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Regulatory Update

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ASIA PACIFIC

Australia Consults on Listing PFAS and PeCB in IChEMS Register Schedule 7, Prohibitions Will Apply

2023-07-24

Australian Government is recently consulting on the proposed scheduling decisions - listing three types of PFAS groups (i.e., PFOA, PFOS and PFHxS) and pentachlorobenzene (PeCB) in IChEMS Register Schedule 7. Generally, Schedule 7 chemicals cannot be imported, exported, manufactured or used within Australia. Comments are welcome before September 1, 2023.

Read More

Chemlinked, 24-07-23

https://chemical.chemlinked.com/news/chemical-news/australia-consults-on-listing-pfas-and-pecb-in-ichems-register-schedule-7-prohibitions-will-apply

Thailand FDA to Update Notification Requirements for Type 1 Hazardous Chemicals

2023-07-25

Manufacturers and importers of Type 1 hazardous substances will be required to provide confirmation information to the authority every six years.

On June 28, 2023, Thailand's Food and Drug Administration (FDA) notified WTO of the proposed updates of the notification requirements for Type 1 hazardous substances (only for items under the FDA's responsibility) for comments. Thailand's current regulation regarding this issue is the Notification of the Ministry of Public Health Re: Notification of Fact Relating to Type 1 Hazardous Substances Under the Responsibility of the FDA B.E. 2562 (2019). Once the proposed updates are adopted and come into force, the 2019 version will be repealed. New regulation is expected to take effect after 180 days from the date of its publication in the Government Gazette. Comments are welcome before September 8, 2023.

Read More

Chemlinked, 25-07-23

https://chemical.chemlinked.com/news/chemical-news/thailand-fda-to-update-notification-requirements-for-type-1-hazardous-chemicals

China MEE Calls for Information on Long-chain PFCAs and MCCPs

2023-07-24

On July 20, 2023, the Chinese Ministry of Ecology and Environment (MEE) issued a notice to call for information on "long-chain perfluorocarboxylic acids (PFCAs), their salts and related compounds" and "medium-chain chlorinated paraffins (MCCPs)" from the industry in China. The information required is:

• Their production and use information (including production quantity, use quantity, use purpose, etc.); and

• Their substitutes or relevant substitute technologies (including the introduction of substitutes or substitute technologies, substitute costs, substitute effects, etc.).

Relevant information is expected to be provided to the MEE in writing before August 27, 2023.

Background

Stockholm Convention on POPs is an international environmental treaty signed on May 22 of 2001, and effective from November 11 of 2004 in China. Initially, the Convention targeted on 12 key POPs, which were listed in Annex A (Elimination), Annex B (Restriction), and Annex C (Unintentional production). Later, the Conference of the Parties (COP), by its decisions, amended Annexes A, B and C to the Convention to include additional POPs. So far, there are 34 POPs listed in the Annexes to the Stockholm Convention.

As the nineteenth meeting to be held in October 2023, the COP to the Stockholm Convention will consider reviewing the followings:

1. Draft risk management evaluation for chlorinated paraffins with carbon chain lengths in the range C14-17 and chlorination levels at or exceeding 45 percent chlorine by weight

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2. Draft risk management evaluation for long-chain PFCAs, their salts and related compounds

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Chemlinked, 24-07-23

https://chemical.chemlinked.com/news/chemical-news/china-mee-calls-for-information-on-long-chain-pfcas-and-mccps

AMERICA

More than 300,000 children's cups recalled due to high lead levels

2023-07-26

Cupkin Double-Walled Stainless Steel Children's Cups have been recalled.

The US Consumer Product Safety Commission on Thursday recalled roughly 346,000 Cupkin Double-Walled Stainless Steel Children's Cups because they "contain levels of lead that exceed the federal lead content ban."

The recalled 8- and 12-ounce cups, which were manufactured in China, were sold online at Amazon.com and Cupkin.com from January 2018 through March 2023 for about $20, according to CPSC.

"Consumers should immediately take the cups away from children and stop using them," the agency said.

"With a few limited exceptions … all children's products manufactured in or imported into the United States must not contain more than 100 parts per million (ppm) of total lead content in accessible parts," the CPSC said.

There is no known safe level of lead exposure in children.

CPSC advised contacting Soojimus, the company that makes the cups, for a full refund, and said it and Amazon were "contacting all known purchasers directly."

No incidents or injuries have been reported.

"After recently receiving feedback from consumer advocates and additional follow up testing, we discovered that the double walled vacuum 8oz and 12oz cups may pose an unacceptable exposure to lead if the cup bottoms are mistreated," Cupkin said on its website.

"Liquids in the cup are not exposed to lead due to the double walled construction of our cups… We will take this opportunity to completely redesign our cups to make them even better."

Read More

CNN Health, 26-07-23

https://edition.cnn.com/2023/07/22/health/cupkin-childrens-cups-lead-recall/index.html

US FDA stands by decision on phthalates in food contact

2023-07-25

On July 21, 2023, the US Food and Drug Administration (FDA) for the second time denied a citizen petition to ban eight ortho-phthalates in food contact. In its announcement, the FDA states "[w]e evaluated the reconsideration petition and concluded that it does not provide a basis for modifying the FDA's response to the original citizen petition."

Earthjustice asked for a reconsideration of the petition with new evidence after FDA denied the original petition in May 2022 (FPF reported).

The petition has gone through years of back-and-forth between civil society organizations and the FDA, with the US Congress stepping in as well. Civil society organizations had put forward the petition in 2016 based on concerns about the human health effects of phthalates that migrate into food from packaging and processing equipment (FPF reported). The FDA is legally supposed to respond to a petition within 180 days. The organizations called for a response from FDA in 2019 (FPF reported) and finally sued the agency in 2021 (FPF reported). After the legal suit, members of Congress also demanded that the FDA formally respond (FPF reported).

Read More

FPF, 25-07-23

https://www.foodpackagingforum.org/news/us-fda-stands-by-decision-on-phthalates-in-food-contact

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U.S. consumers confused about compostable and biodegradable food packaging labels

2023-07-18

A report published by the investment firm Closed Loop Partners' Composting Consortium and the Biodegradable Products Institute (BPI) on July 11, 2023, presents findings about U.S. consumer perception surrounding compostable and biodegradable packaging and labels. The data comes from a completed survey with 2,765 respondents throughout the U.S. All of the gathered data has been made publicly available, and the report is accompanied by a separate policy brief summarizing the main results and recommendations for policymakers on how to take action.

The survey found that up to 49% of the respondents faced difficulty distinguishing between the terms "compostable" and "biodegradable" (FPF reported), which leads to the improper disposal of compostable packaging at the end of its life cycle. Additionally, the labeling phrase "made from plants" commonly found on both recyclable and compostable packaging further contributes to consumer confusion. Up to 50% of the participants stated that they would place packaging labeled as "made from plants" in the composting bin (FPF reported and here).

In response, the study also presents potential approaches to address the misunderstandings. A first step could be to hold biodegradability claims to a standard that is equal to compostable so that composting streams are less at risk. Moreover, the authors argue that brands and retailers ought to take responsibility for educating consumers about the industrial or home compostability of their packaging. Prominently indicating this information on packaging could be crucial to guide consumers. Research findings indicate that consumers responded best to packaging that utilizes two to three design elements, such as coloring or text size, to clearly indicate compostability (FPF reported).

The results show that a fragmented approach using both local and state-level policies and regulations to govern packaging design and labeling "[…] creates unnecessary friction and pain points for consumers, brands, and composters." Therefore, the authors suggest that policymakers, brands, and retailers collaborate to harmonize policies and regulations on a national level. Creating a cohesive framework that simplifies packaging standards could benefit brands across multiple sectors with packaging of all shapes and sizes (FPF reported).

The report concludes that educating the population on proper recycling and composting practices is also critical to ensuring clean material streams in recovery systems. Municipalities and local governments with zero waste targets could also play a crucial role in bridging the comprehension gap. Further, by partnering with brands, retailers, haulers, composters, NGOs, and other stakeholders, they could develop educational campaigns to promote sustainable behavior and establish new social norms.

Read More

FPF, 18-07-23

https://www.foodpackagingforum.org/news/u-s-consumers-confused-about-compostable-and-biodegradable-food-packaging-labels

EUROPE

Global Gateway: EU and Chile strengthen cooperation on sustainable critical raw materials supply chains

2023-07-18

As part of the Community of Latin American and Caribbean States Summit (EU-CELAC) taking place in Brussels on 17 and 18 July, President Ursula von der Leyen and the President of Chile, Gabriel Boric, witnessed the signing of a Memorandum of Understanding (MoU) on establishing a partnership between the EU and Chile on sustainable raw materials value chains. The MoU was signed by Commissioner Thierry Breton and the Minister of Foreign Affairs of Chile Alberto van Klaveren Stork.

In line with the EU's Global Gateway strategy and with the Critical Raw Materials Act, the partnership aims to deepen cooperation in the field of sustainable raw materials value chains that are necessary for the clean energy and digital transition of both partners. It also aims to develop a competitive and sustainable industry for processing raw materials and local value added in the mining sector, creating quality employment and sustainable and inclusive economic growth, to the mutual benefit of both sides.

President of the Commission, Ursula von der Leyen, said: "It is a great pleasure for me to witness the signing of this partnership for the development of sustainable raw materials value chains between the EU and Chile. The Global Gateway will be one of the main drivers of our evolving partnership. We are like-minded, we share the same values, and

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we are partners of choice to become key global players in the clean energy and digital transition."

The new partnership is centred around five areas:

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

As a next step, the EU and Chile have committed to develop an operational Roadmap after the signature of the Memorandum of Understanding. The Roadmap will include cooperation actions that will be carried out by relevant stakeholders from the EU Member States and Chile and will be supported by the EU's Global Gateway Investment Agenda for Latin American and the Caribbean.

Read More

European Commission, 2318-07-23

https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3897

Chemicals: The EU restricts exposure to carcinogenic substance formaldehyde in consumer products

2023-07-14

Today, the Commission adopted measuresEN••• to better protect people from the risk of cancer, by introducing a maximum emission limit for the carcinogenic substance formaldehyde in a range of consumer products.

The new rules establish an emission limit of 0.062 mg/m3 of formaldehyde into indoor air for the largest contributors, such as wood-based articles

and furniture and to the interior of road vehicles. A limit of 0.08 mg/m3 will apply to all other articles such as textile, leather, plastic, construction materials or electronic products.

This will ensure a high level of protection for human health while limiting the socio-economic burden and need for technological changes for a wide range of industries and sectors.

Producers of articles where formaldehyde is used will have 36-months to comply with the new rules, providing sufficient time for stakeholders to implement the restriction requirements, develop relevant analytical methods to test formaldehyde emissions and deploy formaldehyde-free or low emitting formaldehyde products. A 48-month limit will apply to vehicles.

Moreover, the European Chemicals Agency – with the support of industry and experts – will develop guidance facilitating harmonised implementation of the test conditions for the measurement of the formaldehyde emissions.

Formaldehyde is known to have carcinogenic and mutagenic properties and can act as a toxicant and skin sensitiser.

Read More

European Commission, 14-07-23

https://single-market-economy.ec.europa.eu/news/chemicals-eu-restricts-exposure-carcinogenic-substance-formaldehyde-consumer-products-2023-07-14_en

Commission gathers views on how to make the agri-food industrial ecosystem greener, more digital and resilient

2023-07-24

The Commission published an analysis of the existing EU policies supporting the agri-food sector to become greener, more digital and resilient.

With the analyisEN•••, the Commission is launching a public consultation inviting interested parties to propose actions to accelerate the twin transition of the sector. The consultation is open to the whole industrial value chain, as well as public authorities, social partners, research organizations and others.

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In parallel, the Commission plans to organise workshops to discuss and collect views on how to make this industrial ecosystem more competitive. The objective is to co-create a Transition Pathway for the agri-food sector by the end of 2023.

The Commission proposed to develop transition pathways in different industrial ecosystems in the May 2021 Industrial Strategy UpdateEN•••. The Update was accompanied by the first Annual Single Market Report, which offers an analysis of the challenges faced by different ecosystems and serves as a starting point for preparation of the transition pathways.

The targeted public consultationEN••• on the transition pathway for the agri-food industry will last until 19 September.

Read More

European Commission, 24-07-23

https://single-market-economy.ec.europa.eu/news/commission-gathers-views-how-make-agri-food-industrial-ecosystem-greener-more-digital-and-resilient-2023-07-24_en

European Commission to Expedite Phasing Out of Animal Testing

2023-07-26

The EC's roadmap will include legislative and non-legislative actions to further reduce animal testing and aim to ultimately move to an animal-free regulatory system under chemicals legislation.

Responding to the European Citizens' Initiative (ECI), "Save Cruelty-free Cosmetics - Commit to a Europe without Animal Testing," the European Commission (EC) will expedite the phasing out of animal testing, per WWD.

In its response, the EC provided a comprehensive overview of the EU's legislative and policy framework for animal testing. It also proposed creating a "roadmap" to further reduce animal testing. This follows recent allegations and misconceptions that the UK government abandoned the animal testing ban.

See related: Canada Officially Bans Animal Testing for Cosmetics

ECI Support

"The Commission welcomes the initiative and acknowledges that animal welfare remains a strong concern," it wrote. The EC registered the ECI in June 2021 and ECI organizers collected support between August 2021 and 2022. After verifying 1,217,916 statements of support by Member State authorities in January 2023, the organizers submitted the initiative to the EC.

"[The initiative] highlights the leading role of the EU in phasing out the use of animals in testing and improving animal welfare in general," the EC continued. "This is especially reflected in the full ban of animal testing for cosmetics, which has been in place in the EU since 2013."

The EC's roadmap will include legislative and non-legislative actions to further reduce animal testing, "with the aim to ultimately move to an animal-free regulatory system under chemicals legislation (e.g., REACH, Biocidal Product Regulation, Plant Protection Products Regulation and human and veterinary medicines) and continue strongly supporting alternatives to animal testing."

The EC will additionally continue its support to research and develop alternatives to animal testing while exploring the possibility of coordinating the activities of Member States in this field.

Read More

Cosmetics & Toiletries, 26-07-23

https://www.cosmeticsandtoiletries.com/regulations/cruelty-free-halal/news/22868346/european-commission-to-expedite-phasing-out-of-animal-testing

INTERNATIONAL

Saving tens of millions of children a year from the effects of lead poisoning is a surprisingly solvable problem

2023-07-25

Lead is toxic to every system in the human body. This week marks 60 years since a crucial study by Mitsunobu Tatsumoto and Clair Patterson in Nature found that the world's oceans were awash with lead (M. Tatsumoto and C. Patterson Nature 199, 350–352; 1963). Contamination from petrol, paint and industrial sources had leaked planet-wide — it was a public-health crisis. Since then, the fight against lead poisoning has seen great success:

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in 2021, leaded fuels were completely phased out. Yet much remains to be done.

Around the world, 815 million children — 1 in 3 — have dangerous levels of lead in their bloodstream, enough to cause irreversible brain damage, intellectual disability, lower educational attainment, behavioural disorders, reduced lifetime earnings, anaemia, kidney disease and cardiovascular disease. The health effects in children and adults lead to nearly one million deaths annually and widespread disability. Lead's impacts on cognitive development are estimated to cause nearly US$1 trillion of income loss in low- and middle-income countries (LMICs) each year.

The shocking lack of attention to such an enormous and solvable problem is probably because 94% of the disease burden from lead exposure happens in LMICs. Each year, only about $10 million of international funding is spent on addressing global lead poisoning. This is orders of magnitude less than the $8.2 billion that governments donated last year for HIV/AIDS, which similarly kills nearly one million people a year.

Laws banning lead paint are highly effective at preventing lead exposure— but there are more than 70 countries without lead-paint laws, and others where such laws are not well enforced. Strong laws and enforcement are the main things we call for at the Lead Exposure Elimination Project (LEEP), at which I am a programme manager and team leader. I previously coordinated the World Health Organization's efforts to eliminate lead paint in Africa. This issue is personal to me: in Burkina Faso, where I grew up and where most of my 23 nieces and nephews live, around 9 million children have lead poisoning, yet the country has no lead-paint law.

Lead paint has been banned in most high-income countries for decades — but in many LMICs, it is still unregulated and widely used in homes, schools and playgrounds. Its poisonous dust and flakes can be ingested accidentally, particularly by young children. Lead in paint is entirely unnecessary. It is added to give colour, to speed drying and to prevent corrosion, but alternatives are widely available.

Read More

Nature, 25-07-23

https://www.nature.com/articles/d41586-023-02368-0

REACH Update

AUG. 04, 2023

Tattoo inks and permanent make-up

2023-07-22

Tattoos are a popular form of body art – at least 12 % of Europeans have them. In the 18-35 age group, twice as many are likely to have a tattoo.

The health risks of using dirty needles to inject the inks have been under scrutiny for a long time. Now, their chemical-related concerns have also been analysed and their risks have been regulated at EU level.

To protect European citizens, thousands of hazardous chemicals found in tattoo inks and permanent make-up are restricted in the EU under the REACH Regulation from January 2022.

The restriction covers, for example: chemicals that cause cancer or genetic mutations and chemicals that are toxic to reproduction as well as skin sensitisers and irritants. The aim is not to ban tattooing but to make the colours used in tattoos and permanent make-up safer.

Chronic allergic reactions and other inflammatory skin reactions from tattoo and permanent make-up inks are expected to decrease thanks to the restriction. More serious effects such as cancer, harm to our DNA or the reproductive system potentially originating from chemicals used in the inks could also decrease.

Read More

ECHA, 22-07-23

https://echa.europa.eu/hot-topics/tattoo-inks

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Janet's Corner

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Holy Bible Abridged

2023-08-02

https://www.smbc-comics.com/comic/quantum-mechanics-is-weird

Acridine

2023-08-04

USES [2,3]

Acridine has a range of uses across various applications. It is used in the manufacture and synthesis of drugs and dyes. In the latter category, acridine orange, a fluorescent dye used for cell cycle determination. The acridine proflavine is used as an antiseptic.

ROUTES OF EXPOSURE [4]

The main routes of exposure to acridine are ingestion, inhalation and skin contact.

HEALTH EFFECTS [4]

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

Acute Health Effects [2]

Severity of symptoms depend on the level and type of exposure. If inhaled, this compound can irritate the respiratory system. People with already impaired respiratory function, such as chronic bronchitis, could be more impactfully affected. High level doses of ingestion may be fatal. Skin exposure to the chemical could cause dermatitis and could result in phototoxicity. Skin contact with this compound could exacerbate any pre-existing dermal conditions. Eye contact with acridine could result in irritation and/or ocular lesions.

Chronic Effects [2]

Chronic exposure to acridine is toxic to multiple body systems. Long term exposure to the compound may result in difficulty breathing and related systemic problems. This material may produce carcinogenic effects. It may also produce cumulative health effects.

SAFETY

First Aid Measures [2]

- **Ingestion**: DO NOT induce vomiting. Contact a medical professional immediately.

Acridine is a colourless crystalline organic solid that is obtained from coal tar. Its formula is C13H9N. [1]

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- **Skin contact**: Avoid direct contact with contaminated clothing. Wearing protective clothing if necessary, remove all contaminated clothing, footwear and accessories. Do not re-wear clothing until it has been thoroughly decontaminated. Rinse with soap and flowing water for at least 30 minutes. Contact a doctor immediately.
- **Eye contact**: Flush eyes (including under the eyelids), with fresh running water for at least 30 minutes. Removal of contact lenses should only be done by skilled personnel. Do not stop flushing due to the lens. Contact a medical professional at once.
- **Inhalation**: Move the patient to a fresh air source. Keep them warm and rested. Prosthesis, such as false teeth, should be removed prior to conducting CPR. Contact a doctor immediately.

General: Never administer anything by mouth to an unconscious, exposed person.

Workplace Controls & Practices [4]

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

Personal Protective Equipment [5]

Personal protection: Safety glasses with side shields or chemical goggles, protective and dustproof clothing, gloves (e.g. PVC), a P.V.C apron and an appropriate mask or dusk respirator. Do not wear contact lenses as they could absorb chemicals in the air. Wear impervious shoes or gumboots. Other protection could overalls. For specifications regarding other PPE, follow the guidelines set in your jurisdiction.

REGULATION [5]

United States

The Occupational Safety and Health Administration (OSHA)has set a Time Weighted Average (TWA) concentration limit for acridine of 2mg/m3.

Australia

Australia Exposure Standards have set a TWA for acridine of 0.2mg/m3.

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- https://www.cdc.gov/niosh/npg/npgd0145.html

Borax is the new Tide Pods, and poison control experts are facepalming

2023-07-25

The troubling trend harkens back to both the Tide Pod Challenge trend of 2018, in which teens chomped down on detergent packets on camera, and the infamous "Church of Bleach," a faux religious organization that sold industrial beach as a "miracle" solution that could cure a variety of serious diseases when ingested. (The family was recently found guilty of fraud and now awaits sentencing.)

Like the bogus trends that came before them, the new borax enthusiasts have drawn on well-worn conspiracy theories and dubious data to support their poisonous practice. In one video, a TikTok user explained that she put borax in her smoothies because "they are spraying us with chemtrails." Others have suggested borax's unproven health benefits are being purposefully stifled by Big Pharma in a conspiracy to keep people paying for more expensive (and regulated) pharmaceutical products—a common refrain among people peddling unproven health and wellness products.

Meanwhile, the borax trend has hit the radar of poison control centers and toxicology experts. In a debunking article from the National Capital Poison Center, the organization outlined a case of one man who had to go to the emergency department days after soaking in a borax bath, which caused severe skin irritation, swelling, and dryness.

And that's not the worst of it. According to the National Institute of Health's Office of Dietary Supplements, ingesting borax or the related boric acid can cause nausea, gastrointestinal discomfort, vomiting, diarrhea, skin flushing, rash, excitation, convulsions, depression, and vascular collapse.

A report from 1973 outlined the cases of two infants who developed chronic borate intoxication after their mothers repeatedly dipped their pacifiers in a honey-borax solution, thinking the borax was a safe antiseptic (it isn't). After weeks, the infants started having seizures and developed anemia. The study's authors blamed the harm on the "negligence" of the companies selling the mixture, noting that the mixture's packaging did not warn that it "is really a poison."

No benefit, all risk

These days, borax—sodium tetraborate decahydrate—is mainly found in laundry detergents, where it acts as a bleaching agent. It's also used for

In the latest health fad to alarm and exasperate medical experts, people on TikTok have cheerily "hopped on the borax train" and are drinking and soaking in the toxic cleaning product based on false claims that it can reduce inflammation, treat arthritis, and "detoxify" the body.

industrial glass production and, in small amounts, can be combined with glue to form slime that children can play with—without eating.

Some of the TikTokers advocating for drinking or bathing in borax note that it contains boron, which is a naturally occurring trace element readily found in common foods, such as fruits, peanuts, legumes, potatoes, and milk. It's (of course) also found in dietary supplements. But, boron is not considered an essential nutrient for humans, and researchers have not identified a clear biological function for the element. There is some preliminary data suggesting that boron may be important for bone growth and that it could help reduce the symptoms of osteoarthritis, possibly by inhibiting inflammation. There are also hints that it may influence some cancer risks. But no clinical trials have evaluated any of those possible health benefits.

And, importantly, borax is not the same as elemental boron. Borax is toxic, with short-term use leading to irritation, nausea, vomiting, and diarrhea. (The poison center notes that eating borax can turn your vomit and stool a blue-green color.) And, as the report on the two infants highlights, long-term use leads to seizures and anemia.

There's little evidence that the cleaning product can reduce inflammation, despite the false claims on TikTok. Some proponents may note two Turkish studies in rats that suggest borax reduced inflammation from human cancer drugs and spinal cord injuries. But the studies tested borax in groups of just eight and seven rats, respectively, and even larger studies do not support the use of borax in humans.

With the dearth of data indicating benefits in humans, the poison center sums things up succinctly: "Borax is not intended for human consumption, and may cause toxic effects when swallowed, inhaled, or applied to the skin."

ARS Technica, 25 July 2023

https:// https://arstechnica.com/

Steric zipper interactions in artificial crystalline peptide β-sheets

2023-08-02

Now, in a new study published in the Journal of the American Chemical Society, researchers from Japan, led by Associate Professor Tomohisa Sawada from Tokyo Institute of Technology (Tokyo Tech), have presented a novel approach for the construction of crystalline artificial steric zippers.

Steric zippers are a specific type of hydrophobic packing structure that form between two adjacent layers of peptide β-sheets in amyloid and similar fibrils. These structures play a crucial role in the stability and propagation of amyloid fibrils and can aid in designing new peptide-based materials. However, creating artificial steric zippers is challenging owing to the strong aggregation tendency of β-sheet peptides. This often leads to the formation of gels and fibrils, making it difficult to obtain structures in their crystalline form.

"Although previous studies have revealed that peptide fragments derived from native protein sequences exhibit steric zipper structures, their de novo designs have rarely been studied," explains Dr. Sawada.

The researchers began by preparing custom Boc-3pa-X1-3pa-X2-OMe tetrapeptide structures, where Boc refers to tert-butoxycarbonyl, 3pa represents β-(3-pyridyl)-L-alanine, OMe is the methoxy group, and X1 and X2 denote the hydrophobic amino acids, namely alanine, valine, leucine, threonine, and phenylalanine.

The tetrapeptide structures were designed such that the pyridyl groups and the hydrophobic amino acid groups formed side chains on either side of the peptide backbone. This specific arrangement of the residues in the peptide sequence played a crucial role in the formation of steric zippers in the crystalline state.

The tetrapeptide fragments were introduced in microtubes together with a metal salt (Zn(NCS)2, AgNTf2, or AgOTf) and incubated at room temperature. These salts enabled the formation of reversible coordination bonds between the pyridyl group of peptides and the metal ions. Essentially, this interaction prevented the uncontrollable aggregation of β-sheet peptides, leading to the formation of needle-shaped crystals containing steric zippers.

By using different combinations of hydrophobic amino acids in peptides, the researchers constructed various steric zipper structures. Hydrophobic amino acids containing methyl side chains, such as alanine, valine, and leucine groups, resulted in class 1 steric zippers, with peptide backbones arranged parallel to each other.

Moreover, the type of interaction between the β-sheets depended on the steric bulkiness of the alkyl side chains present in the hydrophobic amino acids. For instance, tetrapeptide structures containing alanine, which has a smaller methyl side chain, exhibited interlocked structures through interdigitation. In contrast, when the alkyl side chains of hydrophobic amino acids were larger, as in valine and leucine, the β-sheets were linked via hydrophobic contact.

Notably, the researchers observed a class 3 steric zipper for the first time. These unique structures emerged due to hydrophobic amino acids with side groups other than alkyl groups, such as threonine and phenylalanine.

In these zippers, two β-sheets faced the same direction, adding to the diversity of steric zipper configurations.

Finally, the researchers extended the system to a knob–hole-type zipper using pentapeptide fragments. "The design of peptide materials based on steric zippers has so far been limited to biological systems. The present results open up a new route for the design of artificial peptide materials based on these structures," remarks Dr. Sawada.

In conclusion, the insights into the structural characteristics of steric zippers can pave the way for novel therapeutic strategies for preventing or reversing diseases caused by amyloid fibrils.

Phys.Org, 2 August 2023

https://phys.org

Cracks in Lithium-Ion Batteries May Speed Up Electric Vehicle Charging

2023-08-01

Rather than being solely detrimental, cracks in the positive electrode of lithium-ion batteries reduce battery charge time, research done at the University of Michigan shows.

This runs counter to the view of many electric vehicle manufacturers, who try to minimize cracking because it decreases battery longevity.

"Many companies are interested in making 'million-mile' batteries using particles that do not crack. Unfortunately, if the cracks are removed, the battery particles won't be able to charge quickly without the extra surface area from those cracks," said Yiyang Li, assistant professor of materials science and engineering and corresponding author of the study published in Energy and Environmental Sciences.

"On a road trip, we don't want to wait five hours for a car to charge. We want to charge within 15 or 30 minutes."

The team believes the findings apply to more than half of all electric vehicle batteries, in which the positive electrode—or cathode—is composed of trillions of microscopic particles made of either lithium nickel manganese cobalt oxide or lithium nickel cobalt aluminum oxide. Theoretically, the speed at which the cathode charges comes down to the particles' surface-to-volume ratio. Smaller particles should charge faster than larger particles because they have a higher surface area relative to volume, so the lithium ions have shorter distances to diffuse through them.

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However, conventional methods couldn't directly measure the charging properties of individual cathode particles, only the average for all the particles that make up the battery's cathode. That limitation means the widely accepted relationship between charging speed and cathode particle size was merely an assumption.

"We find that the cathode particles are cracked and have more active surfaces to take in lithium ions—not just on their outer surface, but inside the particle cracks," said Jinhong Min, a doctoral student in materials science and engineering working in Li's lab. "Battery scientists know that the cracking occurs but have not measured how such cracking affects the charging speed."

Measuring the charging speed of individual cathode particles was key to discovering the upside to cracking cathodes, which Li and Min accomplished by inserting the particles into a device that is typically used by neuroscientists to study how individual brain cells transmit electrical signals.

"Back when I was in graduate school, a colleague studying neuroscience showed me these arrays that they used to study individual neurons. I wondered if we can also use them to study battery particles, which are similar in size to neurons," Li said.

Each array is a custom-designed, 2-by-2 centimeter chip with up to 100 microelectrodes. After scattering some cathode particles in the center of the chip, Min moved single particles onto their own electrodes on the array using a needle around 70 times thinner than a human hair. Once the particles were in place, Min could simultaneously charge and discharge up to four individual particles at a time on the array and measured 21 particles in this particular study.

The experiment revealed that the cathode particles' charging speeds did not depend on their size. Li and Min think that the most likely explanation for this unexpected behavior is that larger particles actually behave like a collection of smaller particles when they crack. Another possibility is that the lithium ions move very quickly in the grain boundaries—the tiny spaces between the nanoscale crystals comprising the cathode particle. Li thinks this is unlikely unless the battery's electrolyte—the liquid medium in which the lithium ions move—penetrates these boundaries, forming cracks.

The benefits of cracked materials are important to consider when designing long-lived batteries with single-crystal particles that don't

crack. To charge quickly, these particles may need to be smaller than today's cracking cathode particles. The alternative is to make single-crystal cathodes with different materials that can move lithium faster, but those materials could be limited by the supply of necessary metals or have lower energy densities, Li said.

Technology Networks, 1 August 2023

https://technologynetworks.com

Nature's kitchen: How a chemical reaction used by cooks helped create life on Earth

2023-08-02

Known as the Maillard reaction after the French scientist who discovered it, the process converts small molecules of organic carbon into bigger molecules known as polymers. In the kitchen, it is used to create flavors and aromas out of sugars.

But a research team led by Professor Caroline Peacock at the University of Leeds argues that on the sea floor, the process has had a more fundamental effect, where it has helped to raise oxygen and reduce carbon dioxide levels in the atmosphere, to create the conditions for complex life forms to emerge and thrive on Earth. The study, "Long-term organic carbon preservation enhanced by iron and manganese," has been published in the journal Nature.

Source of organic carbon

Organic carbon in the oceans mostly comes from microscopic living organisms. When those organisms die, they sink to the sea floor and are consumed by bacteria. That decay process uses oxygen and releases carbon dioxide into the ocean which eventually ends up in the atmosphere.

As a result of the Maillard reaction, the smaller molecules are converted into larger molecules. Those larger molecules are harder for microorganisms to breakdown and remain stored in the sediment for tens of thousands—if not millions—of years.

The scientists describe this as the "preservation of organic carbon."

That long-term storage or preservation of organic carbon on the seabed had major consequences for conditions that developed on the surface of the Earth. It limited the release of carbon dioxide, allowing more oxygen to

A chemical process used in the browning of food to give it its distinct smell and taste is probably happening deep in the oceans, where it helped create the conditions necessary for life.

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reach the Earth's atmosphere and limited variation in the warming of the Earth's land surface over the last 400 million years to an average of about five degrees Celsius.

'Too slow to have any impact'

Dr. Oliver Moore, first author in the study and a Research Fellow in Biogeochemistry in the School of Earth and Environment at Leeds, said, "It had been suggested back in the 1970's that the Maillard reaction might occur in marine sediments, but the process was thought to be too slow to impact the conditions that exist on Earth.

"Our experiments have shown that in the presence of key elements, namely iron and manganese which are found in sea water, the rate of reaction is increased by tens of times.

"Over Earth's long history, this may have helped create the conditions necessary for complex life to inhabit the Earth."

As part of the study, the scientists modeled how much organic carbon has been locked into the seabed because of the Maillard reaction. They estimate it has resulted in around 4 million metric tons of organic carbon each year being locked into the seabed. That is the equivalent weight of around 50 London Tower Bridges.

To test their theory, the researchers looked at what happened to simple organic compounds when mixed with different forms of iron and manganese in the laboratory at 10° Celsius, the temperature of the seabed.

Analysis revealed that the "chemical fingerprint" of the laboratory samples—which had undergone the Maillard reaction—matched those from sediment samples taken from seabed locations around the world.

That "fingerprint" analysis was conducted at the Diamond Light Source in Oxfordshire, the UK's synchrotron which generates intense beams of light energy to reveal the atomic structure of samples.

Dr. Burkhard Kaulich, Principal Beamline Scientist of the Scanning X-ray Microscopy beamline (I08-SXM) at Diamond Light Source, said, "Our advanced I08-SXM instrumentation with its high stability, energy and optical resolution was developed and optimized to help probe carbon chemistry and reactions which take place in environmental systems.

"We are very proud to have been able to contribute to a better understanding of the fundamental chemical processes involved in the creation of complex life forms and climate on Earth."

Professor Peacock, from Leeds, said, "It's immensely exciting to discover that reactive minerals such as those made from iron and manganese within the ocean have been instrumental in creating the stable conditions necessary for life to have evolved on Earth."

The lessons learned from a better understanding of the Earth's geochemical processes could be used to harness new approaches to tackling modern-day climate change.

Dr. James Bradley, an environmental scientist at Queen Mary University of London and one of the authors of the paper, said, "Understanding the complex processes affecting the fate of organic carbon that is deposited on the seafloor is crucial to pinpointing how Earth's climate changes in response to both natural processes and human activity, and helping humanity better manage climate change, since the application and long-term success of carbon capture technologies relies on carbon being locked away in stable forms rather than being transformed into carbon dioxide."

Phys.Org, 2 August 2023

https://phys.org

Study reveals peculiar movements of cholesterol in cellular membranes

2023-08-02

Despite its importance, there is still much that remains unknown about cholesterol, specifically how these sterol molecules move and function within the cellular membrane of the cells.

Understanding of the movements and interactions of cholesterol in living systems have been the subject of decades of intense studies but the exact molecular dynamics have remained elusive, partly due to limitations in studying commercially available sterols and resolution of the current solid-state nuclear magnetic resonance spectroscopy (SSNMR) techniques.

Now, a group of researchers from the University of Illinois Urbana-Champaign and the University of Wisconsin-Madison have revealed for the first time how cholesterol behaves in cells at the atomistic level, information that could have broad implications for future studies of health and disease, according to the researchers.

In a study in the Journal of the American Chemical Society, biochemistry professor Chad M. Rienstra, University of Wisconsin-Madison, and University of Illinois Urbana-Champaign chemistry professors Martin D.

Though cholesterol can threaten human health, this waxy substance is one of the most important small molecules in human physiology and plays myriad critical roles in biology and medicine. Its dynamics are critical for the maintenance and regulation of membrane fluidity, sterol interactions with lipids and proteins, and the interactions of viruses with human cells. Cholesterol is also a critical drug target.

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Burke and Taras V. Pogorelov, detail how they combined new advanced experimental and computational methods to capture how cholesterol molecules move in the membrane of cells.

"This work illustrates the powerful synergistic approach of combining new experimental and computational methods to take our understanding of the dynamics of membranous cholesterol to the next level," Pogorelov said.

Specifically, their approach included new SSNMR experiments, state-of-the-art all-atom molecular dynamics simulations, and quantum mechanical calculations on synthetic cholesterol in phospholipids.

Cholesterol, a major component of biological membranes that can be extracted from sources like eggs, is a 27-carbon compound with a structure that includes a tail—made of hydrocarbons—attached to a flat core, which consists of four hydrocarbon rings.

For the first time, researchers in this study were able to label each carbon atom and design a protocol investigating the atomistic dynamics, or motion and forces, on each atom to reveal an overall picture of how cholesterol moves in a membrane.

"Collectively these studies revealed that cholesterol displays segmental dynamic coupling between the fused rings and tail conformations," Pogorelov said. "In particular, the movements of the tail and the whole molecule are correlated, while tails rotate in a 'crankshaft manner.'"

Also, researchers said their closely knit experimental-computational workflow allowed them to identify and quantify the specific conformations cholesterol assumes in the membranes.

According to the researchers, these results have broad implications for better understanding of the function of sterols in living systems, and the methods developed for this study open a new door for future studies of how cholesterol is influencing functional dynamics of membrane proteins in health and in disease.

Phys.Org, 2 August 2023

https://phys.org

While resolving a key asthma challenge, researchers also create a new method to detect proteins in body fluids and other materials

2023-08-01

John Brennan, director of McMaster's Biointerfaces Institute, and Parameswaran Nair, a respirologist at the St. Joseph's-based Firestone Institute for Respiratory Health, led the creation of a new rapid test that can quickly and accurately identify white blood cells known as eosinophils, even when they are present in complex biological samples such as sputum, by tracking their protein signatures.

Having access to quick and reliable information about the presence of eosinophils can guide physicians in making important decisions about patient care.

The test looks similar to the familiar COVID-19 home test, which makes it readily adaptable to mass manufacturing once it is approved for clinical use.

To create the new test, the researchers developed and deployed a protein-targeting element known as a DNAzyme and modified it for use in the rapid test.

First isolated in 1994, DNAzymes have primarily been generated for detection of metals or bacterial targets. Until now, no one had succeeded in using DNAzymes to target specific protein markers in any context.

Now that the team has overcome this obstacle, Brennan believes the new test platform could be adapted to identify any material of biological origin by detecting its protein signature.

The rapid test is the outcome of more than a decade of collaboration between Brennan and Nair, which in turn was built on previous work at the institutions, dating back decades.

"This is what our collaboration set out to achieve," says Brennan, one two corresponding authors of a new paper in the German chemistry journal Angewandte Chemie. "This test and others like it can have the kind of lasting, meaningful impact that will improve or even save many lives."

"Previous research at the Firestone Institute, led by the late Professor Freddy Hargreave, had pioneered another technique to enumerate eosinophils in sputum to guide asthma treatment," says Professor Nair, who is a respiratory physician at St. Joe's and a Professor of Medicine at

Based on decades of work to uncover the underlying mechanisms of asthma and other respiratory conditions, researchers at McMaster University and St. Joseph's Healthcare Hamilton have produced a simple, rapid test that can identify the presence of a key driver of severe asthma.

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McMaster University. "However, this method is cumbersome and time-consuming, and therefore is not widely available to patients. This new approach is a huge advancement to make the technique more widely applicable."

Brennan and Nair's co-authors are Monsur Ali, Manali Mukherjee, Katherine Radford, Zil Patel and Fred Capretta. The researchers are planning a full clinical trial of the new test, which is the next critical step in bringing it to market.

A rapid test to detect eosinophilia would help clinicians make decisions about using drugs such as steroids or new biologics for patients with severe asthma and other lung diseases associated with eosinophilia, such as severe cough, and COPD, says Nair. It would also help to limit the unnecessary use of antibiotics.

Science Daily, 1 August 2023

https://sciencedaily.com

Eco-friendly enzyme to create key chemical building blocks

2023-07-31

Applying this photoenzymatic approach, researchers have developed a clean, efficient way to synthesize crucial chemical building blocks known as chiral amines, solving a longstanding challenge in synthetic chemistry.

The study, published in Nature Catalysis, included researchers from the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI), a U.S. Department of Energy-funded Bioenergy Research Center; the Department of Chemical and Biomolecular Engineering (ChBE) at the University of Illinois Urbana-Champaign; and Xiamen University in China. It was led by CABBI's Zhengyi Zhang, Postdoctoral Research Associate with ChBE Professor Huimin Zhao, CABBI's Conversion Theme Leader and an affiliate of the Carl R. Woese Institute for Genomic Biology (IGB); and Jianqiang Feng and Binju Wang of the College of Chemistry and Chemical Engineering, Xiamen University.

Their work focused on hydroamination, a complex chemical reaction that can be used to produce chiral amines, which have wide applications in the synthesis of agrochemicals and other products. The team developed a photoenzymatic system that can control unstable nitrogen-centered radicals in a reaction known as enantioselective intermolecular radical

Using energy from light to activate natural enzymes can help scientists create new-to-nature enzymatic reactions that support eco-friendly biomanufacturing -- the production of fuels, plastics, and valuable chemicals from plants or other biological systems.

hydroamination, which until now had been a major challenge in chemistry. Radicals are atoms or molecules with at least one unpaired electron, which makes them highly chemically reactive because electrons prefer to be in pairs.

Hydroamination involves adding an amino group (a nitrogen atom bonded to one or two hydrogen atoms) to an unsaturated organic compound. Currently, hydroamination reactions can be carried out by metal- or photo-catalysts, which are substances used to speed up chemical reactions. While photocatalysis has advantages over other methods, using light as the energy source and avoiding the need for expensive and poisonous metals, it has not been applied previously in intermolecular hydroamination reactions for chiral amines because of the difficulty of controlling the nitrogen-centered radicals -- key intermediates in the catalytic process.

To address that problem, the research team turned to natural enzymes -- proteins found in living organisms that catalyze reactions in a process called biocatalysis. Natural enzymes can generate and control radicals for various biological processes. And the high selectivity of biocatalysis allows researchers to deploy enzymes to act on specific substrates and create valuable target products. Zhao's lab has had success steering that process with photocatalysis to produce new enzyme reactivity.

In this study, the CABBI researchers chose the ene-reductase enzyme, which they had previously used with other substrates to achieve different reactions. They successfully repurposed an ene-reductase with natural light to achieve intermolecular radical hydroamination with excellent enantioselectivity (the ability to target a mirror-image molecule known as an enantiomer).

"It's a new reaction that is very hard to accomplish with a chemical catalyst because we are making chiral compounds, and there are no natural enzymes that can catalyze that reaction," Zhao said. "In this work, we created an artificial enzyme that can achieve that unique reaction."

Most biological compounds, including DNA molecules, amino acids, and many agrochemicals, are "chiral," meaning a flipped or mirrored copy cannot be completely superimposed on top of the original molecule (like a left and right hand). Chirality is important in many agrochemical products; in some herbicides, for example, one enantiomer may have higher herbicidal activity and selectivity than the other. Therefore, it is important to develop methods to make chiral molecules efficiently.

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The findings have practical applications for CABBI's research to develop efficient methods for transforming leaves and stems from bioenergy grasses into high-value manufacturing products. Fatty acids that CABBI researchers derive from plant biomass can be readily converted into the unsaturated compounds used in this study, and therefore could potentially be upgraded into chiral amines.

More broadly, the discovery of this new photoenzymatic system demonstrates in principle that chiral amines -- precursors for other valuable molecules -- can be produced from fatty acid-derived material in the lab, thus offering a promising platform for biomanufacturing. It will enable further investigation into upgrading fatty acids into chiral amino acids, which can be used for production of agrochemicals and other molecules and materials.

By collaborating with researchers around the world, the CABBI team has taken a giant step toward understanding the fundamentals of this system, Zhang said. "I am excited to work with the team to study this reaction, which we believe will lead to new discoveries involving nitrogen-centered radicals."

Zhao is hopeful that companies will use the novel method developed by the research team for making their products.

"We still want to continue to discover new reactions that can be catalyzed by enzymes, particularly using the biomass produced by CABBI," he said.

Co-authors on this study included Wesley Harrison of CABBI, IGB, and ChBE; Haiyang Cui of IGB, ChBE, and the NSF Molecular Maker Lab Institute at Illinois; and Chao Yang and Dongping Zhong of Ohio State University.

Science Daily, 31 July 2023

https://sciencedaily.com

Multicyclic Molecular Wheels With Polymer Potential

2023-08-02

Rotaxanes, initially regarded as intriguing chemical curiosities, are now being explored for a wide range of potential applications, ranging from next-generation polymers to ambitious possibilities in molecular computing, sensor technologies and drug delivery.

The Hokkaido University researchers, with collaborators elsewhere in Japan, are focusing their attention on making new network polymers, in

Rotaxanes are interlocked molecular structures with a linear 'axle' molecule penetrating one or more cyclic 'wheel' molecules. Bulky groups at the end of the axle prevent the wheels from coming off. Now, researchers at Hokkaido University have taken the previous achievements of this technology a step further, making macro-rotaxanes that have multicyclic wheels interlocked with several high-molecular-weight axles. They report their innovation in the journal Angewandte Chemie International Edition.

which ring structures more complex than simple circles hold together different strands of long polymer chains.

"We think the multicyclic structures in these macro-rotaxanes could be useful as non-leaching additives, permanently retained in a polymer network by the way they hold onto several neighboring polymer chains," says polymer chemist Professor Toshifumi Satoh of the Hokkaido team.

The 3D wheels act as a unique and highly flexible form of molecular crosslinks, allowing the wheels and the interlocked polymer strands much more freedom of movement than in conventionally cross-linked networks. Structural variations should allow fine control over the properties of soft materials to make them suitable for a variety of industrial and medical applications.

Other research groups have achieved some similar success with smaller molecular arrangements, but the advances at Hokkaido University move the field into the realm of larger molecules.

The researchers explored some of the possibilities of this significant new development in polymer chemistry using chemicals called polydimethylsiloxanes (PDMSs) to make the multicyclic rings. They were able to build different numbers of cyclic units with rings of different sizes. When combined with silicone polymer chains with short crosslinking agents, the multicyclic units became efficiently incorporated into a newly-forming extended, mixed and interlocked network.

"We explored some of the potential for making modified soft materials by measuring the damping performance of the networks, which is essentially the ability of a material to absorb and reduce vibrations," says Satoh. "This revealed that our macro-rotaxanes achieved significant improvements in damping efficiency relative to conventional polymer networks."

Satoh and his colleagues now plan to explore further possibilities that can be built on the proof-of-concept foundations laid by their current progress.

Technology Networks, 2 August 2023

https://technologynetworks11111111111111111111111

A team led by scientists from the National University of Singapore's (NUS) Department of Biological Sciences in collaboration with the French Center for Scientific Research (CNRS) has successfully synthesized a special protein-mimic that can self-assemble into a pore structure. When incorporated into a lipid membrane, the pores permit selective transport of water across the membrane while rejecting salt (ions).

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Scientists develop a new class of artificial water channels for more efficient industrial water purification

2023-08-02

These protein-mimics, known as 'oligourea foldamers,' represent an entirely new class of artificial water channels (AWC) that can be used to improve the energy-efficiency of current methods of industrial water purification.

Current methods of water purification involve the use of reverse osmosis and membrane distillation technologies. Reverse osmosis, however, is a highly energy-intensive process as high pressures are needed to pass seawater or wastewater through a series of semi-permeable membranes to remove salts and other pollutants.

In light of climate change and the growing demand for fresh water, there is an impetus to develop more energy-efficient, water-selective membranes for large-scale desalination purposes. This invention represents an excellent contribution to these efforts. The relatively high-water permeability of the pores formed by these oligourea foldamers suggests that overall energy requirement for water purification can potentially be reduced.

Addressing the limitations of conventional membrane technologies

Research in this field has largely focused on fabricating membranes with aquaporins, which are naturally-occurring proteins containing pores that allow water molecules to pass through in a single file. They are known as 'water channels' and can be found in the cell membranes of all living cells including microbes, plant and animal cells.

Due to the complex structure of aquaporin, synthesizing sufficient quantities of this bulky protein for use in water purification membranes remains an expensive and time-consuming process.

In a paper published in the scientific journal Chem on 8 May 2023, a team of NUS scientists led by Professor Prakash Kumar described a breakthrough in the development of a simpler molecular component that can self-assemble to generate transmembrane channel-like structures with a pore.

These structures mimic the functions of aquaporin, allowing only water molecules to cross the membrane while salts and other pollutants are rejected. The individual oligourea foldamers are also much smaller in size at just 10 amino acid-residues long—which makes them easier to modify, synthesize, and purify compared to aquaporin or other classes of AWC.

How it works

The foldamers are amphiphilic in nature, which means that they possess different charges which allow them to assemble into more complex structures, similar to how magnets tend to clump together in a ball when they are in close proximity with each other. The resulting complex, or quaternary, structures contain pore-like water channels which are further stabilized by strong bonds known as hydrophobic and electrostatic interactions.

The hydrophobic components are clustered on the exterior that allows insertion into lipid membranes. The interior (lumen) of the pore is more hydrophilic, which allows water molecules to move across the membrane while rejecting ions from passing through. And this is responsible for the selective water permeability across lipid membranes observed in lab tests.

The scientists discovered that the oligourea foldamers were similar in function to natural porin-like structures, which makes them viable potential candidates for the fabrication of AWC membranes for water purification.

Greater stability and resistance to degradation

The foldamers developed by the NUS researchers were also demonstrated to be more robust compared to other AWCs.

Normal proteins are made up of amino acids joined together by peptide bonds. These peptide bonds are vulnerable to be cut by microbial enzymes that digest proteins, and such microbes exist in unprocessed water. In their research, NUS scientists replaced the peptide bonds with urea bonds, which makes the oligourea foldamers less susceptible to enzymatic and microbial degradation.

First-of-its-kind protein-mimics that self-assemble into pores

The development of the oligourea foldamers marks the first published attempt to create AWCs using short molecular chains that can self-assemble into precise nanostructures with high porosity and selectivity for water molecules.

Prof Kumar, who has a joint appointment with the NUS Environment Research Institute, said, "The discovery of this new class of artificial water channels is significant because the individual foldamer molecules do not contain any pores, unlike other AWCs where the pores are found within their larger molecular structure. In our novel design, the water-selective

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pores only emerge when the individual units self-assemble. The high-water permeability coupled with resistance to proteolytic degradation makes these foldamers excellent candidates for industrial water purification applications."

Next steps

In the initial phase, the team of scientists applied the foldamers to a test membrane to demonstrate the water purification capabilities of the self-assembling molecules.

For the next phase of research, the team plans to optimize the production of the foldamers and apply them to a larger membrane, before trialing its efficiency in an industrial water purification facility.

Phys.Org, 2 August 2023

https://phys.org

True shape of lithium revealed for the first time

2023-08-02

They descend from another technology, the lithium-metal battery, that hasn't been developed or adopted as broadly. There's a reason for that: While lithium-metal batteries have the potential to hold about double the energy that lithium-ion batteries can, they also present a far greater risk of catching fire or even exploding.

Now, a study by members of the California NanoSystems Institute at UCLA reveals a fundamental discovery that could lead to safer lithium-metal batteries that outperform today's lithium-ion batteries. The research was published today in the journal Nature.

Metallic lithium reacts so easily with chemicals that, under normal conditions, corrosion forms almost immediately while the metal is being laid down on a surface such as an electrode. But the UCLA investigators developed a technique that prevents that corrosion and showed that, in its absence, lithium atoms assemble into a surprising shape—the rhombic dodecahedron, a 12-sided figure similar to the dice used in role-playing games like Dungeons and Dragons.

"There are thousands of papers on lithium metal, and most descriptions of the structure is qualitative, such as 'chunky' or 'column-like,'" said Yuzhang Li, the study's corresponding author, an assistant professor of chemical and biomolecular engineering at the UCLA Samueli School of Engineering and a member of CNSI.

"It was surprising for us to discover that when we prevented surface corrosion, instead of these ill-defined shapes, we saw a singular polyhedron that matches theoretical predictions based on the metal's crystal structure. Ultimately, this study allows us to revise how we understand lithium-metal batteries."

At tiny scales, a lithium-ion battery stores positively charged lithium atoms in a cage-like structure of carbon that coats an electrode. By contrast, a lithium-metal battery instead coats the electrode with metallic lithium. That packs 10 times more lithium into the same space compared to lithium-ion batteries, which accounts for the increase in both performance and danger.

The process for laying down the lithium coating is based on a 200-plus-year-old technique that employs electricity and solutions of salts called electrolytes. Often, the lithium forms microscopic branching filaments with protruding spikes. In a battery, if two of those spikes crisscross, it can cause a short circuit that could lead to an explosion.

Rechargeable lithium-ion batteries power smartphones, electric vehicles and storage for solar and wind energy, among other technologies.

The revelation of the true shape of lithium—that is, in the absence of corrosion—suggests that the explosion risk for lithium-metal batteries can be abated, because the atoms accumulate in an orderly form instead of one that can crisscross. The discovery could also have substantial implications for high-performance energy technology.

"Scientists and engineers have produced over two decades' worth of research into synthesizing metals including gold, platinum and silver into shapes such as nanocubes, nanospheres and nanorods," Li said. "Now that we know the shape of lithium, the question is, Can we tune it so that it forms cubes, which can be packed in densely to increase both the safety and performance of batteries?"

Until now, the prevailing view had been that the choice of electrolytes in solution determines the shape that lithium forms on a surface—whether the structure resembles chunks or columns. The UCLA researchers had a different idea.

"We wanted to see if we could deposit lithium so quickly that we outpace the reaction that causes the corrosion film," said UCLA doctoral student Xintong Yuan, the study's first author. "That way, we could potentially see how the lithium wants to grow in the absence of that film."

The researchers developed a new technique for depositing lithium faster than corrosion forms. They ran current through a much smaller electrode in order to push electricity out faster—much like the way that partially blocking the nozzle of a garden hose causes water to shoot out more forcefully.

A balance was required, however, because speeding up the process too much would lead to the same spiky structures that cause short circuits; the team addressed that issue by adjusting the shape of their tiny electrode.

They laid down lithium on surfaces using four different electrolytes, comparing results between a standard technique and their new method. With corrosion, the lithium formed four distinct microscopic shapes. However, with their corrosion-free process, they found that the lithium formed miniscule dodecahedrons—no bigger than 2 millionths of a meter, or about the average length of a single bacterium—in all four cases.

The researchers were able to see the shape of lithium thanks to an imaging technique called cryo-electron microscopy, or cryo-EM, which beams

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electrons through frozen samples in order to show details down to the atomic level while inhibiting damage to the samples.

Cryo-EM has become ubiquitous in biosciences for determining the structures of proteins and viruses. Use for materials science is growing, and the UCLA researchers had two key advantages.

First, when Li was a graduate student, he demonstrated that cryo-EM can be used to analyze lithium, which falls to pieces when exposed to an electron beam at room temperature. Second, the team performed experiments at CNSI's Electron Imaging Center for Nanomachines, which is home to several cryo-EM instruments that have been customized to accommodate the types of samples used in materials research.

"Cross-pollination between the biology and chemistry communities is producing new ideas," said Matthew Mecklenburg, a co-author of the study and managing director of the imaging center. "We're applying our extensive experience analyzing small molecules, proteins and viruses using cryo-EM methods in new ways to look at battery materials that are sensitive to the electron beam."

Li said the new technique for depositing lithium still requires further work to optimize it.

Phys.Org, 2 August 2023

https://phys.org

"Molecular wedge" renders superbugs vulnerable to antibiotics again

2023-08-01

For much of human history, bacterial infections were a common part of life, and often deadly. But in the early 20th century, scientists discovered a new class of bacteria-fighting medicine, starting with penicillin. These antibiotics helped scientists and doctors perform procedures much more safely and effectively than ever before, and reduce the deadliness of infections like tuberculosis.

But of course, things didn't stay so rosy. Bacteria are proficient adapters, rapidly evolving defenses against each drug we threw at them, so we had to keep developing new ones. Over time, we've exhausted our arsenal to the point where there are now "superbug" bacteria that are completely resistant to every antibiotic we have, and the production line of new ones is drying up. This threatens us with a future where once-routine infections become potentially deadly again.

We're locked in an arms race with bacteria – and worryingly, it looks like we're losing, as they increasingly develop resistance to our best drugs. Now, scientists at the University of Oklahoma have identified a new class of molecules that disable a major superbug weapon, which could make existing antibiotics effective again.

Now, scientists have demonstrated a new way to counter one of the most effective bacterial defense strategies. Some species have evolved efflux pumps – proteins on the bacterial membrane that flush out antibiotic molecules that try to enter the cell. This has worked well for the superbugs so far, but the team has now identified molecules that effectively inhibit these efflux pumps.

The scientists discovered that these inhibitors work like a "molecular wedge," driving themselves between the inner and outer cell membranes of the bacteria. That prevents the protein parts of the pump from sending signals to each other in response to the presence of a drug, which lets the antibiotic go to work in the cell. The team says these molecules could be administered alongside existing antibiotics to make the drugs effective once again.

"We already live in a post-antibiotic era, and things will get much worse unless new solutions are found for antibiotic resistance in clinics," said Helen Zgurskaya, lead author of the study. "The discoveries we've made will facilitate the development of new treatments to help mitigate an impending crisis."

The research was published in the journal Nature Communications.

New Atlas, 1 August 2023

https://newatlas.com

Old mattresses made new: Simple chemistry can recycle polyurethane

2023-08-01

Now, together with Plixxent A/S, Dan-Foam Aps and the Danish Technological Institute as part of the Danish RePURpose consortium, the same researchers have proven that the method can be used to tackle flexible foam polyurethane.

They have broken down approximately 1.5 kilos of foam mattress, extracted its main components, and used one of them, polyol, as a raw material in a new piece of mattress. By replacing "fresh" polyol, which is primarily produced from crude oil, with polyol extracted from the old mattress, the researchers have replaced 64% of the mattress, without impairing quality in any way.

It created something of a stir back in 2022, when researchers from Aarhus University announced a new and inexpensive way of breaking down polyurethane (PU) plastic into its original components, which can then be recycled into new PU material instead of ending up in landfills or incinerators.

They have also demonstrated that the process can be repeated several times. In other words, the polyol can be re-extracted from polyurethane foam and reused again.

The results have just been published in the journal ACS Sustainable Chem & Engineering.

Much-needed solution

This takes us a step further towards a circular economy for flexible PU foam, and it is desperately needed. The vast majority of global PU waste is deposited in landfills because it is difficult to recycle. PU cannot be melted, and for this reason it is not possible to simply mold it into new products like many other plastics.

The global market for PU was 24.7 million tons in 2021, and it is expected to exceed 29 million tons by 2029. The flexible PU foam used in mattresses accounts for about 30% of the market.

PU is not only used in mattresses; it is a group of advanced plastic materials with many different properties and even more applications. It is also used in furniture, refrigerators, shoes, toys, paints, fillers, insulation, cars, wind turbines, aircraft and much more.

Requires waste control

The method developed and patented by the chemists at Aarhus University is called solvolysis, and breaks down the chemical bonds in PU by putting the material in a sort of pressure cooker with hot tert-amyl alcohol and a little caustic potash.

However, the researchers do not expect that this process can be used for the entire PU market. The different types of PU are too different.

"Our technique can push society towards a circular economy for PU mattresses. But if recycling is to put and end to landfilling and incineration, industry and society need full control of waste streams. The problem is that each manufacturer of PU-based materials has its own unique recipe," says Assistant Professor Steffan Kvist Kristensen from the Interdisciplinary Nanoscience Center (iNANO) at Aarhus University, who is a co-author of the study.

Phys.Org, 1 August 2023

https://phys.org

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Multicyclic molecular wheels with polymer potential

2023-08-02

Now, researchers at Hokkaido University have taken the previous achievements of this technology a step further, making macro-rotaxanes that have multicyclic wheels interlocked with several high-molecular-weight axles. They report their innovation in the journal Angewandte Chemie International Edition.

Rotaxanes, initially regarded as intriguing chemical curiosities, are now being explored for a wide range of potential applications, ranging from next-generation polymers to ambitious possibilities in molecular computing, sensor technologies and drug delivery.

The Hokkaido University researchers, with collaborators elsewhere in Japan, are focusing their attention on making new network polymers, in which ring structures more complex than simple circles hold together different strands of long polymer chains.

Rotaxanes are interlocked molecular structures with a linear 'axle' molecule penetrating one or more cyclic 'wheel' molecules. Bulky groups at the end of the axle prevent the wheels from coming off.

"We think the multicyclic structures in these macro-rotaxanes could be useful as non-leaching additives, permanently retained in a polymer network by the way they hold onto several neighboring polymer chains," says polymer chemist Professor Toshifumi Satoh of the Hokkaido team.

The 3D wheels act as a unique and highly flexible form of molecular crosslinks, allowing the wheels and the interlocked polymer strands much more freedom of movement than in conventionally cross-linked networks. Structural variations should allow fine control over the properties of soft materials to make them suitable for a variety of industrial and medical applications.

Other research groups have achieved some similar success with smaller molecular arrangements, but the advances at Hokkaido University move the field into the realm of larger molecules.

The researchers explored some of the possibilities of this significant new development in polymer chemistry using chemicals called polydimethylsiloxanes (PDMSs) to make the multicyclic rings. They were able to build different numbers of cyclic units with rings of different sizes. When combined with silicone polymer chains with short crosslinking agents, the multicyclic units became efficiently incorporated into a newly-forming extended, mixed and interlocked network.

"We explored some of the potential for making modified soft materials by measuring the damping performance of the networks, which is essentially

the ability of a material to absorb and reduce vibrations," says Satoh. "This revealed that our macro-rotaxanes achieved significant improvements in damping efficiency relative to conventional polymer networks."

Satoh and his colleagues now plan to explore further possibilities that can be built on the proof-of-concept foundations laid by their current progress.

Phys.Org, 2 August 2023

https://phys.org

Essential Amino Acids: Chart, Abbreviations and Structure

2023-07-18

There are 20 amino acids that make up proteins and all have the same basic structure, differing only in the R-group or side chain they have. The simplest, and smallest, amino acid is glycine for which the R-group is a hydrogen (H). They can be subdivided according to their properties, dictated by the functional groups they possess. Broadly they are divided by charge, hydrophobicity and polarity. These properties influence the way they interact with surrounding amino acids in polypeptides and proteins, and consequently impact protein 3D structure and properties.

Amino acid abbreviations

This table shows the abbreviations and single letter codes used for the 20 amino acids found in proteins. In addition, pyrrolysine, used in the biosynthesis of proteins in some archaea and bacteria but not present in humans, and selenocysteine, a cysteine analogue only found in some lineages, are included in blue. Finally, abbreviations used for amino acid residues with more than one potential identity, and the termination codon are shown in red to complete the alphabet of single letter abbreviations.

Properties of the carboxyl group

- All amino acids have a carboxyl group and an amino group.
- During amino acid polymerization, the carboxyl group of one amino acid is linked to the amino group of the next amino acid via a peptide bond with the loss of a water molecule.

Properties of hydrophobic amino acids

Amino acids are the building blocks that form polypeptides and ultimately proteins. Consequently, they are fundamental components of our bodies and vital for physiological functions such as protein synthesis, tissue repair and nutrient absorption. Here we take a closer look at amino acid properties, how they are used in the body and where they come from.

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- Amino acids that fall under the classification of hydrophobic are alanine, valine, isoleucine, leucine, methionine, phenylalanine, tryptophan and tyrosine.
- As their classification suggests, the side chains tend to be repelled from water, so this impacts the positioning of these amino acids in the protein tertiary structure.

Properties of polar amino acids

- Polar amino acid residues are typically found on the outside of a protein following polymerization due to the hydrophilic properties of the side chain.
- Four amino acids are classed as polar but not charged (asparagine, glutamine, serine and threonine).

Properties of aromatic amino acids

- The aromatic amino acids (phenylalanine, tyrosine and tryptophan), whilst all falling within other classifications, possess aromatic side chains.
- Consequently, to different degrees, they all absorb ultraviolet light, with tyrosine absorbing the most and phenylalanine the least.

Protein synthesis definition and the amino acid code

To form a protein, amino acids are polymerized with the formation of a peptide bond, starting at the N-terminus and ending at the C-terminus.

- A messenger RNA (mRNA) copied from DNA provides the instruction of which amino acid to incorporate at which position for the synthesis of a specific protein.
- At the ribosome, a transfer RNA (tRNA) binds to one end of the mRNA and carries the required amino acids at the other end.
- Additional protein factors aid in the initiation, elongation and termination of protein synthesis.
- The genetic information required to determine which amino acid needs to be incorporated at which position is encoded as a series of three bases, or triplets, in the mRNA, also called the triplet code. The 64 possible triplets and the amino acids they specify are called the genetic code or amino acid code.
- Many of the amino acids are encoded by more than one triplet code, such as arginine, which is added when CGU, CGC, CGA or CGG is encountered. In most organisms three (and sometimes two) of the triplets signal chain termination.

Nine essential amino acids and amino acid supplements

The human body is able to synthesize 11 of the 20 amino acids, however the other nine we cannot. This is likely as a result of gene loss or mutation over time in response to changing selective pressures, such as the abundance of particular food containing specific amino acids. These are therefore termed essential amino acids and must be acquired through our diet.

Particular animal species are able to synthesize different amino acids and, accordingly, their dietary requirements differ. Humans for example are able to synthesize arginine, but dogs and cats cannot – they must acquire it through dietary intake. Unlike humans and dogs, cats are unable to synthesize taurine. This is one of the reasons that commercial dog food is unsuitable for cats. For humans, the nine amino acids that must be acquired through diet are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.

Foods that contain all nine essential amino acids are referred to as "complete proteins", and include meat, seafood, eggs, dairy products, soy, quinoa and buckwheat. Other protein sources, such as nuts, seeds, grains and beans, contain some but not all essential amino acids and are therefore referred to as incomplete.

Let's talk supplements. All of your bodies' essential amino acid needs can be met by having a healthy, balanced diet. However, there are some advocates for taking high concentration supplements to improve factors such as mood, sleep, exercise performance, weight loss and prevent muscle loss. Look on many "health and wellbeing" pages and there are people peddling the benefits of amino acid supplements, but is there good evidence to back this up?

The essential amino acid tryptophan is required for the production of serotonin, a neurotransmitter with an important role in sleep, mood and behavior. Consequently, the effects of manipulating tryptophan levels on sleep and mood have been investigated in a number of studies. Whilst there is evidence that depleting tryptophan levels can negatively impact sleep and mood, many studies suffer from small sample sizes, lack of sufficient controls or other failings. Consequently, whilst it is clearly a key component in the diet and there may be potential for supplementation to have beneficial effects, evidence to support the administration of tryptophan above and beyond what can be consumed in a healthy diet is currently lacking and further investigation is required.

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Whilst there are some studies suggesting taking amino acid supplements can have positive effects on exercise performance in some groups, results vary greatly between studies, with many studies demonstrating little or no benefit. A clinical trial is also looking at the consequences of taking an amino acid food supplement on skin photoaging but the results are yet to be revealed.

Technology Networks, 18 July 2023

https:// https://www.technologynetworks.com/

Novel molecules fight viruses by bursting their bubble-like membranes

2023-08-02

"We found an Achilles heel of many viruses: their bubble-like membranes. Exploiting this vulnerability and disrupting the membrane is a promising mechanism of action for developing new antivirals," said Kent Kirshenbaum, professor of chemistry at NYU and the study's senior author.

In a new study published Aug. 2 in the journal ACS Infectious Diseases, the researchers show how a group of novel molecules inspired by our own immune system inactivates several viruses, including Zika and chikungunya. Their approach may not only lead to drugs that can be used against many viruses, but could also help overcome antiviral resistance.

The urgent need for new antivirals

Viruses have different proteins on their surfaces that are often the targets of therapeutics like monoclonal antibodies and vaccines. But targeting these proteins has limitations, as viruses can quickly evolve, changing the properties of the proteins and making treatments less effective. These limitations were on display when new SARS-CoV-2 variants emerged that evaded both the drugs and the vaccines developed against the original virus.

"There is an urgent need for antiviral agents that act in new ways to inactivate viruses," said Kirshenbaum. "Ideally, new antivirals won't be specific to one virus or protein, so they will be ready to treat new viruses that emerge without delay and will be able to overcome the development of resistance."

"We need to develop this next generation of drugs now and have them on the shelves in order to be ready for the next pandemic threat—and there will be another one, for sure," added Kirshenbaum.

Antiviral therapies are notoriously difficult to develop, as viruses can quickly mutate to become resistant to drugs. But what if a new generation of antivirals ignores the fast-mutating proteins on the surface of viruses and instead disrupts their protective layers?

Drawing inspiration from our immune systems

Our innate immune system combats pathogens by producing antimicrobial peptides, the body's first line of defense against bacteria, fungi, and viruses. Most viruses that cause disease are encapsulated in membranes made of lipids, and antimicrobial peptides work by disrupting or even bursting these membranes.

While antimicrobial peptides can be synthesized in the lab, they are rarely used to treat infectious diseases in humans because they break down easily and can be toxic to healthy cells. Instead, scientists have developed synthetic materials called peptoids, which have similar chemical backbones to peptides but are better able to break through virus membranes and are less likely to degrade.

"We began to think about how to mimic natural peptides and create molecules with many of the same structural and functional features as peptides, but are composed of something that our bodies won't be able to rapidly degrade," said Kirshenbaum.

The researchers investigated seven peptoids, many originally discovered in the lab of Annelise Barron at Stanford, a co-author of the study. The NYU team studied the antiviral effects of the peptoids against four viruses: three enveloped in membranes (Zika, Rift Valley fever, and chikungunya) and one without (coxsackievirus B3).

"We were particularly interested in studying these viruses as they have no available treatment options," said Patrick Tate, a chemistry Ph.D. student at NYU and the study's first author.

How peptoids disrupt viral membranes and avoid other cells

The membranes surrounding viruses are made of different molecules than the virus itself, as lipids are acquired from the host to form membranes. One such lipid, phosphatidylserine, is present in the membrane on the outside of viruses, but is sequestered towards the interior of human cells under normal conditions.

"Because phosphatidylserine is found on the exterior of viruses, it can be a specific target for peptoids to recognize viruses, but not recognize—and therefore spare—our own cells," said Tate. "Moreover, because viruses acquire lipids from the host rather than encoding from their own genomes, they have better potential to avoid antiviral resistance."

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The researchers tested seven peptoids against the four viruses. They found that the peptoids inactivated all three enveloped viruses—Zika, Rift Valley fever, and chikungunya—by disrupting the virus membrane, but did not disrupt coxsackievirus B3, the only virus without a membrane.

Moreover, chikungunya virus containing higher levels of phosphatidylserine in its membrane was more susceptible to the peptoids. In contrast, a membrane formed exclusively with a different lipid named phosphatidylcholine was not disrupted by the peptoids, suggesting that phosphatidylserine is crucial in order for peptoids to reduce viral activity.

"We're now starting to understand how peptoids actually exert their antiviral effect—specifically, through the recognition of phosphatidylserine," said Tate.

The researchers are continuing pre-clinical studies to evaluate the potential of these molecules in fighting viruses and to understand if they can overcome the development of resistance. Their peptoid-focused approach may hold promise for treating a wide range of viruses with membranes that can be difficult to treat, including Ebola, SARS-CoV-2, and herpes.

Phys.Org, 2 August 2023

https://phys.org

Previously Unknown Sources of Methane Greenhouse Gas Discovered in Hamburg

2023-07-19

After carbon dioxide, methane is the second most common greenhouse gas caused by human activity. Moreover, over a 20-year period, its global warming potential is more than 80 times that of carbon dioxide. The largest known sources are wetland, agriculture, waste, and fossil fuel production. Methane has a much shorter atmospheric lifetime than CO2 (around 12 years compared with centuries for CO2). Consequently, the reduction of methane emissions has considerable potential for limiting global warming in the short to medium term.

Methane emissions in cities

A substantial portion of global methane emissions occurs in cities. There are many locations where methane is released – intentionally or accidentally. The research team at the Technical University of Munich (TUM) selected Hamburg as a location to track down methane leaks and

Reducing methane emissions is considered a strong lever for achieving rapid progress in slowing global warming. That is because methane, unlike carbon dioxide, has a relatively short average atmospheric lifetime of around 12 years. In urban areas, methane sources are often unknown or underestimated. A team of researchers has undertaken a search for gas leaks and other sources of escaping methane in Hamburg.

other unknown sources. Hamburg is not only Germany's second-largest city by population. It is also a port and an industrial center. With its various methane sources, it offers ideal conditions for the project.

Numerous methane sources discovered in Hamburg

Through the project, the team succeeded in identifying numerous previously undetected methane sources in Hamburg. Along with natural sources such as the Elbe River, the largest share of emissions is caused by human activity. Around half of these emissions come from leaking gas pipelines, incomplete combustion, and other industrial and fugitive emissions. The mobile measurements also made it possible for the researchers to detect unknown methane sources. They discovered that around 2 percent of human-caused methane emissions in Hamburg originated from leaking pipes at one oil refinery and a nearby cattle farm, which are highly underestimated in the state-of-the-art emission inventory.

Updating existing emission data

The researchers began with an emission map from the Dutch research institute TNO. It provides a spatial representation of greenhouse gas emissions in Hamburg, based on national reported emissions that have been spatially distributed using proxy data (population density map, etc.). To check and update the values shown on the map, the team selected two approaches:

"First, we conducted mobile measurements using a car equipped with sensors. We drove it through areas, where we expected to detect methane emissions, to gain a better understanding of the spatial distribution. Second, we used our sensor network to measure the overall emissions in the city. The network is made up of four measurement devices, which we used in previous studies to measure emissions in Munich," says Jia Chen, Professor of Environmental Sensing and Modeling at TUM. "Our sensor network uses the sun as a light source. Because every molecule in the atmosphere absorbs only specific frequencies of the sunlight, we can determine the concentrations of the various greenhouse gases in the column of air between our measurement device and the sun."

Measurements in and around Hamburg

To find out the quantities of greenhouse gases being emitted within Hamburg, the researchers positioned one measurement device in the

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city center, with the others placed in the eastern, southern and western outskirts.~swebsite, date

"That meant that one sensor is always upwind from the city, with another one positioned downwind. If the second measurement value is higher than the first, we can use atmospheric transport models to quantify the greenhouse gases being released in the city. For this purpose, we measure wind speed, wind direction and turbulence with an optical wind LiDAR," says Andreas Forstmaier, first author of the study and researcher at the Professorship of Environmental Sensing and Modeling.

Future use of measurement technology

The method designed for cities will be expanded in the future to perform global measurements using satellites. With this work, the researchers aim to make a decisive contribution to understanding climate change and slowing down its progress.

Technology Network, 19 July 2023

https://technologynetwork.com

A low-tech way to create high-tech materials

2023-08-02

With a simple setup, the researchers can precisely control the width of the bands and their spacing. This could be a straightforward and cost-effective way to produce optics, electronics, or sensors. The research was published in the journal Advanced Materials on August 2, 2023.

In all its simplicity, the experiment and its results are remarkable. The plastic sheet appears rather ordinary with its brownish color. However, when a laser beam passes through it, a pattern of dots emerges on the other side: the result of the regular narrow bands of crystals embedded in the plastic, invisible to the naked eye.

Typically, such precise control over pattern formation for electronics requires expensive and complex techniques like lithography. Van Campenhout conducts his research in the Self-organizing matter group led by Wim Noorduin, in collaboration with the Mechanical Materials group led by Martin van Hecke.

The goal is to discover simple, nature-inspired methods to create such components. "In nature, you find regular patterns everywhere, from the stripes of a zebra to the patterns on a butterfly wing. We want to use a

AMOLF researcher Christiaan Van Campenhout has found a new, simple method to create a material with a regular pattern of crystalline bands. The pattern formed by the crystals is not a coincidence.

self-organizing, biologically inspired strategy to create high-tech materials. This research is a good step in that direction."

Dipping instead of shrinking

The crystals in the pattern form through a chemical reaction between a substance in a gel (which solidifies into a plastic sheet after the experiment) and a substance in a solution that diffuses into the gel. The formation of crystal bands in this so-called reaction-diffusion process was already known.

In 2022, the researchers published an article demonstrating that they could create a regular band structure by slightly shrinking the gel. This observation got them thinking: can it not be simpler than shrinking?

"We noticed that the liquid level and the location of the reaction in the gel remained at an equal distance from each other during the shrinkage. This leads to the regular band structure. We thought that we might achieve the same result by gradually dipping the gel into the liquid instead of letting the liquid diffuse into the gel," explains Van Campenhout.

This straightforward setup worked right away. The process was named R-DIP: reaction-diffusion driven immersion-controlled patterning.

Smaller bands for applications

It quickly became evident that the distance between the bands depends on the speed at which the liquid level rises. The faster you dip the gel into the liquid, the closer the bands will be to each other. Initially, the distance between the bands was 200 micrometers (0.2 mm) with a variation of only 6 micrometers. Currently, the smallest band distance is 7 micrometers.

"For many interesting applications, it's essential to have the bands even closer together, around 0.2 micrometers or less," says Van Campenhout. The research will focus on achieving that goal in the coming period. Van Campenhout also demonstrated that the method is scalable—it works with a sheet the size of an A4 piece of paper.

"This suggests that it's suitable for roll-to-roll production, a method already used for large-scale electronics manufacturing." Additionally, you can overlay several sheets with bands, each one slightly rotated. "This allows us to create a polarizing film for items like sunglasses and lenses."

Another application is an ultra-sensitive pressure sensor. When you place two layers parallel to each other, they create a so-called Moiré pattern,

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which changes as the layers are slightly pressed together. "You can observe a visible change with the naked eye when the gel is pressed for 20 micrometer," explains Van Campenhout.

In the future, Van Campenhout will investigate whether he can change the composition of the bands through chemical modifications to make them more suitable for applications. This could possibly be achieved using methods previously developed by Noorduin's group to convert calcium carbonate into semiconductors.

Moreover, the films resemble photographic film, in which silver salts also contribute to color and contrast. "We are investigating whether we can apply the chemical knowledge from photography to develop films for other applications."

Phys.Org, 2 August 2023

https://phys.org

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2023-08-02

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Phys.Org, 2 August 2023

https://phys.org

Proton battery: hydrogen without the gas

2023-07-27

Now researchers have combined the best of both worlds, with an experimental battery that uses hydrogen.

Their fast-charging "proton battery" is made with completely renewable resources, and operates mostly on water and activated carbon.

Hydrogen: it's an energy-dense abundant resource, but also a gas that's difficult to store and transport. Batteries: excellent at storing energy, but containing precious metals like lithium and cobalt.

The researchers, based at RMIT University in Melbourne, have made a proton battery only powerful enough to run a handheld fan for a few minutes.

But by weight, these tiny batteries are already comparable with lithium-ion.

A partnership with an Italian company hopes to see a prototype big enough for home storage within a couple of years.

"The proton battery has evolved from our attempts to get a simpler, more efficient, hydrogen-based energy storage system," says research lead Professor John Andrews, a renewable energy specialist at RMIT University.

Traditional green hydrogen fuel systems take water (H_2O), and use electricity to split it into hydrogen gas (H_2) and oxygen gas (O_2).

But this reaction has a few more steps hidden within it: the hydrogen atoms are first converted into positively charged hydrogen ions (H^+), before they pair up and become H_2 gas.

Then, hydrogen is burned or reacted with oxygen again, releasing energy and water once more.

"The basic reaction that we're using is similar to what is used in a hydrogen fuel cell-based energy storage system," explains Andrews.

"So we start with water, we split that in a cell that's very like an electrolyser that's used in a hydrogen system, and then you get protons, H^+."

Hydrogen atoms mostly just have one positively charged proton and one negatively charged electron. Remove the electron, and you have an H^+ ion – or, in other words, a proton.

"Protons are then passed through a membrane, same as in a fuel cell, but they then enter a porous carbon electrode that is negatively charged. The protons are then stored within this carbon matrix," says Andrews.

"In your normal hydrogen system, those protons combine in pairs with electrons to give you hydrogen gas, and then you have to store the hydrogen gas.

"But in the proton battery, there's no gas. We're storing protons directly in the carbon electrode, which is part of the cell."

Then, when it's time to discharge the battery, those protons react with oxygen in the air, releasing energy and generating water again.

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Curiosities
AUG. 04, 2023

"We've cut out that step of producing and having to store hydrogen gas. The protons are stored directly, which is safer, and it is much more energy efficient," says Andrews.

The electrode which stores these protons best is a type of material called activated carbon.

"Activated carbon is a carbon that's been hollowed out, and it's got a very high internal surface area. It's got lots of pores and channels connecting the pores," says Andrews.

The carbon can be made from any number of feedstocks.

"You can make it from wood and charcoal, you can make it from wheat straw, you can make it from coal," says Andrews.

"We're quite optimistic about the eventual economics of the device. Because the primary sources are very abundant and very cheap.

"As long as we can get a procedure to convert them to activated carbon that is very cost-effective – which, again, we're quite optimistic about – we think that should really mean that we can get a very cost-effective proton battery."

The RMIT researchers have partnered with automotive company Eldor Group, and are hoping to scale their technology up over the next two years.

"We're looking to get to near a kilowatt scale by the end of this two years," says Andrews.

This would make it on par with small home storage batteries, which is the researchers' primary target. They're also toying with smaller scale devices, like solar lights.

"In the future, there's no reason why we shouldn't be looking at applying a similar sort of proton battery to the automotive area, but we're taking it step by step," says Andrews.

Cosmos Magazine, 27 July 2023

https://cosmosmagazine.com

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Technical Notes

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CHEMICAL EFFECTS

Evaluation of the cytotoxicity and genotoxicity of glufosinate-ammonium at technical and commercial grades in HepG2 cells

Investigation of Damage and Creep for Bedding's Carbonaceous Slate with Chemical Erosion Effect

Reactive Palladium-Ligand Complexes for 11C-Carbonylation at Ambient Pressure: A Breakthrough in Carbon-11 Chemistry

ENVIRONMENTAL RESEARCH

Mechanism of bonding, surface property, electrical behaviour, and environmental friendliness of carbon/ceramic composites produced via the pyrolysis of coal waste with polysiloxane polymer

Practical application guide for the discovery of novel PFAS in environmental samples using high resolution mass spectrometry

PHARMACEUTICAL/TOXICOLOGY

Current Review of Increasing Animal Health Threat of Per- and Polyfluoroalkyl Substances (PFAS): Harms, Limitations, and Alternatives to Manage Their Toxicity

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Bacteriophage-based biosensors for detection of pathogenic microbes in wastewater

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