CHEMWATCH

Bulletin Board

Contents

JUN. 30, 2023

(click on page numbers for links)

CONTACT US

subscribers@chemwatch.net
tel +61 3 9572 4700
fax +61 3 9572 4777

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

*** While Chemwatch has taken all efforts to ensure the accuracy of information in this publication, it is not intended to be comprehensive or to render advice. Websites rendered are subject to change.**

Contents

GOSSIP

CURIOSITIES

TECHNICAL NOTES

CHEMWATCH
Bulletin Board

Regulatory Update

JUN. 30, 2023

ASIA PACIFIC

MEE approves the 2nd batch of clearance notification for environmental management on import of toxic chemicals in 2023

2023-06-21

In accordance with the Provisions on the First Import of Chemicals and the Import and Export of Toxic Chemicals (No.140 [1994]) and the Announcement on Issuing the Catalog of Toxic Chemicals Strictly Restricted in China (2020) (Announcement No.60 [2019]) jointly released by the Ministry of Ecology and Environment, the Ministry of Commerce, and the General Administration of Customs, application forms and relevant application materials submitted by Nantong Haotai Products and Chemicals Co.Ltd to MEE are in compliance with relevant requirements.

The 2nd batch of clearance notification for environmental management on import of toxic chemicals is hereby released after official review for the consideration of openness, fairness and justice, and public supervision.

Read More

CIRS, 21-06-23

https://www.cirs-group.com/en/chemicals/mee-approves-the-2nd-batch-of-clearance-notification-for-environmental-management-on-import-of-toxic-chemicals-in-2023

China NIFDC Consults on Updates to Prohibited Cosmetic Ingredients and Test Methods

2023-06-24

China is moving towards updating the Inventory of Prohibited Ingredients for Cosmetics and adopting more toxicological test methods for cosmetic ingredients, as well as animal testing alternatives.

On June 12, 2023, China's National Institutes for Food and Drug Control (NIFDC) initiated a public consultation on proposed updates to the Inventory of Prohibited Ingredients for Cosmetics, along with the introduction of test methods for cosmetic ingredients. Interested parties are invited to provide feedback and suggestions until July 15, 2023, by emailing the "Opinion Feedback Form" to hzpbwh@nifdc.org.cn.

Five New Prohibited Ingredients

The proposed update to the Inventory of Prohibited Ingredients for Cosmetics is the addition of five prohibited prostaglandin analogs.

Read More

REACH24, 21-06-23

https://www.reach24h.com/en/news/industry-news/cosmetic/china-nifdc-consults-on-updates-to-prohibited-cosmetic-ingredients-and-test-methods.html

New rules coming mid-2023 on decaBDE, PFOA-related compounds

2023-0620

Australian importers and exporters of decabromodiphenyl ether (decaBDE), perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds will soon need to comply with new rules following the inclusion of these hazardous chemicals in the Rotterdam Convention. Changes are likely to start in mid-2023.

decaBDE, PFOA-related compounds to be added to the list of chemicals requiring AICIS authorisation.

We will soon amend the Industrial Chemicals (General) Rules 2019 (General Rules) that affect the export or importation of decabromodiphenyl ether (decaBDE), perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds. This move follows the addition of these chemicals in 2022 to Annex III of the Rotterdam Convention.

The amendments will affect Division 1, Part 2 of Chapter 6 of the General Rules that deals with industrial chemicals that are subject to the Rotterdam Convention.

What the changes will mean for importers and exporters?

Once the new rules come into force (around mid-2023), importers and exporters of these chemicals must do the following.

If you are currently importing or exporting any of these chemicals

You must cease any new import or export of these chemicals. You will need to apply to AICIS for import or export authorisation of PFOA, its salts and PFOA-related compounds or decaBDE (application fee will apply).

CHEMWATCH
Bulletin Board
Regulatory Update
JUN. 30, 2023

You will only be able to resume importing or exporting these chemicals if you receive authorisation from AICIS. It will be an offence to import or export these chemicals without authorisation and penalties apply.

If you are planning to introduce any of these chemicals:

- Apply to AICIS for import or export authorisation of PFOA, its salts and PFOA-related compounds or decaBDE (application fee will apply)
- Receive authorisation from AICIS before you can import or export these chemicals - it will be an offence to import or export these chemicals without authorisation and penalties apply.

Read More

AICIS, 20-06-23

https://www.industrialchemicals.gov.au/news-and-notices/new-rules-coming-mid-2023-decabde-pfoa-related-compounds#decabde-pfoarelated-compounds-to-be-added-to-the-list-of-chemicals-requiring-aicis-authorisation

AMERICA

UTAH UPDATES THE BEDDING, UPHOLSTERED FURNITURE AND QUILTED CLOTHING RULE (R70-101)

2023-06-23

In April 2023, the State of Utah revised their Rule R70-101 for Bedding, Upholstered Furniture and Quilted Clothing. The revisions included definitions and increased surveillance for online retail.

The Utah Rule (R70-101) now defines an online retailer as follows: "means any person who advertises and markets via the internet and another electronic network". The retailer, including online retailers, must ensure that the label is easily accessible to the consumer for examination before purchase. Disclosure of the law label for upholstered furniture and bedding and disclosure of the hidden filling material, RN/name and sterilization # if applicable on the textile label for quilted clothing must be available at the point of purchase in retail on the product and disclosed as online content (exact duplicate of the label or a link to the label) prior to purchasing.

Note: Textile label for quilted clothing is defined as a "tag attached to a quilted clothing product that provides information required in 16 CFR

Parts 300, 301, 303 and this rule". Effective January 1, 2024, Utah will begin inspections for online accessibility and compliance for proper law label/ textile label content.

In addition, we would like to clarify further information Under Chapter 10 of the Utah Code, in regards to the terms "reclaimed" or "reclaimed material" and "recycled and recycled material" is defined as follows:

Read More

Bureau Veritas, 22-06-23

https://www.cps.bureauveritas.com/newsroom/utah-updates-bedding-upholstered-furniture-and-quilted-clothing-rule-r70-101

Utah sues over new EPA ozone protection rule

2023-06-23

Utah Attorney General Sean Reyes is suing the federal Environmental Protection Agency due to its newly-released power plant regulations.

The EPA implemented the Ozone Interstate Transport Rule. It requires states to implement a plan to reduce interstate air pollution.

The move has drawn backlash from many of Utah's elected Republican politicians.

Gov. Spencer Cox, Attorney General Reyes, Senate President J. Stuart Adams, House Speaker Brad Wilson, U.S. Senators Mike Lee and Mitt Romney, and Congressmen Chris Stewart, John Curtis, Burgess Owens, and Blake Moore issued a joint statement condemning the decision.

In it, the politicians said Utah had taken responsible action to reduce its emissions while protecting the quality of life of its citizens.

"Utah's measured, all-of-the-above energy policy has powered decades of prosperity by providing some of the country's most reliable and affordable energy," the lawmakers wrote in a statement posted to the governor's Twitter account. "This balanced and commonsense approach has powered our state, fueled our economy, and maintained a high quality of life for Utahns. We have also dramatically decreased emissions and ozone on our own. However, the Biden administration has turned to executive rulemaking to enact policies that will force early closures of Utah power plants, putting reliable, affordable, and dispatchable power significantly at risk – and only in a few years."

CHEMWATCH
Bulletin Board
Regulatory Update
JUN. 30, 2023

The lawmakers think the move will hurt the state's ability to produce affordable energy.

"The Ozone Interstate Transport Rule released by the Environmental Protection Agency harms Utahns and threatens our ability to provide affordable and reliable baseload energy to our state," the lawmakers wrote. "We will not stand by as the administration encroaches on Utah's reasonable, responsible, and realistic approach to powering our state.

"As Utah's elected state leaders, we stand united in pushing back against the administration's egregious power grab that harms Utahns," they added. "We will each fight for a responsible energy policy that embraces efficiency and is based in reality because keeping the lights on is the only option."

Read More

The Center Square, 23-06-23

https://www.thecentersquare.com/utah/article_88c664aa-11fa-11ee-9d66-0fdbda892c0b.html

NEVADA PASSES MENSTRUAL PRODUCT INGREDIENT DISCLOSURE LAW

2023-6-10

Nevada recently passed AB169, an Act relating to the labeling of feminine hygiene products. The law requires manufacturers to label each package or box containing a feminine hygiene product that is sold or distributed in the state with a plain and conspicuous list of all ingredients in the feminine hygiene product. Nevada is the third state to pass a feminine hygiene product ingredient disclosure law, after California and New York.

The list of ingredients in the feminine hygiene product must be declared in the following manner:

- In order of predominance, by weight, unless the weight is 1% or less. If the weight is less than 1%, the ingredient may be listed in any order following the other ingredients.
- Identified using standardized nomenclature, including, without limitation, the INCI , HCPA, or the common name of the chemical. If the ingredient does not have a standardized nomenclature, the ingredient must be identified using the name established by the Center for Baby and Adult Hygiene Products

Note: If an ingredient is confidential business information, it may be identified by its common name. Provided that the ingredient is not on one of the designated lists identified by the Act or a fragrance allergen at a concentration at or above 0.001% or 10 ppm.

Read More

Bureau Veritas, 10-06-23

https://www.cps.bureauveritas.com/newsroom/nevada-passes-menstrual-product-ingredient-disclosure-law

EUROPE

Circular economy: New rules to make phones and tablets more durable, energy efficient and easier to repair, enabling sustainable choices by consumers

2023-06-16

Today, the Commission is proposing new rules to help consumers make informed and sustainable choices when purchasing mobile and cordless phones, and tablets, under the existing EU Energy Labelling Regulation. This new proposal comes on the same day as the approval of measures to make these devices more energy efficient, durable and easier to repair by the European Parliament and Council, following a Commission proposal in November 2022, under the EU Ecodesign Regulation.

These measures help to make the EU's economy more circular, save energy, cut our carbon footprint, support circular business models and deliver the benefits of the European Green Deal for consumers.

Mobile phones and tablets produced according to these rules will save almost 14 terawatt hours in primary energy each year by 2030. This is one third of the primary energy consumption of these products today. The new rules will also help to optimise the use of critical raw materials and facilitate their recycling.

Under the Energy Labelling Regulation proposed today, smartphones and tablets put on the EU market will have to display information on their energy efficiency, battery longevity, protection from dust and water, and resistance to accidental drops. This is also the first time that a product placed on the EU market will be required to display a reparability score. This will help EU consumers make more informed and sustainable purchasing choices and encourage sustainable consumption.

CHEMWATCH
Bulletin Board
Regulatory Update
JUN. 30, 2023

The new products will use the existing and well-known A-G scale EU energy labels, and the EU-wide database European Product Registry for Energy Labels (EPREL) will provide additional information about the product.

Moreover, the newly approved Ecodesign Regulation lays out minimum requirements for mobile and cordless phones and tablets being placed on the EU market, including:

- Resistance to accidental drops or scratches, protection from dust and water and use of sufficiently durable batteries. Batteries should withstand at least 800 cycles of charge and discharge while retaining at least 80% of their initial capacity.
- Rules on disassembly and repair, including obligations for producers to make critical spare parts available to repairers within 5-10 working days, and until 7 years after the end of sales of the product model on the EU market.
- Availability of operating system upgrades for longer periods: for at least 5 years after the product has been placed on the market.
- Non-discriminatory access for professional repairers to any software or firmware needed for the replacement.

Next Steps

These Energy Labelling rules will now be submitted to the European Parliament and Council for a two-month scrutiny period, after which they will be formally adopted if there is no objection to the text by the co-legislators.

To align the entry into force of these two pieces of legislation concerning the same category of products, their publication in the Official Journal will occur on the same day, after the energy labelling rules are adopted.

After their entry into force, the proposals both foresee a 21-month transition period before the requirements become applicable.

Read More

European Commission, 16-06-23

https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3315

Netherlands add tax for plastic takeaway packaging

2023-06-23

Starting on July 1, 2023, the Netherlands imposes a tax for disposable plastic cups and food packaging for takeaway and delivery, as announced by their document on new rules for disposable plastic cups and containers. In addition, a reusable alternative must be offered. By January 1, 2024, the use of disposable plastic food packaging for dine-in options will be prohibited.

The government recommended prices for plastic articles are:

- 25 EUR for cups
- 50 EUR for a meal (which may include several pieces of packaging)
- 05 EUR for pre-packaged vegetables, fruit, nuts, and portion packs.

These rules apply to all single-use plastic cups, even articles that are only partly made of plastic (e.g., plastic coating). For food packaging, the rules only apply to ones out of which food can be directly eaten without preparation and that are made entirely of plastics. The same rules count for bioplastics. Not included are bags and wrappers.

Read More

FPF, 22-06-23

https://www.foodpackagingforum.org/news/netherlands-add-tax-for-plastic-takeaway-packaging

INTERNATIONAL

Global Gateway: EU and Argentina step up cooperation on raw materials

2023-06-13

Today, in Buenos Aires, Commission President Ursula von der Leyen and the President of Argentina, Alberto Fernández, signed a Memorandum of Understanding establishing a partnership between the EU and Argentina on sustainable raw materials value chains.

In line with the EU's Global Gateway strategy, the agreement aims to ensure the development of a secure and sustainable supply of raw materials necessary for the clean energy and digital transition. It also aims to develop a sustainable raw materials industry, and to support the

CHEMWATCH
Bulletin Board
Regulatory Update
JUN. 30, 2023

creation of local added value, quality employment and sustainable and inclusive economic growth, to the mutual benefit of both sides.

President of the Commission, Ursula von der Leyen, said: "I am glad to sign this partnership between the EU and Argentina for the development of sustainable raw materials value chains. This is truly win-win. It is a big step forward for the EU's climate ambitions and it is beneficial to Argentina as a key global player in the clean energy transition. A partnership based on shared commitments to a greener, digital and more resilient future for all."

The partnership is centred around five areas of collaboration:

- Integration in the sustainable raw materials value chains, including through joint development of projects, new business models, promotion and facilitation of trade and investment linkages;
- Cooperation on research and innovation along the raw materials value chains, including on minerals knowledge, the minimisation of environmental and climate footprint, and circular economy;
- Cooperation to leverage environmental, social, and governance (ESG) criteria and align with international standards;
- Deployment of hard and soft infrastructure for projects development, minimising their environmental and climate impact;
- Strengthening capacities, vocational education and training and skills development along sustainable raw materials value chains in accordance with international labour standards.

The EU and Argentina have committed to develop an operational Roadmap within 6 months of the signature of the Memorandum of Understanding. The Roadmap will include cooperation actions that will be carried out by relevant stakeholders from the EU Member States and Argentina and will be supported by the EU's Global Gateway Investment Agenda for Latin American and the Caribbean strategy.

Background

Critical and strategic raw materials are indispensable for a wide set of strategic sectors including the net-zero industry, the digital industry, aerospace, and defence. As demand for critical raw materials is projected to increase drastically, Europe still heavily relies on imports, often from quasi-monopolistic third country suppliers. The EU needs to mitigate the risks for supply chains related to such strategic dependencies to enhance its economic resilience, while achieving its climate and digital objectives.

The proposal for a Regulation on Critical Raw Materials leverages the strengths and opportunities of the Single Market and the EU's external partnerships to diversify and enhance the resilience of EU critical raw materials supply chains. The Critical Raw Materials Act also improves the EU capacity to monitor and mitigate risks of disruptions and enhances circularity and sustainability.

The Commission has already started working to build strategic partnerships with resource-rich third countries, making use of all external policy instruments and respecting its international obligations. The EU will work with reliable partners to promote their economic development in a sustainable manner through value chain creation, while also promoting secure, resilient, affordable and sufficiently diversified value chains for the EU.

The Commission has already established strategic partnerships on raw materials with Canada (June 2021), Ukraine (July 2021), Kazakhstan and Namibia (November 2022), on behalf of the EU. The partnerships allow both sides to advance trade and investments into secure, sustainable and resilient raw materials value chains, which are key to achieving the transition to climate-neutral and digitalised economies.

Read More

European Commission, 13-06-23

https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3217

World Health Assembly adopts resolution on chemicals, waste, and pollution

2023-06-23

On May 24, 2023, nations at the 76th meeting of the World Health Assembly, adopted a resolution on "the impacts of chemicals, waste, and pollution on human health." Among other things, the resolution calls upon Member States to

- "[scale] up work on plastics and health to enable better information of the potential human health impacts associated with plastic" (FPF reported;
- "further explore, recognize and act on the linkages between chemicals, waste and pollution and other health priorities… such as maternal and child health" (FPF reported); and,

CHEMWATCH
Bulletin Board
Regulatory Update
JUN. 30, 2023

- "engage in the ad hoc open-ended working group… to prepare proposals for the science-policy panel to contribute further to the sound management of chemicals and waste" (FPF reported).

The Assembly is the decision-making body of the World Health Organization (WHO) and serves as a platform for member states to discuss and shape global health policies. Composed of representatives from the 194 WHO member states, the Assembly meets annually to review and approve the WHO's work, including setting priorities, adopting resolutions, and discussing key health issues. The resolution on chemicals, waste, and pollution on human health was jointly proposed by Canada, Colombia, Ecuador, the European Union, Mexico, Monaco, Peru, Switzerland, and Uruguay.

The Assembly additionally recognized in the resolution "that robust data is only available for a small number of potential chemical exposures, and that people are exposed to many more chemicals in their daily lives." Research in June 2023 by Muir et al. reviewed 50 years of published scientific literature, finding that the majority of chemicals known to be used by industry have not been the target of any environmental studies. The authors confirmed "significant bias toward repeated measurements of the same substances due to regulatory needs and the challenges of determining new, previously unmeasured, compounds."

Read More

FPF, 23-06-23

https://www.foodpackagingforum.org/news/world-health-assembly-adopts-resolution-on-chemicals-waste-and-pollution

10 EU Member States at risk of not reaching packaging waste recycling targets by 2025

2023-06-21

In a briefing released on June 8, 2023, the European Environment Agency (EEA) assessed the Member States' prospects for meeting the EU's targets for increased recycling of municipal and packaging waste. The targets set out by the Waste Framework Directive as part of the European Green Deal are to ensure 55% of municipal waste and 65% of packaging waste are reused or recycled by 2025 (FPF reported and here). Additional recycling targets for specific materials, such as paper and cardboard, glass, aluminum, and plastic packaging are given for 2025, 2030, and 2035.

The report's key messages highlight that ten Member States are at risk of missing both the municipal and the packaging waste targets in 2025. Furthermore, twelve Member States are at risk of missing at least two of the material-specific recycling targets. It is reported that out of all the packaging materials, plastic packaging is the most challenging waste stream to recycle. The set goal was to have 50% of plastic packaging waste recycled by 2025 – 19 Member States are struggling to fulfill this quota.

On November 30, 2022, the European Commission proposed a revision of EU legislation on packaging and packaging waste (FPF reported and here). In addition to the recycling targets already set, the revision also outlines minimum food packaging reuse and refill targets to achieve by 2023.

Read More

FPF, 21-06-23

https://www.foodpackagingforum.org/news/10-eu-member-states-at-risk-of-not-reaching-packaging-waste-recycling-targets-by-2025

CHEMWATCH
Bulletin Board

ECHA's committees: EU-wide PFAS ban in firefighting foams warranted

SEAC considers that the proposed restriction on the placing on the market, use and formulation of PFAS in firefighting foams is the most appropriate EU-wide measure to address the identified risks. This takes into account available alternatives and the balance between the restriction's benefits and costs to society. These conclusions follow an opinion on the risks adopted by ECHA's Committee for Risk Assessment (RAC) in March 2023.

SEAC suggests, however, that a review of available fluorine-free alternatives for sites that produce, treat or store dangerous substances (covered by the Seveso Directive) and those neighbouring them is carried out before the end of the 10-year transition period. Similarly, a review would be needed for uses at offshore installations in the oil and gas industry, where SEAC is recommending to lengthen the transition period from five to 10 years. The committee considers the reviews important to maintain safety where fires may have high impacts on the environment and human health.

SEAC also recommends to lengthen transition periods for uses in civilian shipping from three to five years and for placing certain types of portable fire extinguishers on the market from six to 18 months. This is to ensure that technically suitable fluorine-free alternatives are available when the transition periods end.

ECHA prepared the proposal at the request of the European Commission. It was introduced for the first time in February 2022.

What's next?

Following the adoption of SEAC's opinion, ECHA prepares the combined opinion of both committees for publication and sends it and and the restriction proposal to the European Commission.

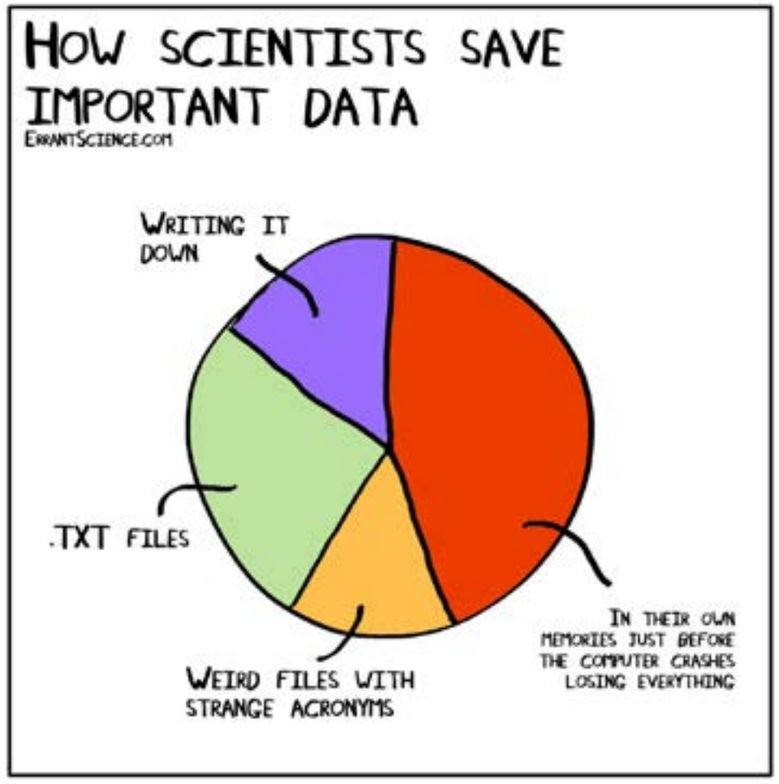
The Commission will then decide whether a restriction is necessary. If so, it will make a proposal to amend the list of restrictions (Annex XVII to the REACH Regulation). The proposal will be voted on by the EU Member States in the REACH Committee and scrutinised by the European Parliament and Council before adoption into law.

Read More
ECHA, 22-06-23

https://echa.europa.eu/-/echa-s-committees-eu-wide-pfas-ban-in-firefighting-foams-warranted

How Scientists Save Important Data

2023-06-30



https://twitter.com/ErrantScience/status/1552617562118279169

Benzoic Acid

2023-06-30

USES [2,4]

Benzoic acid is used across various applications in a range of industries. It is used as an antimicrobial preservative in food and beverages. It is also used in the manufacture of plastics, dyes, insect repellents and various other cosmetics. Benzoic acid is an ingredient in the industrial production of phenol.

HEALTH EFFECTS

Benzoic acid poisoning affects a range of systems, including the integumentary and respiratory systems.

Acute Health Effects [4]

Severity of symptoms depend on the level and type of exposure.

Inhalation of the acid may result in irritation of the respiratory tract, resulting in coughing, red itching eyes, runny nose and eyes and a sore throat. For those who already have impaired respiratory functions, inhalation of this acid may cause further damage. Ingestion of benzoic acid may be fatal. Skin contact could result in dermatitis, characterised by swelling and redness. The acid could also cause systemic injury if it gets into the bloodstream. Eye contact could result in ocular lesions.

Chronic Effects [5]

- While phenanthrene has been tested, it is not classifiable as to its potential to cause cancer.

Other Effects

Chronic exposure to benzoic acid is toxic to multiple body systems. Long term exposure to the acid can result in disease of the airway, including difficulty breathing. Limited research has found that long-term occupational exposure to this acid can result in cumulative health effects. Symptoms can be activated by a variety of environmental triggers, including smoke, perfume, and exhaust.

Benzoic acid, aka benzoate or E210, is a colourless organic crystalline solid, with the chemical formula of C6H5COOH. It has a faint but pleasant odour and is soluble in water. [1,2,3]

SAFETY

First Aid Measures [5]

- Ingestion: DO NOT induce vomiting, and contact a medical professional IMMEDIATELY.
- Skin contact: Remove all contaminated clothing, footwear and accessories. Do not re-wear clothing until it has been thoroughly decontaminated. Immediately rinse affected areas with plenty of soap and water. For the different types of burns, read the SDS on benzoic acid. Contact a doctor immediately.
- Eye contact: Flush eyes (including under the eyelids), with fresh running water for at least 15 minutes. Removal of contact lenses should only be done by skilled personnel. Contact a medical professional immediately. For thermal burns, DO NOT remove contact lens. Pad both eyes, making sure the dressing does not touch the injured eye.
- Inhalation: If the person inhales fumes, remove them from the contaminated site. Prostheses, such as false teeth, should be removed prior to first aid procedures, as they may block airways. Perform CPR if you are qualified and if the patient is unconscious and not breathing. Use a one-way valve and mask if possible. Immediately contact a medical professional.
- General: Never administer anything by mouth to an unconscious, exposed person.

Workplace Controls & Practices [7]

Engineering controls: Emergency eyewash fountains and quick-drench areas should be accessible in the immediate area of the potential exposure. Ensure there is adequate ventilation.

Personal protection: Safety glasses with side shields or chemical goggles, protective and dustproof clothing, gloves, a P.V.C apron and an appropriate mask or dusk respirator. Do not wear contact lenses as they could absorb chemicals in the air. Wear impervious shoes. Other

CHEMWATCH
Bulletin Board
Hazard Alert
JUN. 30, 2023

protection could overalls. For specifications regarding other PPE, follow the guidelines set in your jurisdiction.

REGULATION [6]

Germany

A Time Weighted Average (TWA) concentration limit of 0.5mg/m3 for benzoic acid has been set.

Australia [6]

There is no TWA set for benzoic acid in Australia.

REFERENCES

1. https://byjus.com/chemistry/benzoic-acid/#:~:text=Benzoic%20acid%20is%20an%20organic,colorless%20solid%20under%20normal%20conditions.
2. https://www.britannica.com/science/benzoic-acid
3. https://pubchem.ncbi.nlm.nih.gov/compound/Benzoic-acid
4. https://www.carlroth.com/medias/SDB-9722-GB-EN.pdf

An ingredient in toothpaste may make electric cars go farther

2023-06-28

"An exciting new generation of battery types for electric vehicles beyond lithium ion is on the horizon," said Zhengcheng (John) Zhang, a group leader in Argonne's Chemical Sciences and Engineering division.

The chemistries of non-lithium-ion batteries offer twice or more energy stored in a given volume or weight compared to lithium ion. They could power cars for much longer distances and could even power long-haul trucks and aircraft one day. The expectation is that widespread use of such batteries will help address the problem of climate change. The main problem is that their high energy density declines rapidly with repeated charge and discharge.

One of the main contenders has an anode (negative electrode) made of lithium metal in place of the graphite normally used in lithium-ion batteries. It is thus called a "lithium metal" battery. The cathode (positive electrode) is a metal oxide that contains nickel, manganese and cobalt (NMC). While it can deliver more than double the energy density possible with a lithium-ion battery, that outstanding performance rapidly vanishes within less than a hundred charge-discharge cycles.

The team's solution involved changing the electrolyte, a liquid through which lithium ions move between cathode and anode to implement charge and discharge. In lithium metal batteries, the electrolyte is a liquid consisting of a lithium-containing salt dissolved in a solvent. The source of the short cycle-life problem is that the electrolyte does not form an adequate protective layer on the anode surface during the first few cycles. This layer, also called solid-electrolyte-interphase (SEI), acts like a guardian, allowing lithium ions to freely pass in and out of the anode to charge and discharge the battery, respectively.

Their research is published in the journal Nature Communications.

The team discovered a new fluoride solvent that maintains a robust protective layer for hundreds of cycles. It couples a fluorinated component that is positively charged (cation) with a different fluorinated component that is negatively charged (anion). This combination is what scientists call an ionic liquid—a liquid consisting of positive and negative ions.

"The key difference in our new electrolyte is the substitution of fluorine for hydrogen atoms in the ring-like structure of the cation part of the ionic liquid," Zhang said. "This made all the difference in maintaining high performance for hundreds of cycles in a test lithium metal cell."

An ingredient in many toothpastes is sodium fluoride, a compound of fluorine. It is added to protect teeth against decay. But compounds containing fluorine have other practical uses that might surprise you. Scientists at the U.S. Department of Energy's (DOE) Argonne National Laboratory have discovered a fluoride electrolyte that could protect a next generation battery against performance decline.

To better understand the mechanism behind this difference at the atomic scale, the team drew upon the high performance computing resources of the Argonne Leadership Computing Facility (ALCF), a DOE Office of Science user facility.

As Zhang explained, simulations on the ALCF's Theta supercomputer revealed that the fluorine cations stick to and accumulate on the anode and cathode surfaces before any charge-discharge cycling. Then, during the early stages of cycling, a resilient SEI layer forms that is superior to what is possible with previous electrolytes.

High-resolution electron microscopy at Argonne and Pacific Northwest National Laboratory revealed that the highly protective SEI layer on the anode and cathode led to the stable cycling.

The team was able to tune the proportion of fluoride solvent to lithium salt to create a layer with optimal properties, including an SEI thickness that is not too thick or thin. Because of this layer, lithium ions could efficiently flow in and out of the electrodes during charge and discharge for hundreds of cycles.

The team's new electrolyte offers many other advantages as well. It is low cost because it can be made with extremely high purity and yield in one simple step rather than multiple steps. It is environmentally friendly because it uses much less solvent, which is volatile and can release contaminants into the environment. And it is safer because it is not flammable.

"Lithium metal batteries with our fluorinated cation electrolyte could considerably boost the electric vehicle industry," Zhang said. "And the usefulness of this electrolyte undoubtedly extends to other types of advanced battery systems beyond lithium ion."

Tech Xplore, 28 June 2023

https://techxplore.com

Artificial lipid bilayer vesicle liposomes, also called proteoliposomes, are specialized systems capable of incorporating various molecules, such as chemicals and drugs. Their unique properties make them ideal carriers for delivering substances inside cells. However, they must possess the dual characteristics of high stability in extracellular environments and low stability in intracellular environments.

New light-responsive carriers for intracellular substance delivery

2023-06-28

Several techniques have been developed to regulate the stability of liposomes in a condition-dependent manner, with pH-sensitive liposomes being widely employed. A standard measure of acidity or basicity, the pH scale ranges from 1 to 14, with 7 standing for "neutral," like water, a pH below 7 indicating acidity and that above 7 indicating basicity. Interestingly, pH-sensitive liposomes can be triggered to release their contents when exposed to an acidic pH below 5.5.

In a new study, a team of researchers, led by Professor Yuki Sudo from Okayama University, Japan, have developed a precise method of releasing contents from pH-sensitive liposomes using light. "The study presents a novel nanomaterial called light-induced disruptive liposome (LiDL) and applies it to light-controlled intracellular substance delivery," explains Prof. Sudo. Their work, co-authored by Mr. Taichi Tsuneishi of Okayama University and Prof. Yuma Yamada of Hokkaido University in Japan, was published in the journal Chemical Communications .

The researchers utilized a protein called Rubricoccus marinus Xenorhodopsin (RmXeR), derived from a marine bacterium, to initiate acidification inside liposomes using light. To study the functionality of RmXeR within liposomes without interference from pH-dependent properties, they first developed pH-insensitive proteoliposomes using the lipid hydration method, combining phosphatidylcholine from egg yolk with cholesterol. Then, purified RmXeR was incorporated via the dilution method. The researchers estimated that the pH inside the thus obtained liposomes changed from 7.0 to 4.8 upon exposure to green light, rendering them suitable for light-induced disruption.

Subsequently, the team developed pH-sensitive proteoliposomes based on 1,2-dioleoyl-sn-glycero-3-phosphoethanolamine and cholesteryl hemisuccinate. Interestingly, before introducing RmXeR within the liposomes, the researchers incorporated a water-soluble fluorescent dye called calcein as a testing substance to evaluate their release capability.

By monitoring the fluorescence of calcein, they observed that its release from the liposomes occurred in a light-dependent manner, indicating that the liposomes effectively released substances when triggered by light. These pH-sensitive proteoliposomes, or LiDLs, displayed exceptional

CHEMWATCH
Bulletin Board
Gossip
JUN. 30, 2023

stability in the absence of light, maintaining their physiochemical properties when exposed to a temperature of 4°C for two weeks.

In the next phase of the study, the researchers introduced LiDL into mammalian HeLa cells to evaluate their effectiveness as carriers for delivering substances inside the cells. They monitored the cellular uptake for LiDLs, finding that the presence of LiDL, regardless of the inclusion of RmXeR, enhanced the uptake of liposomes by HeLa cells. This demonstrated the potential of LiDL as a carrier for intracellular substance delivery. To further improve the intracellular delivery efficiency, the researchers introduced a chemical called stearyl octaarginine into LiDL. This enhanced version, called LiDL-R8, exhibited significantly better performance compared to LiDL.

These findings highlight the utility of LiDL for the intracellular delivery of chemicals as well as biomolecules. "With LiDL, drug delivery can be controlled by light, potentially leading to advances in various therapies," emphasizes Prof. Sudo. Going forward, the team aims to enhance the content release efficiency by thoroughly characterizing the structure of the liposomes and optimizing the experimental conditions.

In effect, LiDLs hold great promise as optically controllable carriers for improved drug delivery. These liposomes offer enhanced efficacy without causing side effects, showcasing exceptional extracellular stability and controllable intracellular instability. "Our study will contribute towards ensuring healthy lives and promoting well-being for people of all ages, which ties in with one of the Sustainable Development Goal (SDG3) of the United Nations," concludes Prof. Sudo.

Phys Org, 28 June 2023

https://phys.org

Bigger bottles keep champagne bubbly for decades: Study

2023-06-27

Champagne and other sparkling wines get their bubbliness and tingly sensation from carbon dioxide, which is generated during a second round of fermentation that happens inside their bottles. Combining yeasts, sugar and wine launches the production of this gas and additional alcohol. Although the yeast die within a few months, complex aromas develop as the bottles age undisturbed for 15 months to several decades. But at the same time, the beverage is losing carbon dioxide, which is slowly escaping

Tiny bubbles bursting in a drinker's face and the bite of carbonation are all part of the experience when sipping champagne and sparkling wines. But how long can these drinks be stored in sealed bottles before they go flat? According to researchers reporting in ACS Omega, the answer depends on the container's size. They estimate a 40-year shelf-life for 750-milliliter (25-ounce) bottles, and 82 and 132 years for 1.5-liter (50-ounce) and 3-liter (101-ounce) bottles, respectively.

through the sealed metal caps or corks. So, Gérard Liger-Belair and colleagues wanted to answer the question: How does the size of the bottle influence how long you can age a champagne before it's flat?

The researchers measured the carbon dioxide in different champagne vintages aged for multiple decades, and estimated the original amount of yeast-produced carbon dioxide. They found that the amount of gas inside the vessels, which were sealed with metal caps, decreased the longer the bottles aged. For example, the oldest vintage from 1974 lost the most carbonation, nearly 80%. Additionally, the team observed a correlation between the volume of a bottle and the carbon dioxide level, such that larger bottles retained gas substantially better than smaller ones.

In the end, the researchers developed a formula to calculate a bottle's shelf life, or how long aged champagne would still spontaneously produce bubbles when poured in a glass. They predicted a shelf life of 40 years for standard 750-milliliter bottles, 82 years for 1.5-liter bottles and 132 years for 3-liter bottles, after which point the champagne would be flat. From their large selection of aged champagne, going back nearly 50 years, the researchers say they've shown how the drink's bubbliness over time depends on the bottle's size.

Phys Org, 27 June 2023

https://phys.org

New pathway discovered for RNA degradation in iron-rich environments

2023-06-07

According to a new study by researchers working with Kimberly Parker, assistant professor of energy, environmental & chemical engineering in the McKelvey School of Engineering at Washington University in St. Louis, RNA can undergo rapid hydrolysis when adsorbed into iron oxide minerals. This discovery unveils a previously unknown abiotic pathway for RNA degradation and sheds light on biogeochemical processes and environmental system dynamics. The results were published May 22 in Environmental Science & Technology.

"This is the first abiotic process we've found that causes RNA degradation in the environment on timescales that can compete with biotic degradation," Parker said. "Instead of depending on biological agents like enzymes or microbes to break down RNA molecules, we found that RNA degradation catalyzed by minerals happens relatively quickly regardless of the biological context. This could be an important limit on how long RNA persists in the environment."

RNA, an essential biomolecule for life, has been used in environmental applications including monitoring microbial communities, developing pesticides, and quantifying the abundance of pathogenic viruses, such as SARS-CoV-2, in water and wastewater systems. Understanding how quickly RNA breaks down in given conditions is critical to harnessing the molecule in these and other emerging technologies.

First author Ke Zhang conducted the research in Parker's lab while earning a doctorate in environmental engineering at WashU in 2022. Zhang found that RNA undergoes rapid hydrolysis on the timescale of hours when adsorbed to iron oxide minerals such as goethite and hematite. This hydrolysis process is uniquely facilitated by the presence of iron in the minerals, which chemically accelerates the structural breakdown of the RNA molecule. This finding challenges scientists' previous assumptions about the environmental factors affecting RNA degradation, particularly in iron-rich soils and sediments, which account for approximately 10% of global ice-free land.

"This process could provide an important limit on how long RNA hangs around in the environment, but there are certain conditions that can block this breakdown pathway," Parker said. "While we measured the reaction timescales and determined the reaction products in this research, we need to develop more insights into the reaction mechanism in the future. Understanding the mechanisms as well as timescales of RNA degradation is crucial for accurately interpreting relative amounts of DNA versus RNA, studying viruses and pesticides, and even exploring the origin of life."

Phys Org, 27 June 2023

https://phys.org

Iridium might solve the problems with water supply for making hydrogen fuel

2023-6-28

Electrolysers which split water into oxygen and hydrogen are crucial for making green hydrogen.

But they're still relatively inefficient at an industrial scale, needing expensive catalysts that can withstand high amounts of water and corrosive hydrogen. Chemists are hunting for materials that can make hydrogen electrolysis work better.

The research, done at the University of Adelaide, revolves around a particularly promising type of electrolysis called proton exchange membrane water electrolysis, or PEMWE.

This technique could make pure hydrogen efficiently, but it needs iridium oxide as a catalyst.

A team of researchers has figured out how to dramatically improve the performance of one of the most precious metals used in hydrogen electrolysis: iridium.

Copyright Chemwatch 2023 ©

"Water splitting using PEMWE is a promising method for generating green hydrogen. However, only iridium-based electrocatalysts can withstand the harsh acidic conditions that occur during the reaction," says Associate Professor Yao Zheng, from the University's School of Chemical Engineering.

The researchers have published their findings in Science Advances.

"Our work prepared a new iridium-based catalyst that is active and stable for PEMWE," says co-author and colleague Dr Huanyu Jin.

"We have found that a lattice-water-assisted mechanism – a way of arranging water molecules in a specific pattern – boosts the efficiency of an iridium oxide catalyst by 5-12% resulting in higher energy output while consuming less energy," says Zheng.

While iridium itself, being one of the rarest elements in the Earth's crust, is still a costly material, it doesn't take much work to turn it into the efficient catalyst.

"The iridium oxide catalyst was developed by a molten salt method that was followed by our previous work," says Jin.

"The synthesis could be finished only in five minutes, which provides a rapid and low-cost way to produce."

Now they have an efficient catalyst, the researchers are looking to see where they could best use the electrolysers.

"We would like to develop novel PEMWE electrocatalysts that can be operated in natural seawater," says Jin.

"Compared to pure water electrolysis, seawater electrolysis is more suitable for Australia. In Australia, we have plenty of renewable energy, such as solar and wind power—however, scarce fresh water. For example, recent cancellations of large-scale electrolysis projects, such as the one in South Australia due to water supply concerns, highlight the need for more sustainable and flexible solutions.

"PEMWE using seawater as the feedstock will solve this problem well."

Cosmos Magazine, 28 June 2023

https://cosmosmagazine.com

An international team of researchers has narrowed in on a protein that seems to enhance plants' drought tolerance.

CHEMWATCH
Bulletin Board
Gossip
JUN. 30, 2023

Scientists find protein that makes plants more drought-resistant

2023-06-21

The research, published in New Phytologist, could help to make crops more resistant to increasingly severe droughts.

The protein, called AtMC3, is found within a plant's phloem: tissues that transfer sugars and other materials from leaves to the rest of the plant.

AtMC3 is found within specific cells of the phloem, called companion cells. It's in a class of proteins called metacaspases, which have previously been linked to plant other plant stress responses like pathogens and wounds.

The researchers used thale cress (Arabidopsis thaliana), a small plant commonly used as a model organism in labs, to study the effect of the protein.

They genetically modified thale cress to have different AtMC3 levels, as well as making the protein glow with a fluorescent tag so that they could see where in the plants it was appearing.

They then grew the plants for several weeks, testing them for various stressors and chemical expressions, including water-scarce conditions.

The researchers found that plants with less AtMC3 were less sensitive to a hormone in the plant called abscisic acid (ABA). ABA is a stress hormone that triggers protections in a plant when there's less water around.

They also found that increasing the levels of AtMC3 increased plants' survival rates and their ability to photosynthesis when water was scarce.

Increased AtMC3 levels didn't cause any other damage to the plant.

Dr Eugenia Pitsili, who did the research at the Centre for Research in Agricultural Genomics in Spain, says that this "is a key finding to be able to fine-tune early drought responses at the whole plant level without affecting growth or yield in crops".

The researchers are now interested in finding the mechanism behind AtMC3's helpfulness, which could eventually help to breed more drought-tolerant food.

Cosmos Magazine, 21 June 2023

https://cosmosmagazine.com

Some cells in the human body can generate hypo-chlorite—the same chemical used to kill bacteria and viruses in household bleach.

Study demonstrates hypochlorite can harm but also help human bodies

2023-06-27

When hypochlorite is over-produced in the body it contributes to health problems associated with arthritis, coronary artery disease, Alzheimer's disease and many other inflammatory conditions.

However, new research from Flinders University and the University of Cambridge has demonstrated that some biological molecules are regulated by reacting with hypochlorite in helpful rather than harmful ways.

"The reaction of hypochlorite with biological molecules is typically considered a form of 'collateral damage' within the body," explains Dr. Amy Wyatt, senior lecturer in Biochemistry at Flinders University's College of Science and Engineering.

"We believe it plays a more complex role in human health. Our data shows that hypochlorite neutralizes a molecule that is normally toxic to cultured human brain cells—this finding could be a key to help unlock new ways to prevent or treat Alzheimer's disease and other inflammatory conditions."

Representing a major shift in the understanding of hypochorite in human biology, the research of Dr. Amy Wyatt and a team that includes postdoctoral researcher Dr. Noralyn Mañucat-Tan and collaborators from the University of Cambridge—which has been published in the journal Redox Biology—demonstrates that the reaction of hypochlorite with amyloid-beta peptide, best known for its role in promoting Alzheimer's disease, substantially reduces the peptide's ability to kill cultured human brain cells.

The results of this study support the idea that normally, low levels of hypochlorite production prevent the damaging effects of amyloid-beta peptide in the brain.

However, during inflammation, when hypochlorite production is exacerbated, its role switches to become a chemical that is inherently damaging.

"These findings are just the start," says Dr. Wyatt. "Further studies that identify the biological concentration at which the activities of hypochlorite are helpful versus harmful may pave the way towards designing novel

CHEMWATCH
Bulletin Board
Gossip
JUN. 30, 2023

therapeutic strategies to prevent or treat Alzheimer's disease and other inflammatory conditions."

Phys Org, 27 June 2023

https://phys.org

Don't toss that crab shell. A substance found in it could be key to renewable energy, researchers say

2023-06-27

But what if crab shells could have a bigger impact, playing a vital role in harnessing renewable energy and reducing planet-warming emissions?

University of Maryland researchers are changing the way people look at those thin exoskeletons—investigating the feasibility of putting them to work in an innovative battery.

At summertime backyard feasts, crab shells are just a barrier between hunger and satisfaction. Marylanders smash the crustaceans' protective casings with wooden mallets, pick out the tasty meat and toss the remnants aside.

"People never thought of that before," said Lin Xu, 31, a postdoctoral researcher in the Department of Materials Science and Engineering at College Park.

Xu and a team of researchers have been exploring the use of a chemical that comes from crustacean shells in a zinc-ion battery designed to store renewable energy.

Last fall, working under the direction of Liangbing Hu, a Maryland professor who said he conceived the idea, the team published their findings on chitosan, a substance found in a variety of seafood shells, including crab and lobster.

Since appearing in a scientific journal, their work has turned heads.

"The paper has been cited already more than 20 times," said Xu, who grew up in China and received his doctorate at Massachusetts Institute of Technology. "That's very fast."

He and his colleagues are attempting to solve the problem of how renewable energy—like that generated from solar or wind power—can be stored.

"It's just like a reservoir," Xu said of the way batteries function, essentially holding onto energy until it is needed.

At night, for example, a home's appliances still could be powered by energy from the sun if a battery hooked up to solar panels on the roof

stored energy generated during the day. On a larger scale, a battery plant placed next to a solar panel farm could stockpile energy to power a nearby city.

"We still need to find the material to store that energy, to act as a reservoir," Xu said.

While lithium-ion batteries like those that power cellphones and electric vehicles might seem suited to the task, Xu said they are expensive, and the price tag may rise as demand grows for lithium, a finite resource.

There are also safety concerns surrounding lithium-ion batteries, which can explode and cause fires, said Xueying Zheng, a researcher who has worked alongside Xu.

"If we use a very large scale of lithium-ion batteries packed together … if one pack explodes, that will cause all of the batteries to explode," Zheng said.

The zinc-ion battery has a different drawback: It doesn't have a long lifespan, operating at full capacity for only a few days or a week, Xu said.

That's where crab shells provide a solution perhaps.

With a gel membrane containing chitosan, the chemical found in seafood shells and pronounced CHI-tuh-sn, a zinc-ion battery can last a year and still function at 70% of its initial capacity. They're also much safer, Zheng said.

The battery created and studied by UMD researchers is coin-sized, Xu said, but could be scaled up—with the goal of a more reasonable cost compared to alternatives since chitosan abounds in nature. The substance has an array of applications from biopesticides in agriculture to bandages that aid wound healing in medicine, according to Hu.

In the lab, chitosan arrives as a light yellow powder that is transformed into a translucent gel when dissolved into a solution, according to Hu, who is the director of UMD's Center for Materials Innovation and teaches materials science and engineering.

Chitosan, a carbohydrate, "is most abundantly found in the hard outer skeletons of shellfish, including crabs, lobsters, and shrimps," Hu wrote in an email to The Baltimore Sun. After the shells are washed and dried, they're "pulverized into fine powders," he explained, then treated with chemicals.

CHEMWATCH
Bulletin Board
Gossip
JUN. 30, 2023

Hu's lab has purchased chitosan from Sigma-Aldrich, a chemical and life sciences company. On its website, chitosan sells for around $300 for 250 grams, the equivalent of a little over half a pound.

A spokesperson for Merck, which owns Sigma-Aldrich, said the company could not provide details about how or where it sources chitosan since it is "proprietary information."

"Many researchers are using our products and solutions in very interesting and unique ways," the spokesperson told The Sun via email. "Scientific breakthroughs, both big and small, are exciting to us—especially as they positively impact life and health to create a more sustainable future."

In Maryland, a state known for its blue crabs, some in the crab processing industry have taken notice of the potential new use for their scraps.

"I was blown away when I first saw it, thinking 'Isn't that crazy?'" said Jack Brooks, who read about the battery research in a seafood trade newsletter. Brooks, 71, is president of the Chesapeake Bay Seafood Industries Association and also co-runs J.M. Clayton Co., a family-owned crab and oyster processing plant that has been operating in Cambridge since 1921.

In a single day, J.M. Clayton processes 80 to 350 bushels of crabs with each bushel containing roughly 100 crabs. The crabs are sorted and steamed before being stripped of meat in a "picking room," Brooks explained.

From there, the discarded shells have faced different fates over the decades.

Starting in the 1920s, when J.M. Clayton operated a dehydrating plant in Cambridge, the exoskeletons were turned into a heavy powder called "crab meal," Brooks said.

The product was used as fertilizer and chicken feed, but the equipment was "old and primitive," he said, and his family closed the plant in the 1970s.

For about a decade after that, the shells went straight to the landfill, "which was unfortunate," Brooks said.

Today, J.M. Clayton has a contract to provide crab shells daily—via dumpster truck—to a Dorchester County farm, where they're used as part of a fertilizer program, he said.

"It's a very good source of nutrients for the ground," Brooks said.

Other area processing plants have similar arrangements, he said.

A.E. Phillips & Son, a crab processor that sells to Phillips Seafood Restaurants and other local restaurants and seafood distributors, operates a plant in Fishing Creek that has offloaded its crab shells to a farmer for use as fertilizer since 2018.

It's the most cost-effective option for the plant, which doesn't make any profit from the shells but likely spends less money than it would hiring a private waste removal company, said Brice Phillips, whose great-grandfather started A.E. Phillips & Son over a century ago.

"This is not just normal waste; this is waste that if you don't get rid of it quickly, it starts to rot—and it really stinks," said Phillips, 47, who serves as vice president of sustainability for the separate Phillips Foods.

But A.E. Phillips & Son's processing of 60,000 pounds of crab meat per year in Maryland is dwarfed by Phillips Foods' production in Asia. There, Phillips said, four factories in Indonesia, one in Vietnam and another in India process a combined 100,000 pounds of crab meat each week.

Phillips said he's not sure what happens to the crab shells after they're picked at those plants. But he suggested Asia is an ideal place for innovation.

"Whoever's running this battery research, if they're ever going to do anything with this, they're basically going to be setting up a plant in Asia to get the crab shells," Phillips said.

In Asia, each pound of crab meat comes with four pounds of "guts and shells," he noted.

Both Brooks and Phillips said they'd be open to embracing a new use for shells.

"We've seen ideas come and go, but in this day and time, with all the research and technology and creative minds out there, I mean, hey, anything's possible," Brooks said.

Phillips views it as a potentially fruitful business venture, especially since "it seems there is no demand" for crab shells currently.

"My entrepreneurial spirit's already just grinding the gears, trying to figure out what's the best way to collect this stuff in mass," he mused. "How would it be processed, where would it be processed? Where would the battery production be?"

CHEMWATCH
Bulletin Board
Gossip
JUN. 30, 2023

There's still a long way to go to make chitosan-based batteries a reality outside of the lab. A startup to commercialize new technology is in its infancy, according to Xu.

If chitosan proves to be part of the solution—and if locally processed crab shells can be put to use—it's likely something people in the state would get behind.

"Marylanders certainly love their crabs, and I think most people like renewable energy," Phillips said.

Phys Org, 27 June 2023

https://phys.org

New mass spectrometry combo offers promise for tapping nature's unknown chemical universe

2023-06-27

Scientists at the Department of Energy's Pacific Northwest National Laboratory (PNNL) are taking aim at the other 99%, creating new ways to learn more about a vast sea of unknown compounds. There may be cures for disease, new approaches for tackling climate change, or new chemical or biological threats lurking in the chemical universe.

The work is part of an initiative known as m/q, or "m over q"—shorthand for mass divided by charge, which signifies one of the ways that scientists measure chemical properties in the world of mass spectrometry.

"Right now, we can take a sample from soil, where, depending on soil type, there may be thousands of chemical compounds in just a teaspoon's worth," said Thomas Metz, who leads the m/q Initiative. "And we don't know what most of them are in terms of their chemical structures. We simply have no idea what's in there."

Scientists typically rely on reference libraries that contain information about thousands of molecules to identify substances. Researchers sort their samples from soil, the body, or elsewhere and compare what they have measured experimentally to what's in the library. While that's helpful, it limits scientists to only structurally identifying molecules that have been seen before—for example, through analysis of standard compounds purchased from chemical suppliers.

In the latest development, a team led by scientist Adam Hollerbach has combined two high-resolution instruments into one system to size up

The universe is awash in billions of possible chemicals. But even with a bevy of high-tech instruments, scientists have determined the chemical structures of just a small fraction of those compounds, maybe 1%.

molecules in unprecedented detail. The results were published June 12 in the journal Analytical Chemistry.

Now, scientists can make several important measurements about chemical compounds in one experiment, gaining important information faster, more conveniently, and more accurately than before.

Hollerbach's technique applies to ions—molecules that have either a positive or negative charge. That makes them easier to control and possible to detect using mass spectrometry.

Mass spectrometry: Tool of the ion whisperers

Like the people who study them, ions have many features that distinguish one from another. In people, weight, hair color, size, shape, eye color, and many other characteristics help us know who's who. For ions, identifying characteristics include mass, shape, size, electric charge, and chemical composition. Those not only serve as identifiers but also as guides to the associated molecules' behavior—clues to their potential to cure disease or sop up pollutants, for example.

That understanding should help the efforts of scores of scientists at PNNL who focus on understanding the effect of microbes on climate. Microbes play a key role in transforming elements like carbon into other forms that are important for the planet. Their impact on warming or cooling the planet is mighty. But scientists have much to learn.

"There may be millions of microbes in just a gram of soil, and we don't know who most of them are or what they do. There's a lot of discovery still to happen," said Metz. "From the viewpoint of challenging science, it's either a worst-case scenario or one of our greatest opportunities, depending on how you look at it."

The m/q scientists are seizing the opportunity. Instead of framing their questions within the relatively small number of compounds that can be identified in conventional mass spectrometry measurements, they're trying to leapfrog current limitations and create a whole new way of identifying what is unknown today. It's a bit like when a new telescope is deployed and reveals several distinct stars where before, just one blurry hodgepodge of celestial bodies was visible.

The work is both experimental, putting molecules through their paces in the laboratory, and on computers, where scientists model what they are seeing and predict what they will likely see.

CHEMWATCH
Bulletin Board
Gossip
JUN. 30, 2023

In the experiments described in the Analytical Chemistry paper, Hollerbach and colleagues made sensitive measurements of peptides and lipids. The experiments combined two instruments with similar names but that provide different details about ions. Both are used in mass spectrometry, a field whose history is interwoven with discoveries by PNNL scientists.

The first instrument is a mass spectrometer, which measures an ion's mass, electric charge, and how the ion breaks apart. In this study, the team used an Orbitrap developed by Thermo-Fisher Scientific. Such instruments sort molecules of different masses well, but two molecules with the same mass are difficult to separate. Think of two people, each weighing 180 lbs.—one is tall and thin while the other is short and stocky. On a scale alone, they would be impossible to separate.

A SLIM approach: Ion mobility spectrometry brings hefty results

The second instrument is known as SLIM: structures for lossless ion manipulations. SLIM, created by PNNL scientist Richard D. Smith and colleagues, is an ion mobility spectrometer that measures an ion's size and electric charge.

SLIM, which is about the size of a laptop and stands at just one-quarter of an inch thick, is a hothouse of molecular activity. Dozens of long, winding paths transform the small device into a 42-foot-long molecular racetrack, with ions that are controlled tightly by electric fields racing round and round an oval obstacle course.

The "obstacles" are other, known molecules such as helium or nitrogen molecules. As the ions under study race through the SLIM device, they navigate around or through the other molecules, tumbling and swerving much like a football running back runs through and around opposing blockers. The term "ion mobility spectrometry" truly captures the action.

By recording how long it takes for the ions to complete the course—how deftly they navigate the blocking ions—scientists learn all kinds of things about ions' shape and size. That information, which isn't available from a standard mass spec instrument, is combined with data about the ion's mass, electric charge, and fragmentation pattern. Altogether, the data yields the ion's collision cross section, its molecular formula, and its fragmentation pattern, properties that are central to understanding a molecule's structure.

"Two different molecules can have the same number of atoms, and the same mass and charge, but they could have very different structures and activity. That's where SLIM comes in to tell the difference," said Hollerbach. "Just one small change can mean the difference between a molecule that is indicative of a disease and one that's not."

The key to Hollerbach's experiment was getting the two different instruments to play nicely together. While both standard mass spectrometry and ion mobility spectrometry analyze ions, they work on different time scales. Ions make their journey through SLIM and arrive at the Orbitrap faster than they can be processed.

So Hollerbach drew on an old technique, deploying "dual-gated ion injection." He added gates to control the intake of ions into the system and to control their arrival at the Orbitrap, choosing to send some of the ions from SLIM into oblivion to keep the flow at a manageable rate.

"Really, the questions we ask are very simple," said Hollerbach. "What is this, and how much is there? But the techniques we use are complex."

Other m/q scientists are working on additional ways to identify or exploit unknown molecules. Some are creating ways to use data like that from Hollerbach's experiment to predict an ion's structure automatically, so drug makers and other scientists would know exactly what they're working with. Others are scouting out the millions of possibilities for forms of compounds such as fentanyl, sorting out what's unlikely from what might show up on the street one day. Then they predict how those compounds would behave inside a mass spectrometer—creating a way to identify them if and when they do show up.

Phys Org, 27 June 2023

https://phys.org

CHEMWATCH
Bulletin Board

Solar-powered device turns captured carbon dioxide and plastic waste back into useful products

2023-06-22

"This solar-powered system takes two harmful waste products – plastic and carbon emissions – and converts them into something truly useful," says Dr Sayan Kar, a researcher at the University of Cambridge, UK, and co-first author on a paper describing the device, published in Joule.

The researchers had previously shown that they could turn pure CO2 and water into syngas: a mixture of carbon monoxide and hydrogen, or CO and H2, can be used as a fuel or to make feedstocks like ammonia and methanol.

But the CO2 that comes from industrial exhaust is less concentrated, and CO2 in the the air is less concentrated again, than the lab-grade sources they'd been using.

The researchers have now shown they can selectively remove carbon dioxide from the air or flue gas.

The device starts with a solution of amines and hydroxides. When air is bubbled through the solution, these chemicals bind specifically to CO2 and let the other components of air leave.

Then, the concentrated CO2 is pumped into a "reduction-oxidation" reaction: a system where one side is reduced and the other is oxidised simultaneously.

The carbon dioxide is reduced at a "photocathode" made from crystals called perovskites.

The photocathode uses photons from sunlight and a cobalt-based catalyst to turn the CO2 into syngas.

Meanwhile, at an anode on the other side of the reaction, a plastic-derived substance called ethylene glycol is oxidised into glycolic acid, which is used in cosmetics, dyeing and tanning. The anode uses a copper and palladium-containing catalyst to do this.

"Capturing and using CO2 from the air makes the chemistry more difficult. But, if we add plastic waste to the system, the plastic donates electrons to the CO2. The plastic breaks down to glycolic acid, which is widely used in the cosmetics industry, and the CO2 is converted into syngas, which is a simple fuel."

Researchers have made a solar-powered device which can capture carbon dioxide from the air and combine it with plastic waste to make into syngas.

Syngas can be turned back into carbon-based fuel, or used as a fuel itself, which would return CO2 to the atmosphere when burned – making it a neutral, rather than carbon-negative, fuel.

It can also be used to make methanol and other useful industrial chemicals.

"Instead of storing CO2 underground, like in CCS, we can capture it from the air and make clean fuel from it," says Rahaman.

"This way, we can cut out the fossil fuel industry from the process of fuel production, which can hopefully help us avoid climate destruction."

The researchers are now working on improving the efficiency and practicality of their device.

"The fact that we can effectively take CO2 from air and make something useful from it is special," says Kar.

"It's satisfying to see that we can actually do it using only sunlight."

Cosmos Website, 27 June 2023

https:// cosmosmagazine.com

New study reveals key to sustainable, eco-friendly, next-generation polymers

2023-06-27

Supramolecular polymers can reversibly assemble and disassemble, are highly versatile, and can be used for developing targeted drug delivery therapies, sensors to detect pollutants, diagnostic markers, energy storage devices, personal care products, and self-repairing and recyclable materials. While their excellent recyclability makes them wonderful candidate molecules for sustainable applications, there is one roadblock—researchers have yet to understand how to control their polymer growth.

However, there have been advancements in this aspect. Researchers are now able to build "unlikely" polymers by triggering their assembly with "seeds," enabling control their polymer growth. There are two main mechanisms through which this seed-induced self-assembly occurs: primary nucleation or elongation, where the polymer grows from its end; and secondary nucleation, where new molecules join the polymer by sticking to its surface. The distinction between these processes is important because it enables researchers to better control and manipulate

Supramolecular polymers are a new class of polymers that are currently being evaluated for material applications. These interesting compounds also play an important role in cellular activities in the body. "Supra," as the name suggests, is attributed to some unique properties that go beyond those of conventional polymers. Unlike traditional polymers, which are held together by strong, irreversible covalent bonds, supramolecular polymers are held together by weaker, reversible hydrogen bonds.

CHEMWATCH
Bulletin Board
Curiosities
JUN. 30, 2023

the growth of these unique polymers. Unfortunately, in most cases of seeded self-assembly, primary and secondary nucleation can be difficult to tell apart.

To tackle this issue, a group of researchers led by Professor Shiki Yagai from Chiba University aimed to compare and study the impact of these two processes while delineating the role of precisely controllable "seeded supramolecular polymerization." Their goal was to figure out how different seed shapes affect the formation of new supramolecular polymers. Their findings are published in Chemical Communications.

Prof. Yagai tells us what motivated the team to pursue this topic of research: "Because of the difficulty in controlling polymerization, supramolecular polymers have not yet reached the point of practical application even though three decades have passed since their establishment as a concept." He is convinced, however, that because of their versatility, further research in this area is likely to lead to widespread applications of these self-organizing polymers in our daily lives.

For their experiments, the researchers used two supramolecular polymers as "seeds." While a closed-ended ring-shaped seed was used in a previous study, an open-ended, helicoidal seed was newly prepared. The researchers found that when the open-ended, helicoidal seed was used, it acted as a template for the target molecules to attach and grow longer. On the other hand, when the closed-ended ring-shaped seed was used, it did not elongate itself, but rather served as a surface where new molecules could attach and form clusters, like a platform for new structures.

This research shows that the type of seed used in self-assembling supramolecular polymers influences the way the molecules assemble, and the final shape of the formed structures. This opens up exciting possibilities for various applications, from self-repairing and more easily recyclable materials to more advanced drug delivery systems, sensing technologies, and energy storage devices.

Prof. Yagai states, "By understanding these assembly processes, we can design and develop the next generation of more precise and environmentally friendly polymers with tailored structures and properties. The practical application of supramolecular polymers will enable us to produce plastic materials with lower energy consumption and reduce the energy required for recycling."

The ability to manipulate these versatile, self-assembling polymers at the molecular level offers great potential for addressing complex challenges

and creating innovative, sustainable solutions in fields ranging from healthcare to environmental sustainability.

Phys Org, 27 June 2023

https://phys.org

New enzyme could aid anticancer drug development

2023-06-27

Retracing nature's steps, Rice University chemical engineer Xue Gao and her team mapped out the full series of enzyme-powered reactions a marine fungus uses to produce 21R-citrinadin A, a complex molecule with anticancer properties.

In the process, Gao and her collaborators identified a new enzyme, CtdY, which is the only one of its kind known to break an amide bond, according to the new study published in the Journal of the American Chemical Society.

"CtdY belongs to a large family of enzymes known as cytochrome P450s that perform a variety of different functions and are being studied for their potential use in industrial and pharmaceutical settings," Gao said. "However, none of the P450s documented so far can break an amide bond.

"Amide bonds are found in all proteins—they're the ones linking the amino acids together. It's a fundamental, very stable type of bond."

The enzyme's ability to cleave amide bonds could make it a useful tool for creating new drugs.

"The fact that CtdY can do this is quite remarkable," said Qiuyue Nie, a postdoctoral researcher in the Gao lab who is one of the lead authors of the study. "It holds significant promise for the pharmaceutical industry," she said.

The enzyme is notable not only because it can break a highly-stable bond, but also because it does so for a very complex molecular structure.

"You want to maintain the rest of this structure and only want to break this single, hard-to-break bond this is a very specific and difficult task," Gao said.

Once CtdY breaks the amide bond—which has a circular 3D structure—a group of seven other enzymes intervene to complete the assembly of the 21R-citrinadin A molecule.

Many of the drugs we use to treat cancer and infectious disease are—or derive from—natural products, but it's difficult to know exactly how nature assembles them.

CHEMWATCH
Bulletin Board
Curiosities
JUN. 30, 2023

"Once it opens the ring, all the other enzymes are able to perform oxidation and install oxygen-hydrogen groups in a highly precise way," Gao said. "It's like CtdY brings the Christmas tree home, and then these other enzymes come together to decorate it."

The Gao lab has been working for years to uncover all the steps involved in the production of the 21R-citrinadin A compound, which has been shown to be effective against leukemia in rats and human throat cancer cells, according to Shuai Liu, a Rice postdoctoral researcher who is the study's lead co-author.

The newly identified enzyme is one of several discovered by the Gao lab that can perform singular catalytic functions such as controlling chirality and facilitating the Diels-Alder reaction.

"This really is a complete story," Gao said. "We used gene knockout, heterologous expression, mutagenesis studies, enzymology and so on to solve nearly every single step in the biosynthesis of this compound. Over 20 enzymes assemble and coordinate to produce the molecule. I find it fascinating that enzymes work cooperatively in this way to produce this wonderfully complex molecule."

Phys Org, 27 June 2023

https://website

Lateral flow HPV test could increase detection rates in resource-poor settings

2023-06-28

A new point-of-care assay to detect human papillomavirus (HPV) DNA requires just six user steps, gives results in under 45 minutes and costs less than $5 (£3.90) per test. Its developers hope it can fill a critical gap in resource-limited settings where the HPV rates are highest.

Despite the existence of a highly effective HPV vaccine and other prevention methods, cervical cancer continues to burden healthcare systems significantly, particularly in low- and middle-income countries. Directly detecting viral DNA using nucleic acid amplification tests is more effective than cytological methods such as Papanicolaou tests, also known as pap smears. However, the availability of equipment, reagents and

Low-cost assay works uses self-collected samples and gives results within 45 minutes

trained personnel, and the associated costs, have posed a challenge to implementing these methods in resource-poor environments.

Chemistry World,28 JUNE 2023

https://chemistryworld.com

Chemists develop new method for water splitting

2023-06-28

A team of researchers led by Prof. Armido Studer at the Institute of Organic Chemistry at Münster University (Germany) has developed a photocatalytic process in which water, under mild reaction conditions, is activated through triaryl phosphines, and not—as in most other processes—through transition metal complexes.

This strategy, which has now been published in Nature, will open a new door in the highly active field of research relating to radical chemistry, says the team. Radicals are, as a rule, highly reactive intermediates. The team uses a special intermediate—a phosphine-water radical cation—as activated water, from which hydrogen atoms from H2O can be easily split off and transferred to a further substrate. The reaction is driven by light energy.

"Our system," says Prof. Studer, "offers an ideal platform for investigating unresearched chemical processes which use the hydrogen atom as a reagent in synthesis."

Dr. Christian Mück-Lichtenfeld, who analyzed the activated water complexes using theoretical methods, says, "The hydrogen-oxygen bond in this intermediate is extraordinarily weak, making it possible to transfer a hydrogen atom to various compounds."

Dr. Jingjing Zhang, who carried out the experimental work, adds, "The hydrogen atoms of the activated water can be transferred to alkenes and arenes under very mild conditions, in so-called hydrogenation reactions."

Hydrogenation reactions are enormously important in pharmaceutical research, in the agrochemical industry and in materials sciences.

Phys Org, 28 June 2023

https://phys.org

Hydrogen is seen as an energy source of the future—at least, when it is produced in a climate-friendly way. Hydrogen can also be important for the production of active ingredients and other important substances. To produce hydrogen, water (H2O) can be converted into hydrogen gas (H2) by means of a series of chemical processes. However, as water molecules are very stable, splitting them into hydrogen and oxygen presents a big challenge to chemists. For it to succeed at all, the water first has to be activated using a catalyst; then it reacts more easily.

CHEMWATCH
Bulletin Board
Curiosities
JUN. 30, 2023

Novel computational approach reveals previously inaccessible druggable pockets

2023-06-28

In a paper recently published in the Journal of Chemical Information and Modeling, they describe how this reveals previously inaccessible druggable integrin pockets. At the heart of the research is a novel computational approach for mixed-solvent molecular dynamics simulation developed by Dr. Ioana Ilie at the Computational Chemistry group of the Van 't Hoff Institute for Molecular Sciences at the University of Amsterdam.

Integrins are a family of cell surface adhesion receptors which are capable of transmitting signals bidirectionally across membranes. They are known for their therapeutic potential in a wide range of diseases. However, the development of integrin targeting medication has been impacted by unexpected downstream effects. In particular, these are observed with drugs targeting the native binding site of the integrin.

The so-called allosteric modulation of integrins is a promising approach to potentially overcome these limitations. Here, the drug binds elsewhere on the receptor, changing the conformation and thus impacting the activity of the protein. Allosteric modulation of receptors therefore creates opportunities for drug discovery and development which are potentially superior to classic orthosteric modulation.

Novel druggable pockets

The novel computational approach developed by Ioana Ilie relies on enriching the solvent with small organic molecules (benzene in small concentrations) to enable the gentle opening of the integrin α I domain. This revealed novel previously inaccessible druggable pockets within the integrins LFA-1, VLA-1, and Mac-1. This study thus offers structural and dynamic insight on the effect of small alterations in solvent conditions on the accessibility of novel potentially druggable pockets, which are validated via virtual screening. The study acts as proof of concept and sets the foundation for the design of the next-generation integrin-targeting drugs. Additionally, it opens new research avenues towards the identification of allosteric sites in other up to date undruggable protein targets.

Finally, the study goes beyond drug discovery as it demonstrates that minor changes in the solvent conditions can have a dramatic impact

A team of researchers from the Universities of Amsterdam and Zurich together with the Swiss company Allocyte Pharmaceuticals have for the first time been able to discover allosteric sites in a type of cell surface receptor called integrin.

on the conformational space of the solvated molecule. This offers the opportunity to tune the solvent conditions in order to obtain a specific response of the solvated molecule (e.g., protein, material), which implicitly can aid in the development novel bio-inspired materials with responsive properties.

Phys Org, 28 June 2023

https://phys.org

New method could break down PFAS left on water treatment filters

2023-06-28

PFAS is a group of synthetic chemicals commonly found in household and industrial products such as firefighting foam, food packaging and nonstick cookware. The method is based on the Joule heating effect, which uses the process of electromagnetic induction inside a metallic reactor.

"In this study, we explored the use of an engineering technique used to melt metals," Xiao said. "This method produced 98% degradation of PFAS on the surface of absorbents like granular activated carbon and anion exchange resins after just 20 seconds, which makes this process highly energy efficient and much faster than conventional methods."

In recent years, experts have raised concerns about the risks to human health from environmental exposure to PFAS, including development of cancer and other serious health issues. Xiao, whose appointment is in the Department of Civil and Environmental Engineering, said while PFAS can be filtered out of water using adsorbents, the disposal of used or "spent" adsorbents also creates issues of environmental contamination.

"Since the group of chemicals known as PFAS generally resist degradation, they pose considerable challenges to established treatment processes, including the waste disposal practices for materials used as filters like granular activated carbon and anion exchange resins," Xiao said.

Xiao has spent his career focused on researching ways to safely remove PFAS from the environment, including recently demonstrating similar efficiency with the use of induction heating to rapidly degrade PFAS in soil. He said the current study also drew inspiration from recent proposed regulation by the Environmental Protection Agency (EPA) that, if finalized, would require public water systems in the U.S. to monitor and reduce PFAS contamination in drinking water and spent adsorbents.

In a recent study published in ACS ES&T Engineering, Feng "Frank" Xiao and colleagues at the University of Missouri demonstrate an innovative method using thermal induction heating to rapidly break down PFAS left on the surface of two solid materials—granular activated carbon and anion exchange resins—after these materials have been used to filter PFAS from municipal water systems. The team's goal is to clean the materials before they are properly disposed.

CHEMWATCH
Bulletin Board
Curiosities
JUN. 30, 2023

Potential drawbacks of this method include by-products created during this process—organic fluorinated species and hydrogen fluoride. While these by-products are considered toxic to consume through breathing or ingestion, Xiao has a solution.

"If the gaseous organic fluorinated products are not degraded during induction heating, abatement treatment will be necessary to remove or degrade them," Xiao said. "However, based on my previous studies, some of these products can be degradable by regular thermal approaches. Simultaneously, the generation of hydrogen fluoride is increased, which is desirable because it means greater mineralization, or decomposition, of PFAS. We've found hydrogen fluoride can be removed simply using clay or soil at moderate temperatures."

Tech Xplore, 28 June 2023

https://techxplore.com

Chocolate can be fruity or flowery, if you skip the roasting step

2023-06-27

Chocolate is made from cacao beans, which are fermented, roasted and processed into cacao nibs. These bits can be eaten on their own, or melted down and sweetened to form the chocolate products found on grocery or boutique store shelves. Similar to wines, the environmental conditions, or "terroir," where the cacao is grown provide a unique flavor profile to the bean. However, when the beans are roasted during processing, these subtle flavors can be hidden or destroyed.

To preserve the terroir and potential health benefits of cacao beans, some chocolatiers are now interested in creating minimally processed products by skipping the roasting step. Although these bars and chips are often called "raw," some people say that this is a misnomer because chemical changes have already occurred during fermentation. But regardless of the terminology, exactly which flavor compounds are potentially lost during this process is not well understood. So, Marlon Ac-Pangan, Nicki Engeseth and Keith Cadwallader wanted to investigate how the aroma and sensory characteristics of chocolate change during high-temperature roasting.

The team made two groups of nibs from the same set of cacao beans. One was roasted, and the other was not, and then both groups were molded into chocolates. Using solvent-assisted flavor evaporation and aroma extract dilution analysis, the researchers found that volatile flavor

"Natural" foods are trendy, and proponents claim that little or no processing helps preserve the food's inherent flavor. Research now published in the Journal of Agricultural and Food Chemistry shows that, at least for certain artisanal, bean-to-bar chocolates, this could indeed be the case. The team reports that unroasted, "raw" chocolate features certain compounds responsible for fruity flavors and sour tastes that are lost when the cacao beans are processed at high temperatures.

compounds, including the "hazelnut-like" 2- or 3-methylbutanoic acid and the "caramel-like" HDMF were more pronounced in the roasted samples. But the process masked other volatiles—including the "bell pepper-like" 2-isobutyl-3-methoxypyrazine—which were more noticeable in the unroasted chocolate, along with others that have fruity or flowery aromas.

Additionally, a trained sensory panel found that these unroasted samples tasted sourer and sweeter. The researchers say that this is probably because the vinegary flavors produced during fermentation were allowed to shine, instead of being masked by the more pronounced, "roasty" flavors. So, while roasting does change the flavor profile and may make it more "chocolatey," it may also hide some of the subtler flavors and sourness from the raw cacao beans.

Phys Org, 27 June 2023

https://phys.org

Electrochemical device captures carbon dioxide at the flick of a switch

2023-06-28

According to their study published in Nature, the system from the lab of chemical and biomolecular engineer Haotian Wang can directly remove carbon dioxide from sources ranging from flue gas to the atmosphere by using electricity to induce a water-and-oxygen-based electrochemical reaction. This technological feat could turn direct air capture from fringe industry—there are only 18 plants currently in operation worldwide—into a promising front for climate change mitigation.

Most carbon-capture systems involve a two-step process: First, high-pH liquids are used to separate the carbon dioxide, which is acidic, from mixed-gas streams such as flue gas. Next, the carbon dioxide is regenerated from the solution through heating or by injecting a low-pH liquid.

"Once the carbon dioxide is trapped in these solvents, you have to regenerate it," Wang said.

"Traditional amine scrubbing methods require temperatures of 100–200°C (212–392°F). For calcium carbonate-based processes you need temperatures as high as 900°C (1652°F).

New technology developed by Rice University engineers could lower the cost of capturing carbon dioxide from all types of emissions, a potential game-changer for both industries looking to adapt to evolving greenhouse gas standards and for the emergent energy-transition economy.

"There are literally no chemicals produced or consumed with our process. We also don't need to heat up or pressurize our device, we just need to plug it into a power outlet and it will work."

Another drawback of current carbon-capture technologies is their reliance on large-scale, centralized infrastructure. By contrast, the system developed in the Wang lab is a scalable, modular, point-of-use concept that can be adapted to a variety of scenarios.

"The technology can be scaled up to industrial settings—power plants, chemical plants—but the great thing about it is that it allows for small-scale use as well: I can even use it in my office," Wang said. "We could, for example, pull carbon dioxide from the atmosphere and continuously inject that concentrated gas into a greenhouse to stimulate plant growth. We've heard from space technology companies interested in using the device on space stations to remove the carbon dioxide astronauts exhale."

The reactor developed by Wang and his team can continuously remove carbon dioxide from a simulated flue gas with efficiency above 98% using a relatively low electricity input.

"The electricity used to power a 50-watt lightbulb for an hour will yield 10 to 25 liters of high-purity carbon dioxide," said Peng Zhu, a chemical and biomolecular engineering graduate student and lead author on the study.

Wang noted that the process has "no carbon footprint or a very limited footprint" if powered by electricity from renewable sources such as solar or wind.

"This is great news considering that renewable electricity is becoming more and more cost-effective," Wang said.

The reactor consists of a cathode set up to perform oxygen reduction, an oxygen evolution reaction-performing anode and a compact yet porous solid-electrolyte layer that allows efficient ion conduction. An earlier version of the reactor was used to reduce carbon dioxide into pure liquid fuels and reduce oxygen into pure hydrogen peroxide solutions.

"Previously, our group focused mainly on carbon dioxide utilization," Zhu said. "We worked on producing pure liquid products like acetic acid, formic acid, etc."

According to Wang, Zhu observed during the research process that gas bubbles flowed out of the reactor's middle chamber along with the liquids.

"At the beginning, we didn't pay a lot of attention to this phenomenon," Wang said. "However, Peng observed that if we applied more current there were more bubbles. That's a direct correlation, which means that something not random is happening."

The researchers realized that the alkaline interface generated during reduction reactions at the reactor's cathode side interacted with carbon dioxide molecules to form carbonate ions. The carbonate ions migrate into the reactor's solid-electrolyte layer where they combine with protons resulting from water oxidation at the anode side, forming a continuous flow of high-purity carbon dioxide.

"We randomly discovered this phenomenon during our previous studies," Wang said. "We then tuned and optimized the technology for this new project and new application. We've spent years of continuous work on this type of electrochemical device.

"Scientific discovery often requires this patient, continuous observation and the curiosity to learn what's really going on, the choice not to neglect those phenomena that don't necessarily fit in the experimental frame."

Tech Xplore, 28 June 2023

https://techxplore.com

Molecular mechanics of aging cells may be key to stimulating hair growth

2023-06-21

Senescent cells get a bad rap, given their association with the hallmarks of aging and a number of medical conditions, including cancer, diabetes, cardiovascular disease and Alzheimer's. But new research has found that senescent cells are not all bad.

Cellular senescence is when cells stop dividing but don't die and instead accumulate in the body. It's a normal physiological event that occurs naturally as people age. Now, researchers at the University of California, Irvine (UCI) have looked closely at the molecular mechanics of senescent cells in the skin of mice and found they can stimulate hair growth.

Skin contains progenitor-rich hair follicles that renew themselves in cycles. The process is kicked off by a signal that activates hair stem cells, causing them to divide and enabling the follicles to produce new hair. After each cycle, the stem cells remain inactive until the cycle starts again.

A new study has looked at the molecular mechanisms underlying hair growth and found that aging or senescent cells may be key to promoting hair growth in humans. Their findings potentially open the door to developing new hair loss treatments that harness the innate abilities of these often-maligned cells.

CHEMWATCH
Bulletin Board
Curiosities
JUN. 30, 2023

The researchers examined mice with pigmented skin spots that contained hyperactivated stem cells and showed accelerated hair growth. These spots strongly resemble what in humans are called nevi, a type of birthmark that's dark-colored and hairy. What's unique about these hairy nevi is that while they accumulate a large number of senescent pigment cells, they continue to grow robust hair.

Examining the skin spots, the researchers found that their senescent pigment cells produced high levels of a signaling molecule called osteopontin, for which the senescent hair stem cells had a matching receptor molecule called CD44. When osteopontin and CD44 interacted, the stem cells were activated and produced hair. Mice genetically modified to remove the genes that produced osteopontin or CD44 showed significantly slower hair growth.

"We found that senescent pigment cells produce large quantities of a specific signaling molecule called osteopontin, which causes normally dormant and diminutive hair follicles to activate their stem cells for robust growth of long and thick hairs," said Maksim Plikus, one of the study's corresponding authors. "Senescent cells are typically viewed as detrimental to regeneration and are thought to drive the aging process as they accumulate in tissues throughout the body, but our research clearly shows that cellular senescence has a positive side to it."

The researchers also examined human hairy nevi by way of RNA sequencing and found significant differences between the nevi and neighboring normal facial skin, confirming the role of osteopontin in promoting hair growth in humans.

The researchers say their findings may lead to the development of new treatments for hair loss that exploit the innate properties of senescent cells.

"Our findings provide qualitatively new insights into the relationship between senescent cells and tissue's own stem cells and reveal positive effects of senescent cells on hair follicle stem cells," said Xiaojie Wang, lead author of the study. "As we learn more, that information can potentially be harnessed to develop new therapies that target properties of senescent cells and treat a wide range of regenerative disorders, including common hair loss."

The researchers plan to expand their research to examine other molecular mechanisms underlying hair growth.

"In addition to osteopontin and CD44, we're looking deeper into other molecules present in hairy skin nevi and their ability to induce hair growth," said Plikus. "It's likely that our continued research will identify additional potent activators."

The study was published in the journal Nature.

New Atlas, 21 June 2023

https://newatlas.com

CHEMWATCH
Bulletin Board

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

CHEMICAL EFFECTS

Screening and prioritization of organic chemicals in a large river basin by suspect and non-target analysis

A preliminary study about the potential risks of the UV-weathered microplastic: The proteome-level changes in the brain in response to polystyrene derived weathered microplastics

ENVIRONMENTAL RESEARCH

Environmental and agronomic assessment of soil conditioners produced from bauxite residue and oil palm wastes

Novel polymer optical fibers with high mass-loading g-C3N4 embedded metamaterial porous structures achieve rapid micropollutant degradation in water

Plasmonic nanoparticle's anti-aggregation application in sensor development for water and wastewater analysis

PHARMACEUTICAL/TOXICOLOGY

Multidrug-resistant Enterobacter spp. in wastewater and surface water: Molecular characterization of β-lactam resistance and metal tolerance genes

Clearance of intracellular bacterial infections by hyaluronic acid-based ROS responsive drug delivery micelles

Emerging contaminants in conventional and advanced biological nutrient removal based wastewater treatment plants in India- insights into the removal processes

OCCUPATIONAL

Does occupational health surveillance lead to risk reduction for workers exposed to hand-intensive work?

Health effects of railway-induced vibration combined with railway noise - A systematic review with exposure-effect curves