CHEMWATCH

Bulletin Board

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ASIA PACIFIC

Proposed suspension of specific dimethoate products

2023-08-15

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has proposed to suspend the registration and labels of chemical products containing dimethoate used as a post-harvest dip for fruit with inedible peel.

The APVMA has received reports indicating that the maximum permitted level of pesticide residue (the maximum residue limit or MRL) for dimethoate, and its main degradation product omethoate, has been exceeded in avocados and mangos. The information available to the APVMA shows the MRL exceedance is likely due to the use of dimethoate in accordance with the approved instructions for use as a post-harvest dip.

The APVMA considers the level of residues detected are unlikely to pose a significant risk to human health but has proposed suspension of these specific dimethoate products as a precautionary measure.

The APVMA remains satisfied that all other approved uses of dimethoate are safe.

If dimethoate products are suspended as proposed, the APVMA will provide instructions for use in a deemed permit that will be valid for 12 months. These instructions will allow the continued use of dimethoate but will prohibit use of dimethoate as a post-harvest dip on tropical and sub-tropical fruit.

The APVMA is also proposing to take action on Permit 87164, held by Horticulture Innovation Australia Ltd, to remove the use of dimethoate as a flood spray for post-harvest assorted tropical and sub-tropical fruits – inedible peel (crop group 006). The permitted use of dimethoate on citrus fruit with inedible peel remains acceptable.

Holders of dimethoate registrations and other relevant stakeholders have been given 2 weeks to provide any information that would demonstrate why the products should not be suspended. Members of the public are also invited to comment on the proposed suspension. Comments should be related to the reasons for the proposed suspension and must be submitted to the APVMA by 29 August 2023.

Registered chemical products containing dimethoate can continue to be used during the consultation period, in accordance with the approved label instructions.

The APVMA will consider all submissions before making a final decision.

Read More

APVMA, 15-08-23

https://apvma.gov.au/node/116756

A shudder shakes Australian product standards compliance

2023-08-17

Businesses manufacturing, importing and/or supplying products in Australia must ensure the products meet Australia's regulatory standards. Failure to comply with regulatory standards can result in harsh penalties, with the Australian Consumer law allowing courts to fine companies up to AUD50 million.

Earlier this year, retailers Dusk and The Reject Shop paid infringement notices totalling AUD240k for supplying battery-operated Halloween toys that did not meet Australia's mandatory standards. During this year, we have also fielded an increasing number of inquiries from international clients on automotive standards relating to navigational equipment, braking and LED lighting, and have been called upon to advise on battery product recall procedures.

These developments likely suggest an uptick in government scrutiny of standards compliance, or at the very least, reflect increasing manufacturer and supplier reliance on emerging technologies in their products, where the implications of technology failure could cause dire outcomes, including injury or death. Whatever the motivation, these examples underline the desirability and necessity for Australian suppliers to increase their awareness and vigilance in this critical area of business risk.

In this explainer, senior counsel Alistair Bridges and lawyer Emily Schilling outline the various product standards that operate in Australia and explain some of the key considerations for business.

What are product standards?

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Standards set out technical specifications for particular products. These include testing, packaging, performance, physical design, instructions, and warning requirements. Product claims by suppliers cannot be inconsistent with applicable standards. Standards aim to ensure that products are safe, consistent, and reliable for consumers, and that product descriptions are not misleading or confusing. Higher risk products attract more stringent regulatory oversight than lower risk products.

It is a legal obligation for a supplier to ensure that the products it sells are safe. To avoid facing significant penalties, it is important for business to be aware of the relevant standards that can apply, to understand how to comply with these standards and, in certain circumstances, to be able to demonstrate compliance.

Manufacturers, importers, distributors and retailers who supply products in Australia are considered a "supplier" and are generally responsible for ensuring regulatory standards are met.

Products covered by Australian standards range from sunglasses, aquatic toys and treadmills through to road vehicles and devices with electromagnetic capabilities. At the same time, not all products have accompanying standards, and not all standards for a product necessarily apply in Australia.

Read More

Lexology, 17-08-23

https://www.lexology.com/library/detail.aspx?g=0c67e621-3d37-43e2-94ce-afc40c9f2f09

FSANZ public consultations

2023-08-16

Proposal P1049 – Carbohydrate and sugar claims on alcoholic beverages

FSANZ invites written submissions on the assessment to clarify requirements in the Australia New Zealand Food Standards Code (the Code) with respect to claims about carbohydrate content, and the components of carbohydrates (such as sugar), in relation to food that contains more than 1.15% alcohol by volume (ABV), including alcoholic beverages. Submissions close 6pm (AEST) 4 September 2023.

Proposal P1010 – Review of Formulated Supplementary Sports Foods

FSANZ invites written comments on the review Standard 2.9.4 – Formulated Supplementary Sports Foods (FSSF) of the Code, via Consultation Paper Two – Nutrition and Health Claims. Comments close 6pm (AEST) 4 September 2023.

Application A1270 – Food derived from herbicide-tolerant and insect-protected corn line DP51291

FSANZ invites submissions regarding the sale and use of food derived from corn line DP51291, genetically modified for herbicide-tolerance and protection from insect pests. Submissions close 6pm (AEST) 14 September 2023.

For more information about the consultations underway, visit the FSANZ website.

Read More

FSANZ, 16-08-23

https://mailchi.mp/foodstandards.gov.au/food-standards-news-august-2023

AMERICA

Study: 'Forever Chemicals' show up in nearly half the nation's drinking water

2023-08-15

A federal agency has released the results of a new study that found nearly half the nation's tap water has detectable levels of chemicals that are believed to cause cancer and other health problems.

The study tested drinking water around the country for 32 different chemicals in a group known as perfluoroalkyl substances, or PFAS for short, which are often referred to as "forever chemicals" because they do not break down naturally in the environment.

According to the U.S. Geological Survey team of scientists, the "research marks the first time anyone has tested for and compared PFAS in tap water from both private and government-regulated public water supplies on a broad scale throughout the country."

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PFAS-related chemicals are used in the manufacturing of products commonly found in many homes, including non-stick cookware, stain-resistant carpet and fast-food packaging. The contaminant has been linked to numerous health issues, including increased risk for high blood pressure, cancers, low birth weight and decreased vaccine response in children.

The U.S.G.S. study estimates at least 42% of the nation's tap water contains at least one or more PFAS.

The regulation process for the chemicals is ongoing, but experts say there are no "safe" levels of PFAS, and the effect of the substances depends on the length and levels of exposure — something this new study did not address.

It is estimated that at least 16 million people in the U.S. have been exposed to PFAS through their drinking water, and some impacted communities have taken action, including Rome, Georgia.

In 2016, Georgia's Environmental Protection Division uncovered high levels of PFAS in a river the city used for its drinking water.

Read More

Fox34.com, 15-08-23

https://www.fox34.com/2023/08/14/study-forever-chemicals-show-up-nearly-half-nations-drinking-water/

Tiered Data Reporting to Inform Prioritization, Risk Evaluation and Risk Management under TSCA

2023-08-14

EPA is developing a rulemaking under TSCA Sections 8(a) and (d) to establish reporting requirements based upon a chemical's status in the Risk Evaluation/Risk Management (RE/RM) Lifecycle and to update the reporting requirements under the 40 C.F.R. Part 711 Chemical Data Reporting (CDR) regulation. EPA states that it is developing this rule to obtain information about potential hazards and exposure pathways related to certain chemicals, particularly occupational, environmental, and consumer exposure information. According to EPA, this information is needed to inform prioritization, risk evaluation, and risk management of the chemical substances under TSCA Section 6. EPA intends to issue a notice of proposed rulemaking (NPRM) in February 2024 and a final rule

in July 2025. Information on EPA's July 27, 2021, webinar on a tiered data collection strategy is available in our July 29, 2021, memorandum.

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The National Law Review, 14-08-23

https://www.natlawreview.com/article/epa-s-spring-2023-unified-agenda-includes-proposed-and-final-tsca-and-tri-rules

Science academy backs EPA view that formaldehyde causes cancer

2023-09-15

Apanel of top US scientists has backed a US Environmental Protection Agency draft toxicological risk assessment review that found formaldehyde, a chemical with broad industrial uses, to be a human carcinogen. However, the Aug. 9 report, by the US National Academy of Sciences (NAS), was challenged by the American Chemistry Council (ACC), a trade association, even before it was publicly released.

The NAS review was commissioned by the EPA to assess the draft risk assessment, which was completed more than a year ago and was conducted through the agency's Integrated Risk Information System (IRIS) program. The EPA's assessment cites evidence that inhaling formaldehyde causes nasopharyngeal cancer, sinonasal cancer, and myeloid leukemia in humans. If finalized, the IRIS assessment will serve as a benchmark for future formaldehyde-related regulations.

The EPA's assessment of formaldehyde has long been challenged by industry. The EPA began a health risk assessment for the chemical in 1985 and first proposed it as a probable human carcinogen in 1989, according to the NAS.

The EPA assessment, the academy report notes, "follows the advice of prior National Academies committees, and its findings on hazard and quantitative risk are supported by the evidence identified." However, the academy recommends that the EPA revise the document to ensure that users can find and follow the methods used in each step of its assessment for each health outcome.

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c&en, 15-09-2023

https://cen.acs.org/policy/chemical-regulation/Science-academy-backs-EPA-view-formaldehyde-causes-cancer/101/web/2023/08?utm_source=LatestNews&utm_medium=LatestNews&utm_campaign=CENRSS

Updates to New Chemicals Regulations under TSCA

2023-08-14

EPA is developing proposed amendments to the new chemicals procedural regulations under TSCA that are codified in 40 C.F.R. Parts 720, 721, 723, and 725. EPA states that it is considering amendments to clarify and improve the efficiency of EPA's new chemicals review process and to align its processes and procedures with the statutory requirements that were amended in 2016 and affected how EPA reviews and makes determinations on new chemical notices under TSCA Section 5. According to EPA, the amended statutory requirements "increased EPA responsibilities and it has become more challenging for EPA to complete reviews within the 90-day statutory review period." The rulemaking seeks to increase the quality of information initially submitted in new chemicals notices and to improve EPA's processes for timely, effective completion of the risk assessment and the new chemicals reviews. The rulemaking also seeks to improve EPA's existing practices related to the review of certain groups of chemical substances under premanufacture notification (PMN) exemptions. Information on EPA's May 26, 2023, NPRM is available in our May 24, 2023, memorandum. EPA intends to publish a final rule in February 2025.

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The National Law Review, 14-08-23

https://www.natlawreview.com/article/epa-s-spring-2023-unified-agenda-includes-proposed-and-final-tsca-and-tri-rules

FDA Issues Draft Guidance for Cosmetics Product Registration and Listing

2023-08-16

The U.S. Food and Drug Administration issued a draft guidance which, once finalized, will assist cosmetics companies in submitting cosmetic

product facility registrations and cosmetic product listings, including ingredients, to the FDA.

This includes a wide range of products such as makeup products, nail polishes, shaving creams and other grooming products, perfumes, face and body cleansers, hair care products, moisturizers, and other skin care products.

Read More

SpecialChem, 16-08-23

https://cosmetics.specialchem.com/news/industry-news/fda-issues-draft-guidance-for-cosmetics-product-000231621?li=200384708&lr=ico2308449&utm

Chemical-Specific Rulemakings under TSCA Section 6(a)

2023-08-14

TSCA Section 6(a) requires EPA to eliminate unreasonable risks of injury to health or the environment that the Administrator has determined in a TSCA Section 6(b) risk evaluation are presented by a chemical substance under the conditions of use. After risk evaluations for the following chemicals carried out under the authority of TSCA Section 6, EPA will initiate rulemakings to address unreasonable risks of injury to health identified in the final risk evaluations:

- Methylene Chloride (RIN: 2070-AK70): EPA published an NPRM on May 3, 2023. EPA intends to issue a final rule in June 2024. More information on EPA's NPRM, which would prohibit most uses of methylene chloride, is available in our April 25, 2023, memorandum.
- Cyclic Aliphatic Bromide Cluster (HBCD) (RIN: 2070-AK71): EPA intends to publish an NPRM in April 2024. Information on EPA's final revision to the HBCD risk determination is available in our June 30, 2022, memorandum.
- 1-Bromopropane (1-BP) (RIN: 2070-AK73): EPA intends to publish an NPRM in November 2023 and to issue a final rule in March 2025. Information on EPA's final revision to the 1-BP risk determination is available in our December 21, 2022, memorandum.
- Carbon Tetrachloride (CTC) (RIN:2070-AK82): EPA published an NPRM on July 28, 2023. EPA intends to issue a final rule in October 2024. More information on the NPRM is available in our July 26, 2023, memorandum.

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- Trichloroethylene (TCE) (RIN: 2070-AK83): EPA submitted a proposed rule to the Office of Management and Budget (OMB) for review on July 7, 2023. EPA intends to publish an NPRM in October 2023 and a final rule in October 2024. Information on EPA's final revision to the risk determination for TCE is available in our January 19, 2023, memorandum.
- Perchloroethylene (PCE) (RIN: 2070-AK84): EPA published an NPRM on June 16, 2023. EPA intends to issue a final rule in August 2024. More information on the NPRM is available in our June 16, 2023, memorandum.
- N-Methylpyrrolidone (NMP) (RIN: 2070-AK85): EPA intends to publish an NPRM in October 2023 and to issue a final rule in December 2024. Information on EPA's final revision to the NMP risk determination is available in our December 21, 2022, memorandum.
- Colour Index Pigment Violet 29 (PV29) (RIN: 2070-AK87): EPA intends to publish an NPRM in May 2024. Information on EPA's final revision to the PV29 risk determination is available in our September 9, 2022, memorandum.

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The National Law Review, 14-08-23

https://www.natlawreview.com/article/epa-s-spring-2023-unified-agenda-includes-proposed-and-final-tsca-and-tri-rules

EUROPE

UK Calls for Data on Nanomaterials in Cosmetics

2023-08-14

On August 14, 2023, the United Kingdom's (UK) Office for Product Safety and Standards (OPSS) called for the submission of any scientific information relevant to the safety assessment of nanomaterials used in cosmetics. Article 16 of the UK Cosmetics Regulation requires that cosmetic products containing nanomaterials be notified to the Secretary of State at least six months prior to being placed on the market. These notifications may be completed via the Submit Cosmetic Product Notification (SCPN) portal. In the case of nanomaterials not listed in Annexes IV, V, and VI, notifications must include additional data on the safety of the nanomaterial for use in cosmetic products. OPSS invites any interested parties, including academia, manufacturers of cosmetic

products/raw materials, and consumer associations, to submit any scientific information relevant to the safety assessment of the below listed nanomaterials (or surface functionalized variants, alloys, or other related variants) used in cosmetics:

- Platinum (nano);
- Copper (nano);
- Silver (nano), colloidal silver (nano);
- Gold (nano), colloidal gold (nano), gold thioethylamino hyaluronic acid (nano);
- Silica (nano), hydrated silica (nano), silica silylate (nano), silica dimethyl silylate (nano);
- Lithium magnesium sodium silicate (nano); and
- Hydroxyapatite (nano).

Data on silica (nano), hydrated silica (nano), silica silylate (nano), and silica dimethyl silylate (nano) are due June 27, 2025. Data on all other substances are due December 22, 2023.

Read More

Nano and Other Emerging Chemical Technologies Blog, 14-08-23

https://nanotech.lawbc.com/2023/08/uk-calls-for-data-on-nanomaterials-in-cosmetics/

Pharmaceutical Strategy

2023-08-16

Waiting for positions from Parliament and Council

With the Commission's proposal for the most important health file in its mandate, the pharmaceutical legislation revision, running behind schedule – it was presented after a number of delays on 26 April – only true optimists can hope for interinstitutional negotiations to start before the 2024 European elections.

As of the end of July, Parliament still had not received translations of the European Commission's proposal. A European People's Party (EPP) official told EURACTIV that translations are likely to arrive in September and it is unknown if the Parliament will have enough time to form its position before the end of the mandate.

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Debates will likely unfold over topics like a new incentive system that "rewards companies that go the extra mile", in Health Commissioner Kyriakides' words and a voucher scheme for novel antibiotics.

The pharmaceutical package includes pharmaceutical legislation, orphan drugs and paediatric medicines legislation and a Council Recommendation to step up the fight against antimicrobial resistance (AMR).

The Council Recommendation on AMR has made the most headway, being approved by Parliament and the Council on 13 June.

Read More

Euractiv, 16-08-23

https://www.euractiv.com/section/health-consumers/news/show-must-go-on-for-eu-health-policy-after-summer/

ECHA public consultation: call for comments

2023-08-15

Deadline: 29 September 2023

The Great Britain Mandatory Classification and Labelling (GB MCL) process includes the consideration of information gathered from public consultations, conducted by HSE or international bodies such as the European Chemicals Agency (ECHA).

ECHA has announced public consultations on the following proposals for harmonised classification and labelling (CLH):

- 4,4'-methylenediphenol; bisphenol F (EC: 210-658-2; CAS: 620-92-8). Chemical registered under REACH. Health hazard class open for commenting.
- bronopol; 2-bromo-2-nitropropane-1,3-diol (EC: 200-143-0; CAS: 52-51-7). Biocide active substance. All hazard classes open for commenting.

Read More

HSE CLP, 15-08-23

https://echa.europa.eu/harmonised-classification-and-labelling-consultation?utm_source=govdelivery&utm_medium=email&utm_campaign=chemicals-guidance-hse&utm_term=link-1&utm_content=clp-14-aug-23

German groups call for PFAS exemption

2023-08-16

Industry groups in Germany have called for exemptions for F-gases and spare parts for refrigeration, air conditioning and heat pumps in any future European PFAS bans.

Earlier this year, an axis of five European countries – Germany, the Netherlands, Norway, Sweden and Denmark – submitted a joint restriction proposal to the European REACH regulations for PFAS containing substances. The wider definition proposed would include virtually all HFC and HFO refrigerants.

With consultations on the regulations about to conclude, seven of Germany's leading groups and associations, including the federal guild BIV and contractors' body VDKF, are calling for an exception made for PFAS-containing F-gases and an unlimited exemption for fluorinated refrigerants for service and maintenance purposes.

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It points out that the RACHP industries use PFAS chemicals in a variety of forms and applications, including in seals, construction and coating materials, electrotechnical components, as well as fluorinated refrigerants.

"In many cases material properties are not currently available and also not in the timeframe of the planned ban periods can be developed as marketable products," the group says in a statement.

All fluorinated refrigerants, with five exceptions, would be affected by the PFAS ban. The group argues that the use of F-gases is already being strictly regulated and continuously restricted within the framework of the European F-gas regulation.

Rejecting any ban that was "detached from an assessment of the actual environmental impact and the foreseeable availability of suitable substitutes", the group says: "The safe operation of refrigeration, air conditioning and heat pump systems would otherwise be massively jeopardised – with the corresponding consequences for our entire economy and society."

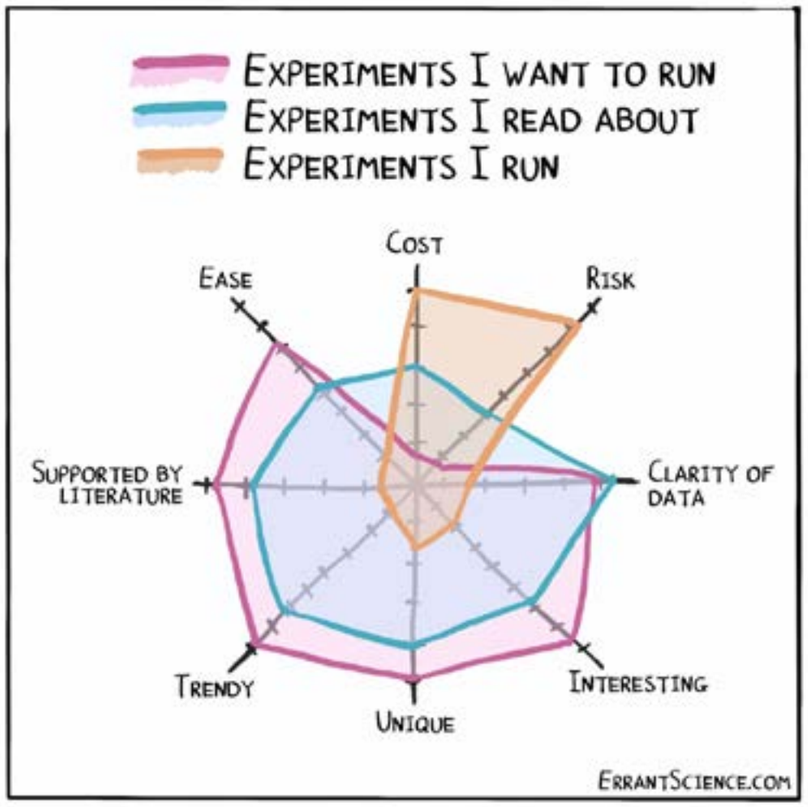
Read More

Cooling Post, 16-08-23

https://www.coolingpost.com/world-news/german-groups-call-for-pfas-exemption/

Experiments

2023-08-25



https://twitter.com/ErrantScience/status/1638512254197923840/photo/1

Hydrazine

2023-08-25

There are many kinds of hydrazine compounds, including hydrazine, 1,1-dimethylhydrazine, and 1,2-dimethylhydrazine.

Hydrazine is very hydroscopic liquid at room temperature and is a highly polar solvent. Anhydrous hydrazine is a very strong reducing agent. It is a very reactive molecule, which can decompose at incredible speed, very exothermically, which makes it ideal as a rocket fuel. Hydrazine is reasonably stable to store if protected from air although the smaller hydrazines are very flammable.

Some nitrogen-fixing bacteria may create hydrazine as a by-product while some derivatives (N-methyl-N-formylhydrazine and agaritine) have been obtained from edible mushrooms. Despite these few natural occurrences, hydrazine is primarily manufactured.[1,2]

USES [2,3]

Hydrazine can be used in nickel plating, the removal of halogens from wastewaters, as an inhibitor to corrosion, and in photograph development. It has also been used in boiler water treatment, in blowing agent manufacturing for producing plastics used in vinyl flooring and auto foam cushions, in the production of agricultural chemicals such as maleic hydrazide, as a reducing agent in nuclear fuel reprocessing, and even used for medicinal purposes as a medication for sickle cell and cancer. Hydrazine is also contained in tobacco and cigarette smoke. in the form of pentafluorobenzaldehyde.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Breathing contaminated air in or near a facility that makes, processes, or uses hydrazines.
- Eating fish contaminated with hydrazines.
- Drinking or swimming in water that has been contaminated with hydrazines.
- Touching soil contaminated with hydrazines, such as near some military bases or hazardous waste sites.
- Breathing cigarette smoke indirectly or using tobacco products may expose you to small amounts of hydrazine or 1,1-dimethylhydrazine.

Hydrazine is an inorganic compound with the formula N2H4. It is a colourless flammable liquid with an ammonia-like odour. It is highly toxic and dangerously unstable unless handled in solution.

- Working in greenhouses where the chemical Alar is used may result in your being exposed to small amounts of 1,2-dimethylhydrazine.

Routes of Exposure

The routes of exposure to hydrazine are as follows:

- Eye and skin contact;
- Inhalation;
- Ingestion;

HEALTH EFFECTS [4]

Acute Health Effects

Symptoms of acute exposure to high levels of hydrazine include irritation of the eyes, nose, and throat, temporary blindness, dizziness, headache, nausea, pulmonary oedema, seizures, and coma in humans. Acute exposure can also damage the liver, kidneys, and the central nervous system (CNS) in humans.

The liquid is corrosive and may produce chemical burns and severe dermatitis from skin contact.

Acute animal tests in rats, mice, rabbits, and guinea pigs have demonstrated hydrazine to have high acute toxicity from inhalation and ingestion and extreme acute toxicity from dermal exposure.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
- **Skin Contact**: If the chemical got onto the clothed portion of the body, remove the contaminated clothes as quickly as possible, protecting your own hands and body. Place the victim under a deluge shower. If the chemical got on the victim's exposed skin, such as the hands: Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cold water may be used. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

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- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** Allow the victim to rest in a well-ventilated area. Seek immediate medical attention.
- **Serious Inhalation:** Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
- **Ingestion:** Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Workplace Controls & Practices [4]

Control measures include:

- Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value.
- Ensure that eyewash stations and safety showers are proximal to the workstation location.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling hydrazine:

- Face shield;
- Full suit;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves;
- Boots.

Personal Protective Equipment in Case of a Large Spill:

- Splash goggles;

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

REGULATION

United States

- OSHA: The Occupational Safety & Health Administration has set the following Permissible Exposure Limit (PEL) for hydrazine:

General Industry: 29 CFR 1910.1000 Table Z-1 - 1 ppm, 1.3 mg/m3; Skin

Maritime: 29 CFR 1915.1000 Table Z-Shipyards - 1 ppm, 1.3 mg/m3; Skin

- ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV)for hydrazine of 0.01 ppm TWA; Skin; Appendix A3 (Confirmed Animal Carcinogen with Unknown Relevance to Humans)
- NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for hydrazine of 0.03 ppm, 0.04 mg/m3 Ceiling (120 Minutes); Appendix A - Potential Occupational Carcinogen

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9. http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/772/Workplace-exposure-standards-airborne-contaminants.pdf

Novel strategy to accelerate design of high-performance lithium metal batteries

2023-08-22

A research team led by Prof. Xue Dongfeng and Dr. Peng Chao from the Shenzhen Institute of Advanced Technology (SIAT) of the Chinese Academy of Sciences (CAS) has recently introduced a novel inorganic-organic hybrid interphase layer strategy based on self-assembled monolayers method.

The strategy endows the Li metal anode interface with good mechanical stability and excellent ionic conductivity and induces Li uniform deposition and suppression of Li dendrite growth. The results were published in the journal Matter.

The researchers applied the high-throughput data-driven workflow to enable intelligent design of self-assembled molecules. The workflow contains screening criterions of self-assembled molecule characteristics, electrochemical stability of molecules, chemical stability and ionic conductivity of interphase protection layer, and it can automatically capture targeted self-assembled molecules from the PubChem database.

This new research paradigm accelerates the screening process for selecting the most promising candidate molecules, and allows intelligent design of artificial interphase layer of Li metal anode by leveraging machine learning techniques.

Furthermore, the researchers revealed the structure-performance relationship between the molecule structural characteristics (head group, tail group and middle group) as well as the electronic properties and the performance of the protection layer, where the quantum mechanical dipole and electrostatic potential of molecules were identified as significant descriptors to predict the energy barrier of Li diffusion through the hybrid protection layer.

They established a database consisting of 128 self-assembled organic molecule candidates selected from the PubChem database and suggested eight best molecules to favor constructing the inorganic-organic hybrid interphase layer at Li metal anode.

These molecules with a terminated fluoride head group (-F) allow the formation of an LiF inner inorganic interphase that improves the stability and ionic conductivity of the interphase layer on the Li metal anode, while the outer linear organic layer provides enriched 3D porous channels that

Lithium metal batteries (LMBs) have attracted much attention for their potential in electronics and electric vehicle applications. However, issues such as the growth of Li dendrites and undesirable side reactions with electrolytes during electrochemical cycling hinder their widespread commercialization.

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facilitate Li diffusion and guide Li uniform deposition and suppress Li dendrite growth.

"Our study opens up new possibilities for the development of more efficient and safer lithium metal batteries," said Dr. Peng, corresponding author of the study.

Phys Org, 22 August 2023

https://phys.org

Surprising River Methane Sources Identified by Global Mapping

2023-08-23

Freshwater ecosystems account for half of global emissions of methane, a potent greenhouse gas that contributes to global warming. Rivers and streams, especially, are thought to emit a substantial amount of that methane, but the rates and patterns of these emissions at global scales remain largely undocumented.

An international team of researchers, including University of Wisconsin–Madison freshwater ecologists, has changed that with a new description of the global rates, patterns and drivers of methane emissions from running waters. Their findings, published recently in the journal Nature, will improve methane estimates and models of climate change, and point to land-management changes and restoration opportunities that can reduce the amount of methane escaping into the atmosphere.

The new study confirms that rivers and streams do, indeed, produce a lot of methane and play a major role in climate change dynamics. But the study also reveals some surprising results about how – and where – that methane is produced.

"We expected to find the highest methane emissions at the tropics, because the biological production of methane is highly sensitive to temperature," says Emily Stanley, a professor at UW–Madison's Center for Limnology and co-author of the Nature report. Instead, she says, their team found that methane emissions in the tropics were comparable to those in the much colder streams and rivers of boreal forests — pine-dominant forests that stretch around the Northern Hemisphere — and Arctic tundra habitats.

Temperature, it turns out, isn't the primary variable driving aquatic methane emissions. Instead, the study found, "the amount of methane

A new study confirms that rivers and streams emit large amounts of methane, revealing surprises about how it's produced.

coming out of streams and rivers regardless of their latitude or temperature was primarily controlled by the surrounding habitat connected to them," Stanley says.

Rivers and streams in boreal forests and polar regions at high latitudes are often tied to peatlands and wetlands, while the dense forests of the Amazon and Congo river basins also supply the waters running through them with soils rich in organic matter. Both systems produce substantial amounts of methane because they often result in low-oxygen conditions preferred by microbes that produce methane while breaking down all that organic matter.

However, not all high methane rivers and streams come by these emissions naturally. In parts of the world, freshwater methane emissions are primarily controlled by human activity in both urban and rural communities.

"Humans are actively modifying river networks worldwide and, in general, these changes seem to favor methane emissions," says Gerard Rocher, lead author of the report and a postdoctoral researcher with both the Swedish University of Agricultural Sciences and the Blanes Centre of Advanced Studies in Spain.

Habitats that have been highly modified by humans — like ditched streams draining agricultural fields, rivers below wastewater treatment plants, or concrete stormwater canals — also often result in the organic-matter-rich, oxygen-poor conditions that promote high methane production.

The significance of human involvement can be considered good news, according to Rocher.

"One implication of this finding is that freshwater conservation and restoration efforts could lead to a reduction in methane emissions," he says.

Slowing the flow of pollutants like fertilizer, human and animal waste or excessive topsoil into rivers and streams would help limit the ingredients that lead to high methane production in freshwater systems.

"From a climate change perspective, we need to worry more about systems where humans are creating circumstances that produce methane than the natural cycles of methane production," Stanley says.

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The study also demonstrates the importance of teams of scientists working to compile and examine gigantic datasets in understanding the scope of climate change. The results required a years-long collaboration between the Swedish University of Agricultural Sciences, Umeå University, UW–Madison and other institutions around the world. They collected methane measurements on rivers and streams across several countries, employed state-of-the-art computer modelling and machine learning to "massively expand" a dataset Stanley first began to compile with her graduate students back in 2015.

Now, Stanley says, "we have a lot more confidence in methane estimates." The researchers hope their results lead to better understanding of the magnitude and spatial patterns of all sources of methane into Earth's atmosphere, and that the new data improves large-scale models used to understand global climate and predict its future.

Reference: Rocher-Ros G, Stanley EH, Loken LC, et al. Global methane emissions from rivers and streams. Nature. 2023. doi: 10.1038/s41586-023-06344-6

Technology Networks, 23 August 2023

https://technologynetworks.com

Hydrocarbon-eating bacteria speed up consumption by reshaping oil droplets

2023-08-18

The bacterium Alcanivorax borkumensis consumes hydrocarbons as its sole carbon and energy source. The marine bacteria are known to form biofilms around oil droplets, but how exactly this process works hasn't previously been fully understood.

Now, a research team based in Japan and France has captured the full dynamics of biofilm development by using a microfluidic device that allowed the real-time imaging of bacteria-covered oil droplets. This enabled the team to observe the whole process from initial colonisation through to complete consumption of oil droplets.

The speed with which the bacteria degrade the droplets depends on the bacteria's adaptation to oil consumption. But rather than this being caused by an increase in individual metabolic throughput, this acceleration appears to be due to the types of biofilms that the bacteria form.

Specialised marine bacteria that bloom following oil spills form unique biofilms that reshape the oil droplets, allowing more bacteria to feed at once. The finding improves scientists' understanding of the processes that drive biodegradation of spilled oil.

Bacteria that were exposed to the oil for longer formed thin biofilms with numerous branching dendrites. These dendritic biofilms decrease the oil–water interfacial tension causing dimples to form on the droplets, which speeds up the bacteria's consumption by expanding the interface of the oil droplet allowing more bacteria to feed simultaneously.

Chemistry World, 18 August 2023

https://chemistryworld.com

Recycling the non-recyclable: New epoxy resin resists flames and reduces waste

2023-08-22

Epoxy resins are tough and versatile polymers. In combination with glass or carbon fibers, they are used, for example, to manufacture components for aircraft, cars, trains, ships and wind turbines. Such epoxy-based fiber-reinforced polymers have excellent mechanical and thermal properties and are much lighter than metal. Their weakness: They are not recyclable—at least not yet.

Now Empa researchers led by Sabyasachi Gaan at Empa's Advanced Fibers laboratory have developed an epoxy resin-based plastic that is fully recyclable, repairable and also flame retardant—all while retaining the favorable thermomechanical properties of epoxy resins. They have published their findings in the Chemical Engineering Journal.

Recycling epoxy resins is anything but trivial, because these plastics are so-called thermosets. In this type of polymer, the polymer chains are closely crosslinked. These chemical crosslinks make melting impossible. Once the plastic has hardened, it can no longer be reshaped.

This is not the case for thermoplasts, such as PET or polyolefins. Their polymer chains lie close together but are not chemically linked to each other. When heated, these polymers can be melted and formed into new shapes. However, because of the lack of crosslinks, their mechanical properties at elevated temperatures are generally not as good as those of thermosets.

A new kind of polymer

The unique epoxy resin that the Empa researchers have developed in collaboration with national and international partners is technically a thermoset—but unlike other thermosets, it can be reshaped like a

Empa researchers have developed an epoxy resin that can be repaired and recycled, in addition to being flame-retardant and mechanically strong. Potential applications range from coating for wooden flooring to composites in aerospace and railways.

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thermoplast. The key is the addition of a very special functional molecule from the class of phosphonate esters into the new resin matrix.

"We originally synthesized this molecule as a flame retardant," says co-inventor of this technology and Empa scientist Wenyu Wu Klingler. However, the bond the molecule forms with the polymer chains of the epoxy resin is dynamic and can be broken under certain conditions. This loosens the crosslinking of the polymer chains so that they can be melted and reshaped.

Such materials, also known as vitrimers, have only been known for about ten years and are considered particularly promising. "Today, fiber-reinforced composites are not recyclable at all, except under very harsh conditions, which damage the recovered fibers," explains Wu Klingler. "Once they have reached the end of their service life, they are incinerated or disposed of in landfills. With our plastic, it would be possible for the first time to bring them back into circulation again."

"Our vision for the future," adds group leader Sabyasachi Gaan, "is a composite material, in which both the fibers and the plastic matrix can be completely separated and reused." The researcher sees an opportunity in carbon-fiber-reinforced plastics in particular, as they're commonly used in the construction of airplanes, trains, boats, cars, bicycles and more.

"The production of carbon fibers requires a lot of energy and releases an enormous amount of CO2," he explains. "If we could recycle them, their environmental footprint would be a lot better—and the price a lot lower." Moreover, the recovery of valuable elements like phosphorus connected to the matrix polymer would be possible.

A material made to measure

Fiber-reinforced composites are not the only application for the new polymer. For example, it could be used to coat wooden floors, as a transparent, resistant layer that has good flame-retardant properties—and where scratches and dents can be "healed" with a little pressure and heat.

"We didn't develop a single material for a specific purpose, but rather a toolbox," Gaan explains. "Flame retardancy, recyclability and repairability are a given. We can optimize all other properties depending on the intended use." For example, he says, flow characteristics are particularly important for the production of fiber-reinforced plastics, while exterior wood coatings should also be weather-resistant.

To pursue these and other applications of the material, the researchers are now looking for industrial partners. The chances of commercial success are good: In addition to all its other advantageous properties, the modified epoxy polymer is also inexpensive and easy to manufacture.

Phys Org, 22 August 2023

https://phys.org

Waste heat from lights could remove indoor pollutants

2023-08-19

They've made a coating for lampshades which can remove volatile organic compounds (VOCs) from the air and turn them into harmless by-products.

The coating currently only works with halogen lights and other bulbs which produce a lot of excess heat, but the researchers are hoping to tune it to more efficient LEDs soon.

VOCs are small, carbon-containing substances like acetaldehyde and formaldehyde, which are emitted by paints, plastics, cooking, and other household sources.

"Although the concentration of VOCs in a home or office is low, people spend more than 90% of their time indoors, so the exposure adds up over time," says Dr Hyoung-il Kim, a researcher at Yonsei University, South Korea.

"Conventional methods to remove VOCs from indoor air rely on activated carbon or other types of filters, which have to be replaced periodically," says Minhyung Lee, a graduate student in Kim's lab.

Kim and colleagues have been investigating catalysts which can trigger a chemical reaction that turns VOCs into CO2. Because concentrations of VOCs are low indoors, the amount of CO2 made is so low as to be harmless – on par with the amount humans exhale.

Chemical reactions typically need some energy to work. The team has been investigating thermocatalysts, which use heat to trigger the reaction.

They've developed a catalyst made mostly from titanium dioxide (a white pigment used in toothpastes, foods, sunscreen and paints) and tiny amounts of the precious metal platinum.

This catalyst can reduce a high concentration of VOCs at room temperature, but it performed better when coating the inside of a halogen lampshade.

A team of Korean researchers has found a way to remove indoor pollutants by tapping into waste heat from lamplights.

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Excess heat from the lamp heated the shade to 120°C, making the catalyst capable of removing even low levels of VOCs.

The researchers are now looking to make the reaction work with cheaper metals than platinum, like iron and copper.

They're also looking into photocatalysts, which use light instead of heat to trigger reactions, to allow them to work with LEDs.

LEDs are an increasingly popular lighting source, because they don't waste most of their energy as heat – but that means they also don't produce the temperatures needed for this catalyst to work.

Using light instead of heat to catalyse the reaction would solve that problem.

"Our ultimate goal is to develop a hybrid catalyst that can utilize the full spectrum produced by light sources, including UV and visible light, as well as waste heat," says Kim.

The researchers have presented their work at the Fall 2023 meeting of the American Chemical Society.

Cosmos, 19 August 2023

https://cosmosmagazine.com

Silica particles found in food and makeup could be chemically reactive, study finds

2023-08-21

As described in a new study, researchers placed commercially available silica particles in a water solution with biomolecules containing compounds called thiols. These thiol-containing biomolecules are widespread in nature and in the human body, for instance, in the form of glutathione, a key antioxidant found in most cells.

When exposed to silica, the thiol biomolecules underwent redox chemical reactions. These reactions, in which electrons are lost, could degrade or alter the molecules' function, potentially posing health risks. For instance, low levels of glutathione can lead to increased oxidative stress in the body that can damage all manner of cellular components, from membranes to DNA.

The findings highlight the need for further research into the reactivity of silica, especially given its extensive usage in everyday products.

New Stanford University research has revealed that the mineral silica, a common food additive and popular cosmetics ingredient, is not a chemically inert substance, as has long been supposed.

"Silica particles are thought to be benign and inert, but our study's results indicate that silica is actually reactive," says Yangjie Li, a postdoctoral scholar in the Department of Chemistry in the Stanford School of Humanities and Sciences and lead author of the study, which published Aug. 17 in Proceedings of the National Academy of Sciences. "We encourage further investigation into whether silica particle exposure can deplete glutathione and other critical compounds in the body."

"Our findings sound an alarm for the continued use of silica particles," said senior author Richard Zare, the Marguerite Blake Wilbur Professor in Natural Science and a professor of chemistry in H&S. "While it's too soon to say that silica is a health risk, at minimum silica poses the potential problem of introducing unwanted chemistry, particularly in food."

Often consumed and applied

Silica—another name for compounds of silicon and oxygen—is a colorless, odorless, tasteless material. While silica occurs naturally in foods including leafy greens, manufacturers often add tiny, sand-like particles of silica as an anticaking agent to soups and coffee creamers, for instance. Currently, the Food and Drug Administration allows foods to contain as much as 2% by weight of silica particles.

For cosmetics, including skin care products, silica serves as a bulking or absorbing agent, or as an abrasive in scrubs. In health care, silica particles have also found significant use in the delivery of drugs and for medical imaging purposes. For those applications, silica particles are manufactured to have tiny holes, or pores, into which pharmaceuticals and other substances can be slotted.

Given this scope of applications, Li and Zare sought to examine the orthodoxy of silica as a chemically inert substance. Li has a background in probing presumed properties of everyday materials. For her doctoral dissertation work, Li investigated how glass—long relied on for stably storing medicines and other important materials—can, in certain circumstances, act as a catalyst and accelerate chemical reactions.

"We've seen before that so-called inert materials may not really be inert," said Zare. "That story may be repeating itself with silica particles."

Overlooked chemistry at work

For the study, the Stanford researchers purchased commercially available, pure silica particles, sold as a dry powder. Working with Kurt Kolasinski, a former graduate scholar of Zare and now a professor of physical chemistry

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at West Chester University, Li added silica to watery solutions containing one of three thiol-bearing biomolecules. The biomolecules studied were cysteine (a key amino acid), the aforementioned antioxidant glutathione, and penicillamine (a so-called heavy metal antagonist for treating Wilson's disease, a condition that occurs when too much copper accumulates in the body).

Li incubated the solutions in the dark for a day at room temperature. She obtained small samples of the solutions at half-hour, 2-hour, 4-hour, and 24-hour marks to gauge the rates of any chemical reactions that might have occurred, using an instrument called a mass spectrometer.

Over time, the biomolecules were oxidized (a loss of electrons in a chemical reaction) by incubation with silica, to the surprising tune of as much as 95% of the molecules in solution ultimately reacting in this way, while the control experiments without silica incubation showed minimal oxidation.

From a chemistry perspective, the reactive pure silica particles converted thiol-containing molecules to disulfide molecules. Spelled out in terms of their elemental compositions, the former molecules, which contain sulfur-hydrogen (S-H) bonded groups, changed to have disulfide bridges, symbolized S-S.

The reverse reaction is familiarly encountered, Zare pointed out, when curly hair is straightened by applying heat with a flat iron. The process breaks disulfide bonds in the proteins in the hair, allowing the hair to be reshaped into straight hair strands. "When people use flat irons to straighten their hair, the chemistry of what's going on there is breaking disulfides and turning them into thiols, the reverse reaction of our study," said Zare.

For the observed reactions, the Stanford researchers think that upon contact with water, silica forms so-called surface-bound silyloxy radicals (a silicon atom bound to an oxygen atom in a configuration that has an unpaired electron). When encountering the radicals, thiol biomolecules in the solution transfer hydrogen atoms (H) to the radicals. Accordingly freed of bonded H, the sulfur atoms in two thiol molecules then recombine to form the S-S disulfides.

Looking ahead, the Zare lab researchers plan to further test how varying sizes of silica particles influence chemical reaction rates. Experiments with larger biomolecules are also ongoing.

Zare and Li hope that their initial findings prompt other researchers, and potentially regulators, to characterize the chemistry of silica more thoroughly.

"Silica is a material that shows up in a lot of places, in the things we eat, in the products we put on our skin, and in medical settings," said Zare. "In light of this new study, we ought to know more about silica and its interactions with other materials."

Phys Org, 21 August 2023

https://phys.org

Pyrolysed plastic waste converted into valuable chemical feedstocks

2023-08-16

Despite huge pressure to address the growing plastic waste problem, recycling rates remain low, with less than 10% of global plastic waste effectively recycled. One of the biggest stumbling blocks is the challenge of developing an economically efficient treatment process. While researchers have developed many different ways to chemically degrade plastics, the cost of operating these processes on scale typically exceeds the value of the repurposed products, making these strategies unfeasible without extensive government subsidies.

With these economic considerations in mind, two teams in the US have now developed alternative chemical upcycling processes that take advantage of existing industrial infrastructures to produce high-value products at low cost.

Exploiting the olefins

Pyrolysis is currently the most common way to recover hydrocarbons from plastic and involves heating the waste to high temperatures. The long polymer chains thermally decompose through a radical mechanism, forming an olefin-rich mixture known as pyrolysis oil which can then be used as a fuel for other industrial processes. However, George Huber from the University of Wisconsin–Madison believes we could extract greater value from this hydrocarbon mixture by exploiting the high proportion of alkenes present in the oil. 'The whole chemical industry is based on first making an olefin from crude oil and then using that to access all these different chemistries,' he explains. 'So why not take advantage of the olefin

New methods of upcycling plastic waste into high-value chemical feedstocks could provide a crucial economic incentive to improve future rates of plastic recycling. By exploiting reactive chemical groups present in degraded plastics, two research teams have developed new ways of preparing valuable products using robust and established chemistry.

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functionality in pyrolysis oil and use it to make higher-value chemicals rather than just making fuels from it, or feeding it back to a steam cracker?'

The team pyrolysed a mixture of polyethylene and polypropylene post-consumer waste and distilled batches of the pyrolysis oil obtained into cuts of similar-sized alkenes. They subjected these separated fractions to industrial hydroformylation conditions, converting the olefins into aldehydes using carbon monoxide and hydrogen in the presence of a cobalt catalyst. The resulting aldehyde mixtures could then undergo further reactions such as hydrogenation, amination, or oxidation to create higher-value chemical products including diols, amines, and fatty acids. 'We're making products that are worth five to 20 times more than the current products of pyrolysis oil,' says Huber 'Our most valuable products are the diols – they're worth $3000–5000 [£2400–4000] per ton and we can make them to 99.99% purity with this technology.'

Controlling pyrolysis

At Virginia Tech, Guoliang Liu was likewise keen to exploit the alkenes produced when plastics thermally decompose. His team was particularly interested in larger hydrocarbon fragments and developed a specialised reaction vessel that applied a temperature gradient over the pyrolysis step to control the size of the breakdown products. 'The temperature is just high enough to partially break some of the bonds in the polymer chains, so we produce short-chain waxes rather than small molecules,' explains Liu. 'The products are evaporated and then condensed in a colder region of the vessel, so the thermal gradient controls the extent of chain scission.'

Oxidation over a manganese catalyst in a second vessel then converts these waxy alkenes into long-chain fatty acids – widely used in surfactant products such as soaps and detergents and worth around four times as much as virgin plastic. 'Practically, the economic value of recycled products must be higher than the plastic waste to provide sufficient financial incentive for industrial deployment of the recycling processes,' says Liu. 'If we can design these processes with an economic mindset, we have a higher likelihood of pushing the technology from the lab to a commercial reality.'

A positive forecast

Susannah Scott, a sustainable catalysis researcher at the University of California Santa Barbara, US was impressed by both teams' work and is optimistic about the future of chemical recycling solutions. 'Processes like these are the key to molecular recycling of polymers,' she says. 'A strength

of both is that the processes are simple, the catalysts are inexpensive and robust, and the products are suitable for a variety of fairly large-scale uses, with the potential to displace fossil fuel-based chemicals. Waste plastics are a hydrocarbon source not much different from crude oil and can eventually be a substitute for oil in a circular carbon economy.'

Both teams have already performed preliminary economic analyses of their methods and forecast that sale of their chemical products would be profitable at the 10,000-ton scale, with larger production plants potentially recouping the initial investment cost within as little as three years. In the immediate future, they will each be working with industrial partners to develop their products and methods at a larger scale, with the ultimate aim of translating these processes into commercial treatments for plastic waste.

Chemistry World, 16 August 2023

https://chemistryworld.com

Getting precious metals out of green energy with catalysts (and putting carbon back in)

2023-08-24

Catalysts don't get consumed in the manufacturing process – they just make the reactions possible.

But the world is going to need more catalysts as we decarbonise, particularly to use in making hydrogen fuel and capturing carbon.

According to Professor Liming Dai, director of the new ARC Centre of Excellence for Carbon Science and Innovation, and a researcher at the University of New South Wales, to be genuinely sustainable we're going to need to update our catalyst science – and get rid of some metals.

Cosmos spoke to Dai at the First Australian Conference on Green and Sustainable Chemistry and Engineering, being held in Cairns this week.

"Now, people use metal-based catalysts, particularly for clean and renewable energy technologies," he says.

Noble metals (not the same as noble gases), including silver, platinum, palladium and gold, are particularly good catalysts.

These metals are all expensive, and difficult to mine in large quantities.

From plastics, to pharmaceuticals, to fertilisers, most industrial chemicals are made with catalysts.

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"Critical minerals, including the noble metals and some precious metals, are concentrated in several countries only. So, due to geopolitical risks, the price of noble metals will increase further," says Dai.

"So, we need to find cheaper, abundant materials to use in catalysts for many things. That's why metal-free catalysts can play important roles in clean energy technologies."

Dai's research group started working on metal-free catalysts 12 years ago and has helped spur researchers around the country and the rest of the world to follow suit.

"We opened the metal-free catalyst research field," he says.

They've found particular success with carbon-based materials, many of which have been derived from graphite and carbon nanotubes.

"We found that carbon catalysts are really good to replace platinum, say, for fuel cell technologies to generate clean electricity with hydrogen," says Dai.

Carbon is abundant on Earth – and there's flexibility in the feedstocks people can use.

"Carbon catalysts can be made from carbon dioxide, which reduces carbon dioxide emissions," points out Dai.

They can also be made from biomass and other agricultural sources – even grasses or plants.

The new Centre of Excellence has received $35 million in funding across seven years.

With this funding, Dai is confident they'll find better chemicals to use in climate change solutions. "We will develop new carbon catalysts for clean energy production and storage without any carbon dioxide emissions, and also, clean production of chemicals to reduce carbon dioxide emissions."

Ellen Phiddian's airfare to Cairns was paid by the Royal Australian Chemical Institute, which is managing the First Australian Conference on Green and Sustainable Chemistry and Engineering.

Cosmos, 5 August 2023

https://cosmosmagazine.com

A Blood Factor Can Rejuvenate the Aging Brain

2023-08-17

In a trio of papers published in Nature, Nature Aging, and Nature Communications, the researchers have revealed platelet factor 4 (PF4)—a type of blood cell normally responsible for blood clot formation—as a pivotal element contributing to cognitive enhancement.

Systemic administration of PF4 in aging mice reduced brain inflammation, improved brain cell connections, and boosted memory and thinking abilities.

"PF4 actually causes the immune system to look younger, it's decreasing all of these active pro-aging immune factors, leading to a brain with less inflammation, more plasticity and eventually more cognition. We're taking 22-month-old mice, equivalent to a human in their 70s, and PF4 is bringing them back to function close to their late 30s, early 40s," said Saul Villeda, PhD, associate professor of anatomy at UCSF and senior author of the Nature study.

Villeda had previously discovered that injecting plasma from younger mice into aging animals improved their cognitive abilities and strengthened their muscles—seemingly bringing back their youth. While taking a closer look at the plasma, his team discovered a much higher PF4 content in young plasma compared to that of the older mice. According to the researchers, injecting PF4 only had the same restorative effect as using whole plasma.

A second team of UCSF scientists discovered that after injection of the longevity protein klotho—associated with improved cognition in young and old animals—mice platelets also released PF4. The protein then proceeded to have positive effects on the brain region responsible for making memories, while simultaneously boosting performance of young and old mice in behavioral tests.

"Ideally, we'll have multiple shots on goal for one of our biggest biomedical problems, cognitive dysfunction, with the fewest side effects and the most benefit," said Dena Dubal, PhD, professor of Neurology at UCSF and senior author of the Nature Communications study.

The third team, led by Queensland Brain Research Institute research fellow Tara Walker, PhD, discovered that platelets released PF4 into the bloodstream following exercise. When testing PF4 on its own, similar to

Research led by two teams from the University of California San Francisco (UCSF) and a team from the University of Queensland, Australia, has identified a blood factor as the common denominator behind rejuvenation of the brain through young blood transfusion, a longevity hormone and exercise.

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Dubal and Villeda's experiments, the protein also improved cognitive abilities in old animals.

"For a lot of people with health conditions, mobility issues or of advanced age, exercise isn't possible, so pharmacological intervention is an important area of research. We can now target platelets to promote neurogenesis, enhance cognition and counteract age-related cognitive decline," Walker concluded in a press statement.

Inside Precision Medicine, 17 August 2023

https://insideprecisionmedicine.com

Anti-inflammatory properties of black soldier fly larvae oil show promise for conditions such as ulcerative colitis

2023-08-22

Ulcerative colitis, a persistent inflammatory bowel disease, often necessitates dietary adjustments. A pivotal factor is the profile of fatty acids within the diet. The research team's investigation delves into the anti-inflammatory potential of BSFL oil, rich in medium chain fatty acids (MCFAs) like C12:0, and its potential role in mitigating inflammation linked to ulcerative colitis.

The study introduces an innovative methodology, comparing the anti-inflammatory effects of BSFL oil with those of C12:0 through the activation of cell lines (THP-1 and J774A.1) by TLR4 and TLR2. The research explores the protective effects of BSFL oil against acute colitis induced by dextran sulfate sodium (DSS). The study is published in the International Journal of Molecular Sciences.

The findings demonstrate that, while both BSFL oil and C12:0 suppress proinflammatory cytokines in lipopolysaccharide (LPS)-stimulated macrophages, only BSFL oil exhibits anti-inflammatory properties in Pam3CSK4-stimulated macrophages.

The study's insights extend to the genetic level, revealing that BSFL oil could potentially influence cellular energy utilization and immune function through signaling pathways such as mTOR and PPAR, facilitating the utilization of fats for energy. In contrast, the impact of C12:0 mainly revolves around cholesterol synthesis.

Additionally, the study identifies beneficial compounds within BSFL oil, including eicosanoids, oxylipins, and isoprenoids, which appear to collaborate in quelling inflammation within the body.

Research conducted at The Hebrew University of Jerusalem has shed light on the anti-inflammatory properties of black soldier fly larvae (BSFL) oil. Led by Prof. Betty Schwartz, from the Faculty of Agriculture, Food and Environment at the Hebrew University of Jerusalem, the study focuses on leveraging metabolomics to modulate toll-like receptor (TLR) signaling pathways. The findings hold significant promise for revolutionizing dietary approaches to inflammatory-related conditions, such as ulcerative colitis.

The researchers ventured into an in vivo setting, where a diet enriched with BSFL oil (at 20%) yielded promising outcomes. This dietary intervention led to improvements in body weight restoration, decreased colon shortening, reduced splenomegaly, and an accelerated phase of secretory IgA response. These results underscore the innovative potential of BSFL oil as a modulator of inflammation.

The researchers assert that these findings present compelling evidence of BSFL oil's potent anti-inflammatory characteristics and its capacity to counter inflammation associated with colitis.

The study's distinct insights into TLR2 and TLR4 activation for macrophage innate immune function could pave the way for groundbreaking strategies in managing inflammatory diseases. Moreover, the identification of anti-inflammatory compounds in BSFL oil lays the groundwork for prospective investigations into precision anti-inflammatory approaches.

Phys Org, 22 August 2023

https://phys.org

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Chemists develop unique design for tough but stretchable gels

2023-08-23

Ke can 3D-print the so-called crystalline-domain reinforced slide-ring hydrogels, or CrysDoS-gels. He and his co-authors also created a materials library and offer methods for how the material can be added to existing materials to enhance their durability, such as in plastic additives to enhance the durability for parts in automobiles in the future.

"There are a series of tradeoffs with these traditional plastic materials—they're usually one or the other," stretchable or rigid, Ke said. "But if you connect two things with a slidable joint, you have very interesting properties of both."

The new material is simple and adaptable, Ke said, and can be combined with a variety of hydrogels to improve the properties of different plastics. For example, it could be added to stretchable materials to make them stronger, or to rigid materials to make them more flexible. In this study, the chemists demonstrated a potential application of their newly discovered CrysDoS-gels by 3D-printing them as stress sensors.

"Think of it increasing the lifespan of plastic parts to reduce the waste we produce," Ke said.

Phys Org, 23 August 2023

https://phys.org

Chenfeng Ke, an incoming associate professor of chemistry in Arts & Sciences at Washington University in St. Louis, developed a unique design for tough but stretchable hydrogels, reported Aug. 23 in the journal Chem. The new material is both flexible and durable thanks to a ring-shaped sugar molecule that encases its polymer network and allows it to stretch without sacrificing strength.

Waste heat from lights could remove indoor pollutants

2023-08-19

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Chemical reactions typically need some energy to work. The team has been investigating thermocatalysts, which use heat to trigger the reaction.

They've developed a catalyst made mostly from titanium dioxide (a white pigment used in toothpastes, foods, sunscreen and paints) and tiny amounts of the precious metal platinum.

This catalyst can reduce a high concentration of VOCs at room temperature, but it performed better when coating the inside of a halogen lampshade.

Excess heat from the lamp heated the shade to 120°C, making the catalyst capable of removing even low levels of VOCs.

The researchers are now looking to make the reaction work with cheaper metals than platinum, like iron and copper.

They're also looking into photocatalysts, which use light instead of heat to trigger reactions, to allow them to work with LEDs.

LEDs are an increasingly popular lighting source, because they don't waste most of their energy as heat – but that means they also don't produce the temperatures needed for this catalyst to work.

Using light instead of heat to catalyse the reaction would solve that problem.

"Our ultimate goal is to develop a hybrid catalyst that can utilize the full spectrum produced by light sources, including UV and visible light, as well as waste heat," says Kim.

The researchers have presented their work at the Fall 2023 meeting of the American Chemical Society.

Cosmos, 19 August 2023

https://cosmosmagazine.com

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Hot chemistry quickly transforms aromatic molecules into harmful aerosols: Study

2023-08-25

Many aromatic molecules are carcinogenic and have negative impacts on health. Their primary source is exhaust fumes from motor vehicles. Aromatics can form aerosol particles when they collide in the atmosphere with the hydroxyl radical, a molecule colloquially dubbed "atmospheric detergent" due to its acute propensity to react chemically.

When breathed in, aerosol particles can lead to a myriad of chronic health issues and even death. These particles also affect Earth's climate by reflecting sun light and increasing the formation of clouds.

Despite their importance to the urban environment, details of the reaction processes that form aerosol from aromatics have until now remained unresolved.

The group of researchers used a combination of quantum mechanics, targeted experiments, and modeling to establish the early steps in the reaction process of toluene, one of the most abundant aromatic molecules.

"We found out that a reaction product that was previously thought to be stable is in fact transient and converts to new hot molecules. These molecules have residual energy that makes subsequent chemistry fast and promptly lead to aerosol precursor products," says Siddharth Iyer, Postdoctoral Research Fellow of Aerosol Physics at Tampere University.

"This result bridges the gap between theory and observation and provides better understanding of the chemistry of aerosol formation in urban environments."

Phys Org, 23 August 2023

https://phys.org

Joint research groups at Tampere University, University of Helsinki, Lund University and Pi-Numerics, Salzburg, have established key early steps in the conversion of aromatic molecules, a major constituent of traffic and other urban volatile emissions, into aerosol. Published in Nature Communications, their findings increase understanding of the chemical processes that degrade urban air quality and influence climate change.

Buckyballs: the soccer ball-shaped molecules

2023-07-19

This shape, technically called a truncated icosahedron, has uses beyond the world game.

These icosahedrons create a strong architectural structure which are often blown up to become the basis of geodesic domes.

But the football panel shape can also be shrunk – eventually it becomes so small that its points become single atoms.

Meet Buckminsterfullerenes: the football-shaped molecules.

These molecules, often called buckyballs, are named after US architect Richard Buckminster Fuller, who popularised the geodesic dome.

Buckyballs are made of pure carbon: specifically, 60 carbon atoms, with each atom connected to three others. These atoms link up in five- and six-pointed rings – both shapes that carbon readily forms into.

Buckyballs exist in nature – including in outer space – but their structure was discovered by three chemists in 1985.

Harry Kroto, a UK chemist, was investigating long chains of carbon that he and some radioastronomers identified in interstellar space.

He got in touch with Richard Smalley, a US chemist based at Rice University who operated a lab where he might be able to make these chains.

Smalley, along with another US chemist, Richard Curl, used a device called a "laser-supersonic cluster beam apparatus".

This equipment uses high-powered lasers to vaporise just about any material into plasma at super-high temperatures, like the surfaces of stars. They mostly used it on metals, but Kroto wanted to try it on carbon.

The three of them found the long carbon chains that Kroto had been looking for, but their experiments also turned up previously unknown carbon molecules. By far the most abundant was a molecule with 60 carbon atoms. Initially, they couldn't tell what structure those atoms took.

After a week of puzzling, Smalley eventually landed on the truncated icosahedron – inspired in part by Kroto's recounting of Fuller's geodesic dome in Montreal.

The chemists built a molecular model of the structure, then phoned mathematician Bill Veech to help describe its shape.

According to the American Chemical Society, Veech's reply was: "I could explain this to you in a number of ways, but what you've got there, boys, is a soccer ball".

This entirely new form of carbon, with its symmetrical structure, delighted chemists and laypeople alike. The New York Times heralded the discovery

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as a "tour de force" at the time, and the three chemists won a Nobel Prize for it 11 years later.

While they spotted its significance, Kroto, Curl and Smalley probably weren't the first chemists to make buckyballs. In fact, in 1991, the Canberran scientist Bill Burch claimed he'd made and observed buckyballs a year prior, in 1984. He told The Canberra Times in 1994 that, being a practical chemist and not a fundamental scientist, it didn't occur to him to write to Nature.

The discovery of buckyballs, and the class of similar molecules called "fullerenes", spurred the making of dozens of other types of carbon.

The most exciting spinoff is probably carbon nanotubes: long, thin cylinders of carbon atoms in hexagonal shapes. These strong, light, electrically conductive materials are being used in everything from ultra-powerful microscopes to extremely black paint.

So that's the football-shaped molecule. Can we make molecules in any other ball shapes?

The 2023 FIFA ball is a tough, but not impossible, shape to crack in molecular form. Triangles are very strained shapes in the molecular world – those tight angles are not favourable for chemical bonds, so while they can form, they're much rarer.

Aussie rules and rugby footballs are easier to create as molecules. In fact, one of the other molecules made by Kroto, Curl and Smalley's laser experiments is a C70 molecule, now often referred to as a "rugby ball" because of its oblong shape.

The C70 'rugby ball' fullerene. Credit: By Jynto (talk) – This image was created with Discovery Studio Visualizer., CC0, https://commons.wikimedia.org/w/index.php?curid=16455276

We've not seen many rugby balls with patches like that, though. German and Russian chemists tried again in 2015 with a "giant rugby ball" – but while this one has a nice divide down the middle, it has rather too many appendages to be easily kickable.

We can supply the football team, however, with some 2003 research by Stephanie Chanteau and James Tour, also from Rice University.

Chanteau and Tour made a delightful set of "NanoPutians": molecules shaped like people, a fraction of a nanometre tall, complete with two oxygen atoms in the "head" to represent eyes.

These NanoPutians can come with a variety of different headwear, like chef hats, top hats and crowns, to help distinguish themselves – useful for denoting different teams, too. They can even hold hands.

And what's the purpose of these little people, beyond a molecular soccer match? They're essentially educational tools – and a nice proof that, given time, chemists could make a molecule shaped like just about anything.

Cosmos, 29 July 2023

https://cosmosmagazine.com

Pompeii's archaeological puzzles can be solved with a little help from chemistry

2023-08-23

The ruins of the ancient Roman city of Pompeii are full of morbid mystery. In 79 CE, a volcanic eruption wiped out the city of between 10,000 and 20,000 inhabitants. Massive plumes of volcanic ash and pumice shot out of Mount Vesuvius, covering and suffocating Pompeii's doomed residents. Archaeologists have found the remains of over 1,300 victims in the site southeast of the city of Naples over the last 250 years.

Some of the bodies of Pompeii were also preserved in plaster, but not from Mount Vesuvius and not in 79 CE. In the 1860s and 1870s, archaeologists led by Giuseppe Fiorelli poured plaster into the voids left behind by the bodies that had decomposed. These casts typically have the skeletal remains embedded in the plaster that retain the body shape and give a realistic image of victims of the eruption.

"Pompeii is one of the most important places from an archaeological point of view," Gianni Gallello, an archeological scientist at the University of Valencia in Spain tells PopSci. "All of Roman society is imprinted at the moment after the eruption, all stuck in time."

However, the plaster may have contaminated the chemical composition of the bones, according to a study published August 23 in the journal PLOS One. While the plaster may have altered the chemical makeup of the bones, bioarchaeological analysis still supports the theory that these specific victims died from asphyxiation and not from blunt force trauma from rocks or burning.

Gallello is one of the co-authors of the study who specializes in applying analytical chemistry to archeological finds. He brought a technique called portable X-ray fluorescence as a way to noninvasively examine the elemental composition of the bones and plaster for the first time.

"It's a portable device that takes the material profile invisibly," Gallello explains. "Everything was in contact with the plaster, so you can get contamination. Plaster also has high levels of compounds similar to the bones."

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In this study, Gallello and his colleagues looked at six plaster casts from the Porta Nola (gate) area of Pompeii and one cast from the city's Terme Surbane (or frescoed bath house) for anthropological and multielemental analysis. They also compared these bones to cremated bones from a Roman necropolis and ones found in a Spanish Islamic necropolis.

"Cross referencing is important for volcanologists and anthropologists. It provides complimentary data [for the] reconstruction of the evidence. Anthropological work can say that the position of the bones of the people who died while they were escaping is telling that they probably died from asphyxiation, while archaeological data can say if it was during the second part of the eruption," says Gallello.

Using portable X-ray fluorescence, they found that the plaster from Pompeii was completely different from the burned and unburned bones from the collection. Testing out this method for the first time on the Pompeii casts also helped add to the prevailing theories of what killed these specific residents of Pompeii during the eruption. While the plaster contamination makes it more difficult to study, the chemical analysis supports the theory that the victims suffocated from the volcanic ash.

"We don't pretend to say how they died. What we do is provide more evidence and data to complement and allow the volcanologists who are very active in Pompeii to study," says Gallello.

The team hopes that using noninvasive techniques like this on other archeological finds and cast skeletons will help find better evidence to draw stronger conclusions on the causes of death.

"It's an honor to work in Pompeii," says Gallello. "We do work that we love, and for us, it's not work."

Popular Science, 23 August 2023

https://popsci.com

Hydrogel locomotion regulated by light and electric fields

2023-08-22

Materials scientists aim to develop autonomous materials that function beyond stimulus responsive actuation. In a new report in Science Advances, Yang Yang and a research team in the Center for Bioinspired Energy Science at the Northwestern University, U.S., developed photo- and electro-activated hydrogels to capture and deliver cargo and avoid obstacles on return.

To accomplish this, they used two spiropyran monomers (photoswitchable materials) in the hydrogel for photoregulated charge reversal and autonomous behaviors under a constant electric field. The photo/electro-active materials could autonomously perform tasks based on constant external stimuli to develop intelligent materials at the molecular scale.

Bioengineering a charged hydrogel

Soft materials with life-like functionality have promising applications as intelligent, robotic materials in complex dynamic environments with significance in human-machine interfaces and biomedical devices. Yang and colleagues designed a photo- and electro-activated hydrogel to capture and deliver cargo, avoid obstacles, and return to its point of departure, based on constant stimuli of visible light and applied electricity. These constant conditions provided energy to guide the hydrogel.

The research team covalently integrated spiropyran moieties with varying substituents into the constructs to regulate the net charge of the soft materials. They used finite element simulations to guide the design and movement of the charged hydrogels and engineer 3D surface profiles to maximize the dielectrophoretic effect. Yang and the team further studied the scope of electroactive locomotion and photoactuation in the spiropyran hydrogels.

Charge reversal of spiropyran-functionalized polymers

Yang and colleagues used two different spiropyran molecules with different net charges. They synthesized each of the molecules with a polymerizable methacrylate group based on existing reports.

They incorporated different ratios of the spiropyran molecules into N-isopropylacrylamide polymer chains (PNIPAM) to form hydrogels. In this instance, they tuned the charge reversal functionalities using copolymers of the spiropyran structural units to show photoswitchable potential and charge reversible behaviors with tunable charge. The scientists tuned the charge reversal time by changing the ratio of the two spiropyran moieties, without changing the switching and recovery rates.

Photo-activated electroactive motion of the spiropyran-PNIPAM hydrogels

Based on charge reversal behavior of the polymers, Yang's team photoregulated the electroactive hydrogels by using a crosslinker to prepare them.

At first, the team could positively charge the hydrogel to move towards the cathode under a direct current electric field, where the positive charge transferred from the spiropyran moieties into the hydrogel network. Thereafter, the permanently bound sulfonate groups on the polymer chain made the net charge of the construct negative, allowing the negatively charged hydrogel to navigate back to the anode.

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The team studied the photoregulated electroactive locomotion speeds of the hydrogel disks across multiple light-dark cycles to examine their locomotion speed, and determined the relationship between the charge and speed of the hydrogel disks. They based this on the balance between the electrostatic force and hydrodynamic drag force, where the higher applied voltage and larger diameter of the hydrogel disks delivered higher locomotion speed. Such polymeric devices are well-suited to capture and deliver cargo through autonomous hunting.

Capturing and delivering cargo

Yang and colleagues explored the cargo delivery potential of the constructs by engineering simple disk-shaped spiropyran-PNIPAM hydrogels and sphere-shaped constructs embedded with nanoparticles as cargos. The strong dielectrophoretic force allowed the materials to undergo autonomous hunting and picking up functions.

Based on simulations, Yang and colleagues formed a 3-arm spiropyran PNIPAM hydrogel object using photoinitiated free radical polymerization with superior capture capability of the cantilever arms. When uncharged, the electric field gradient around the hydrogel vanished, enabling autonomous cargo release during charge reversal. The cargo release also occurred by turning off the electric field.

Automatically avoiding obstacles

The research team showed how materials with a high dielectric constant induced an attractive electrophoretic force, and materials with a lower dielectric constant exerted a repulsive electrophoretic force on the adjacent charged hydrogel object.

Using finite element calculations, they showed the possibility of low dielectric constants to guide the charged hydrogel through obstacles. Under constant stimuli of the electric field and light irradiation, the hydrogel automatically bypassed barriers and traveled back after charge reversal, without human intervention.

Outlook

In this way, Yang and colleagues designed a photo- and electroactive hydrogel that can cargo capture and deliver, as well as avoid obstacles under constant external stimuli. The scientists used two different ratios of spiropyran moieties in the hydrogel and facilitated the net charge in the chemically random network to be tunable under irradiation with blue

light. This enabled photoregulated, electroactive motion with autonomous behavior under the direction of light and electricity.

The autonomous soft matter products elegantly captured and delivered cargo while avoiding obstacles with applications suited for scenarios to ensure the safety of monitoring a situation from afar—for instance, where human intervention is impractical. These new biomaterials with autonomous functionality can be resourcefully engineered using environmentally sensitive electrostatic interactions and photoactuation in soft materials.

Phys Org, 22 August 2023

https://phys.org

How human recreation alters river chemistry

2023-08-24

Human activities like tubing and swimming significantly impact river chemistry, according to preliminary results from researchers at Johns Hopkins University and Colorado School of Mines that were presented at the autumn meeting of the American Chemical Society (ACS) held in San Francisco, California and virtually.

Last year, the Hopkins-led team examined samples from Clear Creek in Colorado over the busy Labor Day weekend in September – when there can be up to 500 people every hour swimming and tubing in the stream – and again on a quieter weekday afterward. To provide a comparison, they analysed samples taken upstream from an undisturbed spot along the waterway.

Specifically, they were looking for inorganic contaminants, including metals and nanoparticles, as well as organic contaminants like pharmaceuticals. The team also investigated the stream's microbiome.

The analysis turned up illegal drugs like cocaine, the local anaesthetic lidocaine, seizure medications, and plasticisers like phthalates. Organic sunscreens and UV filters were also detected, along with the antihistamine fexofenadine, and polyethylene glycol, which is considered a laxative and is also used as a lubricating coating for various surfaces.

All these compounds presumably washed off the skin of people in the creek, or were released in their sweat or urine, among other possible sources, the researchers said.

Noor Hamdan, an environmental engineering PhD student at Hopkins who presented the work at the ACS briefing, explained that the team used liquid chromatography–high resolution mass spectrometry to separate and identify the compounds. 'What we can do with this instrument is blow these compounds into tinier fragments to elucidate their structure and chemical properties, and then we can find out what really is in these samples,' she explained. 'We found that, specifically in the microbial analysis, that the biome composition changes as a function of human recreational activity in the creek.'

Heavy recreation days resulted in elevated major and trace metals, including lead and zinc, Hamdan added, suggesting that humans contribute significantly to resuspending metals and sediment.

Organic sunscreen ingredients like avobenzone and oxybenzone, which have been shown to harm the environment and negative impact aquatic organisms, were also detected.

The researchers searched for the compounds they had found in the US Environmental Protection Agency's Computational Toxicology Chemicals Dashboard (CompTox), which provides public access to chemistry, toxicity, and exposure data.

'What we found is that for a large majority of these compounds, we don't have data on their chronic aquatic toxicity,' Hamdan stated. 'We don't have data on their persistence and their mobility in the environment,' she continued. However, the researchers note that that most of the compounds have low bioaccumulative potential, which means that they won't build up in the bodies of organisms over time.

The team plans to sample Clear Creek again later this year, over Labor Day weekend, and conduct more statistical analysis to confirm that humans really are significantly impacting the stream. Ultimately, they want to collect more samples to track trends over time.

'Most of these compounds that are introduced into the stream are the result of washing off of the body, like sunscreen and personal care products like fragrances,' said Hamdan. 'If you urinate in the river or you sweat in the river, all of those xenobiotic metabolites can also get into the water.' She also recommends wearing mineral sunscreens, which have ingredients like zinc and titanium and aluminum, and do not contain organic contaminants that can be toxic to aquatic organisms.

However, Michael Focazio, who retired earlier this year from the US Geological Survey where he coordinated the agency's environmental health programme tells Chemistry World that further work is needed to fully understand the study's implications. 'It makes sense that people will be direct sources of these contaminants via swimming and tubing as well as indirect sources as bed sediment is disturbed,' he says. 'But as far as I can tell … there is no perspective provided on other risk sources such

as wastewater treatment plant effluents, flooding, etc., which would be needed in order to understand the significance of swimming and tubing.'

Chemistry World, 24 August 2023

https://chemistryworld.com

Potential Treatment Target for Virus-Linked Stomach Cancers Identified

2023-08-23

The work of Italo Tempera, Ph.D., associate professor in the Gene Expression & Regulation Program in the Ellen and Ronald Caplan Cancer Center, at The Wistar Institute, and collaborators demonstrates that an epigenetically active compound called decitabine disrupts the genome of EBVaGC by epigenetically modifying the cancer's DNA, a finding that offers the potential for a new approach to treating EBVaGC.

"What we have identified is essentially a self-destruct button within this kind of cancer, and our paper shows that we figured out how to press that self-destruct button," said Tempera. "Normally, a latent virus that reactivates and starts to kill cells is a bad thing. But by switching that viral lytic process back on in these cancer cells by using epigenetic signaling, we're effectively getting the virus to kill the cancer cells that it's responsible for in the first place."

The research — supported by a research program project grant, otherwise known as a P01-series grant, from The National Institute of Health (NIH) — includes scientists from The Wistar Institute, The Coriell Institute for Medical Research and Brigham and Women's Hospital of Harvard Medical School.

In EBVaGC, the cancer cells' DNA is hypermethylated: the DNA contains a high percentage of cytosine with a 5-methyl group attached to it (relative to normal, unmethylated cytosine). As a silencer of gene expression, DNA methylation allows EBV to remain latent. This methylation pattern plays a significant role in regulating the EBV latency-lysis cycle within the cancer cells. DNA methylation, as an epigenetic factor, usually functions as a gene-silencing mechanism, particularly in certain regions of the genome; a methylated gene still exists within the genome — methylation does not delete the genetic information — but methylation can prevent the protein the gene encodes from being transcribed.

Now, scientists at The Wistar Institute have discovered a potential target for gastric cancers associated with Epstein-Barr Virus; study results were published in the journal mBio. In the paper, Wistar's Tempera lab investigates the epigenetic characteristics of gastric cancer associated with the Epstein-Barr Virus: EBVaGC. In evaluating EBVaGC's epigenetics — the series of biological signals associated with the genome that determines whether a given gene is expressed — the Tempera lab highlights a target that could advance as a future treatment for this type of cancer.

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To disrupt this epigenetic profile, the researchers turned to decitabine, a compound known for its ability to reduce DNA methylation levels (i.e., to hypomethylate the DNA). Tempera and his co-authors treated two cell lines that were derived from EBVaGC tumors with decitabine. The cell lines that received the treatment demonstrated massive reductions in DNA methylation across the genome relative to the control as assessed by a variety of epigenetic assay techniques.

In observing the effects of decitabine treatment on EBVaGC, Tempera's team found a significant disruption of the cancer's epigenetic profile. The EBV genome within EBVaGC treated with decitabine resulted in widespread, mostly uniform hypomethylation of the EBVaGC epigenome (with a few regional exceptions). Tempera and his co-authors discovered that the hypomethylating effect of decitabine treatment reactivated the lytic cycle of the latent EBV in the cancer cells. Because lysis is lethal to cells, the epigenetic reactivation of lysis within gastric cancer associated with EBV offers a promising potential treatment for the specific subset of EBVaGC.

"Now we know that we can use the epigenome of Epstein Barr Virus against the gastric cancer that it affects — that's an exciting potential cancer therapy we have as a result of investigating the interplay between epigenetic patterns and disease lifecycle," explained Tempera.

Reference: Preston-Alp S, Caruso LB, Su C, et al. Decitabine disrupts EBV genomic epiallele DNA methylation patterns around CTCF binding sites to increase chromatin accessibility and lytic transcription in gastric cancer. mBio. 2023.doi: 10.1128/mbio.00396-23

Technology Networks, 23 August 2023

https://technologynetworks.com

Gene "Fingerprint" for Brain Aging Identified in Mice

2023-08-18

Now, a study in mice has determined that the most pronounced changes occur in the white matter, a type of nervous system tissue that's integral to transmitting signals across the brain. The study also examined two treatments — caloric restriction and infusions of plasma from young mice — that affect certain regions of the brain, with the plasma appearing to slow the age-related decline.

Most of us who've reached middle age have noticed a slowing in memory and cognition, but scientists don't have a clear picture of the molecular changes that take place in the brain to cause it.

The results offer insight into the cognitive decline of normal aging, as well as the way aging contributes to neurodegenerative conditions such as Alzheimer's and Parkinson's diseases and multiple sclerosis.

In many neurodegenerative diseases, certain areas of the brain are more vulnerable to damage, but scientists don't know exactly why.

"I saw this study as a way to explain that somewhat mysterious regional vulnerability," said Tony Wyss-Coray, PhD, a professor of neurology and neurological sciences who led the study that examined gene expression in different regions of the mouse brain as it matures.

Wyss-Coray, the D.H. Chen Professor II at Stanford Medicine and the director of the Phil and Penny Knight Initiative for Brain Resilience at Stanford's Wu Tsai Neurosciences Institute, is the senior author of a paper describing the research. Oliver Hahn, formerly a postdoctoral fellow in the Wyss-Coray lab and now a principal investigator at Calico Life Sciences, is the lead author on the paper. The paper was published Aug. 16 in Cell.

Different genes found in different regions

The research team sampled 15 regions in both hemispheres of the brains of 59 female and male mice aged 3 to 27 months. They identified and ranked the top genes expressed by cells found in each region of the brain. They identified 82 genes that are frequently found and vary in concentration in 10 or more regions.

The team used these genes to develop a common aging score, assessing how gene activity in different regions of the brain change with age.

The researchers found that the white matter, which is found deep in the brain and contains nerve fibers protected by white-colored myelin, showed the earliest and most pronounced changes in gene expression for mice 12 and 18 months old. According to Wyss-Coray, these mice are about as old, in mouse years, as a person in their 50s.

"We cannot definitively say how gene expression changes in white matter affect memory and cognition. That would require more genetic manipulation and neurobiology work," Wyss-Coray said. "But we know white matter is the wiring that connects the different brain regions together."

Past work has shown that aging disrupts an otherwise stable gene expression pattern in the brain, turning on genes that regulate inflammation and the immune response, and turning off genes

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responsible for protein and collagen synthesis. The inflammation and immune response affect the integrity of the myelin sheath, the insulation layer around nerves responsible for transmitting signals across the brain.

"White matter has been a rather neglected area in aging research, which usually focuses on the neuron-dense regions like the cortex or hippocampus," Hahn said. "The fact that white matter is emerging in our data as an area of particular vulnerability to aging opens up new and intriguing hypotheses."

Testing interventions

Interventions to slow the genetic shift that leads to the decline in specific regions of the brain could be beneficial in addressing neurodegenerative disease as well as the general decline associated with aging.

During the study, the team explored two interventions — carloric restriction and injections of plasma from young mice — to evaluate whether they protected against the region-specific shifts in gene expression. Each intervention began when the mice were 19 months old and lasted four weeks.

The researchers found that the dietary intervention caused genes associated with circadian rhythms to turn on, while the plasma intervention turned on genes involved in stem cell differentiation and neuronal maturation that led to selective reversal of age-related gene expression.

"The interventions appeared to act on very different regions in the brain and [induce] strikingly different effects," Hahn said. "This suggests that there are multiple regions and pathways in the brain that have the potential to improve cognitive performance at old age."

The team also examined age-related changes in genes associated with three neurodegenerative diseases — Alzheimer's disease, Parkinson's disease and multiple sclerosis — that typically affect specific regions of the brain. The expression distribution for each gene had changed in older animals and occurred in regions of the brain that are not typically associated with a particular neurodegenerative condition. This finding could offer insight into the vast number of patients who have neurodegenerative diseases without a firm genetic link.

The study could also offer new opportunities to explore treatments and interventions by using the gene expression data to zero in on the cell populations vulnerable to aging. Future studies could explore how gene

expression leads to functional changes in neuronal activity and structure. Wyss-Coray and colleagues at the Knight Initiative for Brain Resilience aim to expand on this work by building similar genetic atlases of aging in the human brain.

"The individual gene changes observed in the mouse may not directly translate to humans," Wyss-Coray said. "But we believe the vulnerability of white matter to aging probably does."

Reference: Hahn O, Foltz AG, Atkins M, et al. Atlas of the aging mouse brain reveals white matter as vulnerable foci. Cell. 2023:S009286742300805X. doi: 10.1016/j.cell.2023.07.027

Technology Networks, 18 August 2023

https://technologynetworks.com

Microbial dark matter yields new type of superbug-busting antibiotic

2023-08-22

In developing the antibiotic, researchers from Germany and the United States made use of a device known as iCHip that allows scientists to culture bacteria that up till now were considered "bacterial dark matter," or bacteria that simply can't be grown in a lab. Interestingly, 99% of all bacteria fall into this category. iCHip was developed by a small start-up known as NovoBiotic Pharmaceuticals and microbiologist Kim Lewis from Northeastern University in Boston.

This time around, the device helped researchers find clovibactin, an antibiotic that is produced by soil microbes found in North Carolina known as Eleftheria terrae subspecies carolina. These bacteria produce the clovibactin to attack, and therefore help them outcompete, other soil microbes.

"Clovibactin is different," said study co-author Markus Weingarth, a researcher from the Chemistry Department of Utrecht University. "Since Clovibactin was isolated from bacteria that could not be grown before, pathogenic bacteria have not seen such an antibiotic before and had no time to develop resistance."

Cagey strategy

Once the antibiotic was discovered, the researchers went to work figuring out just how it worked. They discovered that its killing mechanism is

Researchers have derived an antibiotic from microbes living in the sandy soil of North Carolina. Because it works completely differently than others before it, clovibactin might help turn the tide in the battle against superbugs that resist current drugs.

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different from that of current antibiotics. It basically forms a cage around three different precursor molecules that bacterial invaders use to build their cell walls. In fact, the name "clovibactin" comes from "klovi," the Greek word for cage because of its novel method of action.

While some current antibiotics also work by destroying bacterial cell walls, clovibactin is unique in the way it locks up these molecules known as pyrophosphates.

"Clovibactin wraps around the pyrophosphate like a tightly sitting glove," said Weingarth. "Like a cage that encloses its target. As Clovibactin only binds to the immutable, conserved part of its targets, bacteria will have a much harder time developing any resistance against it. In fact, we did not observe any resistance to Clovibactin in our studies."

Bolstering the hope that clovibactin can penetrate the defenses of antibiotic-resistant superbugs is that fact that it goes a few steps further in its fight against bacteria.

Suicide trigger

When the antibiotic attaches itself to harmful bacteria, it sends out filaments that further bind and destroy the bug. It also causes the bacteria to release enzymes known as autolysins that further help them commit suicide by dissolve their own cell walls.

"The multi-target attack mechanism of clovibactin blocks bacterial cell wall synthesis simultaneously at different positions," said study co-author Tanja Schneider from the University of Bonn in Germany. "This improves the drug's activity and substantially increases its robustness to resistance development."

In mouse studies, the clovibactin was effective in fighting a wide range of pathogens and seemed particularly successful against gram-positive bacteria such as those that cause common hospital infections including MRSA, staph, and strep as well as other invaders that cause a range of diseases including tuberculosis.

The research team now plans to figure out how to capitalize on the effectiveness of clovibactin and says it will take some time before the antibiotic is widely available as medication, as it will have to go down the usual pathway of clinical trials and approvals.

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The study has been published in the journal, Cell.

New Atlas, 22 August 2023

https://newatlas.com

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Bio-Functional Mesoporous Silica Nanoparticles as Nano-Structured Carriers in Cancer Theranostic Review on Recent Advancements

Bio-Functional Mesoporous Silica Nanoparticles as Nano-Structured Carriers in Cancer Theranostic Review on Recent Advancements

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