CHEMWATCH

Bulletin Board

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ASIA PACIFIC

Chemicals added to the Inventory following issue of assessment certificate (early listing) - 5 March 2024

2024-03-05

The following industrial chemicals have been added to the Australian Inventory of Industrial Chemicals in accordance with section 83 of the Industrial Chemicals Act 2019.

Chemicals added to the inventory following issue of assessment certificate:

AICIS Approved Chemical Name (AACN)	**Glycine, *N*-methyl-*N*-[(9*Z*)-1-oxo-9-alkenyl]-, calcium salt (2:1)**
Defined Scope of Assessment	The chemical was assessed as an additive in lubricant products for use only in an industrial setting by workers. It can be imported into Australia: at up to 10 tonnes each year; as an additive in lubricant products with a concentration up to 1%.
Listing date	13 February 2024
CAS number	1245725-35-2
Chemical name	Cyclopentanol, 2-methyl-5-(1-methylethyl)-, 1-propanoate
Molecular formula	C12H22O2

AICIS Approved Chemical Name (AACN)	**Glycine, *N*-methyl-*N*-[(9*Z*)-1-oxo-9-alkenyl]-, calcium salt (2:1)**
Defined Scope of Assessment	The chemical has been assessed: as imported into Australia at up to 1 tonne/year as imported in fragrance formulations at up to 1% concentration for local reformulation into finished cosmetic and household products as imported or reformulated as a component of finished cosmetic and households products at up to: 0.01% concentration in leave-on and rinse-off cosmetic products (including non-spray deodorants), hair dye, washing and cleaning household products, polishes and wax blends, and air fresheners (instant action) 0.1% concentration in fine fragrances 0.3% concentration in air fresheners (continuous action)
Listing date	16 February 2024
CAS number	1917323-93-3
Chemical name	L-Lysine, N-(3-carboxy-1-oxopropyl) derivs., calcium salts
Molecular formula	Unspecified
Defined Scope of Assessment	The chemical has been assessed: as imported into Australia at up to 10 tonnes/year as imported neat for local reformulation into construction chemical products at a concentration of up to 5% for use only by professional workers as imported as a component of finished end-use construction chemicals products at up to 5% concentration for use only by professional workers
Listing date	26 February 2024
CAS number	1917323-94-4
Chemical name	L-Lysine, N-(3-carboxy-1-oxopropyl) derivs., sodium salts
Molecular formula	Unspecified
Defined Scope of Assessment	The chemical has been assessed: as imported into Australia at up to 10 tonnes/year as imported neat for local reformulation into construction chemical products at up to 5% concentration for use by professional workers as imported as finished end-use construction chemical products containing the assessed chemical at up to 5% concentration for use by professional workers

AICIS Approved Chemical Name (AACN)	**Glycine, *N*-methyl-*N*-[(9*Z*)-1-oxo-9-alkenyl]-, calcium salt (2:1)**
Listing date	26 February 2024
AICIS Approved Chemical Name (AACN)	2-Propenoic acid, 2-methyl-, Cx-y-alkyl esters, polymers with N-[(dialkylamino)alkyl]-2-methyl-2-propenamide, alkyl methacrylate, alkyl methacrylate and stearyl methacrylate
Defined Scope of Assessment	The chemical has been assessed: as a polymer that meets the polymer of low concern (PLC) definition (Schedule 2 of the Industrial Chemicals (General) Rules 2019) and as a polymer that is not a high molecular weight polymer that has lung overloading potential (within the meaning given by the Industrial Chemicals Categorisation Guidelines) as an ingredient for driveline and engine oils in automotives
Listing date	26 February 2024
CAS number	3017933-60-4
Chemical name	2(3H)-Furanone, 5-(6-hepten-1-yl)dihydro-, (5S)-
Molecular formula	C11H18O2
Defined Scope of Assessment	The chemical has been assessed: as a fragrance component imported into Australia at up to 1 tonne/year as imported in fragrance formulations at up to 1% concentration for local reformulation into cosmetics and household products in continuous action air fresheners at up to 0.5% concentration, in fine fragrances and in instant action air fresheners at up to 0.2% concentration, and in other cosmetic and household products at up to 0.02% concentration as imported in finished products for sale in continuous action air fresheners at up to 0.5% concentration, in fine fragrances and in instant action air fresheners at up to 0.2% concentration, and in other cosmetic and household products at up to 0.02% concentration

AICIS Approved Chemical Name (AACN)	**Glycine, *N*-methyl-*N*-[(9*Z*)-1-oxo-9-alkenyl]-, calcium salt (2:1)**
Listing date	28 February 2024

Read More

AICIS, 05-03-24

https://www.industrialchemicals.gov.au/news-and-notices/chemicals-added-inventory-following-issue-assessment-certificate-early-listing-5-march-2024

Hydrogen cyanamide reassessment

2024-03-06

We are reassessing the use of hydrogen cyanamide, a restricted spray ingredient used in commercial orchards.

- Application formally received
- Public consultation
- Evaluation
- Public hearing
- Final decision

Hydrogen cyanamide has been used in Aotearoa New Zealand since 1988. It is used mainly in kiwifruit orchards to promote bud growth. It is also used in some apple, cherry, apricot, and kiwiberry crops, but to a lesser extent.

There are six hydrogen cyanamide products approved for use. They are restricted to commercial use and can only be used by trained professionals.

Latest application update

1 March 2024

The hearing ran for the week of 26 February and was adjourned on 1 March 2024. The transcriptions are being prepared for publication. The hearing will be formally closed once the Decision-making Committee (DMC) are satisfied that they have enough information to make a decision on the reassessment.

12 February 2024

The hearing notice and hearing schedule have been published. Please note that information in these documents is subject to change at the discretion of the DMC.

Hearing notice (PDF, 126KB)

Hearing schedule (PDF, 202KB)

Read More

Read More

EPA NZ, 06-02-24

https://www.epa.govt.nz/public-consultations/in-progress/hydrogen-cyanamide-reassessment/

Cutting lead levels in paints: proposed amendments to group standards

2024-02-06

We are evaluating the submissions we received during the public consultation period.

- Submissions
- Evaluation
- Report
- Hearing or consideration
- Decision

The public consultation period is now closed. We received 23 submissions which will be published on our website shortly.

Next steps

We will review the feedback we have received and publish a report on our website. This will:

- summarise the feedback
- identify any changes to the proposals that have come out of the feedback
- give example wording showing how the proposals might be implemented in the group standards.

If submitters wish to be heard, a public hearing will be held.

If no hearing is required, the Decision-making Committee will consider the proposals and the submissions in a non-public process.

The Decision-making Committee's decision on the proposals will then be published on the EPA website.

The proposals

We propose to amend a series of group standards to reduce the maximum allowable levels of lead in paint. The main aim of these proposals is to protect people's health and safety as lead is a highly toxic metal.

We are also proposing changes to reduce the risks from lead in graphic materials, especially those used by children (for example, finger paints, crayons, and felt-tip pens).

We will do this by amending the following sets of group standards:

- Surface coatings and colourants
- Aerosols
- Corrosion inhibitors
- Graphic materials.

You'll find details and discussion of all proposals in the full proposals document:

Cutting lead levels in paints: proposed amendments to group standards: Proposals document (PDF, 430KB)

Read More

EPA NZ, 06-02-24

https://www.epa.govt.nz/public-consultations/in-progress/lead-in-paints/

Agricultural chemical products and approved labels

2024-03-05

Pursuant to the Agricultural and Veterinary Chemicals Code scheduled to the Agricultural and Veterinary Chemicals Code Act 1994, the APVMA hereby gives notice that it has registered or varied the relevant particulars or conditions of the registration in respect of the following products and has approved the label or varied the relevant particulars or conditions of the approval in respect of the containers for the chemical product, with effect from the dates shown.

Table 4: Veterinary products based on existing active constituents:

Application no.	138115
Product name	Multiboost
Active constituents	40 g/L zinc (as disodium zinc EDTA), 15 g/L copper (as disodium copper EDTA), 10 g/L manganese (as disodium manganese EDTA), 5 g/L selenium (as sodium selenite)
Applicant name	Biocell Corporation Limited
Applicant ACN	N/A
Date of registration	15 February 2024
Product registration no.	93152
Label approval no.	93152/138115
Description of the application and its purpose, including the intended use of the chemical product	Registration of an injectable solution product containing 40.0 g/L zinc (as disodium zinc EDTA), 15.0 g/L copper (as disodium copper EDTA), 10.0 g/L manganese (as disodium manganese EDTA) and 5.0 g/L selenium (as sodium selenite) indicated for administration to beef and dairy cattle deficient in and/or responsive to zinc, copper, manganese and/or selenium supplementation

Application no.	138116
Product name	Multiboost With B12
Active constituents	40 g/L zinc (as disodium zinc EDTA), 15 g/L copper (as disodium copper EDTA), 10 g/L manganese (as disodium manganese EDTA), 5 g/L selenium (as sodium selenite), 1.4 g/L cyanocobalamin
Applicant name	Biocell Corporation Limited
Applicant ACN	N/A
Date of registration	15 February 2024
Product registration no.	93153
Label approval no.	93153/138116
Description of the application and its purpose, including the intended use of the chemical product	Registration of an injectable solution product containing 40.0 g/L zinc (as disodium zinc EDTA), 15.0 g/L copper (as disodium copper EDTA), 10.0 g/L manganese (as disodium manganese EDTA), 5.0 g/L selenium (as sodium selenite) and 1.4 g/L cyanocobalamin (vitamin B12) indicated for administration to beef and dairy cattle deficient in and/or responsive to zinc, copper, manganese, selenium and/or vitamin B12 supplementation

Read More

APVMA, 05-03-24

https://www.apvma.gov.au/sites/default/files/2024-03/Gazette%20No%205%2C%20Tuesday%205%20March%202024_0.pdf

India Releases Mandatory Data Reporting Rules for Chemical Inventory Portal

2024-02-28

Monthly chemical and petrochemicals data related to production, installed capacity, import, export, sales should be submitted by registered units in India on ChemIndia Portal.

On February 27, 2024, India's Department of Chemicals and Petrochemicals (DCPC) officially announced that the submission of chemical and petrochemical data is mandatory on ChemIndia Webportal. The collected data shall be used to generate Index of Industrial Production every month and ultimately create a comprehensive and authentic inventory of the chemical and petrochemicals data.

Read More

Chemlinked, 28-02-24

https://chemical.chemlinked.com/news/chemical-news/india-releases-mandatory-data-reporting-rules-for-chemical-inventory-portal

AMERICA

FDA Issues Update on Post-Market Assessments of Chemicals in the Food Supply

2024-03-04

FDA Issues Update on Post-Market Assessments of Chemicals in the Food Supply

The FDA assesses the safety of exposure to chemicals in the food supply. This includes ingredients considered generally recognized as safe (GRAS), food additives, color additives, food contact substances, and contaminants.

The FDA may initiate post-market assessments in response to requests from external stakeholders, such as through petitions, and on the agency's initiative when a review is warranted based on new information. We may reassess the safety of food ingredients, food contact substances, and contaminants as new, relevant data become available. The FDA is committed to continuing its evaluation of all relevant scientific information and data when considering whether regulatory action is warranted to ensure the safety of the food supply.

The table below includes select food ingredients (including food and color additives), food contact substances, and contaminants under FDA review as of March 4, 2024. While this table is not intended to be a comprehensive list, it includes some of the contaminants that we are focused on as part of our established programs, such as the Closer to Zero initiative. It also includes some of the chemicals that are of interest among stakeholders who have asked the FDA to review their safety through petitions, including citizen petitions. The FDA anticipates updating this table regularly to provide transparency on our reviews of chemicals in the food supply.

Information about the Food Ingredients and Food Contact Substances Listed in the Table

The FDA has previously reviewed the food ingredients or food contact substances listed in the table. Our reassessments will help fill data gaps and follow up on information reported in the literature and other available information, focusing on food ingredients and food contact substances that may present the most significant public health concerns. Our reassessments are also in response to petitions, which is a way for stakeholders to ask the FDA to establish or change a regulation or to take other administrative action. If new information becomes available from our reassessments indicating that the intended use in food of a chemical is unsafe, the FDA would take further action as warranted. Depending on the results of our reassessments, some of these actions may include revoking authorizations or approvals for certain uses, working with industry on voluntary market phase-out agreements and recalls, and issuing alerts and informing consumers.

Read More

US FDA, 04-03-24

https://www.fda.gov/food/food-chemical-safety/list-select-chemicals-food-supply-under-fda-review

Chemical recycling not 'recycling' in Maine

2024-03-06

Although there are no chemical recycling facilities currently operating in the Pine Tree State, any starting up in the future will be considered "chemical plastic processing" operations subject to solid waste facility permitting, and their process will not be considered "recycling," lawmakers recently voted.

First introduced in April 2023, Maine's Legislative Document 1660 is written as "an act to ensure proper regulation of chemical plastic processing," which is commonly known as chemical recycling, "advanced" or even "molecular" recycling. All terms refer to a group of technologies that process scrap plastic chemically into its basic components (typically its monomers) rather than mechanically, through shredding, washing and re-pelletizing.

The bill enshrines in law that these facilities require solid waste licensing and that they won't be considered to be "recycling."

The bill passed the state Senate 21-13 on Feb. 6 entirely on party lines, with all Democrats in favor and all Republicans opposed. It passed the House 76-56 on Feb. 15, again largely on party lines with Democrats supporting and Republicans opposed. It was chaptered into law on March 5.

The Maine bill was introduced by Sen. Anne Carney, Democrat of Maine's Cumberland County, who spoke ahead of a vote on the bill Feb. 6, noting there are no chemical recycling facilities in Maine. But she referenced the numerous bills sponsored by plastics industry groups in states around the

U.S. that seek to classify chemical recycling as "manufacturing" operations rather than waste disposal facilities.

"The end result … is to exempt these facilities from solid waste management laws and regulations," Carney said. "It allows facilities to evade the public permitting process, siting restrictions, reporting requirements and operating conditions that apply to every other solid waste facility."

She said the bill "will protect Maine from this type of harmful legislation."

Prior to the senate vote, Sen. Peter Lyford, a Republican representing communities in Penobscot County, said opponents view the bill as "problematic" because it penalizes a process he views as complementary to mechanical recycling.

Lyford gave an example of chip bags, typically a multi-layer packaging that is not accepted by traditional mechanical recycling operations. (It's difficult to separate such packaging materials mechanically.) Chemical recycling "is a way to recycle these types of products," he said.

Chemical recycling, he said, "takes products that aren't part of the traditional mechanical recycling and breaks them down" into materials that can be used as feedstock for new products.

Lyford added that he views the bill as being "in conflict" with the state's extended producer responsibility (EPR) program, approved by lawmakers in 2021 and currently in regulatory development.

Republican Sen. Trey Stewart of Aroostook County also spoke against the bill, noting he agrees the process is not "recycling" as typically defined, but that it is a tool to battle plastic waste.

"Preempting that we could do something new and novel about that issue, with this legislation, just to me feels completely backwards," he said.

Carney emphasized that the bill does not prevent chemical recycling facilities from siting in Maine, it just clarifies the permitting requirements they'll need to meet and it offers guidance to state regulators that the process isn't considered "recycling."
Read More

Plastics Recycling Update, 06-03-24

https://resource-recycling.com/plastics/2024/03/06/chemical-recycling-not-recycling-in-maine/

Maine compromise would exempt some industries from ban on 'forever chemicals'

2024-03-06

State regulators have introduced a compromise plan to regulate the sale of products containing forever chemicals.

The proposal by the Maine Department of Environmental Protection would exempt some federally regulated industries such as the automotive, aeronautical and defense sectors from an impending 2030 ban on the sale of products that contain forever chemicals, even if a safer chemical alternative is available.

The proposed amendment to the state's existing forever chemicals law would exempt some of Maine's major manufacturers, including Bath Iron Works, C&L Aviation of Bangor and Idexx of Westbrook, some of which have threatened to move work out of state or even leave if the 2022 law wasn't changed.

"We support surgical changes that eliminate the human health risk but accommodate businesses using these chemicals safely," said Patrick Woodcock, president of the Maine State Chamber of Commerce. "Current Maine law treats all business use of forever chemicals the same, regardless of the health risk."

Read More

Wisconsin Public Radio, 06-03-24

https://www.wpr.org/news/state-appeals-court-upholds-ruling-dnr-lacks-authority-regulate-pfas

EUROPE

Rising PFAS Pesticide Levels in EU Fruits and Vegetables Spark Health Concerns

2024-03-04

A recent study by PAN Europe reveals a troubling increase in PFAS pesticide residues found in EU fruits and vegetables between 2011 and 2021. This rise in contamination levels poses potential health risks to consumers, with some PFAS chemicals linked to cancer and developmental issues.

Expanding Contamination

According to the study, the presence of PFAS in EU-grown fruits and vegetables has tripled over the last decade. High levels of contamination were found in strawberries, peaches, and apricots grown in the EU, with similar contamination levels detected in imported produce. Countries like the Netherlands, Belgium, and Austria were identified as key PFAS-contaminated food producers within the EU. In contrast, Costa Rica, India, and South Africa were noted as the main exporters of PFAS-contaminated food to the EU. This widespread contamination presents a complex challenge for consumers trying to navigate their food choices safely.

Health Risks and Regulatory Gaps

The study highlights the health risks posed by PFAS pesticides, including their potential to cause cancer, developmental issues in children, and adverse effects on the liver, immune system, and endocrine system. The PAN Europe spokesperson emphasized the danger of exposure to mixtures of PFAS pesticides, which are not adequately considered by current regulatory standards setting maximum residue limits. This oversight means that vulnerable groups, such as pregnant women and young children, are at higher risk of adverse health outcomes from consuming contaminated produce. Furthermore, the study calls attention to the regulatory gaps in addressing the risks of PFAS pesticides, pointing out the need for stricter controls and better consumer information.

Call for Action

In response to the growing concerns, a proposal to ban all PFAS as a group in Europe, except for "essential use," was submitted by authorities from Denmark, Germany, the Netherlands, Norway, and Sweden. This proposal aims to address the unacceptable health and environmental risks posed by PFAS pesticides. The spokesperson argues that PFAS pesticides are not necessary for crop growth and can be replaced by safer alternatives, advocating for an integrated pest management approach as a sustainable method of food production. The study also suggests that consuming organic products could help consumers avoid PFAS pesticide residues, although this option might not be affordable for everyone. The absence of labeling on conventional produce regarding pesticide residues, including PFAS pesticides, further complicates consumer decisions.

Read More

BNN, 04-03-24

https://bnnbreaking.com/world/europe/rising-pfas-pesticide-levels-in-eu-fruits-and-vegetables-spark-health-concerns

Society of European endocrinologists confirms endocrine disruptors as major health concern

2024-03-01

The European Society of Endocrinology (ESE) - a community of over 20,000 endocrinologists from across Europe - issued a statement in Nature Reviews Endocrinology highlighting endocrine disrupting chemicals as a major threat to human health.

In short:

- The society has named endocrine disrupting chemicals as one of their four key advocacy and policy areas, alongside obesity, cancers, and rare diseases.
- The ESE also noted that EDCs pose a significant amount of harm to fetuses, infants and children due to their ability to disrupt neurological and reproductive development.

Key quote:

"Continuous efforts in identifying and evaluating EDCs are imperative to enhance public health not only within the EU but also on a global scale."

Read More

EHN, 01-03-24

https://www.ehn.org/eu-endocrinologists-edcs-2667403149.html

Two proposals to identify new substances of very high concern (SVHCs)

2024-03-07

The substances and examples of their uses are:

- Bis(α,α-dimethylbenzyl) peroxide (EC 201-279-3)

This substance is used in products such as pH-regulators, flocculants, precipitants and neutralisation agents.

- Triphenyl phosphate (EC 204-112-2)

This substance is used as a flame retardant and plasticiser in polymer formulations, adhesives and sealants.

Have your say until 15 April 2024.

Read More

ECHA, 07-03-24

https://echa.europa.eu/substances-of-very-high-concern-identification

Substance evaluation: decisions soon sent to registrants

2024-03-07

Member States will finalise the 2023 substance evaluation for six substances on 21 March 2024.

We will send the finalised draft decisions to registrants as they arrive, and wherever possible, within two weeks of receiving them from the evaluating Member States. Registrants will then have 30 days to submit their comments.

The draft decisions address the following five substances, for which further information is needed to clarify identified concerns:

- Butanoic acid, 4-amino-4-oxosulfo-, N-coco alkyl derivs., monosodium salts, compds. with triethanolamine (EC 308-662-5, CAS 98171-53-0) by France;
- Sodium 3-(2H-benzotriazol-2-yl)-5-sec-butyl-4-hydroxybenzenesulfonate (EC 403-080-9, CAS 92484-48-5) by Spain;
- Chlorobenzene (EC 203-628-5, CAS 108-90-7) by the Netherlands;
- 2-Propenoic acid, methyl ester, reaction products with mixed O,O-bis(branched and linear pentyl and iso-Bu) phosphorodithioates (EC 300-340-2, CAS 93925-38-3) by Sweden; and

- Reaction mass of p-t-butylphenyldiphenyl phosphate and bis(p-t-butylphenyl) phenyl phosphate (EC 939-505-4, CAS -) by France.

Substance evaluation does not require further information for:

- N-methylaniline (EC 202-870-9, CAS 100-61-8) by Poland.

Read More

ECHA, 07-03-24

https://echa.europa.eu/information-on-chemicals/evaluation/community-rolling-action-plan/corap-table

Member States vote to restrict PFHxA in the EU

2024-03-07

The EU Member States have voted in favour of restricting PFHxA, its salts and related substances during the European Commission’s REACH committee meeting on 29 February 2024. The initial proposal was introduced by the German authorities in 2020 and supported by ECHA’s scientific committees in late 2021.

The draft regulation will now be subject to a three-month scrutiny by the European Parliament and the Council before it can be adopted by the Commission.

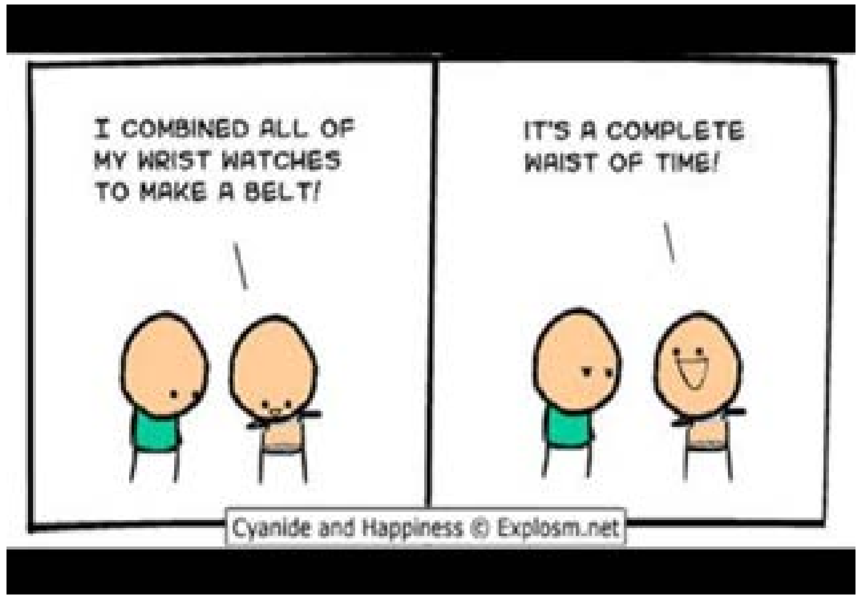
Read More

ECHA, 07-03-24

https://ec.europa.eu/transparency/comitology-register/screen/documents/090483/6/consult

Cyanide and Happiness

2024-03-15



https://explosm.net/

Benzene

2024-03-15

USES [2,3]

Benzene is used mainly as an intermediate to make other chemicals. About 80% of benzene is consumed in the production of three chemicals, ethylbenzene, cumene, and cyclohexane. Its most widely-produced derivative is ethylbenzene, precursor to styrene, which is used to make polymers and plastics. Cumene is converted phenol for resins and adhesives. Cyclohexane is used in the manufacture of Nylon. Smaller amounts of benzene are used to make some types of rubbers, lubricants, dyes, detergents, drugs, explosives, and pesticides. [1] Benzene is used as a constituent in motor fuels; as a solvent for fats, waxes, resins, oils, inks, paints and plastics; in the extraction of oils from seeds and nuts; and in photogravure printing.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Industry sources: Releases to air from industries producing, using or handling benzene eg. rubber industry, oil refineries, chemical plants, footwear manufacturing, petrol.
- Diffuse sources: Present in crude oil; cigarette smoke (will affect both active and passive smokers). Releases to air from service stations; evaporation of fuels during petrol refilling; releases to groundwater from underground storage tanks that leak.
- Natural sources: Occurs naturally in volcanoes, forest fires, some plants and animals. Is present in crude oil.
- Transport sources: Vehicle exhaust, Evaporation of vehicle fuels from motors and vehicle fuel tanks.
- Consumer products: Glues, adhesives, household cleaning products, paint strippers, some art supplies and petrol. These products may contain benzene as a contaminant rather than a deliberately added component (e.g. Shellite may contain 0.1% benzene by volume).

Benzene is an organic chemical compound. It is composed of 6 carbon atoms in a ring, with 1 hydrogen atom attached to each carbon atom, with the molecular formula C6H6. [1]

Routes of Exposure

One of the most common ways phenanthrene can enter your body is through breathing contaminated air. It can get into your lungs when you breathe it. If you work in a hazardous waste site where PAHs are disposed, you are likely to breathe phenanthrene and other PAHs. If you eat or drink food and water that are contaminated with PAHs, you could be exposed. Exposure can also occur if your skin comes into contact with contaminated soil or products like heavy oils, coal tar, roofing tar or creosote where PAHs have been found. Creosote is an oily liquid found in coal tar and is used to preserve wood. Once in your body, the PAHs can spread and target fat tissues. Target organs include kidneys, liver and fat. However, in just a matter of days, the PAHs will leave your body through urine and faeces.

HEALTH EFFECTS [4]

Acute Health Effects

Co-exposure to benzene with ethanol (e.g., alcoholic beverages) can increase benzene toxicity in humans. Neurological symptoms of inhalation exposure to benzene include drowsiness, dizziness, headaches, and unconsciousness in humans. Ingestion of large amounts of benzene may result in vomiting, dizziness, and convulsions in humans. Exposure to liquid and vapour may irritate the skin, eyes, and upper respiratory tract in humans. Redness and blisters may result from dermal exposure to benzene.

SAFETY

First Aid Measures [5]

- Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. WARM water MUST be used. Get medical attention immediately.
- Skin Contact: In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.
- Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.
- Serious Inhalation: Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

- Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Workplace Controls & Practices [4]

- Engineering Controls: Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.
- Personal Protection: Splash goggles, lab coat, vapour respirator (be sure to use an approved/certified respirator or equivalent), gloves.
- Personal Protection in Case of a Large Spill: Splash goggles, full suit, vapour respirator, boots, and 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.
- Exposure Limits: TWA: 0.5 STEL: 2.5 (ppm) from ACGIH (TLV) [United States] TWA: 1.6 STEL: 8 (mg/m3) from ACGIH (TLV) [United States] TWA: 0.1 STEL: 1 from NIOSH TWA: 1 STEL: 5 (ppm) from OSHA (PEL) [United States] TWA: 10 (ppm) from OSHA (PEL) [United States] TWA: 3 (ppm) [United Kingdom (UK)] TWA: 1.6 (mg/m3) [United Kingdom (UK)] TWA: 1 (ppm) [Canada] TWA: 3.2 (mg/m3) [Canada] TWA: 0.5 (ppm) [Canada]Consult local authorities for acceptable exposure limits.

REGULATION

Australia

Safe Work Australia: Safe Work Australia has set a time weighted average (TWA) concentration for benzene of 1 ppm or 3.2mg/m3. It has also been classified category carc. 1A.

Australian Drinking Water Guidelines (NHMRC and ARMCANZ, 1996):

Maximum of 0.001 mg/L (i.e. 0.000001 g/L)

REFERENCES

1. http://en.wikipedia.org/wiki/Benzene
2. http://www.bt.cdc.gov/agent/benzene/basics/facts.asp
3. http://www.epa.gov/ttn/atw/hlthef/benzene.html
4. http://www.npi.gov.au/resource/benzene-0
5. http://www.atsdr.cdc.gov/toxguides/toxguide-3.pdf
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8. https://www.osha.gov/dts/chemicalsampling/data/CH_220100.html

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Micro- and Nanoplastics in the Body Are Passed On During Cell Division

2024-03-12

Besides respiration, ingestion is the most important route for MNPs into the organism. Plastic particles up to the weight of a credit card (approx. five grams) enter the gastrointestinal tract every week. The team led by Verena Pichler (University of Vienna, CBmed) and Lukas Kenner (MedUni Vienna, CBmed, Vetmeduni Vienna) investigated the interactions between MNPs and various colon cancer cells.

In their analyses, they were not only able to show how MNPs enter the cell and where exactly they are deposited, but also observed their direct effects: The MNPs are taken up into lysosomes like other "waste products" in the body. Lysosomes are cell organelles that are also known as the "stomach of the cell" and break down foreign bodies in the cell. However, the researchers observed that, unlike foreign bodies of biological origin, the MNPs are not degraded due to their foreign chemical composition. Depending on various factors, the MNPs are even passed on to the newly formed cell during cell division and are therefore likely to be more persistent in the human body than originally assumed. In addition, there are initial indications that MNPs increase the migration of cancer cells to other regions of the body and thus possibly promote the metastasis of tumours. This effect is now to be investigated further in a follow-up study.

The gastrointestinal tract is already known to researchers as a major storage site for micro- and nanoplastic particles (MNPs) in the human body.

The smaller, the more harmful

The altered behaviour of colorectal cancer cells in relation to cell migration was primarily observed as a result of interaction with plastic particles that are smaller than one micrometre (1 µm = 0.001 mm). Particles of this size are usually referred to as nanoplastics, which occur 10 to 100 times more frequently than microplastics in a water bottle, for example. It is undisputed that the smaller the plastic particles are, the more harmful they are. "This is once again consistent with the results of our analyses," emphasises Verena Pichler. "Our study also confirms recent findings that indicate that MNPs can influence cell behaviour and possibly contribute to the progression of diseases," adds Lukas Kenner.

"Given the ubiquity of plastics in the environment and the persistent exposure of even humans to the smallest plastic particles, further studies are urgently needed to investigate long-term effects in particular," says Kenner. "It can be assumed that MNP causes chronic toxicity," fears Pichler. The latest results and earlier studies show a high uptake and long retention in tissues and cells. The investigated particles therefore fulfil two of three characteristics in toxicology that are used to classify substances as being of concern under the EU Chemicals Regulation ("REACH").

Technology Networks, 12 March 2024

https://technologynetworks.com

Novel optical metamaterial may make true one-way glass a reality

2023-02-14

A traditional material's response to electric and magnetic fields – and, therefore, to light – is determined by atoms. In optical metamaterials, however, atoms are replaced by meta-atoms that can be structurally engineered to possess properties rarely seen in nature, enabling a design that produces unique electromagnetic responses and allows the precise manipulation of light at the nanoscale.

The ability to control and manipulate light at the nanoscale opens up many applications for metamaterials across various fields. Now, researchers at Aalto University in Finland have created a new optical metamaterial that may make true one-way glass a reality.

After decades of physics-based theorizing, researchers have succeeded in creating a novel optical metamaterial using conventional materials.

In its most general form, the magnetoelectric (ME) effect denotes a coupling between a material's magnetic and electric properties. While the effect of magnetization on traditional materials at optical frequencies is negligible, it can be enhanced using metamaterials, where magnetization can be induced by the electric component of light, and polarization can be generated by the magnetic component.

Previous studies have demonstrated that magnetism is strong at microwave frequencies, producing pronounced ME effects at this spectral range. Despite two decades of theorizing, it's been difficult to realize a metamaterial that operates outside of that range, until now.

The new metamaterial relied on the nonreciprocal magnetoelectric (NME) effect. Without getting too 'physics-y,' the NME effect implies that the magnetization and polarization properties of a material are linked to the different components of light or other electromagnetic waves.

"So far, the NME effect has not led to realistic industrial applications," said Shadi Safaei Jazi, the study's lead author. "Most of the proposed approaches would only work for microwaves and not visible light, and they also couldn't be fabricated with available technology."

The researchers successfully overcame these issues using existing tech and nanofabrication techniques to create a three-dimensional optical NME metamaterial whose individual meta-atoms, made of conventional materials, cobalt and silicon, spontaneously magnetize.

The novel metamaterial paves the way for applications that would otherwise need a strong external magnetic field to work, such as true one-way glass. Current so-called 'one-way' glass is really just semi-transparent, letting light through in both directions. It acts like one-way glass when there's a difference in brightness between the two sides. However, an NME-based one-way glass wouldn't require that brightness difference because light could only go through it in one direction.

"Just imagine having a window with that glass in your house, office, or car," Safaei said. "Regardless of the brightness outside, people wouldn't be able to see anything inside, while you would enjoy a perfect view from your window.

The metamaterial also has the potential to make solar cells more efficient by blocking the thermal emissions that existing cells radiate back toward the sun, reducing the amount of energy they capture.

The study was published in the journal Nature Communications.

New Atlas, 14 February 2024

https://newatlas.com

Germany can probably only meet its demand for climate-friendly hydrogen by imports, for example, from South America or Australia.

New catalyst accelerates release of hydrogen from ammonia

2024-03-13

To facilitate the release of the hydrogen afterward, researchers from the Institute of Inorganic Chemistry at Kiel University (CAU) and their cooperation partners have developed a more active and cost-effective catalyst. The results were obtained as part of the hydrogen flagship project TransHyDE and have recently been published in Nature Communications.

The ability to store energy from wind or solar power plays a key role in the energy transition. "Storing energy in the form of chemical compounds such as hydrogen has many advantages. The energy density is high and the chemical industry also needs hydrogen for many processes," says Malte Behrens, Professor of Inorganic Chemistry at Kiel University. In addition, "green hydrogen" can be produced by electrolysis using electricity from renewable energy sources without producing CO2.

Infrastructure for ammonia already exists

But transporting hydrogen directly from regions where wind and solar power are cheap is not easy. An interesting alternative is the chemical conversion into ammonia. Ammonia itself contains a relatively high amount of hydrogen, and a well-developed infrastructure for its overseas transport already exists.

"Ammonia can be liquefied easily for transport, is already produced on a megaton scale and shipped and traded worldwide," says Dr. Shilong Chen, the leader of the Kiel subproject in the TransHyDE project "AmmoRef."

The two scientists from CAU's priority research area, KiNSIS (Kiel Nano, Surface and Interface Science), are collaborating with colleagues from Berlin, Essen, Karlsruhe, and Mülheim/Ruhr. Together, they are investigating how hydrogen can be catalytically released from ammonia after transport. Their newly developed catalyst significantly accelerates this reaction.

AmmoRef is one of ten TransHyDE projects. Scientists from a total of eight institutions are working on various sub-projects to improve hydrogen transport technologies. The results will be incorporated into the recommendations for the national hydrogen infrastructure.

Metal combination makes the catalyst highly active

"A catalyst accelerates a chemical reaction and is therefore directly responsible for the efficiency of chemical processes and energy conversion," Behrens explains. The faster the ammonia reforming process takes place, the lower the conversion losses caused by the chemical storage of hydrogen in ammonia.

"Our catalyst has two special features," says Chen. "First, it is made of the relatively inexpensive base metals iron and cobalt. Secondly, we have developed a special synthesis process that allows a very high metal loading of this catalyst."

Up to 74% of the material consists of active metal nanoparticles, which are arranged between support particles in a way that cavities on the nano-scale are formed, looking like a porous metallic nano-sponge. "The combination of the two metals in an alloy is also crucial," Behrens explains. On their own, both metals are less catalytically active. The combination creates highly active bimetallic surfaces with properties that are otherwise only known from much more expensive precious metals.

"We will continue to investigate this catalyst in the AmmoRef consortium, in which industrial companies are also involved, and transfer it from basic research to application," says Behrens, announcing the next steps. To this end, the team in Kiel will now work on scaling up the synthesis.

Phys Org, 13 March 2024

https://phys.org

Why are all proteins 'left-handed'? New theory could solve origin of life mystery

2024-02-28

Now, a trio of U.S. researchers proposes a novel explanation. Today in Nature, they report that by monitoring the formation rates of amino acid pairs, called dipeptides, they've found multiple mechanisms that ultimately promote dipeptides whose two members share the same handedness.

"It's quite convincing," says Gerald Joyce, a pioneering origin of life chemist and president of the Salk Institute for Biological Studies who was not involved with the study. Researchers next hope to learn whether the same mechanisms skew larger peptides and proteins toward left-handedness—and whether it can explain the opposite bias in RNA and DNA, whose bases have sugars that are inevitably right-handed. If so, the new mechanisms could explain how life itself took on one mirror-image form and not the other.

Several explanations have been advanced in recent decades for life's chirality, as the bias toward a particular handedness is known. For example, meteorites, which could have seeded an early Earth, have been shown to harbor amino acids with an abundance of left-handed chirality, perhaps because their contents were exposed to polarized light. Or magnetic fields on early Earth could have given a twist to early biomolecules. But even if some external force imparted an initial bias, what propagated it?

One clue comes from recent work by Matthew Powner, an origin of life chemist at University College London, and his colleagues. Over the past 5 years, Powner's group has discovered a set of sulfur-based molecules that likely would have been present on early Earth and shown how they readily link individual amino acids to amino acid precursors, called aminonitriles, forming dipeptides. Because these reactions take place in water and work

There's a bias at the heart of life, and its origin is an enduring mystery. Nearly all the amino acid building blocks of proteins today exist in mirror-image forms, like right- and left-handed gloves.

with all the amino acids found in living organisms, they offer a plausible route to how the first proteins may have formed.

Powner's team didn't check whether its sulfur-based catalysts had a chiral bias. That's where Donna Blackmond, an origin of life chemist at Scripps Research, and her colleagues Min Deng and Jinhan Yu grabbed the baton. They tested two of Powner's sulfur compounds to see whether the catalysts were sensitive to chirality as they formed dipeptides. They were, but not in the way Blackmond had expected. The catalysts created about four times as many "heterochiral" dipeptides—those pairing a left-handed amino acid (L) with a right-handed (D) one—as fully chiral products. "We thought it was bad news," Blackmond says, because it suggested that even if amino acids on early Earth started with a bias, it would have been scrambled as proteins formed.

But as Blackmond and her colleagues looked more deeply, the news got better. In a series of experiments, the Scripps researchers started with skewed proportions of L and D amino acids—for example, 60% Ls and 40% Ds. The L,D and D,L heterochiral dipeptides formed most quickly, and as they did they pulled equal numbers of L and D amino acids out of the mix. Because of the baseline bias, eventually a predominance of Ls remained in the pool of unreacted amino acids, raising the likelihood of forming fully lefthanded dipeptides. "It's like a domino effect," Powner says. The first heterochiral reaction eventually encourages more homochirals to form. "And it's a general process that works with all amino acids," Powner says. Joyce adds: "It's just math."

Follow-up experiments suggested a second bias that amplifies the effect. The team found that heterochiral dipeptides precipitate out of a solution more quickly than homochiral ones, speeding the way to a relative abundance of either homochiral L,L or D,D pairs, depending the starting mix. Just why this precipitation bias occurs isn't yet clear, Blackmond says. However, Joyce says, together with the other effect, "it beautifully fits the [experimental] data." Blackmond adds: "The wrong answer turned out to be the right answer to get us to homochirality."

For now, this push toward a particular handedness has only been shown with dipeptides. But Blackmond says preliminary work suggests the same biasing process unfolds when the sulfur catalysts stitch short peptides together into longer peptide chains.

Joyce thinks it's possible that the same sort of math may also help explain how life's genetic molecules gained their handedness. "This could happen with all kinds of other things, like RNA," he says. Perhaps it was just a

statistical coin flip that caused an original bias toward building blocks of one handedness to form, Joyce says. "But once that coin flipped it caused other coins to flip."

Science, 28 February 2024

https://science.org

PFAS in Blood Linked to Increased Risk of Cardiovascular Diseases

2024-03-12

Since their invention in the 1950s, more than 10,000 different substances from the category of per- and polyfluorinated alkyl compounds (PFAS) have been developed, according to estimates. Due to their water, fat and dirt-repellent properties, they are used in thousands of products such as cosmetics, dental floss, but also in pan coatings and fire-extinguishing foam. In addition to their basic chemical structure, PFAS have another thing in common: they are nearly non-degradable. Particularly via groundwater that they enter the human food chain.

Younger people are particularly affected

The findings of the Bonn researchers are the latest contribution to the current debate on the effect of PFAS on human health. "We see clear signs of a harmful effect of PFAS on health. And we have found that at the same PFAS concentration in the blood, the negative effects are more pronounced in younger subjects than in older ones," says Prof. Dr. Dr. Monique Breteler, Director of Population Health Sciences at DZNE. The results of the current study also suggest that even relatively low PFAS concentrations in the blood are associated with unfavorable blood lipid profiles.

Researchers at DZNE provide evidence that traces of the widely used PFAS chemicals in human blood are associated with unfavorable lipid profiles and thus with an increased risk of cardiovascular diseases.

"Our data shows a statistically significant correlation between PFAS in the blood and harmful blood lipids linked to cardiovascular risk. The higher the PFAS level, the higher the concentration of these lipids. Taken strictly, this is not yet a proof that PFAS chemicals cause the unfavorable blood lipid profiles. However, the close correlation supports this suspicion. It is a strong argument for stricter regulation of PFAS in order to protect health," says the Bonn researcher. Strikingly, PFAS could be detected in the blood of almost all test subjects. Which means you cannot escape these chemicals. "Even if we don't see an immediate health threat for the study participants we examined, the situation is still worrying. In the long term, the increased risk may very well have a negative impact on the heart and cardiovascular system," says Breteler.

Blood samples from Bonn and the Netherlands

The current study was based on DZNE's "Rhineland Study" – a population-based health study in the Bonn urban area – and the so-called NEO study from the Netherlands ("Netherlands Epidemiology of Obesity study"). In this framework, researchers from DZNE collaborated with experts from the Leiden University Medical Center in the Netherlands. Blood samples from a total of more than 2,500 women and men aged between 30 and 89 were included in the analyses. For this, state-of-the-art technology was used. "The technology to analyze blood samples with the accuracy required for our research has only become available in recent years," says DZNE scientist Elvire Landstra. She is the first author of the current publication together with a colleague from Leiden.

Most detailed study so far

The blood samples were analyzed in detail using a sophisticated method known as mass spectrometry. In their analysis, the researchers focused on three of the most widespread types of PFAS – PFOA, PFOS and PFHxS – and also determined the concentration of 224 blood lipids, metabolites and amino acids. "With this 'untargeted approach' – an intentionally broad approach without a preconceived target – we were able to prove the connection between the PFAS concentration and a problematic profile of fatty substances, so-called lipids. These include the well-known cholesterol and various other blood lipids that are known to be risk factors for cardiovascular disease," says Elvire Landstra. No significant differences were found between the samples from Bonn and Leiderdorp. "Our study is the most detailed on this topic to date and the one with the largest database. Previous studies had already suggested a correlation between PFAS and unhealthy blood lipids, but this link had never been as clear as in our study."

Future studies could focus on specific areas of the body, the Bonn researchers suggest. "We looked at the blood levels. In a next step, it would make sense to investigate the occurrence of PFAS in individual organs," Monique Breteler says.

Technology Networks, 12 March 2024

https://technologynetworks.com

Brazilian scientists obtain a material that could be useful for hydrogen production

2024-03-13

In an article published in the journal Electrochimica Acta, scientists at the Center for Development of Functional Materials (CDMF), a Research, Innovation and Dissemination Center (RIDC) hosted at the Federal University of São Carlos (UFSCar) in São Paulo state, Brazil, describe the synthesis of a nickel phosphide electrode that showed high efficiency in hydrogen evolution reaction (HER) electrocatalysis.

This type of reaction, which is still costly, breaks down water molecules to release hydrogen ions in a process known as hydrolysis.

Electrochemical production of hydrogen by hydrolysis is a promising technique with zero carbon emissions. Its efficiency depends on the capacity of the electrocatalyst.

In the article, the researchers describe an experiment designed to analyze the performance of amorphous nickel phosphide (Ni-P) electrodes synthesized via electrodeposition on Ni foam used as an HER electrocatalyst. The 3-Ni-P electrode performed outstandingly in alkaline, neutral, and acidic conditions. The Ni-P films showed excellent stability under the different conditions studied.

The electrode's strong performance was attributed to its granular structure, with a large surface area enabling good interaction with the electrolyte and endorsing HER kinetics. According to the authors, the results are relevant to the search for a catalyst that is stable, easy to synthesize, and capable of operating in a wide range of pH with high efficiency for the production of hydrogen from water.

Phys Org, 13 March 2024

https://phys.org

Hydrogen (H2) is considered a possible alternative to fossil fuels, which are responsible for a large proportion of atmospheric emissions and global warming, but production costs must be lowered if it is to become a viable option.

Porphyrin ribbons transport charge with no resistance

2024-03-14

Finding ways to transport charge efficiently has been a key problem for researchers aiming to design molecular-scale circuitry. Previous studies on π-conjugated molecules have generally shown an exponential decrease in conductance as the length of a molecule increases.

Now, a research team led by Harry Anderson from the University of Oxford, UK, and Edmund Leary from the IMDEA Nanoscience Institute in Madrid, Spain, has developed a type of molecular wire that can transport charge perfectly over distances up to 7.1nm. The wires are made of chains of porphyrin rings that are triply fused to one another. This allows for a highly efficient delocalisation of electrons and results in an extremely low energy gap between the molecules' highest occupied molecular orbital and lowest unoccupied molecular orbital.

The researchers note that the work 'proves it is possible for molecular wires in the 5–10 nm range … to have perfect electronic transmission'. The team is now planning to explore the limits of the nanowires' exceptional charge transport and to 'learn how to manipulate it'.

Chemistry World, 14 March 2024

https://chemistryworld.com

New Insights on Altered Protein Folding's Effects on Multicellular Evolution

2024-03-11

In a new study led by researchers from the University of Helsinki and the Georgia Institute of Technology, scientists turned to a tool called experimental evolution. In the ongoing Multicellularity Long Term Evolution Experiment (MuLTEE), laboratory yeast are evolving novel multicellular functions, enabling researchers to investigate how they arise.

The study puts the spotlight on the regulation of proteins in understanding evolution.

"By demonstrating the effect of protein-level changes in facilitating evolutionary change, this work highlights why knowledge of the genetic code in itself does not provide a full understanding of how organisms acquire adaptive behaviors. Achieving such understanding requires mapping the entire flow of genetic information, extending all the way to the actionable states of proteins that ultimately control the behavior of cells," says Associate Professor Juha Saarikangas from the Helsinki Institute of Life Science HiLIFE and Faculty of Biological and Environmental Sciences, University of Helsinki.

Snowflake yeast evolves robust bodies in 3,000 generations by changing cell shape

Researchers have discovered a mechanism steering the evolution of multicellular life. They identified how altered protein folding drives multicellular evolution.

Among the most important multicellular innovations is the origin of robust bodies: over 3,000 generations, these 'snowflake yeast' started out weaker than gelatin but evolved to be as strong and tough as wood.

Researchers identified a non-genetic mechanism at the base of this new multicellular trait, which acts at the level of protein folding. The authors found that the expression of the chaperone protein Hsp90, which helps other proteins acquire their functional shape, was gradually turned down as snowflake yeast evolved larger, tougher bodies. It turns out Hsp90 acted as a critically-important tuning knob, destabilizing a central molecule that regulates the progression of the cell cycle, causing cells to become elongated. This elongated shape, in turn, allows cells to wrap around one another, forming larger, more mechanically tough multicellular groups.

"Hsp90 has long been known to stabilize proteins and help them fold properly," explains lead author Kristopher Montrose, from the Helsinki Institute of Life Science, Finland. "What we've found is that slight alterations in how Hsp90 operates can have profound effects not just on single cells, but on the very nature of multicellular organisms."

Path to adaptive evolution through altering protein shapes

From an evolutionary perspective, this work highlights the power of non-genetic mechanisms in rapid evolutionary change.

"We tend to focus on genetic change and were quite surprised to find such large changes in the behavior of chaperone proteins. This underscores how creative and unpredictable evolution can be when finding solutions to new problems, like building a tough body.", says Professor Will Ratcliff from the Georgia Institute of Technology, USA.

Technology Networks, 11 March 2024

https://technologynetworks.com

Vinegar and baking soda: A cleaning hack or just a bunch of fizz?

2024-03-14

But people also frequently mix vinegar and baking soda to produce a reportedly effective household cleaner. Unfortunately, the chemistry behind the bubbly reaction doesn't support the cleaning hype. The fizzy action is essentially a visual "placebo," formed by the combination of an acid and a base.

Vinegar and baking soda are staples in the kitchen. Many of us have combined them in childhood scientific experiments: think fizzy volcanoes and geysers.

So, how does it work, and is it worth using these chemicals for cleaning? To understand all this, it helps to know a little more about chemistry.

What's an acid?

Foods with a sour taste typically contain acids. These include citric acid in lemon juice, malic acid in apples, lactic acid in yogurt and phosphoric acids in soft drinks. Most vinegars contain around 4%–10% acetic acid, the rest is water and small amounts of flavor chemicals.

There are other naturally occurring acids, such as formic acid in ant bites and hydrochloric acid in our stomachs. Industrially, sulfuric acid is used in mineral processing, nitric acid for fertilizer manufacturing and the highly potent hydrofluoric acid is used to etch glass.

All of these acids share similar properties. They can all release hydrogen ions (positively charged atoms) into water. Depending on their potency, acids can also dissolve minerals and metals through various chemical reactions.

This is why vinegar is an excellent cleaner for showers or kettles—it can react with and dissolve mineral deposits like limescale.

Other common acidic cleaning ingredients are oxalic acid, used for revitalizing timber decks, hydrochloric acid in concrete and masonry cleaners, and sulfamic acid in potent toilet cleaners.

What's a base?

In chemistry, bases—the opposite of acids in many ways—can bind, rather than release hydrogen ions. This can help lift and dissolve insoluble grime into water. Bases can also break apart fat molecules.

Baking soda (also known as sodium hydrogen carbonate, sodium bicarbonate, or bicarb) is a relatively weak base. Stronger common bases include sodium carbonate (washing soda), sodium hydroxide (lye) and ammonia.

Sodium hydroxide is a potent drain cleaner—its strong base properties can dissolve fats and hair. This allows blockages to be broken down and easily flushed away.

Mixing a base and an acid

Mixing vinegar and baking soda causes an immediate chemical reaction. This reaction forms water, sodium acetate (a salt) and carbon dioxide—the fizzy part.

The amount of carbon dioxide gas that is produced from baking soda is remarkable—one tablespoon (around 18 grams) can release over five liters of gas. But only if you add enough acid.

Reactions in chemistry often use equal quantities of chemical reagents. A perfect balance of acetic acid and baking soda would give you just water, carbon dioxide and sodium acetate.

But the majority of vinegar and bicarb cleaner recipes use a large excess of one or the other components. An example from TikTok for a DIY oven cleaner calls for one and a half cups of baking soda and one quarter cup of vinegar.

Crunching the numbers behind the chemical reaction shows that after the fizz subsides, over 99% of the added baking soda remains. So the active cleaning agent here is actually the baking soda (and the "elbow grease" of scrubbing).

Ovens can be cleaned much more rigorously with stronger, sodium hydroxide based cleaners (although these are also more caustic). Many modern ovens also have a self-cleaning feature, so read your product manual before reaching for a chemical cleaner of any sort.

What about the sodium acetate?

Devotees of vinegar and baking soda mixtures might be wondering if the product of the fizzy reaction, sodium acetate, is the undercover cleaning agent.

Unfortunately, sodium acetate is an even weaker base than baking soda, so it doesn't do much to clean the surface you're trying to scrub.

Sodium acetate is used in crystallization-based heating packs and as a concrete sealant, but not typically as a cleaner.

Fun fact: sodium acetate can be combined with acetic acid to make a crystalline food additive called sodium diacetate. These crystals give the vinegar flavor to salt and vinegar chips without making them soggy.

Sorry to burst your bubbles

There are a few rare cases where mixing vinegar and baking soda may be useful for cleaning. This is where the bubbling has a mechanical effect, such as in a blocked drain.

But in most cases, you'll want to use either vinegar or baking soda by itself, depending on what you're trying to clean. It will be less visually exciting, but it should get the job done.

Lastly, remember that mixing cleaning chemicals at home can be risky. Always carefully read the product label and directions before engaging in DIY concoctions. And, to be extra sure, you can find out more safety information by reading the product's safety data sheet.

Provided by The Conversation

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https://phys.org

The U.S. now has a drug for severe frostbite. How does it work?

2024-03-12

In February, the U.S. Food and Drug Administration approved the country's first medication to treat severe frostbite. In a clinical trial, the drug, iloprost, greatly reduced amputations in nearly all the frostbite patients who received it.

Although frostbite affects a relatively small number of people in the United States — a few thousand annually — it is a major concern for people who must spend a lot of time outside in the cold, such as mountain climbers, people in the military and people without housing.

A synthetic drug first developed in Germany in 1980s, iloprost, also known by the brand name Aurlumyn, is given by injection. It works as a vasodilator, meaning it widens blood vessels, improves blood flow and prevents risk of blood clotting. It was primarily used to treat Raynaud's disease, a disorder that causes blood vessels in the fingers and toes to narrow, as well as to treat blood pressure–related illnesses.

A study published in 1994 was the first to test if the drug may also be able to open up jammed blood vessels as a result of frostbite. It was tested in five patients, successfully recovering their frostbitten digits in all cases.

In the worst cases, frostbite can cause the tissues in fingers, toes, noses and other extremities to die and require amputation.

The drug subsequently showed promising results in studies done in England, France and Nepal. In the clinical trial cited by the FDA in its approval of iloprost, patients rescued from high altitudes were randomly assigned to treatment with either buflomedil (another vasodilator), iloprost or iloprost plus a drug that breaks down blood clots. Out of the 47 patients treated over 12 years, none of the 16 patients that received iloprost alone had to have digits amputated, researchers reported in 2011 in the New England Journal of Medicine. In comparison, nine of 15 patients in the buflomedil group needed amputations as did three of 16 patients in the iloprost combination group.

Iloprost is already an approved treatment for frostbite for years in a number of European countries and elsewhere in the world. Science News talked with Chris Imray, a vascular surgeon at University Hospitals Coventry & Warwickshire in England who has been treating patients with this drug for more than a decade, about what frostbite does to the body, how the drug works and what it will mean for patient treatment in the United States. The interview has been edited for length and clarity.

SN: What happens in the body during frostbite?

Imray: Frostbite is a thermal injury that affects [the] hands, feet, nose, ears and occasionally external genitalia after a few hours of cold exposure. When the temperature of the tissue drops to around zero degree Celsius, the blood flow through the tissue slows down. Then you get thrombosis, clots forming within the blood vessels, which subsequently leads to loss of oxygen delivery to the tissue. Over a period of time, you then get gangrene and the tissue dies.

SN: How did scientists realize that targeting blood clotting can be useful in frostbite treatment?

Imray: If we've got a tissue that's damaged from a thermal injury with poor blood supply, you could try to treat by warming the tissue. But the problem is that if there's no blood supply, you may warm up the tissue but you won't restore the oxygen delivery to the tissue, and that actually just speeds up the deterioration.

We've known for some time in other situations, like stroke or acute coronary syndromes, that if you can restore the blood quickly, within four to six hours, you can restore the blood supply, clear the clots in the small blood vessels, and then oxygen is delivered to the tissues again. One of the treatments for acute coronary syndrome was thrombolytic agents to break down the clot. But if a patient had an accident and has soft tissue or bony injuries, giving them thrombolytic agents may cause more bleeding. Iloprost works as a vasodilator rather than as a lytic agent on the clot. That's really sort of where it came from.

SN: How has iloprost changed treatment of frostbite?

Imray: We used to do something called a sympathectomy. Vascular surgeons would cut the sympathetic nerves to open up the blood vessels to the hands or to the feet. Once [iloprost] came out, it seemed to have a similar effect — it would cause the blood vessels to vasodilate. The beauty was you didn't have to cut the nerves permanently.

SN: How is iloprost administered?

Imray: The drug is given intravenously and circulates all through the body. We often start at a low dose and then gradually increase the infusion rate, until the patient starts to get side effects — facial flushing, high heart rate or low blood pressure. At that point, we wind it back a very small amount — just enough to get rid of the symptoms. Then we run it for six hours [and repeat] the process for around five days. We can do imaging tests to see if there's an improvement to the blood supply to the tissues. Then the surgeons will need to manage the tissues that have been almost dead and brought back to life. The overall effect is a dramatic limb and digit salvage rate, which is quite remarkable.

SN: How does iloprost work?

There are multiple mechanisms that have been put forward for it. One is vasodilation. One is that it seems to affect clotting slightly. And it changes the [ability] of the red blood cells to get through the small vessels.

SN: What timing is crucial for treating frostbite?

Imray: All tissues have different metabolic rates. The brain has a very high metabolic rate, which is why [there's] a short window, about six hours, to [break down blood clots] in a stroke. The heart has a little bit longer. And if you don't get there within that time, the person has permanent tissue damage.

We're not really sure about tissues in the hands, feet and muscles. We thought [within] 24 hours was the maximum time [after frostbite injury for using iloprost], but there have been reports of some people who have gone as long as five days. But the longer you go for the type of injury, the less impressive the effects will be.

SN: Who will this new approval benefit most?

Imray: We've had a number of high-profile climbers who have had [frostbite] injuries where they've been told there's nothing that can be done. And they subsequently lost tissue. So, what we're trying to do is to identify medical units [close to the big mountains] where iloprost can be given, so that if you have an injury, you can be flown there as quickly as possible.

Frostbite also affects homeless people. Sadly, they don't generate the same concern [as the high-profile climbers], but they can have serious frostbite injuries and end up with life-changing amputations.

If you look at people who would be at risk of losing limbs, [the iloprost approval] will transform that. I'm delighted [the FDA has] approved it, but they've taken quite a long time to get there.

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https://sciencenews.org

Harmful "Forever Chemicals" Removed From Water With New Electrocatalysis Method

2024-03-06

The researchers, led by assistant professor of chemical engineering Astrid Müller, focused on a specific type of PFAS called Perfluorooctane sulfonate (PFOS), which was once widely used for stain-resistant products but is now banned in much of the world for its harm to human and animal health. PFOS is still widespread and persistent in the environment despite being phased out by US manufacturers in the early 2000s, continuing to show up in water supplies.

Müller and her team of materials science PhD students created the nanocatalysts using her unique combination of expertise in ultrafast lasers, materials science, chemistry, and chemical engineering.

"Using pulsed laser in liquid synthesis, we can control the surface chemistry of these catalysts in ways you cannot do in traditional wet chemistry methods," says Müller. "You can control the size of the resulting nanoparticles through the light-matter interaction, basically blasting them apart."

The scientists then adhere the nanoparticles to carbon paper that is hydrophilic, or attracted to water molecules. That provides a cheap substrate with a high surface area. Using lithium hydroxide at high concentrations, they completely defluorinated the PFOS chemicals.

Müller says that for the process to work at a large scale, they will need to treat at least a cubic meter at a time. Crucially, their novel approach uses all nonprecious metals, unlike existing methods that require boron-doped diamond. By their calculations, treating a cubic meter of polluted water using boron-doped diamond would cost $8.5 million; the new method is nearly 100 times cheaper.

Harnessing PFAS chemicals in sustainable ways

In future studies, Müller hopes to understand why lithium hydroxide works so well and whether even less expensive, more abundant materials can be substituted to bring the cost down further. She also wants to apply the method to an array of PFAS chemicals that are still prevalently used but have been linked to health issues ranging from development in babies to kidney cancer.

Scientists from the University of Rochester have developed new electrochemical approaches to clean up pollution from "forever chemicals" found in clothing, food packaging, firefighting foams, and a wide array of other products.

Müller says that despite their issues, outright banning all PFAS chemicals and substances is not practical because of their usefulness in not only consumer products, but in green technologies as well.

"I would argue that in the end, a lot of decarbonization efforts—from geothermal heat pumps to efficient refrigeration to solar cells—depend on the availability of PFAS," says Müller. "I believe it's possible to use PFAS in a circular, sustainable way if we can leverage electrocatalytic solutions to break fluorocarbon bonds and get the fluoride back out safely without putting it into the environment."

Although commercialization is a long way off, Müller filed a patent with support from URVentures, and foresees it being used at wastewater treatment facilities and by companies to clean up contaminated sites where they used to produce these PFAS chemicals. She also calls it a social justice issue.

"Often in areas with lower income across the globe, there's more pollution," says Müller. "An advantage of an electrocatalytic approach is that you can use it in a distributed fashion with a small footprint using electricity from solar panels."

Technology Networks, 06 March 2024

https://technologynetworks.com

Iodide addition could make high energy lithium-sulfur batteries commercially viable

2024-03-12

Many researchers regard lithium-sulfur batteries as a key prospective advance in lithium battery technology because they could hold much more energy than today's lithium-ion batteries. These usually use lithium cobalt oxide cathodes: during charging lithium deintercalates from the lithium cobalt oxide, oxidising the cobalt(III) to cobalt(IV). During discharge, this process is reversed, releasing electrons into the external circuit. Lithium-sulfur cathodes, however, work by electrochemical conversion. 'Lithium reacts with sulfur to form lithium sulfide – that gives you the energy to form your lithium-ion battery,' explains computational materials scientist Shyue Ping Ong at the University of California, San Diego. This means more lithium ions can be stored and more electrons released, as well as obviating the need for cobalt, which is plagued by supply-chain concerns.

A sulfur iodide crystal discovered by US researchers could help solve some of the key problems of next generation lithium batteries. The material is 11 orders of magnitude more electronically conductive than elemental sulfur, drastically reducing the internal resistance in lithium-sulfur batteries.

However, elemental sulfur is highly insulating, which creates internal resistance. Moreover, the conversion is chemically complex and problematic in liquid electrolytes. ‘Even though the two end-members are solid and are not soluble in the electrolytes, the intermediates unfortunately are,’ explains experimentalist Ping Liu, also at UC, San Diego. ‘This helps to deal with the perfectly insulating nature of the elemental sulfur, but when you’re going back and forth from a solid to a liquid to a solid it’s very difficult to get reversibility.’ Solid state batteries, which naturally have inert electrolytes, help solve the second problem, but they exacerbate the first. Maintaining a conformal interface between solid sulfur and a solid electrode over repeated cycles is also challenging.

Liu and colleagues produced sulfur iodide molecular crystals by heating sulfur and iodine powder together. At the optimum stoichiometry of S9.3I, analysis by Ong’s group showed periodic I2 substitutions into the octahedral structure of elemental sulfur. The iodine added additional electronic energy levels, increasing the material’s conductivity by 11 orders of magnitude. Moreover, it disrupted van der Waals forces, lowering the melting point to 65°C.

The researchers tested their material in a solid-state battery, initially melting it into the electrolyte to achieve conformal interfaces. They found that, as a result of its greater electronic conductivity, it showed much higher capacity than a battery with a sulfur cathode. After 50 cycles, this had decayed slightly as defects had developed in the cathode interface. However, reheating the battery to 100°C restored its function by healing these defects, and with periodic reheating the battery retained 87% of its capacity after 400 cycles. The researchers are now working towards commercialisation of their technology. ‘The thermal management aspect is surprisingly easy to implement,’ says Liu. ‘Most of the challenge with today’s lithium-ion batteries with liquid electrolytes is that they need to be cooled.’

‘As an inorganic chemist and electrochemist who works on lithium-sulfur batteries, I’m very intrigued,’ says Linda Nazar of the University of Waterloo in Canada. She notes that the existence and nature of sulfur iodides was debated for over 100 years, with many chemistry textbooks saying no such compound was possible despite a report of one with a melting point of 65°C in 1908. She notes, however, that the capacity per unit electrode area of the cathode over 400 cycles is around 1mAh/cm2 – less than commercial lithium batteries today. In the extended data, however, the researchers show batteries that have 4–4.5mAh/cm2 capacity sustained

over a ‘very promising’ 50 cycles. Extending this to hundreds of cycles ‘would constitute a big step change,’ she says.

Update: On 13 March 2024 the passage on battery charging/discharging was corrected.

Chemistry World, 12 March 2024

https://chemistryworld.com

New high-speed microscale 3D printing technique

2024-03-13

“We can now create much more complex shapes down to the microscopic scale, at speeds that have not been shown for particle fabrication previously, and out of a wide range of materials,” said Jason Kronenfeld, Ph.D. candidate in the DeSimone lab at Stanford and lead author of the paper that details this process, published today in Nature.

This work builds on a printing technique known as continuous liquid interface production, or CLIP, introduced in 2015 by DeSimone and coworkers. CLIP uses UV light, projected in slices, to cure resin rapidly into the desired shape. The technique relies on an oxygen-permeable window above the UV light projector. This creates a “dead zone” that prevents liquid resin from curing and sticking to the window. As a result, delicate features can be cured without ripping each layer from a window, leading to faster particle printing.

“Using light to fabricate objects without mold opens up a whole new horizon in the particle world,” said Joseph DeSimone, the Sanjiv Sam Gambhir Professor in Translational Medicine at Stanford Medicine and corresponding author of the paper. “And we think doing it in a scalable manner leads to opportunities for using these particles to drive the industries of the future. We’re excited about where this can lead and where others can use these ideas to advance their own aspirations.”

Roll to roll

The process that these researchers invented for mass producing uniquely shaped particles that are smaller than the width of a human hair is reminiscent of an assembly line. It starts with a film that is carefully tensioned and then sent to the CLIP printer. At the printer, hundreds of shapes are printed at once onto the film and then the assembly line moves along to wash, cure, and remove the shapes—steps that can all be customized based on the shape and material involved.

3D-printed microscopic particles, so small that to the naked eye they look like dust, have applications in drug and vaccine delivery, microelectronics, microfluidics, and abrasives for intricate manufacturing.

At the end, the empty film is rolled back up, giving the whole process the name roll-to-roll CLIP, or r2rCLIP. Prior to r2rCLIP, a batch of printed particles would need to be manually processed, a slow and labor-intensive process. The automation of r2rCLIP now enables unprecedented fabrication rates of up to 1 million particles per day.

If this sounds like a familiar form for manufacturing, that's intentional.

"You don't buy stuff you can't make," said DeSimone, who is also professor of chemical engineering in the School of Engineering. "The tools that most researchers use are tools for making prototypes and test beds, and to prove important points. My lab does translational manufacturing science—we develop tools that enable scale. This is one of the great examples of what that focus has meant for us."

There are tradeoffs in 3D printing of resolution versus speed. For instance, other 3D printing processes can print much smaller—on the nanometer scale—but are slower. And, of course, macroscopic 3D printing has already gained a foothold (literally) in mass manufacturing, in the form of shoes, household goods, machine parts, football helmets, dentures, hearing aids, and more. This work addresses opportunities in between those worlds.

"We're navigating a precise balance between speed and resolution," said Kronenfeld. "Our approach is distinctively capable of producing high-resolution outputs while preserving the fabrication pace required to meet the particle production volumes that experts consider essential for various applications. Techniques with potential for translational impact must be feasibly adaptable from the research lab scale to that of industrial production."

Hard and soft

The researchers hope that the r2rCLIP process sees wide adoption by other researchers and industry. Beyond that, DeSimone believes that 3D printing as a field is quickly evolving past questions about the process and toward ambitions about the possibilities.

"r2rCLIP is a foundational technology," said DeSimone. "But I do believe that we're now entering a world focused on 3D products themselves more so than the process. These processes are becoming clearly valuable and useful. And now the question is: What are the high-value applications?"

For their part, the researchers have already experimented with producing both hard and soft particles, made of ceramics and of hydrogels. The first

could see applications in microelectronics manufacturing and the latter in drug delivery in the body.

"There's a wide array of applications, and we're just beginning to explore them," said Maria Dulay, senior research scientist in the DeSimone lab and co-author of the paper. "It's quite extraordinary, where we're at with this technique."

Phys Org, 13 March 2024

https://phys.org

Mercury Levels in Tuna Are Just as High as They Were in 1971

2024-02-21

Despite a global reduction in mercury pollution in the intervening fifty years, the international team of researchers say marine fish are still just as contaminated with the toxin, likely due to legacy mercury still circulating in the oceans.

The findings were published in Environmental Science & Technology Letters.

Mercury levels in tuna have stayed steady since the early 1970s, according to a new paper.

Steady mercury

Mercury pollution enters the seas via industrial discharge, land runoff and atmospheric deposition. Once there, microbes convert the element into methylmercury, a toxic cation that is then consumed by sea life such as plankton.

As the plankton is eaten by small fish, which are in turn eaten by larger fish, the levels of methylmercury accumulate up the food chain.

Sitting near the top of their food chain, tuna fish end up with a notable quantity of methylmercury in their bodies, which can constitute a minor health risk to humans if consumed in exceptionally large portions (three cans or more a day).

Since the implementation of several environmental policies in the late 20th century and the decline of polluting industries such as mining in key areas, some environmental scientists had hoped ocean methylmercury levels would have declined. But this hasn't been the case.

Now, an international team of researchers has compiled previously published data plus their own records on total mercury levels from nearly

3,000 tuna samples of fish caught in the Pacific, Atlantic and Indian Oceans between 1971 and 2022. They specifically looked at three species of tropical tuna: skipjack, bigeye and yellowfin, which account for 94% of global tuna catches.

As none of the species undergo transoceanic migrations, the researchers reasoned that any methylmercury contamination found in the animals' muscles would likely reflect the waters they swam in.

After standardizing the data to allow for comparison across decades and regions, the researchers observed that tuna mercury concentrations remained stable worldwide from 1971 to 2022, except for an increase in the northwestern Pacific Ocean in the late 1990s. This likely resulted from concomitant increasing mercury emissions from Asia. Airborne mercury pollution, however, did decline over the same period.

The researchers posit that the stubbornly static mercury levels in tuna may be caused by upward mixing of old mercury from deeper in the ocean water into the shallower depths where tropical tuna swim and feed. This "legacy" mercury, they say, could have been emitted years or even decades prior and doesn't yet reflect the effects of decreasing emissions in the air.

The team performed some mathematical simulations to test this theory. All three models predicted that even the most restrictive emission policy would take 10 to 25 years to influence oceanic mercury concentrations, with drops in tuna mercury levels following decades later.

While the researchers recognize their forecasting does not consider all variables in tuna ecology, they insist their findings point to a need for a worldwide effort to aggressively reduce mercury emissions and a commitment to long-term and continuous mercury monitoring in ocean life.

Technology Networks, 21 February 2024

https://technologynetworks.com

Giant 'sand battery' holds a week's heat for a whole town

2024-03-12

A new industrial scale 'sand battery' has been announced for Finland, which packs 1 MW of power and a capacity of up to 100 MWh of thermal energy for use during those cold polar winters.

The sand battery, developed by Polar Night Energy, is a clever concept. Basically, it's a big steel silo of sand (or a similar solid material) that's warmed up through a heat exchanger buried in the center, using excess electricity from the grid – say, that generated during a spike from renewable sources, when it's cheap.

That energy can then be stored for months at a time, with reportedly very little loss, before being extracted as heat on demand. This could theoretically be converted back into electricity, although with some energy loss. But Polar Night says that the most efficient method is to just use the heat itself.

In a chilly place like Finland, that means feeding it into the local district heating system, which shares heat produced from industry or energy production through the community. Networks of pipes carry this heat as hot water or steam to warm up houses, buildings, even swimming pools. In this case, the new sand battery would be trialed in the district heating system of the Finnish municipality of Pornainen, run by a company called Loviisan Lämpö.

This new sand battery is expected to stand 13 m (42.7 ft) tall and 15 m (49.2 ft) wide, providing an output power of 1 MW and a capacity of 100 MWh. That, the companies claim, equates to a week's worth of Pornainen's heat demands in winter, or a month's worth in summer. By comparison, Polar Night's previous sand battery stands 4 x 7 m (13 x 23 ft), for a nominal power rating of 100 kW and a capacity of 8 MWh.

The new battery should also reduce the carbon dioxide emissions of the district heating system by 160 tonnes per year, translating to an almost 70% reduction. The sand itself will also be sustainably sourced – it'll consist of crushed soapstone, which is a manufacturing byproduct of another local industry. This material can apparently conduct heat even better than regular old sand.

While sand batteries might not find wide outside of areas that use district heating, they could still be one useful tool in a climate change toolbox that needs to be as diverse as possible. Sand batteries might join other grid-scale storage options like lithium-ion, gravity, molten salt, iron-air or flow batteries.

Polar Night Energy says the new sand battery will complete construction and testing in about 13 months.

New Atlas, 12 March 2024

https://newatlas.com

Combined microscopy technique catches light-driven polymers in the act

2024-03-11

In a study published last month in Nano Letters the researchers from Osaka University used tip-scan high-speed atomic force microscopy (HS-AFM) combined with an optical microscope to create movies as the polymer films changed.

Azo polymers are photoactive materials, meaning they undergo changes when light is shined on them.

Specifically, light changes their chemical structure, which alters the surface of the films.

This makes them interesting for applications such as optical data storage and providing light-triggered motion.

Being able to initiate these changes with a focused laser light while capturing images is known as in situ measurement.

“It is usual to investigate changes in polymer films by subjecting them to a treatment, such as irradiating with light, and then making measurements or observations afterwards. However, this provides limited information,” explains study lead author Keishi Yang.

“Using an HS-AFM setup including an inverted optical microscope with a laser, allowed us to trigger changes in azo-polymer films while observing them in real time with high spatiotemporal resolution.”

The HS-AFM measurements were able to track the dynamic changes in the surfaces of the polymer films in movies with two frames per second.

It was also found that the direction of the polarized light used had an influence on the final surface pattern.

Further investigation using the in situ approach is expected to lead to a thorough understanding of the mechanism of light-driven azo-polymer deformation, allowing the potential of these materials to be maximized.

“We have demonstrated our technique for observing polymer film deformation,” says study senior author Takayuki Umakoshi.

“However, in doing so, we have shown the potential of combining tip-scan HS-AFM and a laser source for use across materials science and physical chemistry.”

Expanding our scientific understanding often comes down to getting as close a look as possible at what is happening. Now researchers from Japan have observed the nanoscale behavior of azo-polymer films while triggering them with laser light.

Materials and processes that respond to light are important in a wide range of fields in chemistry and biology, including sensing, imaging, and nanomedicine. The in situ technique provides an opportunity to deepen understanding and maximize potential and are hence expected to be applied to various optical devices.

Science Daily, 11 March 2024

https://sciencedaily.com

Sodium lumps, glucose and mechanochemistry behind ammonia-free Birch reduction

2024-03-11

Conventional Birch reductions use an electron-rich solution of alkali metals in an amine solvent alongside an alcohol-based proton source to convert arenes into 1,4-cyclohexadiene derivatives. Sodium-based Birch reductions typically use lumps of sodium metal stored in mineral oil. However, such protocols also require liquid ammonia as the solvent, which is toxic and difficult to handle. ‘It also needs a high level of experimental skill to carry it out,’ explains Hajime Ito of Hokkaido University. Several ammonia-free methods that instead use activated sodium sources, such as modified sodium dispersions, have been explored in recent years. These activated sodium sources enable efficient reduction through their large surface area, but their limited shelf-life and substantial cost limit potential for large-scale synthesis.

Now, a team led by Ito has developed a ball-milling method that activates sodium lumps in situ and used them in Birch reductions. Sodium is a very soft metal and would usually be difficult to grind into a powder. To resolve this, the researchers added d-(+)-glucose to solidify the reaction mixture and allow efficient mechanical activation. Glucose ‘also serves to slowly supply protons to the reduced substrate’, explains Ito.

‘The work is advancing a recently emerged field of mechanochemical, solventless reactivity of alkaline metals, showing how inexpensive and readily-available metallic sodium can be engaged in a highly popular organic transformation,’ comments Tomislav Friščić, a mechanochemistry expert at the University of Birmingham, UK.

Duncan Browne, who develops mechanochemical processes for organic chemistry at University College London, UK, says the protocol solves ‘the malleability problem’ of activating alkali metals like sodium, by using a

Researchers in Japan have designed a mechanochemical protocol for the Birch reduction that works in air, at room temperature.

reactive grinding auxiliary, 'which allows reactants to accept the energy from the ball as it's bashing around inside the ball mill'.

Browne also remarks that it's difficult to synthesise 1,4-cyclohexadiene derivatives via processes other than a Birch reduction. 'If they have improved the accessibility to that reaction, then I think that's only a good thing, and mechanochemistry has really allowed them to do this.'

Sodium lumps 'can be weighed and used immediately after wiping the surface oil with paper, making them easy to work with', says Ito. They are also more cost-effective than traditional activated sodium sources, and more sustainable than lithium, which Ito's team tested in a mechanochemical Birch reduction protocol last year.2 However, as sodium is pyrophoric and the Birch reduction is an exothermic reaction, Ito says users should consider the risk of fire before scaling it up.

'The ease and operational simplicity with which sodium metal can be used for this type of reactivity is surprising and the methodology itself opens interesting new mechanistic questions and exciting opportunities,' adds Friščić. 'One of them is the potential mechanistic role of glucose and related molecules in freeing metal surfaces of metal oxide and activating the metal by complexation. Another one is the possibility of using the inherent chirality of d-(+)-glucose to perhaps develop effective mechanochemical approaches to enantioselective, asymmetric Birch-type reactivity, without requiring amine solvents or liquid ammonia temperatures.'

Chemistry World, 11 March 2024

https://chemistryworld.com

Research team develops catalyst that can purify municipal sewage while enhancing hydrogen generation efficiency

2024-03-13

Their research was recently featured in Advanced Functional Materials.

With the growing environmental concerns of pollution associated with fossil fuel, hydrogen has garnered increased interest. Water electrolysis technology is a sustainable process that leverages Earth's abundant water to produce hydrogen. However, the concurrent oxygen evolution reaction during hydrogen production is notably slow, resulting in a considerably low energy conversion efficiency.

Researchers have devised a novel catalyst aimed at enhancing the efficiency of reactions using contaminated municipal sewage to produce hydrogen—a green energy source.

Lately, the academic community has been tackling this issue by integrating the urea oxidation reaction with the hydrogen generation reaction. Urea, a pollutant found in urine, releases a significant amount of energy during its oxidation process, offering a potential means to enhance both the efficiency of hydrogen generation and the purification of toilet wastewater.

Ultimately, it is necessary to find a catalyst that can effectively drive the urea oxidation reaction, thereby amplifying the efficiency of both hydrogen generation and wastewater treatment.

In pursuit of increased efficiency in the urea oxidation reaction, the team created a catalyst known as nickel-iron-oxalate (O-NFF). This catalyst combines iron (Fe) and oxalate on nickel (Ni) metal, resulting in an expansive surface area characterized by nanometer-sized particles in fragment form. This unique property enables the catalyst to adsorb more reactants, facilitating an accelerated urea oxidation reaction.

In experiments, the O-NFF catalyst devised by the team successfully lowered the voltage required for hydrogen generation to 1.47 V RHE (at 0.5 A/cm2) and exhibited a high reaction rate even when tested in a mixed solution of potassium hydroxide (1 M) and urea (0.33 M) with a Tafel slope of 12.1 mV/dec.

The researchers further validated the catalyst's efficacy by confirming its promotion of the urea oxidation reaction through photoelectron/X-ray absorption spectroscopy using a radiation photon accelerator.

Professor Kangwoo Cho and Ph.D. candidate Jiseon Kim from the Division of Environmental Science & Engineering at Pohang University of Science and Technology (POSTECH) collaborated with the Korea Institute of Science and Technology (KIST) for this study.

Cho, who led the research, stated, "We have developed a catalyst capable of purifying municipal sewage while simultaneously enhancing the efficiency of hydrogen production, a green energy source. We anticipate that O-NFF catalysts, synthesized from metals and organics, will contribute to the improved efficiency of industrial electrolysis hydrogen production."

Phys Org, 13 March 2024

https://phys.org

Molecular chaos powers potent ice-busting coating

2024-02-28

While anti-ice coatings aren't new, there have always been problems with them, says a research team at Austria's Graz University of Technology (TU Graz). Primarily, they can often detach from the surfaces they are meant to keep free from freezing.

So researchers there set out to improve upon the process. They used a manufacturing technique known as initiated chemical vapor deposition, or iCVD. It works by applying two substances as a gas onto a surface in need of coating. The process has been used over the years for everything from converting carbon dioxide to graphene to making better lithium-ion batteries.

In this case, a highly adhesive primer was combined with an icephobic polymer. As the gas was laid down on the surface, it consisted mainly of the primer, which allowed it to make a super-strong bond with the surface. As the spray process continued, the researchers increased the amount of ice-resistant material from zero to 100% of the mix. The result was a dual-layer coating that had a strong bond underneath and an outer surface that stopped ice crystals from forming.

The mechanism that created this ice-busting effect has never been seen before, say the researchers. They found that the molecules in the coating arranged themselves in random horizontal and vertical patterns that stymied the formation of ice.

"The ice-repellent material consists of elongated molecules that adhere to the primer in a vertical or horizontal orientation," explained study co-author Gabriel Hernández Rodríguez from TU Graz's Institute of Solid State Physics. "The thicker we applied the material, the more random the alternation between vertical and horizontal molecules became. And the more random the arrangement at the surface, the greater the ice-repellent effect."

The team was able to show that its coating was able to not only reduce ice adhesion levels, but lower the freezing point of water touching it as well.

While car owners in cold climates can dream of using the spray to coat car windows and make frosty freezing mornings a little easier, the researchers have other ideas in mind for the spray such as speeding up the de-icing of aircraft and keeping delicate sensing equipment free from frost.

Scraping ice off your car window might get a lot easier in the future thanks to a new spray coating developed by scientists in Austria.

The research has been published in the journal, ACS Applied Materials & Interfaces.

New Atlas, 28 February 2024

https://newatlas.com

Super-thickeners made from starch reduce calories and carbs in food

2024-02-16

Starch is often added to foods like soups to make them richer and thicker, but doing so increases the calorie count and carbohydrate content. Now, Peilong Li at Cornell University in New York and his colleagues have found that the amount of starch in foods can be reduced without sacrificing texture by arranging starch particles into special shapes.

Starch particles thicken food because they swell up when they are heated. This means the particles jam against each other, leaving less room for liquid components of the dish to flow freely. The researchers wondered whether they could replicate this effect but cut the amount needed by hollowing out globs of starch. "But you can't just carve a starch granule like it's a pumpkin," says Li.

Instead, working with starch particles extracted from amaranth grain, he and his colleagues devised a way to assemble them into three-dimensional shapes by mixing them with water and oil. The starch particles arranged themselves around oil drops, and then the researchers removed the two liquids through a combination of heating and freeze-drying. This left them with just the starchy structures, some shaped like cages with hollow centres, some shaped like sheets that would cascade on top of each other so liquids would get trapped between them.

The team discovered that these starch structures performed so well as thickening agents that they could be used to halve the amount of starch typically needed to thicken foods.

Fan Zhu at the University of Auckland in New Zealand says that using these granules as building blocks for the new class of hollow starch structures is very innovative and could make starches a big part of designing future foods. However, Zhu says that amaranth starch is expensive and can be difficult to source in large quantities, so adapting the new method to more affordable and abundant starches like those made from corn would be advantageous. "And more studies are needed

Building tiny sheets and cages from starch particles turns them into super-thickeners that could reduce the calorie content of foods.

on what happens when you put this kind of structure in your mouth," he says.

New Scientist, 16 February 2024

https://newscientist.com

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

CHEMICAL EFFECTS

Manganese accumulation in red blood cells as a biomarker of manganese exposure and neurotoxicity

Contamination of aquatic ecosystems by persistent organic pollutants (POPs) originating from landfills in Canada and the United States: A rapid scoping review

ENVIRONMENTAL RESEARCH

Associations of environmental cadmium exposure with kidney damage: Exploring mediating DNA methylation sites in Chinese adults

Associations of prenatal ambient air pollution exposures with asthma in middle childhood

Fine-tuning the use of moss transplants to map pollution by Potentially Toxic Elements (PTEs) in urban areas

PHARMACEUTICAL/TOXICOLOGY

Evidence for chromium crosses blood brain barrier from the hypothalamus in chromium mice model

Impact of electronic cigarette usage on the onset of respiratory symptoms and COPD among Chinese adults

OCCUPATIONAL

Ascertaining sensitive exposure biomarkers of various Metal(loid)s to embryo implantation

Maternal exposure to deltamethrin during pregnancy and lactation impairs neurodevelopment of male offspring

Multi-scenario PM2.5 distribution and dynamic exposure assessment of university community residents: Development and application of intelligent health risk management system integrated low-cost sensors