CHEMWATCH

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Contents

NOV. 15, 2024

(click on page numbers for links)

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CHEMWATCH

Bulletin Board

Contents

NOV. 15, 2024

CHEMWATCH

Bulletin Board

Contents

NOV. 15, 2024

ASIA PACIFIC

Silica Worker Register Consultation Paper

2024-10-04

The purpose of this consultation paper is to seek feedback from the public and key stakeholders on the proposed provisions to bring into effect a silica worker register. Silica continues to be a high priority for the NSW Government. As such the Government has made a number of election commitments relating to silica reforms, to address the rise in silicosis cases in NSW over recent years. One of these election commitments is to increase the health screening of at-risk silica workers by registering all workers engaged in the fabrication of engineered stone. This commitment includes the development of a silica worker register, to monitor the health of at-risk workers exposed to silica dust. Your feedback will help inform these reforms, ensuring the NSW Government has the required systems in place to fulfil its election commitment, which will see the ramping up of health screening for those working with silica. SafeWork NSW is conducting the consultation and will carefully consider all feedback received.

Read More

Safe Work NSW, 04-10-24

https://hdp-au-prod-app-nsw-haveyoursay-files.s3.ap-southeast-2.amazonaws.com/7817/2785/0699/ConsultationPaperSilicaWorkerRegister.pdf

Indonesia needs to strengthen energy transition policy for self-sufficiency: Experts

2024-10-24

Indonesia's dependency on fossil energy that is decline in production will threaten the energy self-sufficiency target that the government needs to determine a policy and regulation that encourage investment in renewable energy, experts have suggested.

Putra Adhiguna, Managing Director of Energy Shift Institute, said that energy transition is crucial in meeting the 8-percent economic growth target set by President Prabowo Subianto, considering that energy is the foundation of any economic sectors, while global companies are demanding the availability of clean energy in destination countries of their investment.

CHEMWATCH
Bulletin Board
Regulatory Update
NOV. 15, 2024

"Energy transition is an issue of Indonesia's competitiveness at global level, an issue on competitiveness to attract qualified industrial investment and creating jobs. It is the government that will have to calculate the economic gain and loss if we do not have clean energy supply," Putra said on Monday, October 28, 2024.

He noted the urgency of thorough planning in energy sector to encourage development as well as avoiding long-term burden.

Read More

Indonesia Business Post, 28-10-24

https://indonesiabusinesspost.com/insider/indonesia-needs-to-strengthen-energy-transition-policy-for-self-sufficiency-experts/

AMERICA

Nonprofit Watchdog CEH Sues Two Additional Companies for Illegally Importing Hundreds of Thousands of Pounds of Toxic Chemicals

2024-10-30

Today the nonprofit Center for Environmental Health (CEH) filed lawsuits against two companies Entegris and Lubrizol for failing to report imports of toxic chemicals to the U.S. Environmental Protection Agency, a violation of the Chemical Data Reporting (CDR) rule under the Toxic Substances Control Act (TSCA). CEH also announced it reached a settlement agreement with AOC, LLC, a chemical supplier against which CEH previously filed suit on June 20, 2024.

Entegris makes coatings, trays, filters, and other products and is headquartered in Billerica, MA, and Lubrizol creates additives, polymers, and cleaning product materials and is headquartered in Wickliffe, Ohio.

EPA calls CDR reporting critical for addressing chemical risks and protecting communities, since "exposure information [reported] is an essential part of developing risk evaluations." For years, CEH has systematically analyzed the import data for companies and chemicals and worked collaboratively with companies to report that data to the EPA.

The lawsuit against Entegris cites two chemicals: cobalt sulfate imports, totaling more than 48,000 pounds in 2019 and phosphoric acid imports, totaling more than 180,000 pounds in 2018 and 230,000 pounds in 2019.

Phosphoric acid is a toxic substance that can cause severe health issues through inhalation, ingestion, or skin and eye contact. Phosphoric acid is used as an acidity regulator and preservative in foods and beverages like jams, cereal bars, processed meats, and cheese, and it is also a component of detergents in many household cleaning products.

Read More

CEH, 30-10-24

https://ceh.org/latest/press-releases/nonprofit-watchdog-ceh-sues-two-additional-companies-for-illegally-importing-hundreds-of-thousands-of-pounds-of-toxic-chemicals/

Proposed compositional requirements for infant foods and foods currently regulated as foods for special dietary use

2024-10-23

Health Canada is proposing to take a comprehensive approach to modernizing Divisions 24 and 25 of the Food and Drug Regulations (FDR). These Divisions govern foods for special dietary use (FSDU) and infant foods in Canada. The current regulations, developed decades ago, are outdated and inflexible, hindering the integration of scientific advancements and updates to recommended intakes. This rigidity poses challenges for industry innovation, limits availability of products approved in other countries and leaves Canada more vulnerable to shortages.

On November 28, 2023, Health Canada pre-published a proposal that envisioned a complete restructuring of the current regulatory framework for FSDU and infant foods including how the modernized framework would align with the 2019 amendment to the Food and Drugs Act, which introduced the term "food for a special dietary purpose (FSDP)". The impact of this restructuring would necessitate removing the term FSDU and creating a framework to regulate FSDP that would integrate updates and flexibilities to improve product access and mitigate supply disruptions. Details of the proposed regulatory modernization and restructuring were provided in the last consultation and are not provided again in this paper but influence how the information is organized and how the proposals are set forth.

The 2023 proposal committed to reviewing and updating the compositional and labelling requirements for infant foods and foods currently regulated as FSDU. Details pertaining to the proposed labelling

CHEMWATCH
Bulletin Board
Regulatory Update
NOV. 15, 2024

requirements were outlined, but limited information was shared regarding composition.

This proposal is focused on compositional requirements. To ensure safety and nutritional adequacy, the proposed requirements are underpinned by the latest dietary intake recommendations. Due consideration was also given to approaches applied internationally as well as feedback received from the 2023 consultation relevant to product composition. The updated requirements are proposed to be incorporated by reference in the FDR, allowing a more flexible approach in which future amendments could be made administratively to reflect scientific advancements.

Read More

Government of Canada, 23-10-24

https://www.canada.ca/en/health-canada/programs/consultation-proposed-compositional-requirements-infant-foods-currently-regulated-special-dietary-use/document.html

New Testing Finds High Levels of BPA in Coconut Water

2024-10-29

Today, the nonprofit Center for Environmental Health (CEH) sent legal notices to 11 companies for selling canned coconut water found to contain high levels of the chemical bisphenol A (BPA)–despite several products being labeled as "BPA-free." The brands include: Vita Coco ("BPA Free"), Zola ("BPA Free"), C2O ("BPA Free Package"), 365 Whole Foods Market ("Non-BPA Lining"), Parrot, Sprouts, Jarritos, Goya, Sun Harvest, Raley's, and Iberia.

CEH's testing follows a recent peer-reviewed study that showed high levels of BPA in canned beverages. BPA is an endocrine disruptor that has been linked to reproductive dysfunction and brain and behavior disorders. The chemical has been linked to the development of diabetes, heart disease, erectile dysfunction, and cancer.

Take Action: Get BPA Out of Coconut Water

"The problem with bisphenols like BPA is it can mimic hormones like estrogen and block other hormone receptors, even at low levels, altering the way hormones control the function of our bodies, and resulting in negative health effects," said Mihir Vohra, Science Lead at CEH. "Exposure during pregnancy has been associated with a variety of health problems in children. These problems include abnormal development of the mammary

glands and ovaries that can increase the likelihood of developing breast or ovarian cancer later in life. They also include the abnormal development of male reproductive systems which can lead to delays or defects in puberty."

Read More

CEH, 29-10-24

https://ceh.org/latest/press-releases/coconutwater/

EUROPE

Europe's animal testing legislative reform agenda boosted by grassroots concerns

2024-10-22

With its first commissioner specifically responsible for animal welfare within sight, Europe is responding directly to public concerns for animals. This special report takes a closer look at the complex legislative dynamics in play.

With its first commissioner specifically responsible for animal welfare within sight, Europe is responding directly to public concerns for animals, not least when it comes to animal testing.

This special report takes a closer look at the complex issues surrounding animal welfare, animal testing, the lobbying dynamics influencing public policy, and the stakeholder voices shaping next-generation legislation.

The upcoming 2024 Annual Conference of the European Partnership for Alternative Approaches to Animal Testing (EPAA) will take place on Wednesday, 13 November 2024 in Brussels. Euractiv will be covering this event.

It aims to give participants insights on the EPAA's achievements in 2024. The winners of the EPAA 3Rs Science Prize will also be announced. In addition, the potential to maximise NAM uptake under existing EU chemical and pharmaceutical regulations will be discussed during 2 panels.

EPAA members from industry and the European Commission, stakeholders from European and international institutions, academic or research institutes, NGOs and national regulatory authorities will attend.

CHEMWATCH
Bulletin Board
Regulatory Update
NOV. 15, 2024

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Euractiv, 22-10-24

https://www.euractiv.com/section/health-consumers/special_report/europes-animal-testing-legislative-reform-agenda-boosted-by-grassroots-concerns/

Re-evaluation of argon (E 938) and helium (E 939) as food additives

2024-10-28

The Panel on Food Additives and Flavourings (FAF) provides a scientific opinion re-evaluating the safety of the two food additives argon (E 938) and helium (E 939). Argon (Ar) and helium (He) are two noble gases, highly stable single atoms. Their chemical inertness is well known. Their physicochemical properties have served as a basis for their previous evaluations by SCF and JECFA, which have considered the use of these food additives safe even in the absence of a toxicological evaluation. No business operator or other interested party provided information in response to the call for data published by EFSA to support the re-evaluation of these two food additives with respect to their identity and specifications, manufacturing process (including the identification and quantification of potential impurities) and how they are applied to food to exert their technological function. One business operator replied to the call for data issued by EFSA reporting use levels of E 938 as a packaging gas in one food category. Based on their physicochemical properties, both gases are considered by the Panel to be of low toxicological concern when used as food additives. No information was available on the potential presence of impurities of toxicological concern resulting from the manufacturing process(es) applied to the production of the food additives E 938 and E 939. The Panel however noted that a minimum purity of 99.0% is required to comply with existing specifications. The Panel concluded that the use of argon (E 938) and helium (E 939) as food additives does not raise a safety concern. The Panel recommended an amendment of the existing EU specifications to introduce the respective CAS numbers.

Read More

EFSA, 28-10-24

https://www.efsa.europa.eu/en/efsajournal/pub/9048

Re-evaluation of silicon dioxide (E 551) as a food additive in foods for infants below 16 weeks of age and follow-up of its re-evaluation as a food additive for uses in foods for all population groups

2024-110-17

The present opinion is the follow-up of the conclusions and recommendations of the Scientific Opinion on the re-evaluation of silicon dioxide (E 551) as a food additive relevant to the safety assessment for all age groups. In addition, the risk assessment of silicon dioxide (E 551) for its use in food for infants below 16 weeks of age is performed. Based on the newly available information on the characterisation of the SAS used as E 551 and following the principles of the 2021 EFSA Guidance on Particle-TR, the conventional safety assessment has been complemented with nano-specific considerations. Given the uncertainties resulting from the limitations of the database and in the absence of genotoxicity concern, the Panel considered that it is not appropriate to derive an acceptable daily intake (ADI) but applied the margin of exposure (MOE) approach for the risk assessment. The Panel concluded that the MOE should be at least 36 for not raising a safety concern. The calculated MOEs considering the dietary exposure estimates for all population groups using the refined non-brand loyal scenario, estimated at the time of the 2018 re-evaluation, were all above 36. The Panel concluded that E 551 does not raise a safety concern in all population groups at the reported uses and use levels. The use of E 551 in food for infants below 16 weeks of age in FC 13.1.1 and FC 13.1.5.1 does not raise a safety concern at the current exposure levels. The Panel also concluded that the technical data provided support an amendment of the specifications for E 551 laid down in Commission Regulation (EU) No 231/2012. The paucity of toxicological studies with proper dispersion protocol (with the exception of the genotoxicity studies) creates uncertainty in the present assessment of the potential toxicological effects related to the exposure to E 551 nanosize aggregates.

Read More

EFSA, 17-10-24

https://www.efsa.europa.eu/en/efsajournal/pub/8880

CHEMWATCH
Bulletin Board
Regulatory Update
NOV. 15, 2024

INTERNATIONAL

Protecting the ozone layer for people, nature and climate stability

2024-10-31

We are in a busy and exciting period of law-making by the international environmental community. In a few short weeks, we will have had the Convention on Biological Diversity COP, the climate change COP 29, the desertification COP, and negotiations on a legally binding instrument to end plastic pollution, including in the marine environment.

In addition, of course, to this combined event for the Vienna Convention COP and Montreal Protocol MOP on the Depletion of the Ozone Layer.

But this event is different to the others. Why? Because here, we have a shining example of what multilateral action with full commitment and appropriate resources can achieve.

The great astronomer and planetary scientist Carl Sagan once said: "The hole in the ozone layer is a kind of skywriting. At first it seemed to spell out our continuing complacency before a witch's brew of deadly perils. But perhaps it really tells of a newfound talent to work together to protect the global environment."

We have truly seen how the ozone treaties have proved that cooperation works and can yield results.

To date, the global implementation of the Montreal Protocol has led to the phase-out of 99 per cent of ozone depleting substances. This corresponds to the reduction of approximately 12.5 billion tonnes of carbon dioxide equivalent, since most of ODSs are also powerful greenhouse gases.

Assuming continued compliance with the Protocol, Antarctic ozone is expected to return to its pre-1980 state by around 2066 and globally by mid-century.

This is giving the planet some vital breathing space.

Read More

UNEP, 31-10-24

https://www.unep.org/news-and-stories/speech/protecting-ozone-layer-people-nature-and-climate-stability

World must act faster to protect 30% of the planet by 2030

2024-10-28

The international community has made some headway on pledges to protect 30% of the Earth by 2030 but progress must accelerate, the official progress report from the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and the International Union for Conservation of Nature (IUCN) has found.

The Protected Planet Report 2024 reveals that 17.6% of land and inland waters and 8.4% of the ocean and coastal areas globally are within documented protected and conserved areas.

The increase in coverage since 2020, equivalent to more than twice the size of Colombia, is to be celebrated. But it is a rise of less than 0.5 percentage points in both realms. This leaves a land area roughly the size of Brazil and Australia combined, and at sea an area larger than the Indian Ocean, to be designated by 2030 in order to meet the global target. Over the next six years the global network will need to be urgently expanded by a further 12.4% on land and 21.6% in the ocean.

Governments committed to ensuring that these areas are effective, well-located, connected, equitably governed and uphold human rights. While progress has been made on all elements that can be meaningfully tracked, the new data suggests that the world is falling short on the quality as well as the coverage of protected and conserved areas.

Protected and conserved areas are vital places for both nature and people. They play a critical role in halting and reversing biodiversity loss. They also provide important cultural, spiritual and economic benefits, supplying ecosystem services that help to safeguard the planet for the future of humanity. In December 2022, Parties to the Convention on Biodiversity (CBD) agreed to conserve 30% of Earth's land and seas by 2030. This commitment is referred to as Target 3 and is one of 4 goals and 23 targets to tackle the global nature crisis under the Kunming-Montreal Global Biodiversity Framework. With this target, CBD Parties committed to conserving nature through protected and conserved areas, including those that allow for the sustainable use of resources, recognising Indigenous and traditional territories.

CHEMWATCH
Bulletin Board
Regulatory Update
NOV. 15, 2024

Read More

UNEP, 28-10-24

https://www.unep.org/news-and-stories/press-release/world-must-act-faster-protect-30-planet-2030#:~:text=In%20December%202022%2C%20Parties%20to,Kunming%2DMontreal%20Global%20Biodiversity%20Framework.

IFRA Global Fragrance Summit 2024 in Dubai signals new approach

2024-10-29

The International Fragrance Association (IFRA) opened the Global Fragrance Summit 2024 in Dubai today. This summit, under the theme 'A world of fragrance: building bridges between innovation and global regulation,' explored the evolving dynamics between innovation and regulatory frameworks in the fragrance sector. The two-day conference, which continues tomorrow, addresses the future of fragrance sustainability, technical innovation, global regulation, and multi-stakeholder collaboration.

"This year's IFRA Global Fragrance Summit comes at a pivotal moment for our industry," said Martina Bianchini, President of the International Fragrance Association. "We are proud to bring together fragrance leaders from around the world to discuss how we can continue to innovate while meeting global safety and compliance standards".

The IFRA Global Fragrance Summit is a key event in the sector's calendar. This is the first time IFRA is hosting the Global Fragrance Summit in the Gulf. Previous editions have occurred in Geneva, Sao Paolo, Paris, Barcelona and Singapore. These focused events attract fragrance executives, perfumers and creatives as well as regulatory experts.

"As we gather in Dubai, we are not only hoping to build bridges into a region which is central to the fragrance world but that has its own unique traditions and customs. Among the many topics we'll be focusing on, we'll also be discussing our newly launched IFRA Strategy, that will guide us and our sector into a more sustainable and collaborative future", said Hans Holger Gliewe Chairman of IFRA. "This summit marks our first foray into the Gulf region and is an important milestone for the fragrance industry."

Read More

IFRA, 29-10-24

https://ifrafragrance.org/news/newsroom/ifra-global-fragrance-summit-2024-in-dubai-signals-new-approach

Proposed ASTM Standard Will Support Lead Paint Analysis

2024-10-23

ASTM's paint committee is developing a standard for rapid analysis of new paint samples for the determination of lead content

ASTM International's paint and related coatings, materials, and applications committee is developing a proposed standard that focuses on the recalibration of pXRF analyzers using new paint samples that have known concentrations of lead, improving the accuracy of the individual pXRF analyzer.

Mercer University and the U.S. Environmental Protection Agency (EPA), among others, are working to support the effort, which would support the enforcement of standards to eliminate lead in paint manufactured in or imported into a country referred to as "new paint."

According to ASTM members Adam Kiefer and Caryn Seney, this method will fill the gap in lower- and middle-income countries, allowing for a rapid, cost-effective analysis of new paint samples supporting existing lead paint regulations or the introduction of new regulations.

The proposed standard (WK92076) has the potential to accelerate the efforts of the Global Alliance to Eliminate Lead Paint (a partner of ASTM, Mercer and EPA) to help countries effectively implement lead paint laws.

Currently, there is no direct method to determine low levels of lead in new paint outside conventional, spectroscopic methods, which are both cost-prohibitive and complex to use.

As noted by Kiefer and Seney, both chemistry professors at Mercer University, "There was no capacity in many of these countries to analyze and quantify lead in paint, and so very few people knew that it was in new paint. We want to demonstrate that the less expensive pXRF alternative can be used in lower- and middle-income countries in place of very expensive, highly technical instruments. Ultimately, it would be most protective to prevent lead paint being applied to surfaces, which starts

CHEMWATCH
Bulletin Board
Regulatory Update
NOV. 15, 2024

with rapid screening of new paint being manufactured in a country or coming into port before these new paints make it on the store shelf."

Read More

ASTM International, 23-10-24

https://newsroom.astm.org/newsroom-articles/proposed-astm-standard-will-support-lead-paint-analysis

The Candidate List of substances of very high concern (SVHC) now contains 242 entries for chemicals that can harm people or the environment. Companies are responsible for managing the risks of these chemicals and giving customers and consumers information on their safe use.

2024-11-07

Helsinki, 7 November 2024 - ECHA's Member State Committee confirmed the addition of triphenyl phosphate to the list in its October meeting. The substance has endocrine disrupting properties and is used as a flame retardant and as a plasticiser. The committee's discussion on including the substance was originally foreseen for June but delayed, exceptionally, due to substantial new information becoming available on its properties.

Entry added to the Candidate List on 7 November 2024:

Substance name	EC number	CAS number	Reason for inclusion	Examples of uses
Triphenyl Phosphate	204-112-2	115-86-6	Endocrine disrupting properties (Article 57(f) - environment)	This substance is used as a flame retardant and

The list now contains 242 entries – some are groups of chemicals, so the overall number of impacted chemicals is higher.

This substance may be placed on the Authorisation List in the future. If a substance is on this list, companies cannot use it unless they apply for authorisation and the European Commission authorises its continued use.

Consequences of inclusion on the Candidate List

Under **REACH**, companies have legal obligations when their substance is included – either on its own, in mixtures or in articles – in the Candidate List.

If an article contains a Candidate List substance above a concentration of 0.1 % (weight by weight), suppliers have to give their customers and consumers information on how to use it safely. Consumers have the right to ask suppliers if the products they buy contain substances of very high concern.

CHEMWATCH
Bulletin Board
REACH Update
NOV. 15, 2024

Importers and producers of articles have to notify ECHA if their article contains a Candidate List substance within six months from the date it has been included in the list (07 November 2024).

EU and EEA suppliers of substances on the Candidate List, supplied either on their own or in mixtures, have to update the safety data sheet they provide to their customers.

Under the **Waste Framework Directive**, companies also must notify ECHA if the articles they produce contain substances of very high concern in a concentration above 0.1 % (weight by weight). This notification is published in ECHA's database of substances of concern in products (SCIP).

Under the **EU Ecolabel Regulation**, products containing SVHCs cannot have the ecolabel award.

Read More

ECHA, 07-11-24

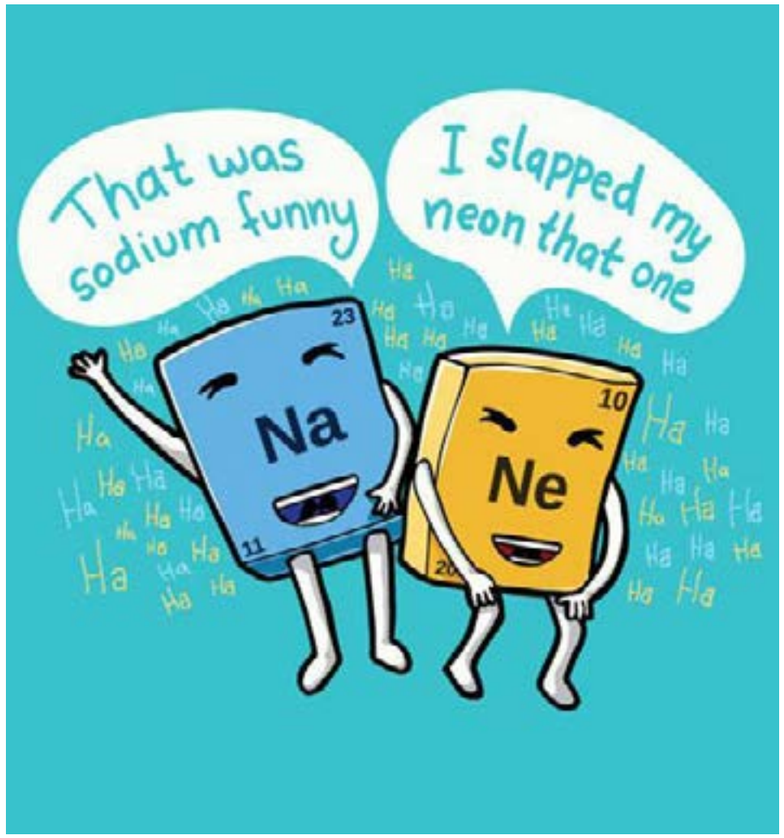
https://echa.europa.eu/-/echa-adds-one-hazardous-chemical-to-the-candidate-list-1

Janet's Corner

NOV. 15, 2024

Sodium Funny

2024-11-15



http://www.buzzfeed.com

CHEMWATCH
Bulletin Board

Hazard Alert

NOV. 15, 2024

Nitrogen Mustards

2024-11-15

USES [2,3]

- HN-1 originally was designed to remove warts but was later identified as a potential chemical warfare agent.
- HN-2 was designed as a military agent but was later used in cancer treatment. Other treatment agents now have replaced it.
- HN-3 was designed solely as a military agent.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- If nitrogen mustards are released into the air as a vapour, you could be exposed through skin contact, eye contact, or breathing.
- If nitrogen mustards are released into water, you could exposed by drinking the contaminated water or getting it on your skin.
- You could be exposed by coming in direct contact with liquid nitrogen mustards.
- Because it is heavier than air, nitrogen mustard vapour will settle in low-lying areas.

Routes of Exposure

- **Inhalation:** Inhalation is an important route of exposure. Nitrogen mustard vapours are heavier than air. The LCt50 (the product of concentration times time that is lethal to 50% of the exposed population by inhalation) is approximately 1,500 mg-min/m^3 for HN-1 and HN-3, and 3,000 mg-min/m^3 for HN-2.
- **Skin/Eye Contact:** Exposure to nitrogen mustard vapour can cause injury to the eyes, skin, and mucous membranes at low concentrations. Direct contact with the liquid can cause skin and eye burns. The median incapacitating dose for the eyes is 100 mg-min/m^3 for HN-2 and 200 mg-min/m^3 for HN-1 and HN-3. Absorption may occur after skin or eye exposure to liquid or vapour nitrogen mustard and may cause systemic toxicity.
- **Ingestion:** Ingestion is an uncommon route for exposure but can lead to local effects such as oesophageal or gastrointestinal burns and systemic absorption.

Nitrogen mustards are vesicants (blister agents) and alkylating agents. They are colourless to pale yellow, oily liquids that evaporate slowly. They are also known by their military designations of HN-1, HN-2, and HN-3. [2] HN-1 has a faint, fishy or musty odour. It is sparingly soluble in water but miscible with acetone and other organic solvents. At temperatures greater than 194°C, it decomposes. HN-2 has a fruity odour at high concentrations and a soapy odour at low concentrations. Its solubility is similar to HN-1. HN-3 is odourless when pure but has been reported to have a butter almond odour. It is the most

HEALTH EFFECTS [4]

Acute Health Effects

Nitrogen mustards are vesicants and alkylating agents; however, the mechanisms of action are not clearly understood. They are highly reactive and combine rapidly with proteins, DNA, or other molecules. Therefore, within minutes following exposure intact mustard or its reactive metabolites are not found in tissue or biological fluids.

- **CNS:** High doses of nitrogen mustards have caused tremors, seizures, incoordination, ataxia, and coma in laboratory animals.
- **Respiratory:** Damage to the mucosa of the airways begins within hours and may progress over several days. Nasal and sinus pain or discomfort, pharyngitis, laryngitis, cough, and dyspnea may occur. Pulmonary oedema is uncommon.
- **Gastrointestinal:** Ingestion may cause chemical burns of the GI tract and haemorrhagic diarrhoea. Nausea and vomiting may occur following ingestion, dermal, or inhalation exposure.
- **Ocular:** Exposure to nitrogen mustard vapour or liquid may cause intense conjunctival and scleral inflammation, pain, swelling, lacrimation, photophobia, and corneal damage. High concentrations can cause burns and blindness.
- **Dermal:** Direct skin exposure to nitrogen mustards causes erythema and blistering. Generally, a rash will develop within several hours, followed by blistering within 6 to 12 hours. Prolonged contact, or short contact with large amounts, may result in second- and third-degree chemical burns.
- **Hematopoietic:** Systemic absorption of nitrogen mustard may induce bone marrow suppression and an increased risk for fatal complicating infections, haemorrhage, and anaemia.
- **Delayed Effects:** Chemotherapeutic doses of HN-2 have been associated with menstrual irregularities, alopecia, hearing loss, tinnitus, jaundice, impaired spermatogenesis, generalised swelling, and hyperpigmentation.
- **Potential Sequelae:** Chronic respiratory and eye conditions may persist following exposure to large amounts of nitrogen mustards. Narrowing of the oesophagus and severe corrosive damage to the stomach lining can result from ingesting formalin.

CHEMWATCH
Bulletin Board
Hazard Alert
NOV. 15, 2024

Carcinogenicity

The International Agency for Research on Cancer (IARC) has classified nitrogen mustard as probably carcinogenic to humans (Group 2A). There is some evidence that it causes leukaemia in humans, and it has been shown to cause leukaemia and cancers of the lung, liver, uterus, and large intestine in animals.

Other Effects

In laboratory animal studies, prolonged or repeated exposures to nitrogen mustards have caused cancer, developmental and reproductive effects, and hepatic toxicity. Repeated exposures result in cumulative effects because mustards are not naturally detoxified by the body.

SAFETY

First Aid Measures [5]

- **EYES:** First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control centre. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- **SKIN:** IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison control centre even if no symptoms (such as redness or irritation) develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.
- **INHALATION:** IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. IMMEDIATELY call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- **INGESTION:** DO NOT INDUCE VOMITING. Corrosive chemicals will destroy the membranes of the mouth, throat, and oesophagus and,

in addition, have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control centre. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. Transport the victim IMMEDIATELY to a hospital.

- **OTHER:** Since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure. (NTP, 1992)

REGULATION

United States

No occupational exposure limits have been established for nitrogen mustard. However, the United States Military has established a TLV (threshold limit value) of 0.003mg/m3.

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New Technique Can Capture and "Destroy" PFAS in Water

2024-11-08

A University of Illinois Urbana-Champaign study is the first to describe an electrochemical strategy to capture, concentrate and destroy mixtures of diverse chemicals known as PFAS — including the increasingly prevalent ultra-short-chain PFAS — from water in a single process. This new development is poised to address the growing industrial problem of contamination with per- and polyfluoroalkyl substances, particularly in semiconductor manufacturing.

A previous U. of I. study showed that short- and long-chain PFAS can be removed from water using electrochemically driven adsorption, referred to as electrosorption, but this method is ineffective for ultra-short-chain molecules because of their small size and different chemical properties. The new study, led by Illinois chemical and biomolecular engineering professor Xiao Su, combines a desalination filtration technology, called redox electrodialysis, with electrosorption in a single device to address the problems associated with capturing the complete PFAS size spectrum.

The study findings are published in the journal Nature Communications.

"We decided upon redox electrodialysis because the very short-chain PFAS behave a lot like salt ions in water," Su said. "The challenge was to produce an efficient, effective electrodialysis system to capture the ultra-short-chain PFAS, have it work in tandem with the electrosorption process for the longer-chain PFAS, destroy them with electrochemical oxidation, and make it happen within a single device."

Su's team has previously demonstrated highly efficient electrodialysis devices that remove various non-PFAS contaminants. However, the process requires ion-exchange membranes, which are expensive and quickly fouled by PFAS molecules.

To clear the membrane hurdle, Su's team introduced an inexpensive nanofiltration membrane that enables the electric-field-driven removal of PFAS without becoming fouled. This technology is based on prior advances made by their group in combining redox polymers with these nanofiltration membranes to enable energy-efficient desalination.

For PFAS removal, having the right material for the job is one thing, but finding the most effective configuration is a significant challenge on its own.

"After experimenting with a variety of device configurations, we finally settled on a system that desalinates the PFAS-contaminated water to remove the ultra-short-chain molecules, then at the same time, carbon electrodes remove the remaining short- and long-chain molecules," Su said. "This process also concentrates all the PFAS, making them easier to destroy once captured."

Finally, the electrochemical oxidation process inherent to redox electrodialysis destroys the captured PFAS by converting them to fluoride ions, a key step towards eliminating these persistent contaminants from the environment.

Su said that the team is excited about the prospect of scaling up the process so they can take it out of the lab and into the field not only to address wastewater applications but also to incorporate the system on-site into industrial wastewater streams.

"This work is very timely due to interest from the U.S. government, wastewater treatment facilities and the semiconductor industry," Su said. "Semiconductor production is expected to rise over the coming years, and PFAS abatement for sustainable production will become a major issue moving forward."

Technology Networks, 8 November 2024

https://technologynetworks.com

New PFAS removal process aims to stamp out pollution ahead of semiconductor industry growth

2024-11-07

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CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

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Phys Org, 7 November 2024

https://phys.org

New route to fluorochemicals: Fluorspar activated in water under mild conditions

2024-11-13

Currently, all fluorochemicals -- critical for many industries -- are generated from the highly dangerous mineral acid hydrogen fluoride (HF). This acid is produced in a high-energy process whereby naturally occurring fluorspar (CaF_2) is reacted with concentrated sulfuric acid under very harsh conditions. Despite stringent safety regulations, HF spills have occurred, sometimes causing fatalities and detrimental environmental effects.

A team in Oxford has now demonstrated that the fluorine content of acid grade fluorspar (>97% CaF_2) can be harvested in water under mild reaction conditions in the presence of a fluorophilic Lewis acid and oxalic acid serving as Brønsted acid. This follows previous work from the team into solid-state activation of fluoride using mechanical energy.

Their new aqueous reaction pathway is adaptable, depending on the Lewis acid used. With boric acid, the process affords an aqueous solution of tetrafluoroboric acid, that was successfully applied to Balz-Schiemann chemistry. When silica is used instead of boric acid, this scalable process carried out at room temperature provides direct access to aqueous hexafluorosilicilic acid that can be converted into commonly used nucleophilic fluorinating reagents such as potassium fluoride and tetraalkylammonium fluoride salts.

This work represents a new departure for the production of fluorochemicals from fluorspar, as well as lower-purity metspar, because the protocol does not rely on the complex supply chain of hazardous hydrogen fluoride (HF). Considering current efforts to prepare oxalic acid at low cost from CO_2 and biomass, the method may become a viable alternative to the traditional sulfuric acid-dependent HF pathway.

CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

Dr Simon Immo Klose, formerly at the University of Oxford and now at Columbia University (USA), and one of the lead authors of the study, says:

"The most challenging aspect of using fluorspar as a fluoride source is its high stability and low solubility. Unlike table salt, which dissolves readily in water, only a tiny pinch of fluorspar would dissolve in the same amount of water. But, like pulling a thread to unravel an entire sweater, if we can continually remove this tiny amount, we can dissolve kilograms of calcium fluoride under mild conditions, despite its low solubility."

Dr Anirban Mondal, from the Department of Chemistry, University of Oxford, and one of the lead authors of the study, says:

"HF-related accidents serve as a constant reminder of the hazards involved in traditional fluorochemical manufacturing. With our technology, however, we can directly access all the commonly used fluorinating reagents from fluorspar without having to rely on HF and its hazardous supply chain. It is incredibly rewarding to be part of a team working on such a practical, real-world problem with a solution that will immediately have an impact."

Calum Patel, formerly at the University of Oxford and now at FluoRok (UK), and one of the lead authors of the study, says:

"Our first mechanochemical method disclosed in 2023 [Science] led to a new reagent that was studied for its ability to serve as nucleophilic fluoride. We have taken a significantly different, yet complementary approach to processing fluorspar into well-known industrially important fluorinating reagents. Remarkably, fluorspar can be activated in water at low temperature through the cooperative action of oxalic acid and a Lewis acid. This process enables us to access broader classes of fluorochemicals from fluorspar without the need to manufacture HF, such as structurally diverse fluoroarenes used to synthesise agrochemicals."

Lead author Prof Véronique Gouverneur FRS, Department of Chemistry, University of Oxford, who conceived and led this study says:

"A solution to use CaF_2 directly for fluorination chemistry, without the need for HF production, has been sought for decades. This study represents an important step because the protocol developed in Oxford is easy to implement and does not require specialized equipment. It can

therefore be used anywhere in academia and industry, minimising carbon emissions by avoiding HF manufacture and enabling supply localisation."

Science Daily, 13 November 2024

https://sciencedaily.com

Anti-Obesity Drug Use Rises, While Weight Loss Surgeries Are Down 25%

2024-11-01

A new study examining a large sample of privately insured patients with obesity found that use of drugs such as Ozempic and Wegovy as anti-obesity medications more than doubled from 2022 to 2023. During that same period, there was a 25.6 percent decrease in patients undergoing metabolic bariatric surgery to treat obesity.

The study, by researchers at Brigham and Women's Hospital, in collaboration with researchers at Harvard T.H. Chan School of Public Health and the Brown School of Public Health, is published in JAMA Network Open.

"Our study provides one of the first national estimates of the decline in utilization of bariatric metabolic surgery among privately insured patients corresponding to the rising use of blockbuster GLP-1 RA drugs," said senior author Thomas C. Tsai, a metabolic bariatric surgeon at Brigham and Women's Hospital.

Using a national sample of medical insurance claims data from more than 17 million privately insured adults, the researchers identified patients with a diagnosis of obesity without diabetes in 2022-2023. The study found a sharp increase in the share of patients who received glucagon-like peptide-1 receptor agonists, or GLP-1 RAs, during the study period, with GLP-1 RA use increasing 132.6 percent from the last six months of 2022 to the last six months of 2023 (from 1.89 to 4.41 patients per 1,000 patients). Meanwhile, there was a 25.6 percent decrease in use of bariatric metabolic surgery during the same period (from 0.22 to 0.16 patients per 1,000 patients).

Among the sample of patients with obesity, 94.7 percent received neither form of treatment during the study period (while 5 percent received GLP-1 RAs and 0.3 percent received surgery). Compared to patients who were prescribed GLP-1 RAs, patients who underwent surgery tended to be more medically complex.

CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

"For now, metabolic bariatric surgery remains the most effective and durable treatment for obesity. National efforts should focus on improving access to obesity treatment — whether pharmacologic or surgical — to ensure patients can receive optimal care," said Tsai, who is also an assistant professor of surgery at Harvard Medical School and an assistant professor in health policy and management at Harvard T.H Chan School of Public Health.

Tsai notes that while GLP-1 RAs can effectively treat obesity and related conditions (such as diabetes), these medications have been limited by high costs, limited supply, and gastrointestinal side effects that may prompt treatment cessation and subsequent weight regain.

"As patients with obesity increasingly rely on GLP-1s instead of surgical intervention, further research is needed to assess the impact of this shift from surgical to pharmacologic treatment of obesity on long-term patient outcomes," Tsai said. "With the national decline in utilization of metabolic bariatric surgery and potential closure of bariatric surgery programs, there is a concern that access to comprehensive multidisciplinary treatment of obesity involving pharmacologic, endoscopic, or surgical interventions may become more limited."

"These results also highlight an opportunity to further expand uptake of surgical and pharmacologic treatments for obesity and related comorbidities," said co-author Ateev Mehrotra, chair of the Department of Health Services, Policy and Practice at the Brown University School of Public Health. "Metabolic bariatric surgery and GLP-1 RAs are both effective interventions for patients with obesity, yet less than 6 percent of patients in our study received either form of treatment."

Considering these results, the authors encourage clinicians and policymakers to continue to monitor access to effective obesity treatment amid a rapidly evolving landscape of treatment options. In addition, further research is needed to understand the tradeoffs between use of surgical intervention and increasingly popular GLP-1 RAs to treat obesity.

Technology Networks, 1 November 2024

https://technologynetworks.com

New platinum-nickel core-shell catalyst shows stability for oxygen reduction reactions

2024-11-13

Electrocatalysis is a key technology for sustainable energy, and understanding how catalysts work is crucial for improving their performance. One of the challenges in using platinum (Pt) as a catalyst for the oxygen reduction reaction (ORR) in fuel cells is that it reacts too slowly and doesn't work efficiently enough. A promising solution is to adjust the surface of the catalyst to improve its activity.

"We can enhance the performance of platinum by tuning its surface structure, which helps it react more efficiently," says Di Zhang, a specially appointed assistant professor at Tohoku University's Advanced Institute for Materials Research (WPI-AIMR).

This surface adjustment, called surface strain, occurs when the arrangement of atoms on the surface of the material is either compressed or expanded. One example is the Pt-Ni system, where platinum is paired with nickel to improve its performance.

While studies have shown that Pt-Ni works well, "many of these studies haven't fully explored which parts of the material are actually active during the reaction," explains Zhang. "Also, most models haven't accounted for how pH affects the reaction, a crucial factor in real-world applications."

To address this, Zhang and an international team of researchers created a new model that takes into account the realistic conditions of electrochemical reactions. The model was used to design a new type of Pt-Ni catalyst, called Pt1Ni1@Pt/C, which has a core-shell structure.

The results were impressive: "Our new catalyst shows a significant boost in activity compared to traditional platinum catalysts," says Hao Li, an associate professor at WPI-AIMR, who, along with Zhang and others, co-authored a paper detailing the findings in the journal Nature Communications.

The new catalyst also proved to be extremely durable, maintaining 98.4% of its activity even after 70,000 cycles. Additionally, the researchers used a special method to anchor tiny Pt-Ni nanoparticles (~2.6 nm) to a carbon substrate, creating bonds that prevent the particles from moving or clumping together.

They then created a Pt-rich shell around the Pt-Ni core, applying a compressive strain that helped improve the catalyst's ability to adsorb

CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

oxygen, making the reaction more efficient. This core-shell design, as well as the improved surface strain, contributed to the catalyst's excellent performance and durability.

"Our research showed that by combining new models, innovative material design, and advanced synthesis techniques, Pt-Ni catalysts can be made much more efficient and stable for use in energy technologies," adds Li. Ultimately, the work opens the door to longer lasting catalysts that could play a big role in the future of renewable energy.

Phys Org, 13 November 2024

https://phys.org

Engineers make converting CO2 into useful products more practical

2024-11-13

As the world struggles to reduce greenhouse gas emissions, researchers are seeking practical, economical ways to capture carbon dioxide and convert it into useful products, such as transportation fuels, chemical feedstocks, or even building materials. But so far, such attempts have struggled to reach economic viability.

New research by engineers at MIT could lead to rapid improvements in a variety of electrochemical systems that are under development to convert carbon dioxide into a valuable commodity. The team developed a new design for the electrodes used in these systems, which increases the efficiency of the conversion process.

The findings will be reported in the journal Nature Communications, in a paper by MIT doctoral student Simon Rufer, professor of mechanical engineering Kripa Varanasi, and three others.

"The CO2 problem is a big challenge for our times, and we are using all kinds of levers to solve and address this problem," Varanasi says. It will be essential to find practical ways of removing the gas, he says, either from sources such as power plant emissions, or straight out of the air or the oceans. But then, once the CO2 has been removed, it has to go somewhere.

A wide variety of systems have been developed for converting that captured gas into a useful chemical product, Varanasi says. "It's not that we can't do it -- we can do it. But the question is how can we make this efficient? How can we make this cost-effective?"

In the new study, the team focused on the electrochemical conversion of CO2 to ethylene, a widely used chemical that can be made into a variety of plastics as well as fuels, and which today is made from petroleum. But the approach they developed could also be applied to producing other high-value chemical products as well, including methane, methanol, carbon monoxide, and others, the researchers say.

Currently, ethylene sells for about $1,000 per ton, so the goal is to be able to meet or beat that price. The electrochemical process that converts CO2 into ethylene involves a water-based solution and a catalyst material, which come into contact along with an electric current in a device called a gas diffusion electrode.

There are two competing characteristics of the gas diffusion electrode materials that affect their performance: They must be good electrical conductors so that the current that drives the process doesn't get wasted through resistance heating, but they must also be "hydrophobic," or water repelling, so the water-based electrolyte solution doesn't leak through and interfere with the reactions taking place at the electrode surface.

Unfortunately, it's a tradeoff. Improving the conductivity reduces the hydrophobicity, and vice versa. Varanasi and his team set out to see if they could find a way around that conflict, and after many months of trying, they did just that.

The solution, devised by Rufer and Varanasi, is elegant in its simplicity. They used a plastic material, PTFE (essentially Teflon), that has been known to have good hydrophobic properties. However, PTFE's lack of conductivity means that electrons must travel through a very thin catalyst layer, leading to significant voltage drop with distance. To overcome this limitation, the researchers wove a series of conductive copper wires through the very thin sheet of the PTFE.

"This work really addressed this challenge, as we can now get both conductivity and hydrophobicity," Varanasi says.

Research on potential carbon conversion systems tends to be done on very small, lab-scale samples, typically less than 1-inch (2.5-centimeter) squares. To demonstrate the potential for scaling up, Varanasi's team produced a sheet 10 times larger in area and demonstrated its effective performance.

To get to that point, they had to do some basic tests that had apparently never been done before, running tests under identical conditions but

CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

using electrodes of different sizes to analyze the relationship between conductivity and electrode size. They found that conductivity dropped off dramatically with size, which would mean much more energy, and thus cost, would be needed to drive the reaction.

"That's exactly what we would expect, but it was something that nobody had really dedicatedly investigated before," Rufer says. In addition, the larger sizes produced more unwanted chemical byproducts besides the intended ethylene.

Real-world industrial applications would require electrodes that are perhaps 100 times larger than the lab versions, so adding the conductive wires will be necessary for making such systems practical, the researchers say. They also developed a model which captures the spatial variability in voltage and product distribution on electrodes due to ohmic losses. The model along with the experimental data they collected enabled them to calculate the optimal spacing for conductive wires to counteract the drop off in conductivity.

In effect, by weaving the wire through the material, the material is divided into smaller subsections determined by the spacing of the wires. "We split it into a bunch of little subsegments, each of which is effectively a smaller electrode," Rufer says. "And as we've seen, small electrodes can work really well."

Because the copper wire is so much more conductive than the PTFE material, it acts as a kind of superhighway for electrons passing through, bridging the areas where they are confined to the substrate and face greater resistance.

To demonstrate that their system is robust, the researchers ran a test electrode for 75 hours continuously, with little change in performance. Overall, Rufer says, their system "is the first PTFE-based electrode which has gone beyond the lab scale on the order of 5 centimeters or smaller. It's the first work that has progressed into a much larger scale and has done so without sacrificing efficiency."

The weaving process for incorporating the wire can be easily integrated into existing manufacturing processes, even in a large-scale roll-to-roll process, he adds.

"Our approach is very powerful because it doesn't have anything to do with the actual catalyst being used," Rufer says. "You can sew this micrometric copper wire into any gas diffusion electrode you want,

independent of catalyst morphology or chemistry. So, this approach can be used to scale anybody's electrode."

"Given that we will need to process gigatons of CO2 annually to combat the CO2 challenge, we really need to think about solutions that can scale," Varanasi says. "Starting with this mindset enables us to identify critical bottlenecks and develop innovative approaches that can make a meaningful impact in solving the problem. Our hierarchically conductive electrode is a result of such thinking."

The research team included MIT graduate students Michael Nitzsche and Sanjay Garimella, as well as Jack Lake PhD '23. The work was supported by Shell, through the MIT Energy Initiative.

Science Daily, 13 November 2024

https://sciencedaily.com

How Immunoglobulins Influence the Aging Process

2024-11-11

A team of scientists from the Chinese Academy of Sciences (CAS) and BGI Research has uncovered the intricate mechanisms by which immunoglobulins influence the aging process, a finding that might reshape our understanding of aging.

This research, published in Cell on Nov. 4, not only charts a high-precision map of aging across various organs but also reveals the dual-edged sword of immunoglobulins in systemic aging.

The quest for systemic biomarkers and key drivers of aging has been a long-standing puzzle in the field of gerontology. This study, a collaborative effort between LIU Guanghui's team from the Institute of Zoology (IOZ) of CAS, GU Ying's team from BGI Research, ZHANG Weiqi's team from the Beijing Institute of Genomics of CAS, and QU Jing's team also from IOZ, has provided compelling answers.

By meticulously analyzing millions of spatial spots across nine organs in male mice, the team created high-precision spatial transcriptomic maps. These maps detailed the spatial distribution of over 70 cell types, offering a vivid picture of aging's spatial characteristics.

The transcriptomic landscape, dubbed Gerontological Geography (GG), exposes the common threads of tissue structural disorder and loss of cellular identity as hallmarks of aging.

CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

"This landscape is a significant step forward, pinpointing the epicenters of aging within multiple organs and uncovering the accumulation of immunoglobulins as a key aging characteristic and driver," said Professor LIU, one of the corresponding authors of the study.

Using the novel method of organizational structure entropy (OSE) analysis, the researchers discovered that increased spatial structural disorder and loss of cellular identity are universal signs of systemic aging, suggesting that spatial structural damage may be a primary cause of organ functional decline during aging.

The team also identified senescence-sensitive spots (SSS), which are structural regions in different tissues more susceptible to aging's effects. They found that areas closer to SSS exhibit higher tissue structural entropy and greater loss of cellular identity, indicating that SSS could be the nucleus of organ aging.

Notably, in immune organs, plasma cells, which are responsible for antibody synthesis, and cells with specific structures and functions, are the main components of the SSS microenvironment. The expression levels of immunoglobulin-related genes in these cells increase around SSS.

The study further discovered that immunoglobulin G (IgG) accumulates in multiple tissues and organs during aging in humans and mice, suggesting that IgG levels could serve as a new biomarker for aging. Moreover, IgG was found to directly induce aging in human and mouse macrophages and microglia, releasing inflammatory factors. Intriguingly, injecting IgG into young mice induced aging in multiple tissues and organs, demonstrating its potent aging effects.

In a promising development, the team developed an intervention strategy using antisense oligonucleotides (ASO) to reduce IgG content in mouse tissues, thereby delaying the aging of multiple organs.

This study is the first to map the spatial transcriptome of pan-organ aging in mammals, revealing tissue structural disorder and loss of cellular identity as key aging hallmarks and precisely locating the core regions and microenvironmental characteristics of aging sensitivity.

The Immunoglobulin-associated Senescence Phenotype (IASP) proposed by the study expands the frontiers of aging science and opens new avenues for delaying aging and preventing related diseases.

Technology Networks, 11 November 2024

https://technologynetworks.com

Electrochemical reactor grabs 97.5% of lithium from geothermal sources

2024-11-14

Lithium-ion batteries power everything from our vape pens to electric cars, but they have one glaring issue: they rely on lots of hard-to-harvest lithium. A new reactor from Rice University is set to make the whole process easier and safer.

It's hard to pick up any rechargeable device these days that doesn't have a lithium-ion battery inside. While there have been alternatives floated, such as those based on potassium or sodium, lithium is currently where it's at in the contemporary battery market. That's primarily because, despite occasionally bursting into flames, Li-ion batteries have an excellent energy density that lets them hold a lot of charge in a relatively small size. They are also fairly lightweight.

Lithium-ion batteries are so popular, in fact, that it's predicted their demand will grow seven-fold by 2030, largely driven by the continued adaptation of electric cars. In terms of dollars, that growth amounts to US$56.8 billion in 2023 to US$187.1 billion by 2032.

The issue with this rapidly growing demand however, is that lithium itself is a problematic element. While it is the 31st most abundant element on the planet, this fact actually makes it fairly rare. What's more, lithium is often trapped in rocks or geothermal brines where its concentration can be quite low, so extracting it is an energy-intensive process that often comes with the risk of creating hazardous gasses. Digging lithium mines can also damage natural habitats and divert water from nearby communities, as it takes about 2.2 million liters of water to create one ton of lithium.

Game changer

Enter a new electrochemical reactor from researchers at Rice University, which is being touted as a game changer for lithium harvesting.

CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

The machine tackles one of the major issues with harvesting lithium from brines found in geothermal water sources. While such sources are good places to find lithium, the brines contain a host of other chemicals with similar ionic sizes and charges including magnesium, calcium, sodium, and potassium. Isolating only the lithium from this chemical stew is extremely challenging. What's more, the brines often contain a lot of chloride ions which can turn into extremely toxic chlorine gas during traditional electrochemical processes to isolate the lithium.

So the Rice team built a three-chambered reactor that has a newly developed lithium-ion conductive glass ceramic (LICGC) membrane in the middle. This membrane is often used inside lithium-ion batteries, but it was never before used in a reactor of this kind. The membrane proved effective at letting only the lithium ions pass through while holding back ions of the other chemicals, especially the potentially harmful chloride ions. In testing, the reactor not only dramatically limited the production of chlorine gas, but it achieved a lithium purity rate of 97.5%.

"This reactor could represent a major step forward in making lithium extraction both more efficient and less harmful to the environment," said study co-author Sibani Biswal.

"Our field has long struggled with the inefficiencies and environmental impacts of lithium extraction," added co-author Haotian Wang, Rice associate professor of chemical and biomolecular engineering. "This reactor is a testament to the power of combining fundamental science with engineering ingenuity to solve real-world problems."

During testing the researchers did find a potential issue with the reactor: sodium ions built up on the LICGC membrane. Such a build-up could affect the reactor's efficiency, so one strategy they found to combat it would be to lower the sodium content of the brine before running the reaction. Another would be to conduct future research to see what other methods – such as specialized membrane coatings – might keep the sodium ions from attaching.

The study detailing the reactor's development and performance has been published in the journal Proceedings of the National Academy of Sciences.

New Atlas, 14 November 2024

https://newatlas.com

New Recycling Method Turns Plastic Waste Into Valuable Chemicals and Clean Energy

2024-11-14

Iron-based electrocatalysis decomposes polystyrene while generating eco-friendly hydrogen.

Plastics have become an integral part of our daily lives, yet the enormous accumulation of plastic waste in landfills and natural environments poses serious challenges. Recently, a German research team reported in the journal Angewandte Chemie a novel method for recycling polystyrene waste. Their efficient electrochemical process, powered by affordable iron catalysts, generates hydrogen as a byproduct and can be operated using solar energy.

Less than 10% of the plastic produced in the world is recycled. Plastic waste is accumulating in landfills and waterways, threatening wildlife and the environment. By 2025, this pile of plastic is predicted to reach 40 billion tons. Globally, about 33 % of the material deposited in landfills consists of polystyrene (PS), which is widely used in packaging and construction. Only about 1 % of polystyrene is recycled.

Worldwide production capacity of polystyrene reached 15.4 million tons in 2022 and continues to increase. Recycling of plastics, particularly polystyrene, is one of the biggest societal challenges of our time. Efficient, cost-effective recycling methods that convert plastic waste to valuable small molecules that can be used in chemical syntheses would be a step toward a sustainable circular carbon economy.

A Breakthrough in Polystyrene Degradation

A team led by Lutz Ackermann at the Friedrich Wöhler Research Institute for Sustainable Chemistry in Göttingen (Germany) has now developed an electrocatalytic method for the efficient degradation of polystyrenes. The degradation produces a relatively high fraction of monomeric benzoyl products that can be used as starting materials for chemical processes, as well as some short polymer chains.

The key to this success is a powerful iron-based catalyst, an iron porphyrin complex that resembles hemoglobin. Its advantage over many other catalytically active metals is that iron is nontoxic, inexpensive, and easy to obtain. During the electrocatalytic reaction, the iron compound cycles between different oxidation steps (IV, III, and II). A series of reaction steps and intermediate products eventually result in the splitting of the carbon-

CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

carbon bonds in the polymer backbone. The main products are benzoic acid and benzaldehyde. Benzoic acid is a starting material for a variety of chemical syntheses in the production of scents and preservatives, for example. The robustness of this novel electrocatalysis was demonstrated by the efficient degradation of real-life plastic waste on the gram scale.

This polystyrene degradation process could be fully powered with electricity from commercially available solar panels. In addition, a useful side reaction occurs during the degradation process: the production of hydrogen. In this way, the new electrocatalytic process, which can easily be scaled to an industrial level, combines efficient plastic recycling with decentralized, green hydrogen production.

website, 14 November 2024

https://scitechdaily.com

RFK Jr and Trump are mulling banning fluoride from drinking water. Here's what the mineral actually does

2024-11-14

Robert F. Kennedy Jr. has said that a second Trump administration would advise the nation to remove fluoride from public water supplies.

"Fluoride is an industrial waste associated with arthritis, bone fractures, bone cancer, IQ loss, neurodevelopmental disorders, and thyroid disease," Kennedy claimed.

He recently wrote that former President Donald Trump and his wife, Melania, want to "Make America Healthy Again," also sharing a link regarding a recent court ruling that found the mineral poses enough risk to be further regulated by the Environmental Protection Agency.

Fluoride is used to strengthen teeth, replacing minerals lost due to wear and tear. Nearly 44 percent of Americans have access to fluoridate tap water.

"Well, I haven't talked to him about it yet, but it sounds OK to me," Trump previously told NBC News. "You know, it's possible."

Kennedy and Trump made their statements before Trump selected him as nominee to oversee the Department of Health and Human Services. That move could give him more power to regulate the nation's health.

The National Toxicology Program previously determined with "moderate confidence" that there is a link between higher levels of fluoride exposure and lower IQ in children, basing conclusions on studies of fluoride levels at approximately twice the recommended limit for drinking water. Previous research was done with similar findings, including a 2019 study that found higher levels of fluoride exposure during pregnancy were associated with declines in IQ in kids.

But, major public health groups support water fluoridation, including the American Academy of Pediatrics, the American Dental Association, and the Centers for Disease Control and Prevention.

The CDC named nationwide fluoridation of drinking water one of the 10 greatest public health interventions of the 20th century because of a dramatic decrease in cavities since the process began in 1945.

Nearly all water contains some naturally occurring fluoride, but at levels too low to prevent cavities. The recommended level is 0.7 milligrams per liter, and state and local governments decide whether or not to implement fluoridation. In some areas, there is enough naturally occurring fluoride to prevent cavities.

Nearly a decade ago, for the first time in more than 50 years, the federal government lowered the recommended level of fluoride in drinking water, which had previously been between 0.7 and 1.2 milligrams per liter.

According to the Fluoride Action Network, 37 states give local governments and residents authority over fluoridation decisions, and 13 states, Puerto Rico, and the District of Columbia, have laws to mandate statewide fluoridation. Some communities have rejected it, the group noted.

Around the world, fluoridation varies, with most European countries utilizing fluoridation in various ways, including through water fluoridation programs, fluoridated salt and milk, and other treatments. As of 2012, 25 countries had artificial water fluoridation to varying degrees, and an additional 28 had water that is naturally fluoridated. Nearly half of the 435 million people receiving water fluoridated at the recommended level were US residents.

Fluoride intake has beneficial effects and negative effects, according to the WHO. It can reduce tooth decay and cavities, and it can cause bone disease after lengthy exposure to high amounts. It is estimated that excessive fluoride concentrations in drinking water have caused tens of millions of

CHEMWATCH
Bulletin Board
Gossip
NOV. 15, 2024

dental and skeletal fluorosis cases globally. Research on other impacts, like bone fractures, is divided.

The experts largely still say benefits outweigh the risks. The American Dental Association says studies prove fluoridation reduces dental decay by at least a quarter in children and adults — even with widespread availability to fluoride toothpaste.

Independednt, 14 November 2024

https://independent.co.uk

Chemicals banned for decades in Australia found inside dying birds: 'Serious concern'

2024-11-13

Pesticides that have been banned for decades in Australia could be behind the mysterious deaths of dozens of magpies, with many of the birds showing signs of paralysis and weakness in recent months.

Yahoo News reported in September vets immediately suspected poisoning when 30 birds were presented to Cooper Street Veterinary Hospital in Cootamundra, NSW. They sounded the alarm, urging locals to keep an eye out for any injured animals in the area, and notified authorities who later ran tests on the birds to determine their cause of death.

Although the results were deemed "inconclusive", the Environment Protection Authority (EPA) confirmed the chemicals found inside the dead birds had previously been used in banned pesticides DDE and dieldrin.

"We cannot confirm whether the birds died from a poisoning incident or from naturally occurring diseases such as 'black and white bird syndrome', of which paralysis and weakness are primary symptoms," NSW EPA Director Operations, Scott Kidd, said.

Discovery of banned pesticides alarms authorities

DDT was made illegal in Australia in 1987 as it poses severe health risks to humans, with the World Health Organisation calling the substance "highly toxic" as it impacts the central nervous system and humans have been poisoned by it.

Use of dieldrin was restricted in the same year until the Australian government banned it completely in 1994.

"This discovery is a serious concern, as the Australian Pesticides and Veterinary Medicines Authority deregistered these two pesticides many years ago," Kidd said.

Hefty fine for those caught using illegal pesticides

The use of illegal pesticides can result in individuals being fined $500,000 while companies can pay $2 million. The message from authorities is simple — don't do it.

"We want to remind the community that using deregistered pesticides is an offence, and heavy penalties apply. Understandably, this incident has

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

been distressing for the community and wildlife carers who responded to and cared for the sick magpies," Kidd said.

Yahoo, 13 November 2024

https://yahoo.com

Fluorspar activated in water under mild conditions provides new route to fluorochemicals

2024-11-13

Researchers at Oxford University have developed a new method to extract fluorine from fluorspar (CaF2) using oxalic acid and a fluorophilic Lewis acid in water under mild reaction conditions.

This technology enables direct access to fluorochemicals, including commonly used fluorinating agents, from both fluorspar and lower-grade metspar, eliminating reliance on the supply chain of hazardous hydrogen fluoride (HF). The findings were published in the journal Nature.

Currently, all fluorochemicals—critical for many industries—are generated from the highly dangerous mineral acid hydrogen fluoride (HF). This acid is produced in a high-energy process whereby naturally occurring fluorspar (CaF2) is reacted with concentrated sulfuric acid under very harsh conditions. Despite stringent safety regulations, HF spills have occurred, sometimes causing fatalities and detrimental environmental effects.

A team in Oxford has now demonstrated that the fluorine content of acid grade fluorspar (>97% CaF2) can be harvested in water under mild reaction conditions in the presence of a fluorophilic Lewis acid and oxalic acid serving as Brønsted acid. This follows previous work by the team into solid-state activation of fluoride using mechanical energy.

Their new aqueous reaction pathway is adaptable, depending on the Lewis acid used. With boric acid, the process affords an aqueous solution of tetrafluoroboric acid that was successfully applied to Balz-Schiemann chemistry.

When silica is used instead of boric acid, this scalable process carried out at room temperature provides direct access to aqueous hexafluorosilicic acid that can be converted into commonly used nucleophilic fluorinating reagents such as potassium fluoride and tetraalkylammonium fluoride salts.

This work represents a new departure for the production of fluorochemicals from fluorspar, as well as lower-purity metspar, because the protocol does not rely on the complex supply chain of hazardous HF. Considering current efforts to prepare oxalic acid at a low cost from CO2 and biomass, the method may become a viable alternative to the traditional sulfuric acid-dependent HF pathway.

Dr. Simon Immo Klose, formerly at the University of Oxford and now at Columbia University (U.S.), and one of the lead authors of the study, says, "The most challenging aspect of using fluorspar as a fluoride source is its high stability and low solubility.

"Unlike table salt, which dissolves readily in water, only a tiny pinch of fluorspar would dissolve in the same amount of water. But, like pulling a thread to unravel an entire sweater, if we can continually remove this tiny amount, we can dissolve kilograms of calcium fluoride under mild conditions, despite its low solubility."

Dr. Anirban Mondal, from the Department of Chemistry, University of Oxford, and one of the lead authors of the study, says, "HF-related accidents serve as a constant reminder of the hazards involved in traditional fluorochemical manufacturing. With our technology, however, we can directly access all the commonly used fluorinating reagents from fluorspar without having to rely on HF and its hazardous supply chain.

"It is incredibly rewarding to be part of a team working on such a practical, real-world problem with a solution that will immediately have an impact."

Calum Patel, formerly at the University of Oxford and now at FluoRok (UK), and one of the lead authors of the study, says, "Our first mechanochemical method disclosed in 2023 [Science] led to a new reagent that was studied for its ability to serve as nucleophilic fluoride.

"We have taken a significantly different, yet complementary approach to processing fluorspar into well-known industrially important fluorinating reagents. Remarkably, fluorspar can be activated in water at low temperature through the cooperative action of oxalic acid and a Lewis acid.

"This process enables us to access broader classes of fluorochemicals from fluorspar without the need to manufacture HF, such as structurally diverse fluoroarenes used to synthesize agrochemicals."

Lead author Prof Véronique Gouverneur FRS, Department of Chemistry, University of Oxford, who conceived and led this study says, "A solution

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

to use CaF2 directly for fluorination chemistry, without the need for HF production, has been sought for decades. This study represents an important step because the protocol developed in Oxford is easy to implement and does not require specialized equipment.

"It can therefore be used anywhere in academia and industry, minimizing carbon emissions by avoiding HF manufacture and enabling supply localization."

Phys Org, 13 November 2024

https://phys.org

Clever coating for medical devices stops clots by imitating a blood vessel

2024-11-13

When a patient's blood flows through catheters, stents or other medical devices, there's always a risk that harmful clots may form. An experimental new bio-inspired coating could keep that from happening, without the use of blood-thinning drugs.

Any time that blood comes into contact with a non-bodily material, protective proteins in the plasma are triggered to isolate that material by forming a clot around it. If that clot should form in something like a dialysis machine, it could hamper the treatment or even come loose and cause a stroke in the patient.

In order to keep this from happening, doctors often administer blood-thinning drugs that stop the blood from coagulating. Such medications have negative side effects, however, including the risk of uncontrollable bleeding.

As a result, some scientists have developed anti-fouling coatings that repel the plasma proteins, keeping them from coming into contact with underlying synthetic surfaces. That said, according to Dr. Jayachandran Kizhakkedathu from Canada's University of British Columbia, such coatings may still allow clots to form in some circumstances.

With this problem in mind, Kizhakkedathu and colleagues created a "selective protein interacting" (SPI) coating, which works like the natural inner lining of blood vessels.

The polymer-based material contains "surface-conjugated sheltered positively charged macromolecules" (SPCMs), which actually interact with

a plasma protein known as factor XII. In a nutshell, although the molecules do engage the protein, they keep it from transforming into its blood-coagulating factor XIIa form.

In tests performed on human blood deposited on glass surfaces, and on shunts placed in rabbits' jugular veins, the SPI coating was found to drastically delay the formation of blood clots. On coated glass, for instance, the blood took over an hour to clot, as opposed to just 10 minutes on uncoated glass.

And importantly, once the blood was no longer in contact with the coating, it was once again able to clot normally.

"This discovery could be a transformative step in the development of safer medical devices," says Kizhakkedathu. "By designing a coating that mimics the body's natural approach to preventing clots, we've created a solution that could dramatically reduce the need for risky blood thinners before and after patients use these devices."

Further research is required to ascertain how the coating interacts with other blood proteins and cells. The study is described in a paper that was recently published in the journal Nature Materials.

New Atlas, 13 November 2024

https://newatlas.com

Simple model system can break down fibrils to investigate drugs for neurodegenerative diseases

2024-11-13

The origin of many diseases such as Alzheimer's or Parkinson's can be found at the molecular level in our body, in other words, in proteins. In a healthy system, these proteins are responsible for numerous physiological functions.

In order to carry out certain tasks, they may also assemble in groups consisting of numerous proteins. Once that job is done, they split up again and go their own ways. However, if larger clusters of a hundred or more proteins form so-called fibrils, which are bundles of long, filament-like accumulations of proteins, the attraction between the proteins is so strong that they can no longer separate from each other.

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

The resultant plaques can induce a wide variety of disorders. If the fibrils accumulate in the brain, for instance, they can increase intracranial pressure, thus triggering neurodegenerative diseases.

Disintegration of fibrils achieved for the first time

The formation of fibrils is generally an irreversible process, both in the human body and in synthetic systems. Professor Shikha Dhiman of Johannes Gutenberg University Mainz (JGU) in Germany and Professor Lu Su of Leiden University in the Netherlands have recently succeeded in creating a model system in which fibrils can be broken down into their individual components or liquid droplets.

The project also involved two Ph.D. students, Mohit Kumar in Mainz and Heleen Duijs in Leiden. "This is the first model system in which we have succeeded in reversing this process without any chemical reaction," reported Dhiman. The findings are published in the Journal of the American Chemical Society.

Within fibrils, non-covalent bonds—such as hydrogen bridges—link the single units together. These are not particularly robust on their own, but it is the high number of bonds and their order that gives fibrils their superior stability. The researchers thus decided to use a bit of a trick: They added substances that embed themselves in fibrils, creating pocket-like formations that make the fibril structure unstable.

"What we are in effect doing is introducing competing binding partners. These form bonds with single units, the interaction between units becomes redundant, and the fibrils begin to disintegrate," explained Dhiman.

Model system allows for systematic investigations

A particularly interesting feature of the model system is that it allows all parameters that can be modified to be systematically studied one by one. Until recently, researchers had assumed that individual proteins come together to form fibrils. Recently, however, this concept has been disproved. Rather, several proteins accumulate together with water and salts resulting in liquid droplets, with the proteins arranging themselves on the surface of these droplets. This is a significant intermediate state in the actual formation of fibrils.

In contrast with fibrils, these droplets can undertake normal functions in the body and can even break up to release the proteins again.

"Our model system has been able to map all three states, namely individual single units, liquid droplets, and fibrils," explained Shikha Dhiman, Professor at the JGU Department of Chemistry and senior researcher in the CoM2Life (Communicating Biomaterials: Convergence Center for Life-Like Soft Materials and Biological Systems) research network.

Fundamental basis for the development of innovative therapies

In the long term, the model system will support the development of drugs to treat a range of disorders, particularly neurodegenerative diseases such as Alzheimer's and Parkinson's. Unlike in complex systems such as cells, all parameters of the model system can be readily explored to answer various questions: What causes protein droplets to clump together to form fibrils? How can this process be regulated? How can fibrils be broken down into short fibers?

Once the researchers have resolved these fundamental issues, they can investigate the cellular level—based on large-scale screening of active substances. "The potential in terms of therapeutic applications is enormous," emphasized Lu Su, Assistant Professor at the Leiden Academic Center for Drug Research.

"We expect that drugs developed on the basis of this model will be used for the targeted disintegration of pathological fibrils to alleviate symptoms and improve outcomes for patients."

Phys Org, 13 November 2024

https://phys.org

Battery-free bioelectronic implants

2024-11-06

Spurred by advances in energy-harvesting materials, a new generation of advanced implantable biomedical devices is emerging that does away with the bulky battery. James Mitchell Crow reports

Wireless power transfer may seem like a recent innovation to keep energy-hungry smartphones topped up, but for biomedical electronics, wireless power transfer has a deep history.

When Swedish doctors performed the first fully implantable cardiac pacemaker surgery in 1958 , the device they had invented was powered by a rechargeable nickel–cadmium battery, connected to a wire coil that

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

enabled magnetic induction wireless recharging across the skin. The battery, coil and controlling electronics were housed in a shoe-polish-sized can implanted in the abdomen, with leads running to the heart to deliver the pulsed electrical stimulus.

Millions of people with a slow or irregular heartbeat have since benefited from a pacemaker implant – which soon evolved to use longer-lasting batteries that were replaced surgically every few years, rather than requiring a weekly recharge. More than six decades later, however, the basic pacemaker design – a remotely located can containing the bulky battery pack and electronics, connected to the heart by long leads – remains unchanged.

Of the few implantable devices that have followed the pacemaker into clinical use, even these typically follow that original design. For example, deep brain stimulation devices for conditions such as Parkinson's and treatment-resistant depression use a pacemaker-like chest-mounted electronics and battery pack, with electrical leads running all the way up the neck to the brain.

The long wires and bulky battery packs are not just the main failure point for implanted devices, notes Jacob Robinson, who designs implantable electronic devices at Rice University in Houston, US. They have become the key constraint on next-generation biomedical implant device design, he says. 'What prevents you from developing implant technologies that could be made extremely small, and scale to a network of nerve stimulation and recording devices, is the battery.'

As bioelectronics has advanced, experimental implants have been demonstrated that enable people with severe spinal cord injuries to walk again, or people who have lost a limb to control and experience a sense of touch from a robotic prosthetic.

To turn these experimental prototypes into practical devices that could be implanted at target sites around the body, developing miniaturised all-in-one implants could be key. The limitation on miniaturisation is not the electronics, but the power available after shrinking the battery. 'A small battery would not support complex stimulation and recording function for a long enough time to be practical,' Robinson says. 'We need to find a way to provide enough energy – and that means a battery-free device.'

With innovative use of advanced materials, Robinson's lab is one of the pioneers seeking to design a new generation of implanted biomedical devices that do away with the bulky battery and failure-prone connecting

leads. The goal is to create implants that can fully satisfy their own power needs by harvesting energy locally available within the body, or via high power wireless energy transfer.

Good vibrations

Batteries don't just limit human medical implants, but also fundamental biomedical research, says John Rogers, a materials scientist at Northwestern University in Illinois, US. As well as designing implantable medical devices, Rogers develops implants designed as advanced tools for neuroscience research, studying brain function in rodents.

'For small animal studies, the size, weight and bulk of the battery can prevent the implantation of electronic systems,' Rogers says. Cumbersome external battery packs don't solve the problem as they compromise the animals' natural behaviours, and studying social interaction is impossible because they chew one another's hardware. 'In those instances, it's essential to get rid of the battery,' Rogers says.

There are many possibilities for battery-free power. 'People have tested pretty much everything you can think of,' says Rogers. Implantable nanogenerator technologies trialled have ranging from tiny electricity-generating biofuel cells that run on the glucose present in the body, to thermoelectric harvesting of power from the temperature gradient between the body and the outside world.

'You can also think about harvesting power from natural mechanical motions of the body, such as the beating of the heart, inflation and deflation of the lungs, or the kinematic motions of the limbs,' Rogers says.

From a materials perspective, there are two main ways to harvest energy from muscle-driven motion, says nanomaterials researcher Xudong Wang, who develops implantable electronic devices at University of Wisconsin–Madison, US. One exploits triboelectricity, a surface effect that generates an electric field when two materials in contact move relative to each other to induce charge separation. The effect is maximised when an electron donor and an electron acceptor material are paired – but beyond that, there's an almost limitless array of materials that can be used.

'Triboelectric generators can be made from materials that are very flexible, biocompatible, even biodegradable,' Wang says. The downside of a triboelectric generator is the requirement to combine materials in a device that allows their individual movement. 'That brings design challenges,

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

particularly in very confined spaces inside the human body, where the displacement is relatively small.'

Piezo power

The alternative is to harvest energy from body motion with piezoelectric materials, which generate an electric field when placed under mechanical strain. 'Piezoelectric nanogenerators use a single piezoelectric material, so we don't need to consider any relative movement inside the device,' says Wang. 'In locations in the body where we cannot accommodate much local movement, piezoelectric materials are a better choice.'

Wang's lab explores biocompatible piezoelectrics made from biomaterials, such as crystalised thin films of amino acids. 'These materials are non-toxic and sustainable, don't need toxic chemistry to produce, biodegrade naturally in the environment – and can provide considerable energy conversion efficiency,' Wang says.

In 2021, the team reported a way to grow piezoelectric thin films made from glycine. In pure form, the amino acid forms a brittle film in which the glycine molecules are randomly aligned. 'For the piezoelectric device to be useful, we need ordered alignment so that all the polarisation is on the same side, just like we have to install batteries in the same way to get high output.'

Wang solved the issue using a method called surface interface directed crystallisation. 'We added a water-soluble polyvinyl alcohol polymer together with the amino acid,' he says. 'The polymer serves as a template, providing a lot of hydroxyl groups, which link with glycine specifically so that all the glycine molecules arrange in the same way.'

The polymer also forms a protective coating that enables the glycine layer to flex without breaking. 'We could use the flexible film in an implantable energy-harvesting device.' In rats, the team showed they could place the device in the thigh to generate power from walking, or in the chest to generate power from breathing.

One application Wang is investigating is as a potential treatment for obesity, which he has successfully demonstrated in animals. 'We developed a device that we put on the surface of the stomach, and wire to the vagus nerve,' he says. The vagus nerve connects the digestive system to the brain. 'When the animal eats, the peristaltic movement of its stomach generates electric pulses from the device, which pass into the vagus nerve and provides a signal to say 'Stomach is full." Rats with

the implant ate one-third less food, and weighed almost 40% less, than untreated animals.

Picking up the pace

For today's cardiac pacemakers, a significant downside is the need for regular surgery to replace the device each time the battery runs low. Self-powered pacemakers that use energy harvesting to continually capture power from the heartbeat could remove that need.

Flexible piezoelectric materials attached to the heart's outer surface have been one avenue of exploration. A team in China recently tested an alternate design, an all-in-one capsule-shaped device attached to the inner wall of a heart chamber. As the heart beats, polyformaldehyde pellets inside the capsule roll back and forth between polytetrafluoroethylene-coated gold electrodes at either end of the capsule. The motion produces an alternating current due to triboelectricity and electrostatic induction. In pigs, the device captured enough energy from every four heartbeats to power a pacing pulse. The team aims to improve the device to harvests enough energy from each heartbeat to generate a stimulating pulse.

Energy harvesting materials implanted deep within the body can also power sensing applications, says Hoe Joon Kim, who leads the nanomaterials and devices lab at Daegu Gyeongbuk Institute of Science and Technology in South Korea.

One project underway in Kim's lab is to develop a flexible piezoelectric cuff, which could be placed around a large blood vessel deep within the body. The device would be powered by, but also directly sense, the pulses of blood passing through the blood vessel. 'We could directly monitor blood pressure near the heart, which is not really possible with existing blood monitoring systems,' Kim says.

The team is also exploring the use of piezoelectrics or triboelectrics to support healing. Bone is piezoelectric, and the effect naturally plays a role in bone fracture healing. 'There's always a very minimal generation of electric charge, which really doesn't affect our body function, but let's say you have a crack on your bone,' Kim says. As you move, there's more of a flex – and so a more focused generation of electric charge – at the fracture site. This charge stimulates osteoblast activity, promoting healing.

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

Powerups

Energy harvesting can generate enough power for simple devices. But when Robinson considered the power demands of the more sophisticated sensing and stimulating electronics he hopes to implant, capable of wireless data transfer, he found a significant shortfall.

Whichever mode of energy harvesting you look at, biological systems have evolved for energy efficiency, Rogers says. 'There's not a lot of free energy floating around that you can tap into,' he says. And trying to take too much can have extreme consequences.

Chemistry World, 6 November 2024

https://chemistryworld.com

Seaweed proteins could be the next sustainable food source

2024-11-13

The protein in sea lettuce, a type of seaweed, is a promising complement to both meat and other current alternative protein sources. Seaweed also contains many other important nutrients, and is grown without needing to be watered, fertilized or sprayed with insecticides. However, the proteins are often tightly bound, and their full potential has not yet been realized on our plates.

But now researchers at Chalmers University of Technology, in Sweden, have found a new way to extract these proteins three times more efficiently than before—and this progress paves the way for seaweed burgers and protein smoothies from the sea.

"It tastes like umami with a certain salty flavor, despite not containing such high levels of salt. I would say it's a great flavor enhancer for seafood dishes and products, but the possibilities to explore are endless. Why not protein smoothies or 'blue burgers' from the sea?" says João Trigo, Ph.D. in Food Science at Chalmers, about the dark green powder, which is a concentrate of proteins from sea lettuce, scientifically known as Ulva fenestrata.

Sea lettuce is a type of macroalgae, commonly called seaweed, which grows on rocks in calm waters, or free-floating on the surface, and resembles ordinary lettuce leaves in appearance.

The so-called protein shift—switching from red meat to more sustainable and healthy protein sources—is a way to reduce the climate impact of food production while providing everyone with a nutritious diet. Many alternative protein sources, mainly based on pea, soy and mushroom, are common in our grocery stores. But all the vegetarian protein that is found under the sea is still an untapped source.

The CirkAlg-project, led by Chalmers University of Technology, has explored the possibilities of developing processes that can create a new, "blue-green" food industry in Sweden, and make use of seaweed as a promising source of protein.

Within the framework of the project, a newly published scientific study shows a unique way of extracting proteins from sea lettuce, so that it is now possible to extract three times more protein from the seaweed than was possible with previous methods. The paper is published in the journal Food Chemistry.

"Our method is an important breakthrough, as it brings us closer to making it more affordable to extract these proteins, something that is done with pea and soy proteins today," says João Trigo.

Contains several essential nutrients

In addition to essential proteins, sea lettuce contains several other substances of great nutritional value for humans, such as vitamin B12 and the same kind of omega-3 fatty acids found in oily fish, like salmon. People who do not eat animal products are at risk of developing a deficiency of vitamin B12, which is necessary for the body to form red blood cells, among other things.

And the cultivation of sea lettuce has several advantages compared to land-growing proteins—such as the fact that the seaweed does not need to be watered, fertilized or sprayed with insecticides. Sea lettuce is also hardy and grows well under many different conditions, such as different salinity and access to nitrogen.

"Humanity will need to find and combine the intake of many more diversified protein sources than we have available in our diet today, to meet sustainability and nutritional requirements. Algae is a good addition to many of the products already on the market. We need all these solutions and so far, the sea-based possibilities, the so-called blue proteins, have been overlooked," says Ingrid Undeland, Professor of Food Science at Chalmers and coordinator of CirkAlg.

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

In addition to the newly published extraction method, the Chalmers researchers are working together with the University of Gothenburg to increase the actual protein content in the seaweed. By cultivating sea lettuce in process water from the seafood industry, the protein content can be increased significantly, while nutrients that would otherwise be lost are circulated back into the food chain.

At Tjärnö Marine Laboratory (part of the University of Gothenburg) in northern Bohuslän in Sweden, a large number of successful cultivation experiments have been carried out within the CirkAlg-project, based on industrial water side currents.

"In the future, we also want to be able to make use of the parts of the algae that are not proteins, and that could be used in food, materials or for medical applications. The goal is that no molecules should go to waste, to achieve both sustainability and commercial opportunities," says Undeland.

More about the extraction method

In addition to proteins that are water-soluble, sea lettuce also contains plenty of fat-soluble so-called membrane proteins. This means that the seaweed proteins are more complex to extract than, for example, soy and pea protein.

In a first-step of the new process, the cell membranes of the sea lettuce are opened up in order to access the fat-soluble proteins. The different types of proteins are then extracted with water adjusted to a high pH, and in the next step, by making the solution acidic, the proteins are precipitated into aggregates that could then be separated from the water and utilized as a protein-rich ingredient.

It was also seen that the marine omega-3 fatty acids were enriched in the protein ingredient, and a follow-up study confirmed that the same was true for vitamin B12. The new algae protein ingredient can thus help meet a wider range of nutritional needs compared to soy protein.

The study's authors are João Trigo, Sophie Steinhagen, Kristoffer Stedt, Annika Krona, Simone Verhagen, Henrik Pavia, Mehdi Abdollahi and Ingrid Undeland. At the time of the study, the researchers were active at Chalmers University of Technology, the University of Gothenburg and RISE—Research Institutes of Sweden.

Phys Org, 13 November 2024

https://phys.org

Metal-organic framework materials to remove dye contaminants for cleaner water

2024-11-13

The future of MOFs, metal-organic framework materials, looks bright. A review in the International Journal of Environment and Waste Management has looked at how a specific class of these sponge-like materials might find increasing use in removing dye contaminants from industrial wastewater.

Irvan Dahlan and Hamidi Abdul Aziz of the Universiti Sains Malaysia in Pulau Pinang, Malaysia, and Yung-Tse Hung of Cleveland State University in Cleveland, Ohio, U.S., have focused on MOF-5 materials. These substances, constructed from a metal such as zinc to which organic molecules are bonded to build vast crystalline structures, are highly porous and so have a large internal surface area compared to their overall volume, which means they can soak up, or adsorb (sic) small molecules, such as organic dye pollutants present in industrial wastewater.

The textile, pharmaceutical, and paper industries all generate vast quantities of wastewater contaminated with synthetic dyes. This represents an enormous burden on the environment and a serious risk to ecosystems where this contaminated wastewater might end up.

Organic dyes can be stubborn pollutants, as they are often chemically stable and difficult to break down. They can resist traditional wastewater treatments. Once present in natural waters, they block sunlight and so hamper photosynthesis in aquatic plants, and can thus disturb entire ecosystems.

Moreover, some dyes are toxic, carcinogenic, or have mutagenic properties, and so represent a risk to marine life and health concerns for communities dependent on the water sources that are contaminated.

Conventional dye-removal methods, such as chemical treatment, filtration, and biological processes, are often too costly and complex to be commercially viable and commonly inefficient at handling large volumes of wastewater, regardless of cost. MOFs, on the other hand, have emerged as a promising alternative due to their unique structures.

Importantly, simple changes to the organic molecules from which they are constructed, and the metals used to lock these molecules together into a three-dimensional structure can be made relatively easily so that they can be given different pore sizes and adsorption characteristics.

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

The team's review shows that much work remains to be done with MOF-5 materials so that the bigger pore sizes can be developed for the larger dye molecules. There is also a need to improve the durability and reusability of these materials to make them suitable for industrial remediation use. Optimization of their physical and chemical characteristics is now possible, but there is also a need to find ways to scale up their manufacturing economically.

Phys Org, 13 November 2024

https://phys.org

'Game changer' in lithium extraction: Researchers develop novel electrochemical reactor

2024-11-13

A team of Rice University researchers led by Lisa Biswal and Haotian Wang has developed an innovative electrochemical reactor to extract lithium from natural brine solutions, offering a promising approach to address the growing demand for lithium used in rechargeable batteries. This breakthrough, published in the Proceedings of the National Academy of Sciences, holds significant potential for renewable energy storage and electric vehicles.

Lithium is a critical component in batteries for renewable energy storage and electric vehicles, but traditional lithium extraction methods have faced numerous challenges, including high energy requirements and difficulty separating lithium from other elements. Natural brines -- salty water found in geothermal environments -- have become an attractive lithium source, because traditional ore sources are increasingly difficult and expensive to mine. However, these brines also contain other ions like sodium, potassium, magnesium and calcium, which have very similar chemical properties to lithium, making efficient separation extremely challenging. The similarity in ionic size and charge between lithium and these other ions means that traditional separation techniques often struggle to achieve high selectivity, leading to additional energy consumption and chemical waste. Moreover, brines contain high concentrations of chloride ions that can lead to the production of hazardous chlorine gas in traditional electrochemical processes, adding further complexity and safety concerns to the extraction process.

The Rice engineering team has tackled these challenges with a novel three-chamber electrochemical reactor that improves the selectivity

and efficiency of lithium extraction from brines. Unlike traditional methods, this new reactor introduces a middle chamber containing a porous solid electrolyte -- think of interconnected highways -- that prevents these unwanted reactions by controlling ion flow as the brine passes through. The cation exchange membrane acts as a barrier to chloride ions, preventing them from reaching the electrode area where they could combine to produce chlorine gas and thereby minimizing hazardous by-products. The key component that enables highly selective lithium extraction lies in the specialized lithium-ion conductive glass ceramic (LICGC) membrane on the other side of the electrolyzer, which selectively allows lithium to pass through while blocking other ions. The LICGC membrane's high ionic conductivity and selectivity are crucial for maintaining efficiency as it significantly reduces the interference from the other ions present in natural brines such as potassium, magnesium and calcium. Although LICGC membranes are typically used in solid-state lithium-ion batteries, this application for selective extraction of lithium represents a novel and efficient use of the material's high ionic conductivity and selectivity.

"Our approach not only achieves high lithium purity but also mitigates the environmental risks associated with traditional extraction methods," said first author Yuge Feng, a graduate student in the Biswal lab. "The reactor we created is designed to minimize by-product formation and improve lithium selectivity."

The reactor achieved impressive results, including a lithium purity rate of 97.5%. This means the setup could effectively separate lithium from other ions in the brine, which is critical for producing high-quality lithium hydroxide, an important material for battery manufacturing. In addition, the new reactor design significantly reduced the production of chlorine gas, making the process safer and more environmentally friendly. The researchers said it has the potential to be a game changer for lithium extraction from challenging sources like geothermal brines.

"This reactor could represent a major step forward in making lithium extraction both more efficient and less harmful to the environment," said Biswal, the William M. McCardell Professor in Chemical Engineering and co-corresponding author with Wang.

Another key finding related to challenges with the reactor's stability over time. The team observed that sodium ions, unlike potassium, magnesium or calcium, tended to build up on the LICGC membrane surface, which hindered lithium transport and increased energy consumption. While this

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

buildup could affect the efficiency of lithium extraction, the researchers identified strategies to mitigate this issue, such as lowering the current levels, and suggested that future research explore surface coatings or current pulsing to further optimize the reactor.

By offering a cleaner, more efficient and potentially faster method for extracting lithium from geothermal brines, this research marks an important step toward ensuring a steady supply of lithium for renewable energy technologies.

"Our field has long struggled with the inefficiencies and environmental impacts of lithium extraction," said Wang, associate professor of chemical and biomolecular engineering. "This reactor is a testament to the power of combining fundamental science with engineering ingenuity to solve real-world problems."

Graduate students contributing to this study from Rice's Department of Chemical and Biomolecular Engineering include Feng, Yoon Park, Chang Qiu, Feng-Yang Chen, Peng Zhu and Quan Nguyen. Postdoctoral fellows from the same department are Shaoyun Hao, Zhiwei Fang, Xiao Zhang and Shoukun Zhang. Tanguy Terlier serves as the director of surface and interface characterization at the SIMS Laboratory within Rice's Shared Equipment Authority.

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https://sciencedaily.com

Revolutionizing Carbon Capture: Berkeley's Breakthrough Tackles Industrial Emissions Head-On

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Researchers have developed a metal-organic framework that effectively captures CO2 at temperatures typical of industrial exhausts, such as those from cement and steel plants.

Unlike traditional methods, which require cooling of exhausts, this new material operates efficiently at up to 300 °C (570 °F), offering a promising solution for hard-to-decarbonize industries.

High-Temperature CO2 Capture Challenges

Industrial plants, like those that manufacture cement or steel, release large amounts of carbon dioxide, a powerful greenhouse gas. However, their exhaust is often too hot for current carbon removal technologies, which

require a lot of energy and water to cool down these hot gas streams. This cooling requirement has made it difficult for some of the highest-emitting industries to adopt CO2 capture.

Now, chemists at the University of California, Berkeley, have discovered that a porous material can act like a sponge to capture CO2 at temperatures close to those of many industrial exhaust streams. The material — a type of metal-organic framework, or MOF — will be described in a paper that will be published in the November 15 print edition of the journal Science.

The dominant method for capturing carbon from power or industrial plant emissions employs liquid amines to absorb CO2, but the reaction only works efficiently at temperatures between 40 and 60 °C (100–140 °F). Cement manufacturing and steelmaking plants produce exhaust that exceeds 200 °C (400 °F), and some industrial exhaust approaches 500 °C (930 °F). New materials that are now being piloted, including a subclass of MOFs with added amines, break down at temperatures above 150 °C (300 °F) or work far less efficiently.

Advantages of MOFs in Carbon Capture

"A costly infrastructure is necessary to take these hot gas streams and cool them to the appropriate temperatures for existing carbon capture technologies to work," said UC Berkeley postdoctoral fellow Kurtis Carsch, one of two co-first authors of the paper. "Our discovery is poised to change how scientists think about carbon capture. We've found that a MOF can capture carbon dioxide at unprecedentedly high temperatures — temperatures that are relevant for many CO2 emitting processes. This was something that was previously not considered as possible for a porous material."

"Our work moves away from the prevalent study of amine-based carbon capture systems and demonstrates a new mechanism for carbon capture in a MOF that enables high-temperature operation," said UC Berkeley graduate student and co-first author Rachel Rohde.

Experimental Success and Future Potential

Like all MOFs, the material features a porous, crystalline array of metal ions and organic linkers, with an internal area equivalent to about six football fields per tablespoon — a huge area for adsorbing gases.

CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

"As a result of their unique structures, MOFs have a high density of sites where you can capture and release CO2 under the appropriate conditions," Carsch said.

Under simulated conditions, the researchers showed that this new type of MOF can capture hot CO2 at concentrations relevant to the exhaust streams of cement and steel manufacturing plants, which average 20% to 30% CO2, as well as less concentrated emissions from natural gas power plants, which contain about 4% CO2.

Moving Beyond Traditional Carbon Capture

Removing CO2 from industrial and power plant emissions, after which it is either stored underground or used to make fuels or other value-added chemicals, is a key strategy for reducing greenhouse gases that are warming Earth and altering the climate globally. While renewable energy sources are already reducing the need for CO2-emitting, fossil fuel-burning power plants, industrial plants that make intense use of fossil fuels are harder to make sustainable, so flue gas capture is essential.

"We need to start thinking about the CO2 emissions from industries, like making steel and making cement, that are hard to decarbonize, because it's likely that they're still going to be emitting CO2, even as our energy infrastructure shifts more toward renewables," Rohde said.

The Future of Carbon Capture Technology

Rohde and Carsch conduct research in the lab of Jeffrey Long, UC Berkeley professor of chemistry, chemical and biomolecular engineering, and of materials science and engineering. Long has been conducting research on CO2-adsorbing MOFs for more than a decade. His lab created a promising material in 2015 that was further developed by Long's startup company, Mosaic Materials, which in 2022 was acquired by the energy technology company Baker Hughes. This material features amines that capture the CO2; next-generation variants are being tested as alternatives to aqueous amines for CO2 capture in pilot-scale plants, and as a way to capture CO2 directly from ambient air.

But those MOFs, like other porous adsorbents, are ineffective at elevated temperatures associated with many flue gases, Carsch said.

Amine-based adsorbents, like those developed by Long, have been the focus of carbon capture research for decades. The MOF studied by Rohde, Carsch, Long and their colleagues instead features pores decorated with

zinc hydride sites, which also bind CO2. These sites turned out to be surprisingly stable, Rohde said.

Stability and Effectiveness of New MOF Material

"Molecular metal hydrides can be reactive and have low stability," Rohde said. "This material is highly stable and does something called deep carbon capture, which means it can capture 90% or more of the CO2 that it comes into contact with, which is really what you need for point-source capture. And it has CO2 capacities comparable to the amine-appended MOFs, though at much higher temperatures."

Once the MOF is filled with CO2, the CO2 can be removed, or desorbed, by lowering the partial pressure of CO2, either by flushing with a different gas or putting it in a vacuum. The MOF is then ready to be reused for another adsorption cycle.

High-Temperature Performance and Research Directions

"Because entropy favors having molecules like CO2 in the gas phase more and more with increasing temperature, it was generally thought to be impossible to capture such molecules with a porous solid at temperatures above 200 C," Long said. "This work shows that with the right functionality — here, zinc hydride sites — rapid, reversible, high-capacity capture of CO2 can indeed be accomplished at high temperatures such as 300 °C."

Rohde, Long and their colleagues are exploring variants of this metal hydride MOF to see what other gases they can adsorb, and also modifications that will allow such materials to adsorb even more CO2.

"We're fortunate to have made this discovery, which has opened up new directions in separation science focused on the design of functional adsorbents that can operate at high temperatures," said Carsch, who has taken a faculty position in the Department of Chemistry at The University of Texas at Austin. "There's a tremendous number of ways we can tune the metal ion and linker in MOFs, such that it may be possible to rationally design such adsorbents for other high-temperature gas separation processes relevant to industry and sustainability."

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CHEMWATCH
Bulletin Board
Curiosities
NOV. 15, 2024

On the origin of life: How the first cell membranes came to exist

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Few questions have captivated humankind more than the origin of life on Earth. How did the first living cells come to exist? How did these early protocells develop the structural membranes necessary for cells to thrive and assemble into complex organisms?

New research from the lab of University of California San Diego Professor of Chemistry and Biochemistry Neal Devaraj has uncovered a plausible explanation involving the reaction between two simple molecules. This work appears in Nature Chemistry.

Life on Earth requires lipid membranes -- the structure of a cell that houses its interior mechanics and acts as a scaffold for many biological reactions. Lipids are made from long chains of fatty acids, but before the existence of complex life, how did these first cell membranes form from the simple molecules present on Earth billions of years ago?

Scientists believe that simple molecules of short fatty chains of fewer than 10 carbon-carbon bonds (complex fatty chains can have nearly twice that many bonds) were abundant on early Earth. However, molecules with longer chain lengths are necessary to form vesicles, the compartments that house a cell's complicated machinery.

While it may have been possible for some simple fatty molecules to form lipid compartments on their own, the molecules would be needed in very high concentrations that likely did not exist on a prebiotic Earth -- a time when conditions on Earth may have been hospitable to life but none yet existed.

"On the surface, it may not seem novel because lipid production happens in the presence of enzymes all the time," stated Devaraj, who is also the Murray Goodman Endowed Chair in Chemistry and Biochemistry. "But over four billion years ago, there were no enzymes. Yet somehow these first protocell structures were formed. How? That's the question we were trying to answer."

To uncover an explanation for these first lipid membranes, Devaraj's team started with two simple molecules: an amino acid named cysteine and a short-chain choline thioester, similar to molecules involved in the biochemical formation and degradation of fatty acids.

Curiosities

The researchers used silica glass as a mineral catalyst because the negatively charged silica was attracted to the positively charged thioester. On the silica surface, the cysteine and thioesters spontaneously reacted to form lipids, generating protocell-like membrane vesicles stable enough to sustain biochemical reactions. This happened at lower concentrations than what would be needed in the absence of a catalyst.

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CHEMWATCH
Bulletin Board

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CHEMICAL EFFECTS

ENVIRONMENTAL RESEARCH

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