper was verified through mouse experiments.

Through this study, the joint research team proposed a coating strategy that can improve packaging performance while upholding sustainability to address the drawbacks of paper packaging. The boric acid-crosslinked PVA-coated paper eliminates the need for artificial composting conditions or sewage treatment facilities.

Being biodegradable in natural environments and characterized by low toxicity, this newly coated paper does not exacerbate environmental pollution when accidentally discarded. Thus, it presents a sustainable substitute for plastic packaging materials.

Professor Jaewook Myung at KAIST, who led the sustainability study of coated paper, said, "The development of a marine biodegradable high-performance paper coating is the result of combining the innovative technologies of three leading research teams in each field. We will continue to develop sustainable materials with excellent performance."

Professor Jongchul Seo of Yonsei University, who led the research on the development of high-performance paper coating, said, "Through this research, we have developed a sustainable paper packaging technology

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that can replace non-degradable plastic packaging, and we expect the research outcome will be applied in industry."

Phys Org, 22 May 2024

https://phys.org

"Better Than Graphene" Material May Improve Implantable Technology

2024-05-07

Move over, graphene. There's a new, improved two-dimensional material in the lab. Borophene, the atomically thin version of boron first synthesized in 2015, is more conductive, thinner, lighter, stronger and more flexible than graphene, the 2D version of carbon. Now, researchers at Penn State have made the material potentially more useful by imparting chirality — or handedness — on it, which could make for advanced sensors and implantable medical devices. The chirality, induced via a method never before used on borophene, enables the material to interact in unique ways with different biological units such as cells and protein precursors.

The team, led by Dipanjan Pan, Dorothy Foehr Huck & J. Lloyd Huck Chair Professor in Nanomedicine and professor of materials science and engineering and of nuclear engineering, published their work — the first of its kind, they said — in ACS Nano.

"Borophene is a very interesting material, as it resembles carbon very closely including its atomic weight and electron structure but with more remarkable properties. Researchers are only starting to explore its applications," Pan said. "To the best of our knowledge, this is the first study to understand the biological interactions of borophene and the first report of imparting chirality on borophene structures."

Chirality refers to similar but not identical physicality, like left and right hands. In molecules, chirality can make biological or chemical units exist in two versions that cannot be perfectly matched, as in a left and right mitten. They can mirror each other precisely, but a left mitten will never fit the right hand as well as it fits the left hand.

Borophene is structurally polymorphic, which means its boron atoms can be arranged in different configurations to give it different shapes and properties, much like how the same set of Lego blocks can be built into

different structures. This gives researchers the ability to "tune" borophene to give it various properties, including chirality.

"Since this material has remarkable potential as a substrate for implantable sensors, we wanted to learn about their behavior when exposed to cells," Pan said. "Our study, for the first time ever, showed that various polymorphic structures of borophene interact with cells differently and their cellular internalization pathways are uniquely dictated by their structures."

The researchers synthesized borophene platelets — similar to the cellular fragments found in blood — using solution state synthesis, which involves exposing a powdered version of the material in a liquid to one or more external factors, such as heat or pressure, until they combine into the desired product.

"We made the borophene by subjecting the boron powders to high-energy sound waves and then mixed these platelets with different amino acids in a liquid to impart the chirality," Pan said. "During this process, we noticed that the sulfur atoms in the amino acids preferred to stick to the borophene more than the amino acids' nitrogen atoms did."

The researchers found that certain amino acids, like cysteine, would bind to borophene in distinct locations, depending on their chiral handedness. The researchers exposed the chiralized borophene platelets to mammalian cells in a dish and observed that their handedness changed how they interacted with cell membranes and entered cells.

According to Pan, this finding could inform future applications, such as development of higher-resolution medical imaging with contrast that could precisely track cell interactions or better drug delivery with pinpointed material-cell interactions. Critically, he said, understanding how the material interacts with cells — and controlling those interactions — could one day lead to safer, more effective implantable medical devices.

"Borophene's unique structure allows for effective magnetic and electronic control," Pan said, noting the material could have additional applications in health care, sustainable energy and more. "This study was just the beginning. We have several projects underway to develop biosensors, drug delivery systems and imaging applications for borophene."

Technology Networks, 07 May 2024

https://technologynetworks.com

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'Fossilizing' cracks in infrastructure creates sealing that can even survive earthquakes

2024-05-22

The underground disposal of pollutants, such as radioactive waste and carbon dioxide, poses unique challenges. To avoid their release, it is necessary to seal the shafts and boreholes used for investigations and ensure that there are no leaks from the rock for long periods of time. Unfortunately, current cement-based sealing materials do not offer long-term functionality and durability. Especially in earthquake-prone countries, such as Japan, this may cause future complications, such as leaks.

To find a solution, lead researcher Hidekazu Yoshida of the Nagoya University Museum turned to his expertise in fossil preservation in calcium carbonate concretions. He understood that such concretions form quite rapidly within a few weeks to years, and fossils in concretions remain remarkably intact for millions of years, even when extracted from locations prone to weathering and seismic disturbances. He mused about the potential use of a similar approach in an industrial context.

"I realized that well-preserved fossils in concretions had withstood weathering and the like for tens to hundreds of thousands of years in the natural environment," Yoshida said. "I became inspired by studying how fast concretions were formed and why the fossils inside were preserved so well."

One reason for the durability of fossils is the concretion process. This is a natural fossilization process in which minerals in groundwater precipitate out of the water and accumulate around the organic material. Calcite in the groundwater seals the remains by forming crystals around them, binding the surrounding sediments. This mechanism creates an almost impenetrable fossil, with the crystals blocking even small, micrometer-sized openings.

Based on the concretion-forming process, the researchers mixed two agents to develop a "concretion-forming resin." The resin holds the ions needed to form calcite when water is introduced. Calcite forms impenetrable crystals in cracks and holes, reproducing the concretion formation process seen in nature, only much faster.

During a test in an underground laboratory 350 meters below the surface in Hokkaido, the northernmost island of Japan, the researchers discovered

that their resin-based material had remarkable sealing abilities. When applied to flow-paths in the rock, it sealed them completely and rapidly.

The area experienced six earthquakes in the space of two days, including a magnitude 5.4 earthquake, putting their resin to the ultimate test. Despite a further five earthquakes during the test period, the cracks remained sealed. In fact, open cracks even resealed as the crystals reformed.

"The earthquakes were coincidence; something we never expected and planned for," Yoshida said. "They were a surprise to us, but it was such a great opportunity to see the material's performance. Such a fast-acting and sustained sealing effect of rock fractures, including post-earthquake crack repair, has never been reported before. Conventional cement materials cannot achieve this result."

The group is working closely with the Japan Atomic Energy Agency, Sekisui Chemical Co., and Chubu Electric Power Co., Ltd. to ensure that the resin will be commercially viable. Following their successful test, the team anticipates a wide range of applications, including long-term underground sequestration of radioactive waste and carbon dioxide, sealing abandoned oil wells, groundwater control during rock and mine excavation, and repair of cracks in ageing infrastructure such as roads and buildings.

Science Daily, 22 May 2024

https://sciencedaily.com

New polystyrene recycling process could be world's first to be both economical and energy-efficient

2024-05-22

Engineers have modeled a new way to recycle polystyrene that could become the first viable way of making the material reusable. The chemical method identified to tackle hard-to-recycle packaging material, cutting landfill waste

The team of chemical engineers, based at the University of Bath in the UK and Worcester Polytechnic Institute in Massachusetts, US, say their technique could be the first to make recycling polystyrene both economically viable and energy efficient.

Explained in a new research paper published in the Chemical Engineering Journal, the technique uses a chemical process called pyrolysis to break down polystyrene into parts which can be reformed into new pieces of the material.

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Dr. Bernardo Castro-Dominguez, a Senior Lecturer in Chemical Engineering at the University of Bath and a Co-Director of the Centre for Digital, Manufacturing & Design (dMaDe), says, "Chemical recycling techniques are a major focus within chemical engineering right now, and cost- and energy-efficient ways to breakdown plastics to their primary building blocks such as polystyrene are urgently needed.

"Less than 5% of polystyrene is recycled at present—our work shows that as much as 60% of all polystyrene used today could be replaced by chemically recycled styrene."

Michael Timko, Ph.D., Professor of Chemical Engineering at Worcester Polytechnic Institute, adds, "Our analysis finds polystyrene to be an ideal candidate for a chemical recycling process. Surprisingly, the process is energetically efficient and potentially economically competitive. In terms of emissions, investing in this process has the potential to be equivalent to simple measures such as energy conservation in terms of the amount of emissions reduction that can be achieved for a given investment."

Polystyrene can be chemically recycled using heat, but repeated treatments degrade the material, causing it to lose strength and flexibility. Because this process requires specialized facilities, most recycling centers do not accept polystyrene—and because of its bulk, high transport costs mean it is rarely moved to these facilities. Consequently, very little polystyrene is recycled at present.

Pyrolysis involves exposing a material to very high temperatures (of more than 450°C) in an oxygen-free chamber, meaning it cannot ignite. Instead, the polystyrene breaks down into parts known as monomers, which can then be purified and subsequently reconstituted into virgin polystyrene. Creating one kilogram of the new material requires less than 10 megajoules of energy—roughly enough to power a typical microwave for around 30 minutes.

The identified process involves a pyrolysis reactor, heat exchanger and a pair of distillation columns, which separate out the parts of polystyrene into 'monomer grade' styrene—the part which can be reformed into polystyrene—and 'light' and 'heavy' petroleum-like by-products, which can be reused in other ways.

The process has a yield of 60%—meaning that if 1kg of used polystyrene were used, 600 grams of 99% pure monomer grade styrene would be left available to generate new polystyrene, thus reducing the use of fossil fuels. This work also highlights the environmental benefits, noting that the cost

to decrease the amount of carbon emissions through the implementation of this process is approximately $1.5 per ton of CO2, considerably lower than many other recycling processes.

The researchers say that policies to incentivize consumers to recycle polystyrene, or divert it from landfill, would help make the process even more economically attractive.

Phys Org, 22 May 2024

https://phys.org

Young people's use of diabetes and weight loss drugs is up 600 percent

2024-05-22

From 2020 to 2023, the number of U.S. adolescents and young adults who picked up prescriptions for Ozempic, Wegovy and related drugs rocketed up nearly 600 percent — from roughly 8,700 people to more than 60,000, scientists report May 22 in JAMA.

That spike "palpably feels like a massive increase," says Joyce Lee, a pediatric endocrinologist at the University of Michigan Medical School in Ann Arbor. In comparison, the number of young people receiving other medications stayed relatively flat over the same period.

The drugs, GLP-1 receptor agonists, have gained a reputation in recent years for their drastic effect on weight — and other health benefits (SN: 12/13/23).

First approved by the U.S. Food and Drug Administration in 2005, GLP-1 drugs have continued to roll in. Ozempic, an injectable form of the drug semaglutide, was approved for adults with type 2 diabetes in 2017; liraglutide for weight loss in adults in 2014 and kids 12 and older in 2020; and Wegovy, high dose semaglutide, for weight loss in adults in 2021. A year later, Wegovy's approval extended to kids.

Lee's team wanted to find out what was happening in the real world: Who was actually receiving these drugs? The researchers analyzed information about people ages 12 to 25 using a database that reports prescriptions from U.S. pharmacies.

The uptick Lee's team reported in people receiving GLP-1 drugs wasn't surprising, she says, given enthusiasm among doctors and patients. What stood out was the extent of the rise — and the difference between

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males and females. More than three times as many females ages 18 to 25 received the drugs than males of the same age. That may reflect societal bias around weight, she says.

Lee wants to learn more about the medications' safety, side effects and how well they work over time. Clinical trials have shown that the drugs can spur weight loss, she says, "but we don't know what the long-term effects are."

Science News, 22 May 2024

https://sciencenews.org

Chemists develop new method for making gamma chiral centers on simple carboxylic acids

2024-05-16

The term chiral refers to a type of asymmetry that allows some chemical compounds to exist in left-handed and right-handed forms. Often, only one of these forms has the desired biochemical activity, but for synthetic chemists, stereoselective reactions -- those that yield just the desired form -- are almost always challenging.

The new method enables what had been impossible except in narrow cases: creating a center of chiral asymmetry at a hard-to-reach position called the "gamma" position on a cyclic carboxylic acid.

"This approach offers unprecedented and relatively easy access to a broad set of chiral carbocycles that are privileged structures for pharma industry drug discovery programs," says study senior author Jin-Quan Yu, PhD, Frank and Bertha Hupp Professor of Chemistry and Bristol Myers Squibb Endowed Chair in Chemistry at Scripps Research.

The co-first authors were Tao Zhang, PhD, and Zi-Yu Zhang, PhD, both postdoctoral research associates in the Yu lab.

A potentially valuable but elusive method

The development of small molecule pharmaceuticals or other chemical products typically involves the construction of many hundreds or thousands of compounds, each representing a variation on a central structural theme. Once these "libraries" of compounds are constructed, they are methodically tested for the desired biological or chemical activity; in this way, developers can zero in on the best compound for further refinement. Naturally, in constructing these libraries and in making more

refined variants, chemists would like to have easy and versatile techniques for building and modifying molecules. But while their tools have greatly improved over the years, some types of molecular transformation have remained essentially undoable, despite the obvious value they would have. Gamma chiral center construction using readily available carboxylic acids has been one of these, defying the efforts of prominent synthetic chemistry labs.

The Yu lab's success hinged on the development of special "ligand" molecules containing both oxazoline and pyridone structural elements. Ligand molecules help bring the reaction catalyst to the right spot on the initial compound. In this case, they fasten to one point on the starting carboxylic acid -- which contains a ring of mostly carbon atoms -- and direct a bond-breaking palladium atom to the distant gamma position on the other side of the ring. The effect is to remove a hydrogen atom from the backbone carbon atom at the targeted spot, allowing a new cluster of atoms to bond to the carbon -- thus adding complexity to the molecule in a precise way.

This type of reaction is called a "C-H activation," and over the past decade, Yu and his team have reported similar C-H activation methods for constructing chiral centers at "alpha" and "beta" positions on carboxylic acids.

The chemists demonstrated the power and versatility of their new method by using it to make gamma chiral centers on a wide variety of relatively simple carboxylic acid starting compounds containing rings of from five to eight carbon atoms. In one case, they achieved a single-step synthesis of a chiral version of a cancer drug molecule called an HDAC inhibitor -- whose standard, patented synthesis method requires 10 steps and a costly separation to obtain pure samples of the left-handed or right-handed form.

The team also used the new technique to add complexity to existing drug molecules, including the steroid hormone pregnenolone.

Finally, the chemists showed they could use their new approach sequentially on a starting molecule to construct three chiral centers -- including a very challenging "delta" chiral center.

The Yu lab is now working to extend the new approach so it can be used for making other types of chiral molecules.

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"Enantioselective Remote Methylene C–H (Hetero)Arylation of Cycloalkane Carboxylic Acids" was co-authored by Tao Zhang, Zi-Yu Zhang, Guowei Kang, Tao Sheng, Jie-Lun Yan, Yuan-Bin Yang, Yuxin Ouyang and Jin-Quan Yu, all of Scripps Research.

Support for the research was provided by the National Institutes of Health (2R01GM084019).

Science Daily, 16 May 2024

https://sciencedaily.com

Researchers report a simpler method for precise molecular orbital visualization

2024-05-22

Discoveries and progress in materials science often lay the foundation for technological breakthroughs that reshape many industrial and commercial fields, including medicine, consumer electronics, and energy generation, to name a few.

Yet, the development of experimental techniques crucially underpins the exploration of new materials, paving the way for groundbreaking discoveries. These techniques allow scientists to delve into a material's chemical and physical properties, unlocking insights essential for realizing their potential applications.

In a recent study published in the Journal of Physical Chemistry A, a research team led by Associate Professor Kaori Niki from Chiba University, Japan, reported a new methodology to experimentally visualize molecular orbitals (MOs)—the distribution and state of electrons in a given molecule.

Their latest paper, which was submitted on September 29, 2023, and published online on March 26, 2024, was co-authored by Rena Asano and Prof. Manabu Hagiwara from Chiba University, Prof. Yoichi Yamada from the University of Tsukuba, and Prof. Kazushi Mimura from Hiroshima City University.

The proposed method is centered around photoemission orbital tomography (POT). This technique consists of measuring the distribution and momentum of electrons released all around a material after absorbing energy from incoming light. By mapping these variables, one can then theoretically work out the MOs of the material.

Despite being promising, traditional POT faces several challenges that greatly limit its applicability. First, multiple rounds of POT measurements are needed to probe the material at different photon energies and reconstruct three-dimensional MOs. This takes time and requires complex experimental protocols.

Second, to properly account for differences in molecular orientation and deformations in a given material, it's necessary to combine POT with other analytical techniques, which is quite expensive and tedious. Third, traditional POT techniques are sensitive to noise in the measured data, which makes it difficult to observe small MOs.

To address all these limitations, Prof. Niki's team developed a novel POT technique based on a mathematical analysis tool called the PhaseLift algorithm. This algorithm is designed to address a fundamental problem in signal and image processing: reconstructing a signal or image from incomplete or indirect measurements.

Using PhaseLift, the researchers simplified the photoelectron momentum maps (PMMs) obtained through POT into a more manageable form, which in turn enabled them to more easily and accurately calculate the desired MOs.

One of the key advantages of the proposed approach is that precise MOs can be obtained from a single set of PMM measurements. Moreover, it is much better at handling noisy data. This is, in part, thanks to the clever use of sparsity-based techniques, which limits the space where solutions to MOs are considered to be only the most relevant molecular orbitals.

Both theoretical analyses, as well as experimental tests, confirmed the validity of this innovative method, showcasing its potential. "This research was a collaboration between mathematicians, information theorists, and physical scientists and specifically included both experimentalists and theorists," explains Prof. Niki.

"Leveraging their expertise, we have achieved successful cross-disciplinary fusion research. This collaborative approach has enabled us to overcome previous challenges and deliver a POT method that holds promise for broader accessibility and applicability," she added.

Using the proposed technique, scientists will be able to visualize the electronic states of molecules in thin film materials more easily. In turn, this will help better understand the origin of any relevant physical

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properties, leading to new smart material designs and further innovations in applied science.

"Our developed method represents a breakthrough in the visualization of the electronic states of materials that were previously challenging to observe," states Prof. Niki.

Recognizing the immense potential that PhaesLift-based POT offers, Prof. Niki and the team hope to become pioneers in this emerging research field. "In anticipation of the global spread of PMM, I hope that we can establish a center specializing in PMM analysis ahead of the rest of the world," she says.

"This core institute will hopefully become a hub of innovation, driving the development of numerous new materials that will support the Japanese economy for the next half-century."

Phys Org, 22 May 2024

https://phys.org

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Microplastic coupled with soil dissolved organic matter mediated changes in the soil chemical and microbial characteristics

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A review of occurrence, bioaccumulation, and fate of novel brominated flame retardants in aquatic environments: A comparison with legacy brominated flame retardants

Microplastic Pollution in Surface Sediments of Coromandel Coastline, South-East Coast, India: Diversity Index, Carbonyl Index, Pollution Load Index, Risk Fraction and MPs Inventory

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Capmatinib plus nivolumab in pretreated patients with EGFR wild-type advanced non-small cell lung cancer

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Epidemiology of work-related injuries, musculoskeletal disorders and dermatitis among hospital food service workers in a tertiary hospital in Asia

Application and demonstration of meso-activity exposure factors to advance estimates of incidental soil ingestion among agricultural workers