CHEMWATCH

Bulletin Board

Contents

JUL. 14, 2023

(click on page numbers for links)

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CHEMWATCH

Bulletin Board

Contents

JUL. 14, 2023

GOSSIP

CURIOSITIES

CHEMWATCH

Bulletin Board

Contents

JUL. 14, 2023

TECHNICAL NOTES

ASIA PACIFIC

Council calls for tighter regulation on 'water mining' near Springbrook's world heritage rainforest

2023-07-01

There are growing calls for tighter regulations on the extraction of water within a stone's throw from a UNESCO world heritage rainforest in the Gold Coast hinterland.

More than 50 million litres of water is permitted to be extracted from bores near Springbrook National Park each year before it's trucked away and sold as bottled drinking water.

While there are a range of other uses for groundwater in the area, the impacts of water extraction on the surrounding environment is "virtually unknown", according to the Gold Coast City Council.

The controversial process has prompted the council to fund a study into the impacts on the aquifer, and the Queensland government enforcing an ongoing ban on new commercial underground bores in the area.

Springbrook resident and environmental activist Ceris Ash wants the ban to be permanent.

"The water isn't regulated as far as the state government is concerned," Ms Ash said.

Read More

ABC, 01-07-23

https://www.abc.net.au/news/2023-07-01/springbrook-bottled-water-regulation-gold-coast-logan-water-plan/102414532

China Introduces the First Standard for Micro-Ecological Cosmetics

2023-07-05

China has taken a major stride in standardizing the efficacy evaluation of micro-ecological cosmetics with the recent release and implementation of two group standards.

CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 14, 2023

Micro-ecological cosmetics, which typically include microbial-derived ingredients like probiotics, prebiotics, and postbiotics, offer benefits in restoring and maintaining the balance of the skin's microbiome, leading to the improvement of the overall skin condition.

Read More

Chemlinked, 05-07-23

https://cosmetic.chemlinked.com/expert-article/china-introduces-the-first-standard-for-micro-ecological-cosmetics

New Zealand becomes first country to ban single-use produce bags at grocery stores

2023-07-03

Customers in New Zealand already are expected to bring their own shopping bags to grocery stores. Now they also will be asked to carry their own reusable bags for fruits and vegetables.

New Zealand is considered the first country in the world to ban single-use produce bags at supermarkets. The measure officially went into effect on July 1.

Single-use plastics can cause a multitude of problems, including clogging storm sewers, littering landscapes and killing wildlife. New Zealand Secretary for the Environment James Palmer anticipates that the new ban will eliminate 150 million plastic produce bags from circulation each year.

"That's 17,000 plastic bags, every hour," Palmer said in a statement.

In 2019, New Zealand no longer allowed stores to provide single-use plastic shopping bags. This measure takes waste-reducing efforts a step further by banning recyclable, biodegradable or plant-based plastic. Instead, customers are encouraged to carry mesh, paper or canvas bags to hold their produce.

Countries across the globe slowly have been moving away from single-use plastic bags — either imposing fees to use them or banning them from stores.

Through the United Nations Environment Assembly, representatives from 175 nations are working through the end of 2024 to forge an international plan to end plastic pollution.

Read More

NPR, 03-07-23

https://www.npr.org/2023/07/03/1185758479/new-zealand-single-use-plastic-produce-bag-ban-grocery-stores

AMERICA

EPA Receives Thousands of Comments On its Proposed PFAS Maximum Contaminant Levels

2023-06-30

As discussed in a previous post, the United States Environmental Protection Agency (EPA) proposed a National Primary Drinking Water Regulation to establish maximum contaminant levels for six different PFAS compounds: perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), hexafluoropropylene oxide dimer acid (HFPO–DA) and its ammonium salt (also known as GenX chemicals), perfluorononanoic acid (PFNA), and perfluorobutane sulfonic acid (PFBS). EPA accepted public comments regarding the proposal until May 30, 2023; per EPA's docket, EPA received over 120,000 comments in total. Commentators ranged from individuals to industry trade groups, chambers of commerce, state regulatory agencies, and local water authorities.

Many commentators posted substantive comments and critiques of EPA's proposed MCLs. Commentators include industry trade groups, state regulatory agencies, and local water service providers. Comments ranged from the depth and adequacy of the data EPA relies on to support its proposal to EPA's legal authority to develop its proposed MCLs. Many commentators also identified practical barriers, such as the limited number of available laboratories that can analyze samples for PFAS using approved EPA methods.

Some industry trade groups asserted that:

1. EPA's determination to regulate PFHxS, HFPO-DA, PFNA, and PFBS is inconsistent with the criteria under the federal Safe Drinking Water Act;

CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 14, 2023

2. EPA's health effects assessment selectively relies on data from a limited number of studies;

3. Establishing a hazard index (HI) as a basis for an MCL is contrary to EPA policy;

4. EPA should not regulate PFOA, PFOS, or other PFAS as "likely carcinogens."

Some water service provider entities asserted that:

1. EPA's cost estimate for its proposal is much lower than expected costs;

2. EPA significantly overestimates the quantifiable benefits of its proposal;

3. EPA's action will disproportionately impact economically disadvantaged and underserved communities.

Read More

JD Supra, 30-06-23

https://www.jdsupra.com/legalnews/epa-receives-thousands-of-comments-on-7654779/

PFAS Food Packaging Regulations Boil Over: Time to Develop a Compliance Plan

2023-06-30

- Vermont's ban on per- or polyfluoroalkyl substances (PFAS) in food packaging will be the most recent ban when it takes effect on July 1, 2023.
- The vast majority of these chemicals have not been studied, but recent research suggests that certain PFAS – which are found in food packaging – may cause adverse health effects in humans.
- This Holland & Knight alert focuses on the current state regulatory landscape for PFAS in food packaging.

Forever chemicals are about to be forever regulated. With the most recent ban on per- or polyfluoroalkyl substances (PFAS) in food packaging set to go in effect in Vermont on July 1, 2023, this Holland & Knight alert focuses on the current state regulatory landscape for PFAS in food packaging. The two-sentence takeaway: Plot your PFAS compliance path now. Inaction is not a path towards compliance.

PFAS and Their Effects

The term PFAS refers to an entire family of wholly synthetic chemicals. Most state statutes and regulations that regulate the use of these substances in food packaging define PFAS broadly as any compound with at least one fully fluorinated carbon atom. Though estimates vary, as many as 12,000 unique compounds may exist within this family. The vast majority of these chemicals has not been studied, but recent research suggests that certain PFAS may cause adverse health effects in humans.

While more research is needed, some studies also suggest human exposure to PFAS comes from food packaging. Indeed, several major restaurant chains have already committed to phasing out PFAS from their food packaging. For these reasons, 19 states have either passed legislation banning PFAS in food packaging or have legislation pending that would regulate PFAS in food packaging (California, Colorado, Connecticut, Hawaii, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont and Washington). Where bans are not in effect or pending, some states have opted to commission research to study how PFAS attach to food and what action the state should take.

Current State Regulations on Food Packaging and Compliance Difficulties

State legislative action varies. For instance, some PFAS food packaging bans only apply to plant-based packaging, whereas others apply to any packaging that has direct contact with food. In states such as Maine, a notification period may precede any outright ban on PFAS within food. Some, but not all, states provide exemption provisions for PFAS where a less harmful chemical is unavailable to accomplish the same purpose. Yet, given the state of Washington's recent study finding four safer alternatives to PFAS in food packaging, companies may struggle to find exemptions even when available. The bottom line: Intense regulation is already here in a variety of states and imminent in others.

Finding the right compliance recipe is difficult. For starters, the limited amount of research on PFAS has practically resulted in an outright ban, regardless of a given chemical compound's properties. Although some analytical methods exist for PFAS, more development in this area is also needed. For example, one common analytical method measures the total organic fluorine within a medium as a proxy for PFAS presence. This may result in the overestimation of the presence of PFAS and therefore the potential risks. The sheer number of chemicals to consider creates both

CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 14, 2023

compliance and administrative enforcement difficulties, too. Maine, for instance, the sponsor of one of the most aggressive PFAS bans, has had to push back its reporting requirement deadline and seek more funding.

The statutes themselves present compliance difficulties as well. For example, several statutes apply bans only to "intentionally added" PFAS. The definition of this phrase differs across states. Some states have construed "intentionally added" to mean only if a specific characteristic is sought, or only if an intended function is sought. Other states set limits even for the incidental presence of PFAS. The vagueness of these definitions may result in differing interpretations and standards across the country. A conglomeration of states in the Northeast corridor are also working on a model PFAS bill that may result in changes to all of the existing state statutes. Monetary penalties can be $100 per violation, which, on a per-package basis, will result in hefty fines quickly. Recent remediation settlements for PFAS exposure in drinking water systems have been in the billions-of-dollars range. Given these costs, clarity on these laws and necessary compliance efforts were needed yesterday.

Read More

JDSupra, 30-06-23

https://www.jdsupra.com/legalnews/pfas-food-packaging-regulations-boil-8798448/

California City Cancels Fireworks Shows for Fourth of July Due to Environmental Regulations

2023-07-02

Los Angeles has canceled several Fourth of July fireworks shows scheduled to take place along the city's coastline due to new environmental regulations. The regulations, which were put in place to protect the local ecosystem, require that cities in the area reduce the pollution and debris generated by fireworks displays.

Redondo Beach Cancels 4th of July Fireworks Display Due to New Pollution Rules

New Environmental Regulations

The new regulations require that cities in the Los Angeles area reduce the pollutants released into the air during fireworks displays. This includes limiting the amount of smoke and debris that is generated by the

fireworks, as well as reducing the amount of chemicals that are used in the production of the fireworks.

Impact on Fourth of July Celebrations

The cancellation of the Fourth of July fireworks shows is a disappointment for many residents of Los Angeles, who look forward to the annual event as a highlight of the summer. The displays typically draw large crowds to the city's beaches and waterfront areas and are a significant source of revenue for local businesses.

Read More

Maryland News, 02-07-23

https://morningsidemaryland.com/california-city-cancels-fireworks-shows-for-fourth-of-july-due-to-environmental-regulations/

EUROPE

Publication of GB MCL Agency Opinions

2023-07-05

A GB MCL Agency Opinion formally proposes the GB mandatory classification and labelling for chemical substances, based on the scientific and technical assessment of the scientific data in line with the GB CLP Regulation, together with an assessment of the policy and socio-economic impacts on the UK.

It sets out whether there is adequate scientific evidence to support a new or revised GB MCL of a substance and what the potential impact of the proposed GB MCL may be.

The next batch of 7 GB MCL Agency Opinions are now available for download in the GB MCL publication table (.xlsx).

These GB MCL Agency Opinions relate to substances for which HSE (as the GB CLP Agency) published an Agency Technical Report under Article 37 of the GB CLP Regulation in June 2022.

At the time of publication, the classification and labelling proposed in this Agency Opinion has not been agreed and/or adopted in Great Britain.

For information on the next steps in the process, please see our webpage on the GB MCL system.

CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 14, 2023

We expect to publish our next batch of Agency Opinions in August 2023. CLP ebulletin alerts will be issued when Agency Opinions are published on the HSE website.

If you have any questions or feedback on the GB MCL Agency Opinions, please contact us at: GBCLP.GBMCL@hse.gov.uk

Read More

HSE, 05-07-23

https://www.hse.gov.uk/chemical-classification/gb-mcl-list.htm

ZWE examines aspects and challenges of sustainable packaging in three reports

2023-06-22

On June 22, 2023, eunomia and Zero Waste Europe published a report examining the Net Zero pathways of aluminum, polyethylene terephthalate (PET), and glass used for beverage packaging in the EU. The authors focus on whether the greenhouse gas (GHG) emissions from these food contact materials (FCMs) align with the goal of limiting global warming to 1.5 °C. According to the report, all three FCMs pose a risk to climate change and net zero targets

Key challenges identified by the authors include transitioning smelting processes to run on green energy for aluminum, shifting to bio-based feedstock for PET, and electrifying gas furnaces for glass.

The allocated carbon budget for each material is set to be surpassed by 2050 according to the report. This is the case even when considering that beverage container use might not increase by 2050 (especially with the EU population expected to shrink). The material consumption that will be needed for beverages and their packaging will still not be compatible with achieving the maximum 1.5 °C warming target.

In conclusion, the authors emphasize that while technological investment will be needed to overcome significant challenges, the top priority should be reducing demand. The authors explain that "developing reuse systems for beverage containers appears to be the most promising approach to achieve this goal," and comparative studies are needed to get a more holistic understanding of decarbonization pathways and how they can be optimized.

In a second report published on June 26, 2023, by Zero Waste Europe in collaboration with reloop, the impacts and challenges of single-use glass are investigated more closely. The report states that while single-use glass has the highest overall environmental footprint compared to all other single-use materials, glass presents the greatest potential to reduce environmental impact through reuse systems. Based on this, the authors urge that the upcoming Packaging and Packaging Waste Regulation (PPWR) must set guidelines for shifting away from single-use glass to reusable glass packaging (FPF reported, here, and here). The document reports that with the current version of the PPWR proposal (FPF reported), the usage of single-use glass is projected to increase as glass is exempted from the circular requirements that apply to metal and plastic beverage packaging.

Read More

FFP, 05-07-23

https://www.foodpackagingforum.org/news/zwe-examines-aspects-and-challenges-of-sustainable-packaging-in-three-reports

INTERNATIONAL

Biden's hydrogen bombshell leaves Europe in the dust

2023-07-03

The EU is investing billions into becoming a green energy superpower. But Washington's Inflation Reduction Act means it's the U.S. reaping the rewards.

European leaders have devoted tens of billions of dollars toward encouraging production of hydrogen, a clean-burning fuel that advocates say will create jobs and help fight climate change.

But now, many of those jobs will be going to the United States instead.

The clean energy subsidies that undergird President Joe Biden's climate agenda have just prompted one Norwegian manufacturer to choose Michigan, not Europe, as the site of a nearly $500 million factory that will produce the equipment needed to extract hydrogen from water. And other European-based companies are being tempted to follow suit, people involved in the continent's hydrogen efforts say — making the universe's most abundant substance the latest focus of the transatlantic trade battle on green energy.

CHEMWATCH
Bulletin Board
Regulatory Update
JUL. 14, 2023

The Norwegian firm, Nel, announced its decision in May, nine months after Congress approved Biden's flagship climate law, the Inflation Reduction Act. The move takes 500 new jobs to the other side of the Atlantic, despite the European Union's efforts to position itself as the obvious place for clean tech investment.

Read More

Politico, 03-07-23

https://www.politico.com/news/2023/07/05/biden-hydrogen-europe-00104024

ECHA public consultation: call for comments

Deadline: 18 August 2023

2023-07-05

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

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

- **Talc (Mg3H2(SiO3)4)** (EC: 238-877-9; CAS: 14807-96-6). Chemical registered under REACH. Health hazard classes open for commenting
- **eugenol; 2-methoxy-4-(prop-2-en-1-yl)phenol** (EC: 202-589-1; CAS: 97-53-0). Pesticidal active substance. All hazard classes open for commenting

Read More

ECHA, 05-07-23

https://echa.europa.eu/harmonised-classification-and-labelling-consultation

Integrated Regulatory Strategy annual report

2023-07-04

Assessing chemicals in groups has continued to speed up identification of substances for which regulatory risk management may be required. In 2022 EU authorities opened assessments of 2 000 substances in 61 groups.

Helsinki, 4 July 2023 – ECHA's fifth annual report of its Integrated Regulatory Strategy shows continued progress in identifying substances of concern.

In 2022, the assessments of regulatory needs were opened for more than 2 000 substances grouped based on their structural similarity. ECHA, by assessing the regulatory needs of groups of substances, identified almost 500 substances for which further risk management actions may be needed. However, for most of them the potential hazards need to be

CHEMWATCH
Bulletin Board
REACH Update
JUL. 14, 2023

confirmed first by further data generation. Over 750 substances assessed in 2022 do not require further risk management action

Since ECHA launched its grouping approach in 2019, around 5 000 substances have been assessed and 1 400 substances identified for which further risk management actions may be needed. These assessments feed into the European Commission's restriction roadmap and have identified hundreds of substances for which a harmonised classification may be necessary, thereby contributing to the aims of the EU's Chemicals Strategy for Sustainability and the EU's Green Deal.

We will continue to further develop our approach to speed up the risk management actions for the most harmful chemicals, and we plan in late 2023 and early 2024 to involve stakeholders in discussions on the approach.

Background

ECHA's Integrated Regulatory Strategy aims to speed up data generation, identification of groups of substances of concern, and regulatory action. It does so by integrating different regulatory processes into one coherent approach to manage chemical risks effectively and efficiently. The strategy also encourages collaboration between ECHA, Member States and the European Commission.

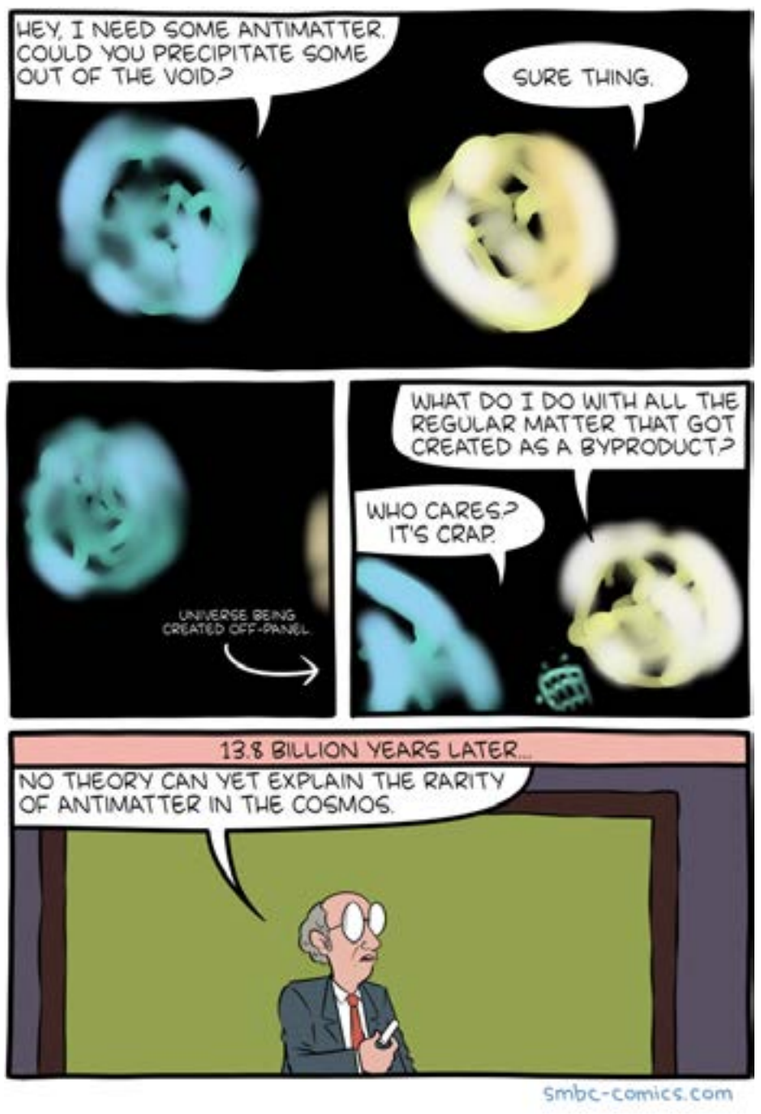
The goal of the work is to clarify which registered substances are a high priority for regulatory risk management or data generation, and which are currently a low priority for further regulatory action.

Read More

ECHA, 04-07-23

https://echa.europa.eu/-/integrated-regulatory-strategy-annual-report#msdynttrid=4nPbxuBYZHNQUhRX7i_jFzFRk5PUjzGRkws28grI7eM

2023-07-14



https://www.smbc-comics.com/comic/antimatter

Ammonium Chloride

2023-05-12

USES [2,4]

Ammonium chloride is used across a range of applications in various industries. It is used aa an ingredient in fertilisers, as an electrolyte in dry cells and in tinning. The chemical is used to clean soldering irons, in tanning and in washing powders and in the manufacture of dyes. It is also used in cold and cough medicines, and in veterinary medicine to prevent urinary stones.

ROUTES OF EXPOSURE [5]

Exposure Sources

A person can be exposed to different forms of ammonium chloride by multiple routes of exposure, including skin and eye contact, ingestion and inhalation.

HEALTH EFFECTS [4]

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

Acute Health Effects

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

Inhalation of ammonium chloride fumes can result in irritation of the nose, throat and lungs, including coughing and a sore throat. People with impaired respiratory functions, such as those with emphysema much incur further damage if the chemical is inhaled. Ingestion of the chemical could result in serious negative health consequences, including death. Eye contact with the chemical may cause corneal injury, pain, redness, inflammation and/or significant ocular lesions.

Chronic Effects

Chronic exposure to ammonium chloride is not thought to cause major adverse health effects. However, as a matter of course, exposure to all routes should be minimised. Long term exposure to high concentrations of the chemical in dust form may result in changes of lung function, e.g.,

Ammonium chloride is an inorganic white crystalline chloride. It is soluble in water. Its chemical formula is NH4Cl. It is a product from the reaction between hydrochloric acid and ammonia. [1,2,3]

pneumoconiosis. This is caused by chemical particles less than 0.5 micron entering and staying in the lung. A major symptom is breathlessness.

SAFETY

First Aid Measures [5]

Ingestion: If swallowed, contact a medical professional without delay. If the patient is more than 15 minutes away from a hospital, or unless otherwise instructed, induce vomiting ONLY IF THE PATIENT IS CONSCIOUS.

Skin contact: Remove all contaminated clothing, footwear and accessories. Do not re-wear clothing until it has been thoroughly decontaminated. Immediately rinse affected areas with plenty of soap and water. Contact a doctor in the event of continued irritation.

Eye contact: Flush eyes (including under the eyelids), with water for at least 15 minutes. Removal of contact lenses should only be done by skilled personnel. Contact a medical professional immediately.

Inhalation: If the person inhales fumes, combustion products or aerosols, remove them from the contaminated site. Other measures are usually unnecessary. If in doubt, contact the poisons information centre.

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

Exposure Controls & Personal Protection [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. Use a local exhaust ventilation or process enclosure, to limit the amount of chemical dust in the air.

Personal protection: Safety glasses, protective and dustproof clothing, gloves (protection class 5 or higher), a P.V.C apron and an appropriate mask or dusk respirator. Do not wear contact lenses as they could absorb chemicals in the air. Wear impervious shoes. Other protection could include barrier cream and skin cleansing cream. For specifications regarding other PPE, follow the guidelines set in your jurisdiction.

CHEMWATCH
Bulletin Board
Hazard Alert
JUL. 14, 2023

REGULATION

United States

The National Institute for Occupational Safety and Health (NIOSH) has set a Time Weighted Average (TWA) concentration limit for ammonium chloride (fume) of 10mg/m3.

Australia

Australia Exposure Standards have set a TWA for ammonium chloride of 10mg/m3.

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2. https://www.britannica.com/science/ammonium-chloride
3. https://en.wikipedia.org/wiki/Ammonium_chloride
4. https://www.cdc.gov/niosh/npg/npgd0029.html

NEW BIOPLASTIC DEGRADES AS FAST AS A BANANA PEEL

2023-07-11

The best-case solution would be to use bio-based plastics that biodegrade instead, but many of those bioplastics are not designed to degrade in backyard composting conditions. They must be processed in commercial composting facilities, which are not accessible in all regions of the country.

The new bioplastics are made entirely from powdered blue-green cyanobacteria cells, otherwise known as spirulina.

The researchers used heat and pressure to form the spirulina powder into various shapes, the same processing technique used to create conventional plastics. The new bioplastics have mechanical properties that are comparable to single-use, petroleum-derived plastics.

"We were motivated to create bioplastics that are both bio-derived and biodegradable in our backyards, while also being processable, scalable, and recyclable," says senior author Eleftheria Roumeli, assistant professor of materials science and engineering at the University of Washington.

"The bioplastics we have developed, using only spirulina, not only have a degradation profile similar to organic waste, but also are on average 10 times stronger and stiffer than previously reported spirulina bioplastics. These properties open up new possibilities for the practical application of spirulina-based plastics in various industries, including disposable food packaging or household plastics, such as bottles or trays."

The researchers opted to use spirulina to make their bioplastics for a few reasons. First of all, it can be cultivated on large scales because people already use it for various foods and cosmetics. Also, spirulina cells sequester carbon dioxide as they grow, making this biomass a carbon-neutral, or potentially carbon-negative, feedstock for plastics.

"Spirulina also has unique fire-resistant properties," says lead author Hareesh Iyer, a materials science and engineering doctoral student. "When exposed to fire, it instantly self-extinguishes, unlike many traditional plastics that either combust or melt. This fire-resistant characteristic makes spirulina-based plastics advantageous for applications where traditional plastics may not be suitable due to their flammability. One example could be plastic racks in data centers because the systems that are used to keep the servers cool can get very hot."

We use plastics in almost every aspect of our lives. These materials are cheap to make and incredibly stable. The problem comes when we're done using something plastic—it can persist in the environment for years. Over time, plastic will break down into smaller fragments, called microplastics, that can pose significant environmental and health concerns.

CHEMWATCH
Bulletin Board
Gossip
JUL. 14, 2023

Creating plastic products often involves a process that uses heat and pressure to shape the plastic into a desired shape. The researchers took a similar approach with their bioplastics.

"This means that we would not have to redesign manufacturing lines from scratch if we wanted to use our materials at industrial scales," Roumeli says. "We've removed one of the common barriers between the lab and scaling up to meet industrial demand.

"For example, many bioplastics are made from molecules that are extracted from biomass, such as seaweed, and mixed with performance modifiers before being cast into films. This process requires the materials to be in the form of a solution prior to casting, and this is not scalable."

Other researchers have used spirulina to create bioplastics, but the new bioplastics are much stronger and stiffer than previous attempts. The team optimized microstructure and bonding within these bioplastics by altering their processing conditions—such as temperature, pressure, and time in the extruder or hot-press—and studying the resulting materials' structural properties, including their strength, stiffness, and toughness.

These bioplastics are not quite ready to be scaled up for industrial usage. For example, while these materials are strong, they are still fairly brittle. Another challenge is that they are sensitive to water.

"You wouldn't want these materials to get rained on," Iyer says.

The team is addressing these issues and continuing to study the fundamental principles that dictate how these materials behave. The researchers hope to design for different situations by creating an assortment of bioplastics. This would be similar to the variety of existing petroleum-based plastics.

The newly developed materials are also recyclable.

"Biodegradation is not our preferred end-of-life scenario," Roumeli says. "Our spirulina bioplastics are recyclable through mechanical recycling, which is very accessible. People don't often recycle plastics, however, so it's an added bonus that our bioplastics do degrade quickly in the environment."

The findings appear in the journal Advanced Functional Materials. Additional coauthors are from the University of Washington and Microsoft.

Futurity, 11 July 2023

https://futurity.org

Sustainability: New catalyst makes chemical processes more efficient and less harmful to the environment

2023-07-07

Using the innovative technique of dispersing isolated atoms on carbon nitride supports, the team developed a catalyst that is more active and selective in esterification reactions. This is an important reaction in which carboxylic acids and bromides are combined to form products used in the manufacture of medicines, food additives and polymers.

The revolutionary feature of this new catalyst is that it reduces the use of rare metals, a significant step towards conserving critical resources and making processes more sustainable. In addition, the catalyst can be activated by sunlight, eliminating the need for energy-intensive methods. This discovery holds enormous potential in reducing dependence on finite resources and lowering the environmental impact of catalytic processes.

Professor Gianvito Vilé, Associate Professor of Chemical Engineering at the "Giulio Natta" Department of Chemistry, Materials and Chemical Engineering, coordinated the project, while Mark Bajada, a Marie Skłodowska-Curie Postdoctoral Fellow at the Politecnico di Milano, is the first author of the paper. The study was conducted in close collaboration with researchers from the University of Milan Bicocca and the University of Turin.

Phys Org, 7 July 2023

https://phys.org

New system enables rapid monitoring of volatile organic compounds in water

2023-07-10

VOCs in water not only affect microbial growth, but also contribute to air pollution and harm human health. Understanding the distribution of VOCs in water is critical to understanding pollution, managing water bodies, and improving the environment. However, traditional detection methods

A new discovery by the Politecnico di Milano opens up new perspectives in the field of sustainable chemical synthesis, promoting innovative solutions that allow chemicals to be created in a more efficient and environmentally friendly way. The research was published in the journal Nature Synthesis.

CHEMWATCH
Bulletin Board
Gossip
JUL. 14, 2023

are time-consuming and cannot provide rapid insight into the spatial and temporal characteristics or emission sources of VOCs in water.

The shipborne system developed in this research can monitor VOCs in water. It mainly consists of a shipborne platform, a spray inlet system, a proton transfer reaction mass spectrometer, and geographic information software (GIS). During the navigation, VOCs in water can be quickly extracted to gaseous state by the SI system and transferred into the proton transfer reaction mass spectrometry (PTR-MS) for detection.

Additionally, the system can integrate their component and concentration information with geographic information system (GIS). It enables real time visualization of the spatial distribution of VOCs in water. In this way, it is possible to quickly visualize and trace the sources contributing to the distribution of VOCs in water.

In a field test, the researchers verified its potential application. The system can be installed on ships to conduct large-scale surveys of VOC distribution in water bodies and trace VOC emissions in rivers. It can also be installed at specific locations for real-time monitoring and early warning of VOCs in water, such as pipelines and rivers.

Phys Org, 11 July 2023

https://phys.org

You've heard of microplastics, now get ready for nanoplastics

2023-07-10

But plastic can break up into even smaller pieces – nanometre-sized – and at this size, they are even less well understood.

Nanoplastics are fragments of plastic which are between roughly one nanometre in size (or a few atoms), to one micrometre in size (or about bacterium-sized).

According to Associate Professor Melanie MacGregor, a chemist at Flinders University, scientists still need to find out where these nanoplastics are, and what risks they might pose.

MacGregor talked about nanoplastics at the Cosmos Science City session held on World Environment Day.

They seem to be everywhere, and yet scientists are still struggling to understand microplastics: plastic fragments between a micrometre and a few millimetres in size.

"We are a bunch of scientists from different fields, trying to answer the questions: where else do we find them? How many are there? When do they actually become toxic? What do we do about it?" she says.

"People from all sorts of science, engineering, biology, chemistry, physics, we're all coming together to try and work out what to do next, basically, from the scientific point of view."

The most popular, and fastest, methods of detecting microplastics tend not to work for nanoplastics.

"Everything that's based on optical detection, you can't use," says MacGregor.

This is because nanoplastics are usually smaller than the "diffraction limit" of light: light waves are too big for them.

"You need to use different types of microscopes, such as scanning electron microscopes, which are slower and more expensive," says MacGregor.

Researchers tend to use completely different methods to study nanoplastics. One method involves burning samples with pyrolysis and analysing the remains with mass spectrometry, which can identify which molecules might have been in the sample.

Because they're so difficult to study, it's not yet clear what the environmental and health effects of nanoplastics are.

"We're still at the point of identifying it. I think that's really what we need to keep working on, especially: is it actually a real threat? There's not enough data yet to say something that is that small, is actually still toxic, or if we can, you know, eliminate it naturally without it causing much trouble," says MacGregor.

This is particularly pertinent after research published last year has found nanometre-sized plastics in human blood.

"That's one thing, but then the bloodstream goes through the kidneys. So what happens there? Are they filtered by the kidney? Do we find them in urine afterwards, and we don't need to worry about it further, or do they accumulate in the kidney?" says MacGregor.

One of her new PhD students is working on this exact problem.

CHEMWATCH
Bulletin Board
Gossip
JUL. 14, 2023

It's also not yet clear what we could do to prevent nanoplastics from getting into our waterways and our bodies – other than, of course, drastically reducing plastic production.

Filters that target microplastics based on size can't simply be downsized – filters with nanometre-sized holes would slow down the water you could push through significantly.

Researchers are still working on solutions. MacGregor says that one way around this is to build filters that target polymeric materials specifically, so they'd stick to plastics but not other things.

"That way you still can keep a flow, but you're capturing the things that you don't want to have in your water."

Cosmos Magazine, 10 July 2023

https://cosmosmagazine.com

Droplets that can spot cancer and improve DNA testing: the new field of micro elastofluidics

2023-07-05

That's the theory of Professor Nam-Trung Nguyen, director of the Queensland Micro and Nanotechnology Centre at Griffith University, who is in a new field called micro elastofluidics.

Nguyen gave a plenary talk at the First Australian Conference on Green and Sustainable Chemistry and Engineering, being held in Cairns this week and also just received an ARC Laureate Fellowship to make wearable devices that can connect with the body chemically.

Nguyen tells Cosmos that he first became interested in micro elastofluidics after looking at wearable medical devices, which for the moment are mostly solid.

Because liquids can be more flexible, small devices made from them could be more effective at providing medical care.

Micro elastofluidics looks at how fluids flow in solid structures, at the scale of molecules and devices.

This means drops of fluids somewhere on the scale of micrometres to nanometres (or human hairs to molecules).

Fluids behave differently at microscopic and nanoscopic levels. If their behaviour can be manipulated, they could be used to deliver medicines to the body, spot diseases, and grow cells that become vital medical treatments.

It also concerns things that happen within a fraction of a fraction of a second, meaning that, even though the distances are very short, the speed is very quick.

"With high speed, and short distance, you get a lot of energy," said Nguyen at the talk.

"This energy can help your reaction happen faster."

What's the catch?

"The problem is, liquid is difficult to handle at in the smaller scale," says Nguyen.

"Liquid is formless: you cannot control it easily."

Nguyen and colleagues have figured out some ways to manage this.

One is to coat micrometre-sized drops of liquid with a solid, such as a gel, making liquid marbles.

These tiny beads have a number of applications. One could be to fill them with medicine, for targeted drug delivery without needles.

"If I can make this type of small capsule, micrometre-sized, and use kinetic energy to ballistically pierce the skin, I can deliver the same liquid into the skin without pain," says Nguyen.

They could also be used to grow and deliver stem cells to treat injuries and make PCR testing – the best way to sequence DNA – more accurate, being able to show the concentration of DNA as well as its presence.

Another technique can both mix together, and separate, fluids at the microscale.

"Mixing is a problem at the microscale," says Nguyen.

"We solve that by [adding] small, long, flexible molecules to make [fluid] elastic."

This allows researchers to mix fluids like sweat, which can help them figure out its contents.

Nguyen and colleagues have shown that this method can be used to separate cancer cells from ordinary blood cells, potentially allowing for faster and more accurate diagnoses.

CHEMWATCH
Bulletin Board
Gossip
JUL. 14, 2023

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

Cosmos Magazine, 5 July 2023

https://cosmosmagazine.com

New findings shed light on the chemical evolution of the Earth

2023-07-10

Between three and four billion years ago, on primordial Earth, the first biomolecules were being formed prior to an explosion of life. These early chemical reactions, however, required catalysts. Xinchen Wang and a team of researchers from Fuzhou University in China have discovered that the primordial atmosphere itself could have served as a source for these catalysts.

Using methane and ammonia gases, which were most likely present in the hot gas mixture shrouding the world in the Archean age, the team used chemical vapor deposition to produce nitrogenous carbon compounds as possible catalysts. They found that, in a reaction chamber, molecules condensed out of an ammonia and methane plasma onto a surface, quickly growing to form a solid nitrogenous carbon polymer similar to nitrogen-doped graphite.

As the team observed, the irregularly incorporated nitrogen atoms gave this polymer catalytically active sites and an electron structure that enabled it to be excited by light. The researchers then turned to proving the extent to which the substance could reduce or oxidize other substances under the effect of light.

One of the most significant reactions on early Earth may have been imine formation. Imines, also referred to as Schiff bases, are a dehydrogenated form of amines, compounds composed of carbon, nitrogen, and hydrogen. Many chemists assume that, on primordial Earth, imines may have served in the formation of the first hereditary molecules of ribonucleic acid (RNA). Wang and his team could show that their plasma-generated catalyst can convert amines to imines using nothing other than sunlight.

The team says that carbon nitride-based photocatalysts, such as the plasma-generated substance, could have lasted for millions of years and produced important chemical intermediates. In addition, they could also

The sun as a source of energy, and catalysts to accelerate chemical reactions, were of critical importance in the emergence of the first biochemical molecules on Earth. A research team has now shown that a solid deposited from ammonia and methane plasma is capable of using light energy for amine-to-imine conversions. This process might have played an important role in the creation of the first biomolecules. The study has been published in the journal Angewandte Chemie.

have served as a source of carbon- and nitrogen-containing compounds. By demonstrating that it is possible to produce such a catalyst using only the gases and conditions present in the atmosphere of early Earth, the study sheds new light on the possible evolutionary path taken by biomolecules.

Phys Org, 10 July 2023

https://phys.org

Just add dendrimers, cellulose and graphene: New eco-friendly, long-lasting light-emitting electrochemical cell

2023-07-07

Electroluminescence is the phenomenon where a material emits light in response to a passing electric current. Everything from the screen you're using to read this sentence to the lasers used in cutting edge scientific research are results of the electroluminescence of different materials. Due to its ubiquity and necessity in the modern age, it is only natural that extensive resources go into research and development to make this technology better.

"One such example of an emerging technology is 'light-emitting electrochemical cells' or LECs," explains Associate Professor Ken Albrecht from Kyushu University's Institute for Materials Chemistry and Engineering and one of the leads of the study. "They have been attracting attention because of their cost advantage over organic light emitting diodes, or OLEDs. Another reason for LECs popularity is their simplified structure."

OLED devices generally require the carful layering of multiple organic films, making it tricky and costly to manufacture. LECs on the other hand can be made with a single layer of organic film mixed with light-emitting materials and an electrolyte. The electrode that connects it all together can even be made from inexpensive materials unlike the rare or heavy metals used in OLEDs. Moreover, LECs have lower driving voltage, meaning they consume less energy.

"Our research teams have been exploring new organic materials that can be used in LECs. One such candidate are dendrimers," explains Prof. Rubén D. Costa of the Technical University of Munich, who led the research team in Germany. "These are branched symmetric polymeric molecules whose unique structure has led to their utility in everything from medicine to sensors, and now in optics."

In research that could lead to a new age in illumination, researchers from Japan and Germany have developed an eco-friendly light-emitting electrochemical cells using new molecules called dendrimers combined with biomass derived electrolytes and graphene-based electrodes. Their findings were published in the journal Advanced Functional Materials.

Building upon their past work on developing dendrimers, the research team began modifying their materials for LECs.

"The dendrimer we developed initially had hydrophobic, or water repelling, molecular groups. By replacing this with hydrophilic, or water liking, groups we found that the lifetime of the LEC device could be extended to over 1000 hours, more than 10-fold from the original," explains Albrecht. "What makes it even better is that thanks to our collaboration with Dr. Costa's team the device is very eco-friendly."

For years, Costa's team in Germany had been working on developing cheaper and more environmentally friendly materials in light-emitting devices. One material they have been experimenting with is cellulose acetate, a common organic compound used in everything from clothing fibers and eyeglass frames.

"We used biomass derived cellulose acetate as the electrolyte in our new LEC device, and confirmed that it has the same long-life span," continues Costa. "Moreover, we also found that graphene can be used as an electrode as well. This is a vital step toward making flexible light-emitting devices using environmentally friendly materials."

The team explains that while their work is promising more research is necessary before the devices can be made to market.

"The device we made here only illuminates in yellow, so we need to develop it to illuminate in the three primary light colors: blue, green, and red. Luminescence efficiency, how bright the light is, also needs work," concludes Albrecht. "Though thanks to our international collaboration, the future looks bright."

Phys Org, 7 July 2023

https://phys.org

Curious compound: Tin selenide may hold the key for thermoelectric solutions

2023-07-10

The study provides information that could lead to new technologies for applications such as refrigeration or waste heat recovery from cars or nuclear power plants. The research was published by Nature Communications.

Researchers at the FAMU-FSU College of Engineering and the National High Magnetic Field Laboratory discovered that atomic-level structural changes occur when the compound tin selenide heats up—changes that help it to conduct electricity but not heat.

"Tin selenide is a curious compound," said Theo Siegrist, a chemical and biomedical engineering professor at the FAMU-FSU College of Engineering. "It has gotten a lot of interest for its special high-temperature thermoelectric properties. Optimizing those characteristics may lead to viable options for sustainable power generation and other uses in the future."

Scientists already knew that tin selenide had a high thermoelectric coefficient at elevated temperatures, meaning it can create a strong electric current from a temperature gradient. The question was why and how.

The researchers found that as the compound heated up, the bonds between tin and selenium remained mostly unchanged, still connected by three short and several long bonds. But the tin atoms in the compound began to move around, changing from a fully ordered lattice structure into a partially disordered one.

"The initial idea about this change was that the atoms were displaced, but we found that it is an order-disorder phase transition that was actually what was happening," Siegrist said. "The tin atom was flopping around, so to speak. That was what allowed tin selenide to scatter the energy waves that conduct heat."

A good thermoelectric material needs strong electrical conductivity but thermal conductivity that is as low as possible. In tin selenide, this is achieved by a dynamic partial disorder of the tin atoms at elevated temperatures that results in a reduction of the heat conductivity.

Siegrist collaborated on the work with researchers from Oak Ridge National Laboratory, or ORNL, and the University of Tennessee, Knoxville. They used a type of particle accelerator at ORNL called a spallation neutron source to test the material. The accelerator shoots protons onto a target to generate bursts of neutrons, allowing scientists to analyze that target's crystal structure.

By examining what is happening at the atomic scale, researchers can understand what is driving certain properties that engineers may want to optimize.

"This is fundamental research, and we are interested in the mechanism and influence of the material to get it to do what we want in a

CHEMWATCH
Bulletin Board
Gossip
JUL. 14, 2023

thermoelectric device," Siegrist said. "All these ideas can improve energy conversion devices by making them more efficient."

Phys Org, 10 July 2023

https://phys.org

Newly-identified compound inhibits SARS-CoV-2 by targeting the nucleocapsid protein

2023-07-10

The authors of an article published in Acta Materia Medica have established a method to screen inhibitors of N protein by using microscale thermophoresis assays to obtain potential anti-SARS-CoV-2 agents. 1,7-bis(4-hydroxyphenyl)-1,4,6-heptatrien-3-one (N-17, a diphenylheptane) was identified as a compound with outstanding inhibitory activity.

The binding of N-17 to the N-terminal domain of N protein (N-NTD) was further validated by using drug affinity responsive target stability assays. The ability of N-17 to bind N protein was evaluated and the affinity of N-17 to the N-NTD with molecular docking and molecular dynamics simulation was predicted.

N-17 exhibited excellent anti-viral activity against HCoV-OC43 and SARS-CoV-2, with EC50 values of 0.16 ± 0.01 μM and 0.17 ± 0.07 μM, respectively. Thus, a novel SARS-CoV-2 inhibitor targeting the N protein was discovered and its anti-viral activity in vitro was validated. The results may contribute to the development of promising therapeutic agents for COVID-19.

Phys Org, 10 July 2023

https://phys.org

New material shows promise for next-generation memory technology

2023-07-10

While this field is in its infancy, phase change memory could potentially revolutionize data storage because of its high storage density, and faster read and write capabilities. But still, the complex switching mechanism and intricate fabrication methods associated with these materials have posed challenges for mass production.

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has spread globally since 2020. The nucleocapsid (N) protein plays a crucial role in the life cycle of SARS-CoV-2.

In recent years, two-dimensional (2D) Van Der Waals (vdW) transition metal di-chalcogenides have emerged as a promising PCM for usage in phase change memory.

Now, a group of researchers from Tohoku University has highlighted the potential use of sputtering to fabricate large-area 2D vdW tetra-chalcogenides. Using this technique, they fabricated and identified an exceptionally promising material—niobium telluride (NbTe4)—that exhibits an ultra-low melting point of approximately 447 ºC (onset temperature), setting it apart from other TMDs. Details of the group's discovery were published in the journal Advanced Materials.

"Sputtering is a widely used technique that involves depositing thin films of a material onto a substrate, enabling precise control over film thickness and composition," explains Yi Shuang, assistant professor at Tohoku University's Advanced Institute for Materials Research and co-author of the paper. "Our deposited NbTe4 films were initially amorphous but could be crystallized to a 2D layered crystalline phase by annealing at temperatures above 272 ºC."

Unlike conventional amorphous-crystalline PCMs, such as Ge2Sb2Te5 (GST), NbTe4 demonstrates both a low melting point and a high crystallization temperature. This unique combination offers reduced reset energies and improved thermal stability at the amorphous phase.

After fabricating the NbTe4, the researchers then evaluated its switching performance. It exhibited a significant reduction in operation energy compared to conventional phase-change memory compounds.

The estimated 10-year data retention temperature was found to be as high as 135 ºC—better than the 85 ºC of GST—suggesting an excellent thermal stability and the possibility of NbTe4 to be used in high-temperature environments such as in the automotive industry. Additionally, NbTe4 demonstrated a fast-switching speed of approximately 30 nanoseconds, further highlighting its potential as a next-generation phase change memory.

"We have opened up new possibilities for developing high-performance phase change memories," adds Shuang. "With NbTe4's low melting point, high crystallization temperature, and excellent switching performances,

CHEMWATCH
Bulletin Board
Gossip
JUL. 14, 2023

it is positioned as the ideal material to address some of the current challenges face by current PCMs."

Phys Org, 10 July 2023

https://phys.org

EPA sets stricter limits on hydrofluorocarbons used in refrigerators, air conditioners

2023-07-12

A rule announced Tuesday will impose a 40% overall reduction in HFCs starting next year, part of a global phaseout designed to slow climate change. The rule aligns with a 2020 law that calls for an 85% reduction in production and use of the climate-damaging chemicals by 2036.

Officials said refrigeration and air conditioning systems sold in the United States will emit far fewer HFCs as a result of the rule, the second step in a 15-year phasedown of the chemicals that once dominated refrigeration and cooing equipment.

Here's a look at HFCs and what the United States and other countries are doing to limit their use.

WHAT ARE HFCs?

Hydrofluorocarbons are highly potent greenhouse gases commonly used in refrigerators and air conditioners. HFCs produce greenhouse gases that are thousands of times more powerful than carbon dioxide. They often leak through pipes or appliances that use compressed refrigerants and are considered a major driver of global warming.

WHAT IS BEING DONE TO LIMIT HFCs?

More than 130 countries, including the United States, have signed a 2016 global agreement to greatly reduce use and production of HFCs by 2036.

The Senate ratified the so-called Kigali Amendment to the 1987 Montreal Protocol on ozone pollution last year in a rare bipartisan vote. The measure requires participating nations to phase down production and use of HFCs by 85% over the next 13 years, as part of a global phaseout intended to slow climate change.

Scientists said the agreement, reached in Kigali, Rwanda, could help the world avoid a half-degree Celsius of global warming.

Ratification of the amendment, signed last year by President Joe Biden, follows bipartisan action Congress took in 2020 to approve the American Innovation and Manufacturing Act, which phased out domestic HFC manufacturing. The AIM Act has accelerated an industry shift from HFCs to alternative refrigerants that use less harmful chemicals and are

WASHINGTON (AP) — The Environmental Protection Agency is enforcing stricter limits on hydrofluoro-carbons, highly potent greenhouse gases used in refrigerators and air conditioners that contribute to global warming.

CHEMWATCH
Bulletin Board
Curiosities
JUL. 14, 2023

widely available throughout the country. The law also averts a previous patchwork of state laws and regulations that govern HFCs.

WHAT DOES THE LATEST RULE DO?

The new rule announced Tuesday builds on a 10% reduction required by the end of this year. It requires a 40% overall reduction from 2024 through 2028.

Companies that produce, import, export, destroy, use, process or recycle HFCs are subject to the rule.

EPA officials said the rule would help ensure the U.S. leads the way as countries around the world implement the Kigali Amendment. The HFC phasedown, "bolstered by domestic innovation to develop alternative chemicals and equipment, is paving the way for the United States to tackle climate change and strengthen global competitiveness," said Joe Goffman, principal deputy assistant administrator of EPA's Office of Air and Radiation.

White House climate adviser Ali Zaidi said the rule will help develop next-generation technologies for refrigeration, "ensuring that American workers reap the benefits of a growing global market for HFC alternatives."

WHAT DOES INDUSTRY SAY?

The Air Conditioning, Heating and Refrigeration Institute, which represents air conditioning, heating and commercial refrigeration manufacturers, called the rule a crucial step to implement the AIM Act.

"Our industry appreciates the work of the EPA and the timely issuance of this rule as we prepare for the next HFC reduction step-down next January," said AHRI president & CEO Stephen Yurek.

The American Chemistry Council, which represents chemical manufacturers and users, welcomed the EPA rule.

"ACC has long supported the HFCs phasedown, which can reduce a sizable source of greenhouse gas emissions while creating manufacturing jobs and growing our nation's share of the global market for air-conditioning and refrigeration products," the group said in a statement. U.S. companies have developed effective alternatives to HFCs, the group added.

WHAT HAPPENS IF INDUSTRY DOES NOT COMPLY?

The EPA rule includes a range of administrative penalties, including license revocation and retirement of allowances for companies that don't comply. Fines and criminal penalties also can be imposed. EPA said it has finalized administrative consequences retiring more than 6.5 million metric tons of carbon dioxide equivalent for 2022 and 2023 for companies that misreported data or imported HFCs without required allowances.

Since January 2022, an interagency task force on illegal HFC trade, led by EPA and the Department of Homeland Security, has prevented illegal HFC shipments equivalent to more than 1 million metric tons of carbon dioxide at the border, officials said. That is the equivalent to carbon emissions from more than 200,000 homes for one year.

AP News, 12 July, 2023

https://apnews.com

New biodegradable plastics are compostable in your backyard

2023-07-10

The best-case solution would be to use bio-based plastics that biodegrade instead, but many of those bioplastics are not designed to degrade in backyard composting conditions. They must be processed in commercial composting facilities, which are not accessible in all regions of the country.

A team led by researchers at the University of Washington has developed new bioplastics that degrade on the same timescale as a banana peel in a backyard compost bin. These bioplastics are made entirely from powdered blue-green cyanobacteria cells, otherwise known as spirulina. The team used heat and pressure to form the spirulina powder into various shapes, the same processing technique used to create conventional plastics. The UW team's bioplastics have mechanical properties that are comparable to single-use, petroleum-derived plastics.

The team published these findings June 20 in Advanced Functional Materials.

"We were motivated to create bioplastics that are both bio-derived and biodegradable in our backyards, while also being processable, scalable and recyclable," said senior author Eleftheria Roumeli, UW assistant professor of materials science and engineering.

"The bioplastics we have developed, using only spirulina, not only have a degradation profile similar to organic waste, but also are on average 10

We use plastics in almost every aspect of our lives. These materials are cheap to make and incredibly stable. The problem comes when we're done using something plastic—it can persist in the environment for years. Over time, plastic will break down into smaller fragments, called microplastics, that can pose significant environmental and health concerns.

CHEMWATCH
Bulletin Board
Curiosities
JUL. 14, 2023

times stronger and stiffer than previously reported spirulina bioplastics. These properties open up new possibilities for the practical application of spirulina-based plastics in various industries, including disposable food packaging or household plastics, such as bottles or trays."

The researchers opted to use spirulina to make their bioplastics for a few reasons. First of all, it can be cultivated on large scales because people already use it for various foods and cosmetics. Also, spirulina cells sequester carbon dioxide as they grow, making this biomass a carbon-neutral, or potentially carbon-negative, feedstock for plastics.

"Spirulina also has unique fire-resistant properties," said lead author Hareesh Iyer, a UW materials science and engineering doctoral student.

"When exposed to fire, it instantly self-extinguishes, unlike many traditional plastics that either combust or melt. This fire-resistant characteristic makes spirulina-based plastics advantageous for applications where traditional plastics may not be suitable due to their flammability. One example could be plastic racks in data centers because the systems that are used to keep the servers cool can get very hot."

Creating plastic products often involves a process that uses heat and pressure to shape the plastic into a desired shape. The UW team took a similar approach with their bioplastics.

"This means that we would not have to redesign manufacturing lines from scratch if we wanted to use our materials at industrial scales," Roumeli said. "We've removed one of the common barriers between the lab and scaling up to meet industrial demand. For example, many bioplastics are made from molecules that are extracted from biomass, such as seaweed, and mixed with performance modifiers before being cast into films. This process requires the materials to be in the form of a solution prior to casting, and this is not scalable."

Other researchers have used spirulina to create bioplastics, but the UW researchers' bioplastics are much stronger and stiffer than previous attempts. The UW team optimized microstructure and bonding within these bioplastics by altering their processing conditions—such as temperature, pressure, and time in the extruder or hot-press—and studying the resulting materials' structural properties, including their strength, stiffness and toughness.

These bioplastics are not quite ready to be scaled up for industrial usage. For example, while these materials are strong, they are still fairly brittle. Another challenge is that they are sensitive to water.

"You wouldn't want these materials to get rained on," Iyer said.

The team is addressing these issues and continuing to study the fundamental principles that dictate how these materials behave. The researchers hope to design for different situations, by creating an assortment of bioplastics. This would be similar to the variety of existing petroleum-based plastics.

The newly developed materials are also recyclable.

"Biodegradation is not our preferred end-of-life scenario," Roumeli said. "Our spirulina bioplastics are recyclable through mechanical recycling, which is very accessible. People don't often recycle plastics, however, so it's an added bonus that our bioplastics do degrade quickly in the environment"

Phys Org, 10 July 2023

https://phys.org

Researchers devise a better way to build aptamers

2023-07-06

Aptamers—short strands of DNA or RNA capable of binding to specific target receptors—can be incredibly useful for measuring metabolites and proteins in biological research, identifying disease markers, and treating disease. They behave much like antibodies, but are easier to synthesize and incorporate in biosensors, are more stable at room temperature, have a longer shelf life, and are far less likely to trigger unwanted immune responses.

While aptamers come in countless configurations, finding exactly the right one for a specific task is daunting. Researchers typically identify aptamers by sifting through massive libraries of randomly generated bits of DNA or RNA. The rare aptamer that shows an affinity for the desired target can be improved through further studies, but only to a point. Consequently, aptamers have found limited use in biomedicine.

But that may soon change. Milan Stojanovic, Ph.D., professor of medical sciences, biomedical engineering, and systems biology at Columbia University Vagelos College of Physicians and Surgeons, and his colleagues

When is having trillions of choices not enough? Apparently when making aptamers.

CHEMWATCH
Bulletin Board
Curiosities
JUL. 14, 2023

have devised a better way to build aptamers. The researchers first analyzed how individual structural units within organic compounds (functional groups or fragments) contribute to binding within 27 target-aptamer pairs. The analysis yielded new insights into how to overcome structural barriers that prevent aptamers from engaging their targets.

To demonstrate the utility of their approach, the researchers created two new aptamers with potential clinical applications. One aptamer measures blood levels of the amino acid leucine and could be applied to newborn screening for maple syrup urine disease, a metabolic disorder in which the body cannot properly convert food into energy.

Another aptamer detects blood levels of the antifungal drug voriconazole, commonly used in immunocompromised patients. High levels of voriconazole can cause serious side effects, such as brain and liver toxicity. The two new aptamer-based tests have the potential to improve upon existing blood tests for leucine and voriconazole.

The paper is published in the journal Science.

website, 6 July 2023

https://phys.org

Chemists develop sustainable method to remove 'forever chemicals' from water

2023-07-06

And that's where the problem lies. Because they are so inert and there are no natural pathways by which they can be broken down, these highly persistent chemicals accumulate in the natural environment—posing a problem for human health and the environment.

PFAS have now been detected all over the planet: in water, soil and air, in plants, animals and—at the end of the food chain—in humans, too. Just how much of a health risk these chemicals pose is still not clear. Initial laboratory animal studies have shown that PFAS may impair reproductive health. What is clear is that these synthetic compounds do not belong in the natural environment and certainly not in living organisms. It therefore makes sense to find ways to try and reduce PFAS contamination levels in the environment.

But PFAS remediation is both complex and challenging, and the processes used can themselves have a detrimental impact on the environment and the climate. And before they can be removed, the PFAS have to be

Perfluoroalkyl substances (PFAS) are highly versatile chemicals. These fluorine-containing organic molecules are the reason why rain drops simply slide off outdoor jackets. They are used in the grease-proof coating of paper food packaging and are key ingredients in fire-extinguisher foams and the protective gear worn by firefighters. PFAS were first introduced in the 1940s and since then, the number of products and areas in which they are used has grown astronomically.

detected. Detection is not made any easier by the fact that only small quantities of PFAS are required for a large effect (e.g. the ultra-thin coatings in food packaging).

Conventionally, PFAS have been removed from water by filtration using special membranes or lower-cost activated carbon adsorbents. However, recovering the PFAS from these filter systems so that they can be permanently destroyed either requires the use of harsh chemical conditions or incineration.

At least that has been the case up to now. A team of researchers led by Markus Gallei, Professor of Polymer Chemistry at Saarland University, Professor Xiao Su from the University of Illinois Urbana-Champaign, and their doctoral students Frank Hartmann (Saarland) and Paola Baldaguez (Illinois) have developed a new electrochemical method that can remove PFAS chemicals from water and then efficiently release them again for destruction.

This new PFAS remediation platform allows these fluorinated contaminants to be collected, identified and then destroyed without needing to incinerate the filter. The research is published in the journal ACS Applied Materials & Interfaces.

In the method developed by the research team, the central role is played by metal-containing polymers known as metallocenes. Metallocenes first came on the scene in 1951 with the discovery of the iron-containing molecule ferrocene. Since then, many other metallocenes have been reported. Frank Hartmann, Markus Gallei and their international team have found that electrodes functionalized with ferrocene or—even more effectively—with a cobaltocene synthesized by Frank Hartmann, are able to remove even minute quantities of PFAS molecules from water.

But the real key lies in the fact that if a voltage is applied to the ferrocene or cobaltocene metallopolymers, they can 'switch' their electrical state and release the PFAS molecules previously captured. "And cobalt is significantly better at doing this than iron," observed Frank Hartmann.

"We've found a means by which PFAS can be efficiently removed from water and then released again, effectively regenerating the electrode for further use. Unlike the activated carbon filter, which I have to destroy once it has become saturated with PFAS molecules, I can switch the metallocenes a thousand times, should I want to," said Markus Gallei, summarizing the significance of the research work.

CHEMWATCH
Bulletin Board
Curiosities
JUL. 14, 2023

Having laid the foundations, Frank Hartmann, Markus Gallei and their colleagues at the University of Illinois are now looking to upscale development to facilitate the removal of these highly persistent contaminants from our rivers and oceans.

Phys Org, 6 July 2023

https://phys.org

These lollipops could 'sweeten' diagnostic testing for kids and adults alike

2023-07-10

Throat swabs are commonly used to collect samples for the diagnosis of a wide variety of illnesses, including strep throat. A less-gag-inducing method is saliva sampling, in which technicians analyze a patient's spit with methods such as quantitative polymerase chain reaction (qPCR). Because this type of sample can be collected directly by a patient, the technique is popular for at-home testing and saw expanded use during the COVID-19 pandemic. Gathering the necessary amount of saliva can be somewhat gross, though, which is why some scientists are looking to make the process more enjoyable by combining it with the equally drool-filled, yet much more pleasant, experience of enjoying a lollipop.

Previously, Sanitta Thongpang, Ashleigh Theberge, Erwin Berthier and colleagues developed their own lollipop collection device dubbed CandyCollect. At first glance, CandyCollect looks like most lollipops, except for its spoon-like stick with a spiral-shaped groove carved into the top. This flattened end is covered with isomalt candy, allowing for saliva to easily flow into the groove as the lollipop is eaten.

In a past study, the researchers showed in lab tests that the device could capture the bacteria responsible for strep throat. Now, they wanted to target other, naturally occurring bacteria and see how their system compared to other commercially available, at-home saliva sampling methods with real people.

Researchers sent CandyCollect and two conventional saliva sampling kits to 28 adult volunteers, who used them, answered some survey questions, then shipped the devices back to the lab. The researchers eluted the samples and then quantified Streptococcus mutans and Staphylococcus aureus bacteria using qPCR. Whenever one or both of the conventional

A lollipop might be a sweet reward for a kid who's endured a trip to the doctor's office, but now, this candy could make diagnostic testing during a visit less invasive and more enjoyable. Research-ers publishing in Analytical Chemistry have shown, for the first time, that a lollipop-based saliva collection system can capture bacteria from adults and remain shelf-stable for up to a year. Study participants also preferred the candies over conventional collection systems.

methods detected the target bacteria, CandyCollect also detected them 100% of the time.

Additionally, the candies were the most popular method of the three among participants, who also agreed it was the "most sanitary" and "least disgusting." The devices still produced accurate results after being stored for a year. Although the studies are still ongoing, the team says that this work shows that the system is adaptable and well liked. The researchers say it could inspire other scientists to develop more intuitive and convenient at-home testing methods.

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Neutron beam measurements reveal shrinking mechanism of microgels in colloids

2023-07-10

They flow through our arteries, add color to our walls or make milk tasty: tiny particles or droplets that are very finely distributed in a solvent. Together they form a colloid. Whereas the physics of colloids involving hard particles, such as color pigments in emulsion paint, is well understood, colloids involving soft particles, such as hemoglobin, the red pigment in blood, or droplets of fat in milk, hold some startling surprises.

An experiment carried out 15 years ago showed that soft particles made of polymers—so-called microgels—shrink abruptly when their concentration in a solvent is increased above a certain threshold. When this happens, large particles contract until they are the size of their smaller neighbors. Amazingly, this happens even when the particles are not actually in contact with one another. The researchers were puzzled: How does a gel particle know how big its neighbor is without touching it? Is there some sort of "telepathy" going on between microgels?

Hypothesis of 2016 confirmed

"Of course not," says Urs Gasser. The physicist has been studying the miraculous shrinking of microgels in colloids for the past ten years. Together with a team of researchers, he published a paper in 2016 explaining the phenomenon.

Briefly explained, in this situation the polymer particles consist of long carbon chains. These carry a weak negative charge at one end. These chains form a ball, the microgel. This can be thought of as resembling

Researchers at PSI and the University of Barcelona have managed to explain the strange behavior of microgels. Their measurements using neutron beams have pushed this measuring technique to its limits. The results open up opportunities for new applications in materials and pharmaceutical research.

CHEMWATCH
Bulletin Board
Curiosities
JUL. 14, 2023

a ball of wool, with the properties of a sponge. This three-dimensional tangle therefore contains negative point charges that attract positively charged ions in the liquid. These so-called counterions arrange themselves around the negative charges in the ball, forming a positively charged cloud on the surface of the microgel. When the microgels come close together, their charge clouds overlap (see image above). This in turn increases the pressure inside the liquid, which compresses the microgel particles until a new equilibrium is reached.

At the time, however, the research team was unable to provide experimental proof of the cloud of counterions. Together with his Ph.D. student Boyang Zhou and Alberto Fernandez-Nieves of the University of Barcelona, Gasser has now furnished that evidence—and it impressively supports the 2016 hypothesis. The results have been published in the journal Nature Communications.

SINQ neutron source crucial to solving the puzzle

This was possible thanks to the neutrons from PSI's spallation source SINQ—along with an experimental trick. Because the cloud of counterions in the colloid is so rarefied that it is not actually visible in the image of the scattered neutrons. The counterions account for no more than 1% of the mass of a microgel. So Gasser, Zhou and Fernandez-Nieves examined two samples: one colloid in which all the counterions were sodium ions, and another in which they were ammonium ions (NH4).

Both these ions also occur naturally in microgels—and they scatter neutrons differently. Subtracting one image from the other leaves the signals of the counterions. Boyang Zhou states, "This seemingly simple solution requires the utmost care in preparing the colloids so as to make the ion clouds visible. No one has ever measured such a rarefied ion cloud before."

Applications in cosmetics and pharmaceuticals

Knowing how soft microgels behave in colloids means that they can be tailored to fit many different applications. In the oil industry, they are pumped into underground reservoirs to adjust the viscosity of the oil in the well and facilitate its extraction. In cosmetics, they give creams the desired consistency. Smart microgels are also conceivable, which could be loaded with medicines. The particles could react to gastric acid, for example, and release the drug by shrinking.

Or a microgel could shrink into a small, densely packed polymer ball when the temperature increases, one that reflects light differently than in its swollen state. This could be used as a temperature sensor in narrow fluid channels. Other sensors could be designed to respond to changes in pressure or contamination. "There are no limits to the imagination," says Gasser.

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https://phys.org

Researchers discover safe, easy, and affordable way to store and retrieve hydrogen

2023-07-10

This discovery, published in the Journal of the American Chemical Society on July 10, makes it possible not only to safely and conveniently store ammonia, but also the important hydrogen is carries. This finding should help lead the way to a decarbonized society with a practical hydrogen economy.

For society to make the switch from carbon-based to hydrogen-based energy, we need a safe way to store and transport hydrogen, which by itself is highly combustible. One way to do this is to store it as part of another molecule and extract it as needed. Ammonia, chemically written as NH3, makes a good hydrogen carrier because three hydrogen atoms are packed into each molecule, with almost 20% of ammonia being hydrogen by weight.

The problem, however, is that ammonia is a highly corrosive gas, making it difficult to store and use. Currently, ammonia is generally stored by liquefying it at temperatures well below freezing in pressure-resistant containers. Porous compounds can also store ammonia at room temperature and pressure, but storage capacity is low, and the ammonia cannot always be retrieved easily.

The new study reports the discovery of a perovskite, a material with a distinctive repetitive crystal structure, which can easily store ammonia and also allows easy and complete retrieval at relatively low temperatures.

The research team led by Masuki Kawamoto at RIKEN CEMS focused on the perovskite ethylammonium lead iodide (EAPbI3), chemically written as CH3CH2NH3PbI3. They found that its one-dimensional columnar structure undergoes a chemical reaction with ammonia at room temperature and

Researchers at the RIKEN Center for Emergent Matter Science (CEMS) in Japan have discovered a compound that uses a chemical reaction to store ammonia, potentially offering a safer and easier way to store this important chemical.

CHEMWATCH
Bulletin Board
Curiosities
JUL. 14, 2023

pressure, and dynamically transforms into a two-dimensional layered structure called lead iodide hydroxide, or Pb(OH)I.

As a result of this process, ammonia is stored within the layered structure through chemical conversion. Thus, EAPbI3 can safely store corrosive ammonia gas as a nitrogen compound in a process that is much cheaper than liquification at -33°C (-27.4°F) in pressurized containers. Even more importantly, the process to retrieve the stored ammonia is just as simple.

"To our surprise, ammonia stored in ethylammonium lead iodide could be easily extracted by heating it gently," says Kawamoto. The stored nitrogen compound undergoes a reverse reaction at 50°C (122°F) under vacuum and returns to ammonia. This temperature is much lower than the 150°C (302°F) or more that is needed to extract ammonia from porous compounds, making EAPbI3 an excellent medium for handling corrosive gases in a simple and cost-effective process.

Additionally, after returning to the one-dimensional columnar structure, the perovskite can be reused, allowing ammonia to be repeatedly stored and extracted. An added bonus was that the normally yellow compound became white after the reaction. According to Kawamoto, "the compound's ability to change color when storing ammonia means that color-based ammonia sensors can be developed to determine the amount of ammonia stored."

The new storage method has several uses. In the short-term, the researchers have developed a safe method for storing ammonia, which already has multiple uses in society, from fertilizer to pharmaceuticals to textiles. "In the long-term," says to co-author Yoshihiro Ito of RIKEN CEMS, "we hope that this simple and efficient method can be a part of the solution for achieving a decarbonized society through the use of ammonia as carbon-free hydrogen carrier."

This research will help achieve the 2016 Sustainable Development Goals (SDGs) set forth by the United Nations, especially Goal 7: Affordable and clean energy and Goal 13: Climate action.

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CHEMWATCH
Bulletin Board
Curiosities
JUL. 14, 2023

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Phys Org, 10 July 2023

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Discovery of 100 fatty acids opens new research paths

2023-07-07

QUT researchers have discovered 103 new unsaturated fatty acids in human derived samples. These findings have doubled the number of these fundamental building blocks of life previously reported in human blood plasma.

In their article published in Nature Communications, QUT researchers and their colleagues in Adelaide and Prague have described their findings and the new analytical technique that enabled the discoveries.

Professor Stephen Blanksby, from the QUT Center for Materials Science said the human body made its own fatty acids but also took up fatty acids from food that were then modified to make them fit for purpose.

Fatty acids are the molecular building blocks that form the lipids essential for life. While some lipids form cell membranes, others are present naturally as triglycerides in body fat and the waxes on our hair and skin.

"Lipids play many roles in the body—some form cell membranes, others are precursors for signaling molecules that regulate how the body copes with inflammation and the resolution of inflammation," Professor Blanksby said.

"This means changes in fatty acids and other lipids (complex fats made from fatty acids) in the body can provide critical clues for health and disease.

"We know that blood tests report on lipids like cholesterol and triglycerides that are linked to our health status and, with further research, these new molecules could provide critical information about our bodies' responses to diet or disease."

Professor Blanksby said QUT researchers developed advanced analytical technology to probe the human lipidome (all lipids in a cell) more deeply than was previously possible.

"The discovery of new lipids and new lipid metabolism using this approach paves the way for more sensitive and selective diagnostic tests," he said.

Dr. Jan Philipp Menzel, a postdoctoral fellow in the QUT School of Chemistry and Physics, said the discoveries were enabled by a combination of liquid chromatography with a mass spectrometer modified to enable a gas-phase reaction with ozone that broke down the carbon-carbon double bonds in unsaturated fatty acids.

Dr. Menzel developed custom software to trawl the complex datasets the team obtained to identify the novel lipids.

"It was an innovative approach that allowed us to characterize the structure of unsaturated fatty acids," Dr. Menzel said. "Using this process we studied human blood plasma, cancer cells, and vernix caseosa, a white layer covering newborns, and found new and different fatty acids in each.

"Some of the newly found fatty acids may not originate from human metabolism but are likely present in blood plasma, for example, after being consumed in food whereas most fatty acids found in vernix caseosa are likely to be a product of human metabolism.

"Our investigation of cancer cell lines included the addition of an enzyme inhibitor to one cell line that helped to assign which fatty acids were formed in increased amounts in laboratory conditions. Some of our results show the same trends established in several recent publications and add

CHEMWATCH
Bulletin Board
Curiosities
JUL. 14, 2023

to the body of evidence that fatty acid metabolism is an important aspect of the metabolism of cancer cells.

"It will take a concerted effort by many scientists around the world to unravel the full biological significance of all the fatty acids that were identified in this study. For example, some new omega-3 fatty acids found in vernix caseosa have unusual patterns of double bonds.

"Fish and seafood, walnuts and flaxseed are well known for essential fatty acids (omega-3 polyunsaturated fatty acids) and their health benefits. However, we currently know very little about the new omega-3 fatty acids we detected on the skin of newborns.

"The exact structure of a biomolecule determines its biological function, a principle used extensively in biochemistry and biomedical research. Finding biomolecules with new structures (here, differences in the position of double bonds along a fatty acid chain) could be a first step towards studying new metabolic pathways or even develop diagnostic methods or treatments," Menzel said.

Phys Org, 7 July 2023

https://phys.org

Climate-friendly air conditioning inspired by termites

2023-07-07

Termite mounds have a sophisticated ventilation system that enables air circulation throughout the structure. This helps to maintain and regulate temperature and humidity.

"The digitalization of design and construction processes creates enormous opportunities for how we shape architecture, and natural and biological systems provide an important model for how we can best utilize these possibilities," says David Andréen, senior lecturer at the Department of Architecture and Built Environment at Lund University, who wrote the article.

The results, published in the journal Frontiers in Materials, show a structure for buildings based on termite mounds that facilitates indoor climate control.

"The study focuses on the interior of termite mounds, which consist of thousands of interconnected channels, tunnels and air chambers, and how these capture wind energy in order to 'breathe,' or exchange oxygen

The climate control used by termites in their mounds could inspire tomorrow's climate-smart buildings. New research from Lund University in Sweden shows that future buildings inspired by the termites could achieve the same effect as traditional climate control, but with greater energy efficiency and without its carbon dioxide footprint.

and carbon dioxide with the surroundings. We have explored how these systems work and how similar structures could be integrated in the walls of buildings to drive the flow of air, heat and moisture in a new way."

The idea is thus to create new ways to control the airflow in buildings that will be significantly more energy-efficient and climate-smart than traditional air conditioning, which uses the bulk flow principle, normally driven by fans. Instead, it is possible to develop systems that are turbulent, dynamic and variable.

"These can be controlled by very small equipment and require minor energy provision," says David Andréen.

In the study, the researchers demonstrated how airflows interact with geometry—the parameters in the structure that cause the flows to arise and how they can be selectively regulated. These can be driven without using mechanical components such as fans, valves and similar, as only electronic control is required.

"This a precondition for a distributed system in which many small sensors and regulating devices are placed in the climate-adaptive building envelope through miniaturization, durability/sustainability and cost reduction," says David Andréen.

This enables regulation of the building's indoor climate and to control factors such as temperature and humidity without relying on large fans and heating and air conditioning systems. The mechanisms are dependent on being able to create complex internal geometries (on the millimeter to centimeter scale), which is only possible using 3D printing. Through 3D printing, value can be added to the built environment to create sustainable architecture that otherwise would not have been possible.

"It's fascinating how the termites' building process manages to create extremely complex well-functioning 'engineering masterpieces,' without having the centralized control or drawings to refer to that we would need," concludes David Andréen.

Phys Org, 7 July 2023

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