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ASIA PACIFIC

'Where can you hide from pollution?': cancer rises 30% in Beirut as diesel generators poison city

2024-04-22

Lebanon's economy and electricity system are broken and much power is now generated locally, with devastating effects on air quality and health

Smog hangs over Beirut most days, a brownish cloud that darkens the city's skyline of minarets and concrete towers. An estimated 8,000 diesel generators have been powering Lebanese cities since the nation's economic collapse in 2019. The generators can be heard, smelled and seen on the streets, but their worst impact is on the air the city's inhabitants are forced to breathe.

New research, to be published by scientists at American University of Beirut (AUB), has found that the Lebanese capital's over-reliance on the diesel generators in the past five years has directly doubled the risk of developing cancer. Rates of positive diagnosis, oncologists say, are shooting up.

"The results are alarming," says Najat Saliba, an atmospheric chemist who led the study. In the area of Makassed, one of the more densely populated parts of Beirut tested, levels of pollution from fine particulates – that is, less than 2.5 micrometres in diameter (PM2.5) – peaked at 60 micrograms a cubic metre, four times the 15 mcg/m^3 level the World Health Organization says people should be not exposed to for more than 3-4 days a year.

Read More

The Guardian, 22-04-24

https://www.theguardian.com/global-development/2024/apr/22/where-can-you-hide-from-pollution-cancer-rises-30-in-beirut-as-diesel-generators-poison-city

Many questions surround microplastics, what about micro(bio)plastics?

2024-04-15

Literature review of micro- and nano(bio)plastics research; scrutinizes the complexities of micro- and nano(bio)plastics degradation and their toxicological effects; highlights gaps in long-term impact studies and

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interactions with environmental conditions; challenges the assumption that "biodegradable" means complete degradation; calls for greater transparency in research practices to bolster collective understanding

The field of micro and nanoplastics research is still developing, with standardized research protocols and communication yet to come to a scientific consensus (FPF reported). The research around bioplastic particles is newer still.

Udara Piyathilake from the National Institute of Fundamental Studies in Sri Lanka and co-authors set out to summarize what has been researched so far in this sub-field of microplastics research. Their literature review investigated multiple avenues of micro- and nano(bio)plastics (MNBs) research published since 2012 including degradation pathways, toxicity, interactions with hazardous contaminants, and research gaps. Overall, "[t]he general belief that 'biodegradable' always implies complete biodegradation is questionable."

Bioplastics and other polymers can degrade in many ways including through mechanical, thermal, chemical, bacterial, and fungal methods. Piythilake et al. discuss the research that has gone into our understanding of each degradation pathway but in nearly every case they highlight many situations that still need investigating – e.g., degradation in natural environments, alternate pH soils, differences in salinity, and local bacterial communities (FPF reported, also here).

About 20% of the approximately 250 MNB studies they reviewed included toxicological experiments, with the majority of those investigating soils. "The findings reveal a spectrum of toxicological impacts, ranging from seemingly minor growth inhibitions to more severe issues affecting digestive systems, endocrine systems, immune systems, reproductive capabilities, metabolism, and even mortality." Even with this range of impacts, the authors highlight that the majority of studies focused on short-term exposures, "with the long-term effects of chronic exposure being less understood."

Nineteen studies in the review mention substances released into the environment from MNB degradation including heavy metals, plasticizers, antioxidants, volatile organic compounds, and others (FPF reported, also here).

Read More

FPF, 15-04-24

https://www.foodpackagingforum.org/news/many-questions-surround-microplastics-what-about-microbioplastics

Fragrance distributor fined $37,560 for unlawful imports

2024-04-19

AICIS has issued 2 infringement notices totalling $37,560 to an Australian fragrance, toiletries, and cleaning products importer.

These infringement notices (a total of 120 penalty points) were issued because the business is alleged to have:

- imported industrial chemicals from the US without holding an AICIS registration, which contravenes section 13 of the Industrial Chemicals Act 2019 (the IC Act)
- failed to submit an annual declaration required under section 99 of the IC Act.

All importers and manufacturers (introducers) of industrial chemicals must be registered with AICIS and submit an annual declaration every year.

Read More

AICIS, 19-04-24

https://www.industrialchemicals.gov.au/news-and-notices/fragrance-distributor-fined-37560-unlawful-imports

AMERICA

Breaking Down New Rules About 'Forever Chemicals'

2024-04-24

Cookware. Dental floss. Shampoo.

Perfluoroalkyl and polyfluoroalkyl substances, known as PFAS, can be found in those items and hundreds of other household products. Nicknamed "forever chemicals" because they do not fully degrade, PFAS are resistant to heat, oil, grease and water. (One of the first uses of PFAS chemicals was as a nonstick agent in Teflon cookware in the 1940s.)

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But exposure to PFAS has been linked to cancer, liver damage and birth defects, among other health issues.

Worse, the chemicals have made their way into our showers, sinks and drinking glasses — a 2023 study detected PFAS in nearly half of the nation's tap water. But there's some good news: For the first time, the Environmental Protection Agency is regulating PFAS. This month, the E.P.A. announced that it would require municipal water systems to remove six forever chemicals from tap water.

Lisa Friedman, a reporter on the Climate desk at The New York Times, wrote about the new rules. In a recent conversation, Ms. Friedman discussed the whirlwind month in climate news, what could stall the implementation of the regulations and how her beat has evolved over 15 years. This interview has been edited and condensed.

How significant is this moment?

This is a really big deal. The E.P.A. has finalized rules that will require some PFAS chemicals to be reduced to near-zero levels in our drinking water. But PFAS chemicals are hard to eliminate, and doing so will involve an expensive process. It will be a pretty big headache for water utility companies.

Read More

NY Times, 24-04-24

https://www.nytimes.com/2024/04/24/insider/pfas-water.html

Federal and State PFAS Regulation Continues to Expand

2024-04-25

On April 19, 2024, the US Environmental Protection Agency ("EPA") announced its intent to publish a final rule designating two perfluoroalkyl substances ("PFAS") as hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"). The announcement follows EPA's publication of final drinking water standards for certain PFAS under the Clean Water Act ("CWA") earlier this month, demonstrating the agency's continued focus on PFAS. Many states are also moving toward sweeping PFAS restrictions, including California, where lawmakers have proposed a bill that would ban PFAS in most products by 2030.

PFAS CERCLA Rule and Enforcement Policy

EPA's newest PFAS rule will designate two of the most widely used PFAS, perfluorooctanoic acid ("PFOA") and perfluorooctane sulfonic acid ("PFOS"), as hazardous substances under CERCLA. The rule will require that releases of PFOA and PFOS that meet or exceed certain reportable quantities be reported to the National Response Center and the appropriate state or tribal emergency response authorities, and that reasonable notice be provided to any potential injured parties by publication in local newspapers. Federal entities that transfer or sell property will be required to provide notice about any storage, release or disposal of PFOA or PFOS on the property. The US Department of Transportation will also be required to list PFOA and PFOS as hazardous materials under the Hazardous Materials Transportation Act. These new requirements will take effect 60 days after the final rule is published in the Federal Register.

Concurrently with its announcement of the final CERCLA rule, EPA also published a PFAS Enforcement Discretion and Settlement Policy Under CERCLA (the "PFAS Enforcement Policy"), which describes how EPA will approach holding responsible entities that significantly contributed to releases of PFAS contamination into the environment. The PFAS Enforcement Policy states that the "designation of PFOA and PFOS as hazardous substances should not disrupt CERCLA's liability framework," and that EPA will continue to follow its existing enforcement discretion policies. EPA "will focus on holding accountable those parties that have played a significant role in releasing or exacerbating the spread of PFAS into the environment, such as those who have manufactured PFAS or use PFAS in the manufacturing process, and other industrial parties." The PFAS Enforcement Policy also discusses environmental justice considerations, noting that EPA remains committed to "identifying and protecting overburdened communities" and will "conduct investigations and cleanup to protect communities from high-risk, high-concentration PFOA and PFOS exposure."

Read More

O'Melveny, 25-04-24

https://www.omm.com/insights/alerts-publications/federal-and-state-pfas-regulation-continues-to-expand/

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Large retailers don't have smokestacks, but they generate a lot of pollution – and states are starting to regulate it

2024-04-25

Did you receive a mail-order package this week? Carriers in the U.S. shipped 64 packages for every American in 2022, so it's quite possible.

That commerce reflects the expansion of large-scale retail in recent decades, especially big-box chains like Walmart, Target, Best Buy and Home Depot that sell goods both in stores and online. This has led to the growth of distribution centers that fulfill these orders. While mail-order commerce is convenient, these centers also have harmful impacts, including traffic congestion and air and water pollution.

I study environmental history, and I am part of a group of scholars examining the environmental impacts of big-box stores like Walmart, Target, REI and Bass Pro Shops. Sustainability is a hot topic in the retail sector, but my research on the history of Target – the sixth-largest retailer in the U.S. – shows how retail companies have largely escaped the kinds of environmental regulations that affect other sectors such as manufacturing.

Indirect pollution sources

Doing business on Target's scale, with US$108 billion in sales in 2022, creates a big physical footprint. The company has nearly 2,000 stores in the U.S. that cover over 240 million square feet of retail space, not including parking lots. Its 55 supply chain facilities add an additional 60 million square feet. For perspective, 1 million square feet is slightly larger than 15 football fields.

Read More

The Conversation, 25-04-24

https://theconversation.com/large-retailers-dont-have-smokestacks-but-they-generate-a-lot-of-pollution-and-states-are-starting-to-regulate-it-222090

EUROPE

Revision of the Packaging and Packaging Waste Directive

2024-04-24

OVERVIEW

Most goods require packaging at several stages of their product life. Today, the diversity of packaging items and materials is considerable. Between 2009 and 2020, the total mass of packaging waste generated in the EU rose by 20 %. The Packaging and Packaging Waste Directive (PPWD – Directive 94/62/EC) lays down measures to prevent the production of packaging waste, and to promote reuse of packaging and recycling and other forms of recovering packaging waste. It also sets out the requirements that all packaging placed on the EU market must meet. These provisions are designed to reduce the disposal of packaging waste and to promote a more circular economy. As part of the European Green Deal and the new circular economy action plan, the European Commission put forward a revision of the PPWD in November 2022. The initiative's objective is to ensure that all packaging is reusable or recyclable in an economically feasible way by 2030. The aim is to reinforce the essential requirements for packaging to ensure its reuse and recycling, boost the uptake of recycled content, and improve the requirements' enforceability. Measures are also envisaged to tackle over-packaging and reduce packaging waste. On 4 March 2024, the Parliament and the Council reached a provisional agreement on the new regulation. This agreement still needs to be formally approved by both institutions.

Context

Most goods require packaging at several stages of their product life. Packaging is defined in the current Packaging and Packaging Waste Directive (PPWD – Directive 94/62/EC) as 'products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer'. A wide range of materials is used for packaging, including glass, paper and cardboard, metal (such as steel or aluminium), plastics (polymers such as polyethylene terephthalate (PET)), wood, cork, textile (bags), ceramics or porcelain stoneware. They may also be made of more than one kind ofmaterial (composite materials). The diversity of packaging items is considerable, ranging from cans, tubes and boxes, to films and bags. In 2018, packaging

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manufacturing generated a turnover of €355billion in the EU. The packaging market is characterised by high-levels of crossborder trade, with many producers selling packaging in multiple Member States. Cross-border movements of packaging have recently grown, with the rise in internet use for distance sales of packaged goods.

Read More

European Parliament, 24-04-24

https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/745707/EPRS_BRI(2023)745707_EN.pdf?source=email

Air pollution: Parliament adopts revised law to improve air quality

2024-04-24

- Stricter 2030 limits for several air pollutants
- Air quality indices to be comparable across all member states
- Access to justice and right to compensation for citizens
- Air pollution leads to around 300,000 premature deaths per year in the EU

The revised law aims to reduce air pollution in the EU for a clean and healthy environment for citizens, and to achieve the EU's zero air pollution vision by 2050.

Parliament on Wednesday adopted a provisional political agreement with EU countries on new measures to improve air quality in the EU so it is no longer harmful to human health, natural ecosystems and biodiversity, by 381 votes in favour, 225 against, and 17 abstentions.

The new rules set stricter 2030 limits and target values for pollutants with a severe impact on human health, including particulate matter (PM2.5, PM10), NO2 (nitrogen dioxide), and SO2 (sulphur dioxide). Member states may request that the 2030 deadline be postponed by up to ten years, if specific conditions are met.

If the new national rules are violated, those affected by air pollution will be able to take legal action, and citizens may receive compensation if their health has been damaged.

More air quality sampling points will also be set up in cities and currently-fragmented air quality indices across the EU will become comparable, clear and publicly available.

You can read more about the new rules in the press release after the deal with EU countries. A press conference with the rapporteur is planned for Wednesday 24 April at 14.00 CET.

Read More

European Parliament, 24-04-24

https://www.europarl.europa.eu/news/en/press-room/20240419IPR20587/air-pollution-parliament-adopts-revised-law-to-improve-air-quality

INTERNATIONAL

Plastics Treaty should align circular economy goals with waste hierarchy, scientists say

2024-04-19

A letter published in Science on April 19, 2024, encourages negotiators at the upcoming session of the United Nations Intergovernmental Negotiating Committee (INC) for the Plastic Treaty (INC 4, April 23 – 29) to align circular economy and waste hierarchy goals within the treaty. Previous INC meetings have had difficulties coming to consensus on the exact goals that should be included in the officially-named UN Treaty to Prevent Plastic Pollution including in the Marine Environment (FPF reported), which means that many decisions need to be made at INC 4.

The waste hierarchy is a way of organizing waste management approaches "from most valuable (prevention, reduction, and reuse) to least (recycling, recovery, and disposal)." By organizing discussion in this way, negotiators can support changes that are effective in the long term. "These decisions should be made with the goal of shifting the market to one in which producing and disposing plastics reflects the real cost to society, and alternatives become more cost-effective and attractive to consumers."

Read More

FPF, 19-04-24

https://www.foodpackagingforum.org/news/plastics-treaty-should-align-circular-economy-goals-with-waste-hierarchy-scientists-say

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Beyond the Stockholm Convention: new regulations targeting PFAS

2024-04-25

The signing of the Stockholm Convention on Persistent Organic Pollutants (POPs) in 2001 marked a historic moment, as it was the first global treaty aimed at eliminating or restricting chemicals harmful to human and environmental health. The addition of perfluorooctanesulfonic acid (PFOS) to the Convention in 2009 marked yet another milestone, as PFOS and its related substances became the first of the PFAS family to be regulated on an international level. PFAS stands for per- and poly-fluoroalkyl substances and are colloquially called "forever chemicals" for their persistence in the environment. PFOS would not be the only "forever chemical" regulated by the Convention, as PFOA (perfluorooctanoic acid) and PFHxS (perfluorohexane sulfonate) were added in 2019 and 2022, respectively.

Despite the Stockholm Convention's international reach, its inclusion of just three PFAS chemicals only scratches the surface of the PFAS family, which, under the OECD definition of PFAS, includes nearly 5,000 substances. Given that research is increasingly identifying further risks that different PFAS pose to human and environmental health, activists and legislators worldwide are beginning to take a more active approach to regulating PFAS.

With a new framework of PFAS regulations potentially developing internationally, it is essential for businesses to understand the new PFAS regulatory landscape to identify its potential effect on them. This is particularly relevant for businesses in emerging high-tech industries, whose technologies may rely on the utilization of PFAS. In IDTechEx's report,

Asia-Pacific (APAC): Aligning with the Stockholm Convention

In major APAC countries such as China, Japan, and South Korea, there appears to be a general trend towards adopting and enforcing the restrictions on the specific PFAS outlined in the Stockholm Convention. This is most notable for China, which is a major chemical producer (including PFAS like PFOA). However, China does appear to be increasing regulations on its chemical industry broadly, having published the first List of New Pollutants for Priority Management in 2023.

Still, for the most part, APAC countries do not appear to be moving towards broader PFAS bans beyond those PFAS identified in the Stockholm Convention. However, there are some instances of PFAS

regulations being introduced for specific industries. For example, South Korea proposed the ban of 8 PFAS in the cosmetics industry in 2022.

Read More

Envirotec, 25-04-24

https://envirotecmagazine.com/2024/04/25/beyond-the-stockholm-convention-new-regulations-targeting-forever-chemicals/

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EU Policy. Commission seeks to clarify 'essential use' of dangerous chemicals

2024-04-24

The European Commission has drawn up strict criteria on when the use the most dangerous substances is justified, but with an overhaul of the EU's core chemicals regulation still on ice, green NGOs have urged a redoubling of efforts to limit pollution and health risks.

European Commission guidance on what constitutes the 'essential use' of dangerous substances divided opinion this week as policy makers and industry representatives gathered in Brussels to discuss future chemicals policy. Green groups issued a warning that the EU executive is failing to meet commitments to tackle pollution and health risks, pointing particularly to a shelved revision of the flagship REACH regulation.

"Better protection for human health, tackling pollution, and moving towards a toxic-free environment is our priority for the long run," Environment Commissioner Virginijus Sinkevičius said on Tuesday (23 April) in a video message to open a two-day conference on the future of EU chemicals regulation, hosted by Belgium as holder of the rotating EU Council presidency.

The gathering came a day after the European Commission had set out guiding principles for assessing when the benefits to society of using a dangerous chemical outweigh the risks. The criteria for 'essential use', intended to nudge producers towards safer production processes and inform future policy making, met with mixed reaction from industry representatives, campaigners and academics.

Read More

Euronews, 24-04-24

https://www.euronews.com/green/2024/04/24/commission-seeks-to-clarify-essential-use-of-dangerous-chemicals

Janet's Corner

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Cooking itself is just chemistry

2024-05-02

https://twitter.com/SWFloridaRealE/status/1784035394633498749/photo/1

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Hazard Alert

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Diazinon

2024-05-02

Diazinon (IUPAC name: O,O-Diethyl O-[4-methyl-6-(propan-2-yl) pyrimidin-2-yl] phosphorothioate), a colourless to dark brown liquid, is a thiophosphoric acid ester developed in 1952 by Ciba-Geigy, a Swiss chemical company. It is a non-systemic organophosphate insecticide formerly used to control cockroaches, silverfish, ants, and fleas in residential, non-food buildings. Diazinon was heavily used during the 1970s and early 1980s for general-purpose gardening use and indoor pest control. A bait form was used to control scavenger wasps in the western U.S. In 2004, residential use of diazinon was banned but it is still approved for agricultural uses. Diazinon kills insects by inhibiting acetylcholinesterase, an enzyme necessary for proper nervous system function. It has a low persistence in soil, with a half-life of between 2 to 6 weeks. [1,2]

USES [2,3]

Diazinon is used throughout the world to control a wide range of sucking and chewing insects and mites on a range of crops, including deciduous fruit trees, citrus fruit, bananas, vegetables, potatoes, beet, sugar cane, coffee, cocoa, tea, tobacco, cotton, and rice. It is also used to control agricultural soil-dwelling insects, and is applied as a sheep dip to control ectoparasites such as sheep scab and blow fly strike. Diazinon use in homes controls cockroaches, ants, and carpet beetles, and is in insecticidal pet collars.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- The general population may be exposed via diazinon-contaminated air, water, or food, but there is little potential for high level exposure because home and garden uses for diazinon have been banned.
- Significant inhalation exposure is likely only near areas where diazinon is produced or used as a restricted pesticide.
- Oral exposure may occur by drinking contaminated water or eating foods containing diazinon residue.
- Significant dermal exposure is likely only near areas where diazinon may be used as a restricted pesticide.

- Occupational exposure may occur at facilities that produce diazinon or in working environments where diazinon is used as a pesticide. Inhalation and dermal exposure are the predominant routes of exposure for workers during production, handling, and application.

HEALTH EFFECTS [4]

Acute Health Effects

The World Health Organisation (WHO) classifies diazinon as a class II 'moderately hazardous' pesticide. The acute oral LD50 (the dose required to kill half a population of laboratory animals) for rats is 1,250 mg/kg, and for mice it is 80-135 mg/kg(12). Diazinon, poisons humans and insects through its effects on nerve enzymes. It combines chemically with the acetylcholinesterase enzyme and inactivates it. This enzyme is essential for the control of nerve impulse transmission. Loss of acetylcholinesterase allows the accumulation of acetylcholine, the substance secreted by nerves that activates muscles, glands, and other nerves. Accumulation of sufficient levels of acetylcholine at junctions between nerves muscles will cause muscle contractions or twitching. Accumulation of acetylcholine at junctions between nerves and glands results in gland secretion; and accumulation between nerves in the brain causes sensory and behavioural disturbances. The main symptoms of acute diazinon poisoning are headache, nausea, dizziness, pin-point pupils, blurred vision, tightness in the chest, difficulty in breathing, muscle weakness or twitching, difficulty in walking, vomiting, abdominal cramps, and diarrhoea. Effects on the central nervous system may include confusion, anxiety, drowsiness, depression, difficulty in concentrating, slurred speech, poor recall, insomnia, nightmares, and a form of toxic psychosis resulting in bizarre behaviour.

Carcinogenicity

Diazinon is not considered carcinogenic by agencies such as the International Agency for the Research on Cancer, or the US EPA. However, use of diazinon by farmers in Iowa and Minnesota has been linked to increased risk of non-Hodgkins lymphoma, a rare form of cancer. Similar links were found in the 1980s in Nebraska.

Other Effects

Based on inhibition of the enzyme acetylcholinesterase, the daily administered no-observed-adverse-effect-level (NOAEL) for humans is 0.025 mg/kg body weight per day, according to WHO. Other reports

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suggest no-effect doses have ranged from 0.02 mg/kg/day in humans to 0.1 mg/kg/day in rats(20). In sub-chronic and chronic toxicity studies conducted in mice, rats and dogs, systemic toxicity occurred with decreases in body weight and body weight gains. There are also potential concerns about breakdown products. In animals diazinon is converted to diazoxon (where the sulphur molecule is substituted for oxygen), a compound that is a strong enzyme inhibitor.

SAFETY

First Aid Measures [5]

- Call a poison control centre or doctor immediately for treatment advice.
- If swallowed: Have a person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control centre or doctor. Do not give anything by mouth to an unconscious person.
- If on skin or clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 to 20 minutes.
- If inhaled: Move person to fresh air. If person is not breathing, call 000 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.
- If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.

Workplace Controls & Practices [4]

- Engineering Controls: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets with requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40CFR 170.240 (d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.
- Respiratory Protection: Not normally required, if vapours exceed acceptable levels, wear a MSHA/NIOSH approved pesticide respirator with cartridges for pesticide vapours.
- Eye Protection: Chemical goggles or shielded safety glasses.
- Skin Protection: Wear protective clothing: long-sleeved shirts and pants, hat, rubber boots with socks. Wear rubber or chemical resistant gloves.

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Methane emissions from landfill could be turned into sustainable jet fuel in plasma chemistry leap

2024-04-30

In a world first, University of Sydney researchers have developed a chemical process using plasma that could create sustainable jet fuel from methane gas emitted from landfills, potentially creating a low-carbon aviation industry.

Methane is a far more potent greenhouse gas than carbon dioxide (CO2). According to the International Energy Agency, the concentration of methane in the atmosphere is currently around two-and-a-half times greater than pre-industrial levels and is increasing steadily, with waste emissions and the burning of fossil fuels accounting for a significant proportion.

Australia recently joined the international methane mitigation agreement with the United States, the European Union, Japan and the Republic of Korea.

Lead author, Professor PJ Cullen from the University of Sydney's School of Chemical and Biomolecular Engineering and Net Zero Initiative said: "Globally, landfills are a major emitter of greenhouse gases, mainly a mixture of CO2 and methane. We have developed a process that would take these gases and convert them into fuels, targeting sectors that are difficult to electrify, like aviation."

"Modern landfill facilities already capture, upgrade and combust their gas emissions for electricity generation, however, our process creates a much more environmentally impactful and commercially valuable product," he said.

Global landfill emissions are estimated at 10-20 million tonnes of greenhouse gases per year, a value comparable to the emissions of the global energy sector.

Aviation currently accounts for approximately three percent of the world's emissions. Creating a "closed loop" fuel based on existing emissions would eliminate the need for traditional and sustainable jet fuels, which add further emissions into the atmosphere.

How plasma makes the process work?

The process would work by extracting methane from a landfill site, known as a methane well, which uses a shaft-like mechanism to extract gases.

"The beauty of this is that this simple process captures almost the exact composition that we need for our process," said Professor Cullen.

"Non-thermal plasma is an electricity-driven technology which can excite gas at both a low temperature and atmospheric pressure. Essentially, what this means is this approach facilitates the conversion of the gas into value-added products by inducing plasma discharge within forming gas bubbles. The process doesn't require heat or pressure, meaning it requires less energy, making it highly compatible with renewable energy power sources."

DISCLOSURE

Authors PJ Cullen, Emma Lovell and Tianqi Zhang are associated with PlasmaLeap Technologies, the supplier of the plasma technology employed to generate plasma bubbles in this study.

The authors acknowledge the MagRes node at Sydney Analytical Core Research Facility for access to the NMR infrastructure, Michelle Wood at Sydney Analytical for additional assistance in ATR-FTIR and Aditya Rawal at the University of New South Wales Mark Wainwright Analytical Centre for solid-state NMR measurements.

Sci Tech Daily, 30 April 2024

https://scitechdaily.com

Revolutionizing Plastics: Safer, Greener LDPE Alternatives Unveiled

2024-04-23

A new sustainable method replicates the desirable properties of LDPE plastic using less energy, through a novel catalytic process that creates a ladder-like molecular structure, making it industrially viable.

Researchers have developed a more sustainable method to do the work required to make plastics that are comparable to widely used low-density polyethylene (LDPE) plastics. They say their method is industrially viable. LDPE is a soft, flexible, and lightweight plastic material that is widely used in a variety of commercial applications, including plastic films, bottles, and other pliable products.

LDPE's unique properties are derived from its tree-branch-like molecular structure, bestowing flexibility. The material is also ductile due to its lower crystallinity. These properties set it apart from other, more linear varieties

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of polyethylene. However, the characteristic long-chain branching polymerization of LDPE is achieved through an energy-intensive, high-pressure synthesis process.

Here, Robert Froese and colleagues describe a novel approach to control long-chain branching in polyethylene under milder, solution-phase conditions. The method uses dual-chain catalysts, which can assemble two polymer chains at once, linked to one another through a small amount of diene mixed in with the ethylene, creating a ladder-like molecular structure. According to Froese et al., the ladder-branching process produces a plastic that exhibits comparable properties to those of LDPE or its blends with other forms of linear low-density polyethylene (LLDPE).

Sci Tech Daily, 23 April 2024

https://scitechdaily.com

Could a Novel RNA-Based Vaccine Strategy Stop Endless Boosters?

2024-04-22

Each year, seasonal influenza vaccines are designed to protect against the four main types of flu that researchers predict are likely to be most prevalent in the upcoming flu season. A decline in vaccine-specific antibodies in the body, the antigenic drift of influenza viruses over time and the emergence of novel strains of the virus result in this need for annual revaccination.

Now, a novel RNA-based vaccine strategy developed by scientists at the University of California, Riverside (UCR) may eliminate the need to chase new strains of viruses. The research is published in the Proceedings of the National Academy of Sciences.

Small silencing RNAs target viruses indiscriminately

"Traditional vaccines depend on adaptive immunity such as antibodies to provide specific protection," Shou-Wei Ding, distinguished professor of microbiology at UCR and lead paper author, told Technology Networks.

The new vaccine developed at UCR does not rely on the vaccinated body having a traditional immune response or immune active proteins. Instead, it relies on small interfering RNA molecules.

"Our vaccine-induced inhibition of infection mechanistically resembles RNAi therapeutics, which inhibit specific gene expression by delivering

chemically synthesized siRNAs. Our vaccines induce the natural production of a large population of siRNAs to target all viral RNAs for degradation. We have demonstrated full protection in mutant mouse strains without a functional adaptive immune system," said Ding.

In the study, the scientists characterized a unique live-attenuated RNA virus vaccine, utilizing a mouse virus called Nodamura. Attenuation resulted from the elimination of the viral RNAi suppressor, enhancing the production of virus-targeting siRNAs.

The results showed that single-dose immunization with the vaccine just 2 days in advance induced full protection in neonatal and adult mutant mice lacking adaptive immunity. Moreover, the immunized mutant mice remained protected against lethal challenge for at least 90 days postvaccination.

Rapid and complete protection for children

This new type of vaccine strategy does not require the body to have traditional immune active proteins; during the study, even newborn mice produced small RNAi molecules. Therefore, the researchers suggest that this vaccination strategy could be used in babies with underdeveloped immune systems or individuals with a compromised immune system.

Summarizing the potential benefits of the new vaccine strategy, Ding said: "Protection is induced (i) much faster than traditional vaccines (2 days after vaccination instead of a week or longer); (ii) in young infants and adult patients with under-developed or compromised adaptive immunity; (iii) to completely prevent infection in most vaccinated individuals rather than only reducing disease severity."

Combating the arrival of new strains

When a virus replicates, its genes undergo random genetic mutations. Over time, these mutations can lead to alterations in the virus' surface proteins or antigens. In influenza viruses, genetic mutations accumulate and cause the antigens to drift. When the influenza virus drifts enough, vaccines against old strains of the virus and immunity from previous infections are no longer effective. Antigenic drift is one of the main reasons the flu vaccine must be reviewed and updated yearly.

The novel vaccine strategy developed by the researchers targets the entire viral genome with thousands of siRNAs. The researchers believe there is little chance of a virus mutating to avoid this vaccination strategy.

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Working towards a universal vaccine

An earlier study by the same research team identified that flu infections also induce the body to produce siRNAs. The scientists' next step is to use this concept to generate a flu vaccine for infants, enabling them to no longer depend on their mothers' antibodies for protection.

The researchers intend to create this vaccine as a nasal spray as opposed to an injection, recognizing that some individuals have an aversion to needles. This would not be the first nasal spray flu vaccination to be approved for use in children.

Several other well-known human pathogens such as dengue and COVID all have similar viral functions. The researchers believe this new vaccine strategy should apply to them all and could allow for the creation of a "one-and-done" vaccine for any number of viruses.

Ding concludes: "We aim to see if this also works in humans. Our work provides a new vaccination strategy, which may facilitate the development of vaccines against viruses without any vaccine available or vaccines that can prevent infection (not just reducing virulence)."

Prof. Shou-Wei Ding was speaking to Blake Forman, Senior Science Writer & Editor for Technology Networks.

About the interviewee:

Shou-Wei Ding is a distinguished professor of microbiology at UCR. He received his PhD from the Australian National University. His current research focuses on understanding the host immune response to RNA viruses and viral counter-defense strategies.

Technology Networks, 22 April 2024

https://technologynetworks.com

Researchers create new chemical compound to solve 120-year-old problem

2024-05-01

For the first time, chemists in the University of Minnesota Twin Cities College of Science and Engineering have created a highly reactive chemical compound that has eluded scientists for more than 120 years. The discovery could lead to new drug treatments, safer agricultural products, and better electronics. The study is published in Science.

For decades, researchers have been investigating molecules called N-heteroarenes, which are ring-shaped chemical compounds that contain one or more nitrogen atoms. Bio-active molecules having a N-heteroarene core are widely used for numerous medicinal applications, lifesaving pharmaceuticals, pesticides and herbicides, and even electronics.

"While the average person does not think about heterocycles on a daily basis, these unique nitrogen-containing molecules are widely applied across all facets of human life," said Courtney Roberts, the senior author of the study and a University of Minnesota Department of Chemistry assistant professor who holds the 3M Alumni Professorship.

These molecules are highly sought out by many industries, but are extremely challenging for chemists to make. Previous strategies have been able to target these specific molecules, but scientists have not been able to create a series of these molecules.

One reason for this is that these molecules are extremely reactive. They are so active that chemists have used computational modeling to predict that they should be impossible to make. This has created challenges for more than a century and prevented a solution to create this chemical substance.

"What we were able to do was to run these chemical reactions with specialized equipment while getting rid of elements commonly found in our atmosphere," said Jenna Humke, a University of Minnesota chemistry graduate student and lead author on the paper. "Luckily, we have the tools to do that at the University of Minnesota. We ran experiments under nitrogen in a closed-chamber glovebox, which creates a chemically inactive environment to test and move samples."

These experiments were accomplished by using organometallic catalysis—the interaction between metals and organic molecules. The research required collaboration between both organic and inorganic chemists. This is something that is common at the University of Minnesota.

"We were able to solve this long-standing challenge because the University of Minnesota Department of Chemistry is unique in that we don't have formal divisions," Roberts added. "This allows us to put together a team of experts in all fields of chemistry, which was a vital component in completing this project."

After introducing the chemical compound in this paper, the next steps will be to make it widely available to chemists across multiple fields to

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streamline the creation process. This could help solve important problems like preventing food scarcity and treating illnesses to save lives.

Phys Org, 1 May 2024

https://phys.org

Liquid metal synthesis of diamonds achieved at atmospheric pressure

2024-04-30

Diamonds have been synthesised at atmospheric pressure by researchers in South Korea. The researchers do not yet fully understand the underlying mechanism that forms these diamond films, but it involves passing methane over liquid gallium. They are working, however, to optimise the synthesis to produce higher-quality diamonds that they hope could find a range of uses.

Diamonds are not just the most expensive gemstones in the world: they have important uses in science and technology, ranging from drill bits to quantum computing. Researchers have therefore developed various ways to synthesise diamonds including advanced types of chemical vapour deposition. Around 99% of artificial diamonds, however, are produced using modifications of a technique developed at General Electric in the 1950s. This involves placing a small seed diamond on iron sulfide and heating it to 1600°C in the presence of a carbon source at 7GPa. As the sulfide melts, the carbon source gradually converts into diamond and grows around the original seed.

The new work was inspired by a 2017 paper where liquid gallium catalysed the low-temperature production of graphene from methane. 'In the course of their work the researchers present indirect – but nonetheless compelling – evidence that there is carbon subsurface in their gallium,' says physical chemist Rodney Ruoff at the Institute for Basic Science in Ulsan. 'Gallium is perceived to be completely immiscible with carbon, and other low-melting point metals like bismuth, indium, tin and lead don't have binary phase diagrams with carbon either.'

Ruoff's group decided to ascertain whether gallium could be used to grow large diamonds from seeds at atmospheric pressure. In one experiment, the researchers inadvertently allowed their gallium to dissolve the silicon on the cut edge of a silicon dioxide substrate. Lead author Yan Gong, a PhD student in Ruoff's group, noticed small pyramids forming on the edge of the diamond crystal. 'That led us to understand that silicon was

somehow important,' says Ruoff. However, they could not develop this further. 'If we added more silicon we got silicon carbide instead.'

Diamond state

The researchers then tried growing diamond without adding a seed, holding silicon-doped gallium in a crucible and feeding in methane and hydrogen at temperatures around 1000°C. They found that graphite was deposited on the bottom of the gallium. Ruoff believes the low affinity of gallium for carbon probably allows the gases to diffuse down the rough edges of the crucible and form graphite underneath the liquid metal.

Diamond can be grown on this metal substrate by passing methane over it when it is liquid

The researchers then experimented with adding other metals to the gallium–silicon mixture. 'If we use gallium–silicon–iron we just get graphite,' says Ruoff. 'If we use the same combination with nickel, we might get a different amount of graphite but we still don't get diamond. But with both the iron and nickel together, one day Yan Gong was ecstatic to find a rainbow-coloured region and realise "Wow! That's actually diamond"'. The researchers then optimised their parameters to produce the best possible diamond films tens of micrometres across and found that they were superior to a commercial sample produced by chemical vapour deposition.

Spectroscopic analysis showed that significant quantities of carbon had penetrated only a few nanometres and that some silicon had been incorporated into the diamond – which could be useful for some applications like silicon vacancy quantum computing and potentially problematic in others. Many questions remain, however, including whether the diamonds are stable or metastable at ambient conditions in the liquid metal. 'I find zero exploration of ternary phase diagrams of carbon with several other elements in the literature – so that opens up a lot of basic science,' says Ruoff. How's carbon going to behave with these two or these three elements chosen as liquid metals?' The researchers hope increased understanding of the underlying science will allow them or others to produce diamonds that contain other trace elements or no trace elements at all. Ruoff says 'it's too early to say' where the work's biggest applications may lie.

Materials chemist Torben Daeneke at RMIT University in Australia believes the work shows huge promise. 'It's quite evident that this could be used to develop thin coatings of diamond on surfaces and we use these all the

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time,' he says. 'You could think about using this as an anti-corrosive coating in chemical reactors, for example…. Gallium is a relatively abundant, non-toxic liquid metal and all you have to do here is place it on the surface you want to coat and flush some methane over it.'

He believes the largest chemistry advance, however, lies in the catalysis. 'Reacting methane with gallium has been done before,' he says, 'but typically they end up with graphitic carbon, amorphous carbon or sometimes carbon nanotubes…. For me what's really exciting is that they've really fine-tuned the recipe and that completely changes the outcome. That tells me there's so much more to be done with liquid metal catalysis.'

CHemistry World, 30 April 2024

https://chemistryworld.com

Nanomaterial That Mimics Protein Behavior Could Help Treat Alzheimer's

2024-04-26

A new nanomaterial that mimics the behavior of brain proteins could be used as an effective tool to treat Alzheimer's and other neurodegenerative diseases.

The nanomaterial, a "protein-like polymer" or PLP, works by altering the interaction between two key proteins in brain cells that are believed to play a role in the development of diseases like Alzheimer's, Parkinson's and amyotrophic lateral sclerosis, or ALS.

The research – a collaboration between researchers at the University of Wisconsin–Madison and nanomaterial engineers at Northwestern University – was published in Advanced Materials.

Targeting brain proteins with nanoscience

The first protein of interest is Nrf2, a transcription factor that helps to regulate cells' defenses against toxic and oxidative threats. It is Nrf2's strong antioxidant effect that is of the most interest, as this oxidative stress is the common denominator for the neuronal cell loss seen in different neurodegenerative diseases.

Previously, researchers have found evidence suggesting that Nrf2 might be a good target for treating neurodegenerative diseases. In 2022, a group led by Jeffrey Johnson, a professor at the University of Wisconsin–Madison

School of Pharmacy, found that increasing Nrf2 activity within astrocytes – a specific type of cell found in the brain – can reduce memory loss in mouse models of Alzheimer's.

Unfortunately for researchers, translating this insight into something that might be useful for humans has so far remained elusive.

"It's hard to get drugs into the brain, but it's also been very hard to find drugs that activate Nrf2 without a lot of off-target effects," explained Johnson, who is also a corresponding author on the new research paper.

To get around this issue, scientists are now beginning to investigate the potential for nanomaterials to be used to activate Nrf2, instead of drugs.

Nathan Gianneschi, a professor of chemistry at Northwestern University and faculty member at the university's International Institute for Nanotechnology, is one of the researchers spearheading this research avenue. Gianneschi and his colleagues have previously reported the development of several PLPs, all designed to target different proteins.

Recently, Gianneschi's group has created a PLP designed to alter the interaction between Nrf2 and another key protein, Keap1, that controls when Nrf2 responds to oxidative stress. The two are bound together in unstressed conditions, with Keap1 releasing Nrf2 to act as an antioxidant when needed.

Using biomaterials to combat oxidative stress

Now, Gianneschi and the University of Wisconsin-Madison researchers – led by Jeffrey Johnson and his wife, senior scientist Dr. Delina Johnson – have teamed up, bringing together Gianneschi's knowledge of nanomaterials with the Johnsons' experience investigating mouse model brain cells and neurodegenerative disorders.

In the new study, they found that Gianneschi's new PLP nanomaterial was extremely effective at binding to Keap1 in primary cortical cultures, allowing Nrf2 to accumulate in the cells' nuclei and exert its antioxidant effects. Crucially, the PLP did this without causing any of the undesirable off-target effects that have plagued other treatment strategies.

Following the success of the PLP material in cultured cells, the Gianneschi and Johnsons' groups intend to investigate whether this new nanomaterial could also prove effective in mouse models of neurodegenerative diseases.

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"We don't have the expertise in biomaterials," said Dr. Delinda Johnson, a senior scientist within the UW-Madison School of Pharmacy. "So getting that from Northwestern and then moving forward on the biological side here at UW shows that these types of collaborations are really important."

Technology Networks, 26 April 2024

https://technologynetworks.com

$B_4C–TiB_2$ composite ceramics with adjustable mechanical and electrical properties

2024-04-30

In recent years, electro-conductive composite ceramics have gradually become a research hotspot in the functionalization of structural ceramics. However, the improvement of conductivity is generally achieved at the cost of increasing the content of conductive phases or sacrificing the mechanical properties of the composite ceramics.

Therefore, achieving high conductivity of composite ceramics at low conductive phase content is of great significance. In a recent study, electrically conductive B4C–TiB2 composite ceramics containing only 15 vol% TiB2 were prepared by a two-step spark plasma sintering process, and their mechanical and electrical performances were adjusted by the optimal particle size coupling of raw material powders.

A team of material scientists led by Songlin Ran from Anhui University of Technology in Maanshan, China recently prepared highly electro-conductive B4C–TiB2 ceramics by a two-step spark plasma sintering method.

The three-dimensional interconnected intergranular TiB2 network consisting of large B4C grains and small TiB2 grains established an excellent conductive path for the passing of electrical current, which was beneficial to the improvement of electrical conductivity. Moreover, they have also achieved controllable adjustment of the mechanical and electrical properties of B4C–TiB2 ceramics by the optimal particle size coupling of raw material powders.

"In this work, we prepared highly electro-conductive B4C–TiB2 ceramics via a two-step method based on the novel selective matrix grain growth strategy. During the sintering progress, small B4C grains were completely consumed, leaving small TiB2 grains around B4C grains to form the three-dimensional interconnected intergranular TiB2 network.

"As a result, more conductive channels were formed and thus improving the electrical conductivity of the composites," said Dr. Ran, the corresponding author of the paper, a professor in the School of Materials Science and Engineering at Anhui University of Technology.

B4C–15 vol% TiB2 composite ceramic prepared from 10.29 μm B4C and 0.05 μm TiC powders exhibited a perfect three-dimensional interconnected conductive network with a maximum electrical conductivity of 4.25×104 S/m, together with excellent mechanical properties including flexural strength, Vickers hardness and fracture toughness of 691±58 MPa, 30.30±0.61 GPa and 5.75±0.32 MPa·m1/2, respectively, while the composite obtained from 3.12 μm B4C and 0.8 μm TiC powders had the best mechanical properties including flexural strength, Vickers hardness and fracture toughness of 827±35 MPa, 32.01±0.51 GPa and 6.45±0.22 MPa·m1/2, together with a decent electrical conductivity of 0.65×104 S/m.

"The method proposed in this paper can prepare highly electro-conductive ceramics at low conductive phase content, which greatly reduces the production cost and also provides a new strategy for the regulation of microstructure and properties of composite ceramics," said Dr. Ran.

The next step is to restructure the three-dimensional network and construct a more perfect conductive network by introducing ceramic particles, whiskers, fibers, etc. In addition, the effect of the multiple conductive phases on the microstructure, electrical properties and mechanical properties of the composite ceramics need to be investigated in detail to reveal the conductive mechanism.

Other contributors include Jun Zhao, Xingshuo Zhang, Zongning Ma, Dong Wang and Xing Jin from Anhui University of Technology in Maanshan, China; and Chaohu University in Hefei, China.

Phys Org, 30 April 2024

https://phys.org

Almost 100%-recyclable circuit board turns to jelly for disassembly

2024-04-29

A new type of printed circuit board (PCB) could drastically reduce the amount of electronic waste that ends up in landfills. Although most PCBs

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are difficult to recycle, such is not the case with this one, which partially turns into a reusable jelly when necessary.

Among other components, PCBs typically incorporate a layer of non-conductive fiberglass which serves as a substrate for electronic parts such as chips, resistors and transformers. The fiberglass is in turn made up of two ingredients – woven glass fibers and epoxy resin – which are very difficult to separate from one another.

Because this substrate material can't be easily broken down, retrieving the electronics for reuse is labor-intensive and time-consuming. Sometimes the fiberglass is burned away in order to harvest the electronics, but this process is environmentally-unfriendly plus it may damage the very components that it's freeing up.

That's where the experimental new PCB comes in.

Created by scientists from the University of Washington, it replaces the resin in the fiberglass with a polymer known as a vitrimer. As long as the PCB is in use, that vitrimer remains strong, rigid and non-conductive, allowing the substrate to function just like one made of traditional fiberglass.

Once such a "vPCB" (vitrimer printed circuit board) has reached the end of its use, it will be sent to a recycling facility and immersed in an organic solvent which has a relatively low boiling point. When that solvent boils, it causes the vitrimer to swell and become gelatinous.

All of the glass fibers and electronics – which remain completely undamaged – can then be easily plucked out for reuse. Additionally, lab experiments have shown that 98% of the vitrimer itself can be reused, along with 91% of the solvent.

And importantly, vPCBs can be manufactured at existing facilities, plus they can be recycled over and over again. In fact, the scientists estimate that the use of recycled vPCBs could entail a 48% reduction in global warming potential and an 81% reduction in carcinogenic emissions as compared to traditional PCBs.

"PCBs make up a pretty large fraction of the mass and volume of electronic waste," says Asst. Prof. Vikram Iyer, co-senior author of a paper on the research. "They're constructed to be fireproof and chemical-proof, which is great in terms of making them very robust. But that also makes them basically impossible to recycle. Here, we created a new material

formulation that has the electrical properties comparable to conventional PCBs as well as a process to recycle them repeatedly."

The paper was recently published in the journal Nature Sustainability. And as an interesting side note, some of the same scientists previously used vitrimers in a more easily repairable and recyclable type of carbon fiber.

Source: University of Washington

New Atlas, 29 April 2024

https://newatlas.com

Biodegradable 'living plastic' houses bacterial spores that help it break down

2024-04-30

The work is detailed in a paper published on April 30 in Nature Communications.

The biodegradable TPU was made with bacterial spores from a strain of Bacillus subtilis that has the ability to break down plastic polymer materials.

"It's an inherent property of these bacteria," said study co-senior author Jon Pokorski, a nanoengineering professor at the UC San Diego Jacobs School of Engineering and co-lead of the university's Materials Research Science and Engineering Center (MRSEC). "We took a few strains and evaluated their ability to use TPUs as a sole carbon source, then picked the one that grew the best."

The researchers used bacterial spores, a dormant form of bacteria, due to their resistance to harsh environmental conditions. Unlike fungal spores, which serve a reproductive role, bacterial spores have a protective protein shield that enables bacteria to survive while in a vegetative state.

To make the biodegradable plastic, the researchers fed Bacillus subtilis spores and TPU pellets into a plastic extruder. The ingredients were mixed and melted at 135 degrees Celsius, then extruded as thin strips of plastic.

To assess the material's biodegradability, the strips were placed in both microbially active and sterile compost environments. The compost setups were maintained at 37 degrees Celsius with a relative humidity ranging from 44 to 55%. Water and other nutrients in the compost triggered

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germination of the spores within the plastic strips, which reached 90% degradation within five months.

"What's remarkable is that our material breaks down even without the presence of additional microbes," said Pokorski. "Chances are, most of these plastics will likely not end up in microbially rich composting facilities. So this ability to self-degrade in a microbe-free environment makes our technology more versatile."

Although the researchers still need to study what gets left behind after the material degrades, they note that any lingering bacterial spores are likely harmless. Bacillus subtilis is a strain used in probiotics and is generally regarded as safe to humans and animals -- it can even be beneficial to plant health.

In this study, the bacterial spores were evolutionary engineered to survive the high temperatures necessary for TPU production. The researchers used a technique called adaptive laboratory evolution to create a strain that is resilient to extrusion temperatures. The process involves growing the spores, subjecting them to extreme temperatures for escalating periods of time, and allowing them to naturally mutate. The strains that survive this process are then isolated and put through the cycle again.

"We continually evolved the cells over and over again until we arrived at a strain that is optimized to tolerate the heat," said study co-senior author Adam Feist, a bioengineering research scientist at the UC San Diego Jacobs School of Engineering. "It's amazing how well this process of bacterial evolution and selection worked for this purpose."

The spores also serve as a strengthening filler, similar to how rebar reinforces concrete. The result is a TPU variant with enhanced mechanical properties, requiring more force to break and exhibiting greater stretchability.

"Both of these properties are greatly improved just by adding the spores," said Pokorski. "This is great because the addition of spores pushes the mechanical properties beyond known limitations where there was previously a trade off between tensile strength and stretchability."

While the current study focused on producing smaller lab-scale quantities to understand feasibility, the researchers are working on optimizing the approach for use at an industrial scale. Ongoing efforts include scaling up production to kilogram quantities, evolving the bacteria to break down plastic materials faster, and exploring other types of plastics beyond TPU.

"There are many different kinds of commercial plastics that end up in the environment -- TPU is just one of them," said Feist. "One of our next steps is to broaden the scope of biodegradable materials we can make with this technology."

This work was supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy and Advanced Manufacturing Office (DE-EE0009296), UC San Diego Materials Research Science and Engineering Center (MRSEC) and the National Science Foundation (DMR-2011924).

Science Daily, 30 April 2024

https://sciencedaily.com

Golden Graphene: Researchers Successfully Synthesize "Goldene"

2024-04-17

Scientists at Linköping University, Sweden, have successfully synthesized single-atom–thick sheets of gold for the first time. Their new material has been dubbed "goldene", in a nod to the more well-known 2D carbon material, graphene.

According to the researchers, goldene could one day be used in applications such as carbon dioxide conversion, hydrogen production and the production of value-added chemicals, among others. The research is published in Nature Synthesis.

In search of "goldene"

The discovery and synthesis of graphene – an allotrope of carbon forming a single layer of carbon atoms – prompted significant interest in the development of alternative 2D materials. Gold became one of the elements at the forefront of these efforts, due to the already apparent usefulness of gold nanoparticles in electronics and biomedicine. But synthesizing a 2D material comprised solely of metals turned out to be a very difficult task, due to the metal's tendency to lump together.

"If you make a material extremely thin, something extraordinary happens – as with graphene. The same thing happens with gold. As you know, gold is usually a metal, but if single-atom–layer thick, the gold can become a semiconductor instead," explained Shun Kashiwaya, a researcher at the Materials Design Division at Linköping University and the study's first author.

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To succeed in creating goldene, the Linköping University team used a 3D base material where gold is embedded between other layers of titanium and carbon. This technique is called intercalation.

"We had created the base material with completely different applications in mind," said senior study author Lars Hultman, a professor of thin film physics at Linköping University. "We started with an electrically conductive ceramic called titanium silicon carbide, where silicon is in thin layers. Then the idea was to coat the material with gold to make a contact. But when we exposed the component to high temperature, the silicon layer was replaced by gold inside the base material."

This created a material called titanium gold carbide. But this material has existed for years – the trouble for researchers has always been working out how to extract these gold sheets from the 3D base material.

Japanese smithing technique releases goldene

In Japanese forging art, smiths use a chemical known as Murakami's reagent to etch away carbon residue and change the color of steel for knife making. Hultman and Kashiwaya wondered whether it might be possible to use a modified version of Murakami's reagent to etch away the titanium and carbon in their titanium gold carbide material, leaving the goldene sheets behind.

"I tried different concentrations of Murakami's reagent and different time spans for etching. One day, one week, one month, several months. What we noticed was that the lower the concentration and the longer the etching process, the better. But it still wasn't enough," Kashiwaya said.

In the end, the researchers found that carrying out the etching process in the dark allowed the goldene sheets to be released – carrying out the same process in light led to the development of cyanide, which ruined the material. In a final step, the team applied a long-molecule surfactant to the released goldene sheets to prevent them from curling up or lumping together.

"The goldene sheets are in a solution, a bit like cornflakes in milk. Using a type of 'sieve', we can collect the gold and examine it using an electron microscope to confirm that we have succeeded, which we have," said Kashiwaya.

Goldene is interesting because it exhibits some very special properties. Gold has two free bonds when two-dimensional, which the researchers say could lead to the application of goldene in carbon dioxide conversion,

hydrogen-generating catalysis, selective production of value-added chemicals, hydrogen production, water purification, communications and much more.

It is also possible that some applications that currently use thin wafers of gold might benefit from replacing those with goldene, saving on the amount of precious gold that needs to be used in industry.

Next, the team is planning to investigate whether similar methodologies could be used to create 2D sheets of other noble metals. They also intend to work on identifying future applications for such materials.

Technology Networks, 17 April 2024

https://technologynetworks.com

Drug Candidate Reverses Obesity in Mice

2024-05-01

Researchers at Karolinska Institutet may have found a new way to treat obesity and related disorders by targeting the cells' powerhouses, the mitochondria. A study published in Nature Metabolism shows that a specific class of drugs that block mitochondrial function can reverse diet-induced obesity, fatty liver and diabetes in mice.

Mitochondria are essential for human health, as they process the nutrients in the food we eat and harvest the energy needed for various processes in the cell. They are central regulators of metabolism, which is very dynamic and can be rerouted and reprogrammed according to different needs or in response to disease.

Increased fat metabolism

Professor Nils-Göran Larsson's research group at Karolinska Institutet has recently developed highly specific drug candidates that block mitochondrial function, and thus cellular energy production, to treat cancer. Now the researchers have shown that these drugs also have a beneficial effect on metabolism in mice.

"Four weeks of treatment led to an unexpected increase in fat metabolism, resulting in a drastic weight loss, a reduction in fat accumulation in the liver and restored glucose tolerance," says postdoctoral researcher Taolin Yuan at the Department of Medical Biochemistry and Biophysics, Karolinska Institutet.

The treatment was given orally to male obese mice who had been fed a high-fat diet. The surprising effect suggests that blocking the cells' energy production can reverse obesity and diabetes.

Collaboration with a biotech company

"It's exciting that we have identified a new potential strategy for treating common diseases like obesity and type 2 diabetes," says Professor Nils-Göran Larsson. "We now aim to further investigate the mechanisms that can explain the drugs' effect. We have also initiated a collaboration with a biotech company to see if this can be further developed into a treatment for humans. Still, it will be many years before we know if it works," he concludes.

The study was financed by the Novo Nordisk Foundation, the Swedish Diabetes Foundation, the Swedish Research Council, the Knut and Alice

Wallenberg Foundation, ALF funding, the Swedish Cancer Society and the Swedish Brain Foundation. Nils-Göran Larsson is a scientific founder and holds stock in Pretzel Therapeutics Inc. Three of the coauthors are employees of Lead Discovery Center and are listed as co-inventors on a patent application concerning mitochondrial RNA polymerase inhibitors for the treatment of cancer. The remaining authors declare no competing interests.

Technology Networks, 1 May 2024

https://technologynetworks.com

Why you can taste more ethanol in a cold pint of beer or warm glass of baijiu

2024-05-01

We all have our own preferred drinking temperatures for different alcoholic beverages, with people commonly enjoying beer or white wine chilled, red wine near room temperature, or baijiu (Chinese whisky) or sake warmed.

In a paper published in the journal Matter on May 1, researchers report that alcoholic beverages may taste more or less "ethanol-like" at different temperatures, and this may be explained by how water and ethanol form either chain-like or pyramid-shaped clusters at the molecular level.

"Two years ago, first author Xiaotao Yang and I were drinking beer together. He had just finished his doctorate degree thesis and asked me, 'what should we do next?'" says lead author and materials scientist Lei Jiang of the Chinese Academy of Sciences.

"At the time, I was a scientific committee member of one of the biggest Chinese alcoholic beverage companies, and I had the idea to ask the question 'why does Chinese baijiu have a very particular concentration of alcohol, either 38%–42%, 52%–53%, or 68%–75%?'"

"Then we decided, let's try something, so I put a drop of beer on my hand to see the contact angle," says Jiang.

Soon after, Jiang, Yang, and the rest of their team set off to the lab to measure the contact angle of a series of solutions with increasing concentrations of alcohol in water. Contact angle is a common measurement of a liquid's surface tension, and it also tells you how the molecules within the droplet are interacting with each other and with the surface below.

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For example, water has a low contact angle on a surface like glass, and so a drop of it will appear "bead-like," where a drop of high alcohol concentration spirits will have a higher contact angle and will instead flatten and spread out.

They were surprised to find that the contact angle did not increase linearly with increasing alcohol concentration, but instead the plot showed an irregular series of plateaus as it increased. Additional experiments indicated that this was happening due to the formation of different clusters of ethanol and water in solution.

At low ethanol concentrations, the ethanol forms more pyramid-shaped structures around water molecules; however, when the concentration of ethanol is increased, the ethanol begins to arrange end to end as if in a chain.

Interestingly, the researchers also found that the plateaus that they observed disappeared or appeared when the solutions were cooled or heated, and that some of these trends could explain differences in how alcohol taste is perceived.

For example, 38%–42% and 52%–53% ethanol solutions—like the ethanol concentrations in baijiu—have distinct cluster structures at around room temperature, but this difference disappears at higher temperatures, like 40°C. This could explain why both professional and amateur tasters can distinguish these concentrations of baijiu at room temperature but not at high temperature. At higher temperatures, both concentrations have more chain-like structures and therefore a more "ethanol-like" taste.

"Although there is only 1% difference, the taste of baijiu at 51% and 52% is noticeably different; the taste of baijiu at 51% is similar to that of lower alcohol content, such as 38%–42%. So, in order to achieve the same taste at a lower alcohol content, the distribution of baijiu products ranges most within the 38%–42% and 52%–53% categories," says Jiang.

Similarly, professional testers observe a stronger "ethanol-like" taste in beer after it has been chilled. The results of these experiments show that there is a distinct enhancement in the chain-like structures at 5°C in 5% and 11% ethanol solutions.

"At low temperature, the tetrahedral (pyramid-shaped) clusters become the low concentration amount, and this is why we drink cold beer," says Jiang.

The researchers propose that this information could be leveraged by the alcoholic beverage industry to achieve an "ethanol-like" taste with the lowest ethanol concentration possible.

Phys Org, 1 May 2024

https://phys.org

Steeped in chemistry

2024-01-25

As a keen tea drinker I was intrigued by a January 2020 tweet in which @ andrechemist wondered if a tetrahedral teabag produced a better cup of tea. The question sent me into the literature to see what chemists knew about the shape of teabags and the resulting brew. In fact, just what did chemists know about making tea more generally?

Quite a lot as it turns out. This should not have surprised me as tea is the most popular beverage in the world after water (a statistic nearly every paper on tea I read cited). In the end I wrote my own version of George Orwell's 1946 essay, 'A Nice Cup of Tea' for Nature Chemistry. That essay grew into my book Steeped: The chemistry of tea.

There is a vast chemical literature on tea: I read some 500 papers. To flesh out what I was reading, I did some experiments of my own. I measured cooling curves for teapots of different materials, spiked my tea with extra doses of its naturally occurring amino acid l-theanine to see if it affected the flavour (researchers disagreed, but I could taste the difference) and sampled heavy water to determine if it is sweet (it is). Given its price tag I drew the line at buying deuterium-depleted water to see if that produced an exceptional cup of tea as one author suggested, and a lack of snow the past two winters kept me from scraping it off plum blossoms to reproduce a famously extraordinary cup detailed in an 8th century Chinese manuscript.

The biggest challenge I faced in writing Steeped – beyond the daunting scope of the literature – was how to present the chemistry in such a way that someone who had not taken a chemistry course could appreciate what was happening in a cup of tea on the molecular level. I settled on highlighting four big ideas that chemists use to explain the behaviour of molecules: atoms make up everything, opposites attract, getting close matters, and molecular function depends on molecular structure. I wrote an introductory chapter that fleshes out these concepts and provides a short course in how to read chemical structures. In case people were

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daunted by even that much chemistry, I wrote a three paragraph TL;DR that was just enough (I hoped) to get them through. I wanted not only to help non-chemists navigate the chemistry in the book, but to let them catch a glimpse of the world as chemists see it. I hope that readers without a science background will be able to wield these concepts to understand other everyday chemistry.

Researching Steeped changed my own tea making habits. My experiments measuring the cooling curves drove home to me the importance of pre-warming the teapot or the cup whenever possible. If I don't, the temperature in my favorite Japanese cast-iron tetsukyūsu quickly drops below the optimum temperature for extracting caffeine and other desirable compounds. These days I reach more often for a double-walled glass pot that not only keeps the tea hot while it brews, but also keeps it at a drinkable temperature longer without the need for a tea cozy.

I have also become a more agitated brewer of tea. I repeatedly dunk teabags and swish my tea basket infuser as the tea steeps in order to expose the tea leaves more evenly to the solvent and extract more catechins—tea's signature antioxidants. Finally I unscrew the lid on my travel mug when I can to inhale the volatile calming compounds such as linalool found in the steam.

While writing Steeped certainly enhanced my enjoyment of a cup of tea, there were several disquieting discoveries along the way. There are the remains of lots of bugs in my tea – the DNA of hundreds of different insects have been identified in tea leaves. I also now know how closely the white film that appears on tea when water is heated in the microwave resembles bathtub scum. Though that also means that the remedy is the same for both, some citric acid to chelate those hard water ions.

I particularly enjoyed encountering other women connected to the chemistry of tea. The earliest paper I read was from 1885, a careful analysis of an infusion of tea by Wilhelmina Green, a chemist I wish I knew more about. And while the invention of the modern teabag is usually credited to Thomas Sullivan in 1908, a US patent for such a teabag was issued to Roberta Lawson and Mary McLaren five years earlier.

And to answer the question that kicked off this project, it is not so much the shape of the teabag that matters as the size. To use one of the big

ideas of chemistry, the tea leaves need enough space to get close to the water. Agitate well and enjoy a better cup of tea.

Chemistry World, 25 January 2024

https://chemistryworld.com

New Plastic Coating Discovery Gives Greater Functionality to 3D Printing

2024-04-19

Scientists and engineers have developed a new coating for plastic particles that are used in 3D printing, which significantly increases their functionality and opens up new possibilities for commercial application.

Researchers from the University of Nottingham's School of Chemistry and Faculty of Engineering have used supercriticial carbon dioxide to create an efficient, effective and clean process to coat PA-12 polymer particles used in a 3D printing process.

The researchers have demonstrated that the new coatings have the ability to add colour and anti-mould and fungal properties to the printing process. The research has been published in Nature Communications.

One of the most common commercial 3D printing techniques is powder bed fusion or laser sintering. In this process a layer of free-flowing polymer powder is laid down and a laser is guided by a computer generated design and melts the powder layer-by-layer. A new layer of powder is applied to the previous layer and once again the laser melts the powder together whilst simultaneously anchoring it to the layer below. This process continues until the designed part is complete, often consisting of thousands of layers.

Polyamide-12 (PA12) is a strong plastic that is often is often used in the 3D printing industry to print complex and detailed parts, commonly deployed in the automotive or aerospace industries.

Two key capabilities the new process can deliver are the addition of coatings for colour and anti-fungal and anti-mould properties. Currently the only options for manufacturers are grey or white powders and colour is added afterwards, now the team have created a range of coloured polymers that coat the PA-12 particles.

Currently objects made using PA-12 can't be used in moist environments due to the growth of mould and fungi. The new shell coating can also be

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used to develop coatings that prevent this from happening, opening up new possibilities for the use of 3D printed objects in new areas.

Professor Howdle adds: "A key benefit of this process is that it can easily be incorporated into current commercial 3D printing processes and this could be potentially transformative for the industry in widening scope by introducing new functionality, simplifying processes and importantly achieving all of this sustainably."

Technology Networks, 19 April 2024

https://technologynetworks.com

Researchers turn to two crops to tackle environmental harm of apparel made with synthetic fibers

2024-05-01

From risottos to sauces, mushrooms have long been a staple in the kitchen. Now fungi are showing the potential to serve up more than just flavor—as a sustainable, bendy material for the fashion industry.

Researchers are using the web-like structure of the mushroom's root system—the mycelium—as an alternative to synthetic fibers for clothing and other products such as car seats.

"It's definitely a change of mindset in the manufacturing process," said Annalisa Moro, EU project leader at Italy-based Mogu, which makes interior-design products from the mycelium. "You're really collaborating with nature to grow something rather than create it, so it's kind of futuristic."

Mogu, located 50 kilometers northwest of Milan, is managing a research initiative to develop nonwoven fabrics made of mycelium fibers for the textile industry.

Called MY-FI, the project runs for four years through October 2024 and brings together companies, research institutes, industry organizations and academic institutions from across Europe.

MY-FI highlights how the EU is pushing for more sustainable production and consumption in the textile and apparel industry, which employs around 1.3 million people in Europe and has annual turnover of €167 billion.

While getting most of its textiles from abroad, the EU produces them in countries including France, Germany, Italy and Spain. Italy accounts for more than 40% of EU apparel production.

Delicate and durable

The mycelium grows from starter spawn added to crops such as cereals. The threadlike filaments of the hyphae, the vegetative part of the fungus, create a material that grows on top. It is harvested and dried, resulting in soft, silky white sheets of nonwoven fabric that are 50 to 60 square centimeters.

The delicate material is made stronger and more durable through the addition of bio-based chemicals that bind the fibers together.

Its ecological origins contrast with those of most synthetic fibers such as nylon and polyester, which derive from fossil fuels such as coal and oil. That means production of synthetic fibers adds to greenhouse-gas emissions that are accelerating climate change. In addition, when washed, these materials shed microplastics that often end up polluting the environment including rivers, seas and oceans.

The MY-FI mycelium needs very little soil, water or chemicals, giving it greener credentials than even natural fibers such as cotton.

Dress rehearsal

For the fashion industry, the soft, water-resistant properties of the mycelium are as appealing as its environmental credentials.

Just ask Mariagrazia Sanua, sustainability and certification manager at Dyloan Bond Factory, an Italian fashion designer and manufacturer that is part of MY-FI.

The company has used the mycelium-based material—in black and brown and with a waxed finish—to produce a prototype dress, a top-and-midi-skirt combination, bags and small leather accessories.

Laser cutting and screen printing were used to evaluate the material's behavior. The challenge was to adapt to the sheets of fabric—squares of the mycelium material rather than traditional rolls of textiles like cotton, linen and polyester—as well as properties such as tensile strength and seam tightness.

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"We have had to completely change the paradigm and design processes and garments based on the material," said Sanua.

The company hopes the mycelium material will be a way of offering consumers a range of products that can be alternatives to animal leather.

"It's beautiful to see the prototypes," said Moro. "It's a wonderful thing to see how many people with different backgrounds and perspectives are working together to create this result."

For its part, Mogo is working towards a large-scale manufacturing plant to move the MY-FI material from the research stage to the market. While the material is currently relatively expensive to make, costs would fall with large-scale production.

Leather-unbound

Meanwhile, Germany-based Volkswagen, the world's No. 2 car manufacturer, is looking to mycelium technologies to reduce its environmental footprint and move away from leather for vehicle interiors.

Customers increasingly want animal-free materials for interiors from seat covers and door panels to dashboards and steering wheels, so adding a sustainable substitute for leather is an exciting prospect, according to Dr. Martina Gottschling, a researcher at Volkswagen Group Innovation.

"A fast-growing biological material that can be produced animal-free and with little effort, which also does not require petroleum-based resources, is a game-changer in interior materials," she said.

The mycelium material is also lighter than leather, another positive for reducing VW's carbon footprint.

The company's involvement in MY-FI is driving project researchers at Utrecht University in the Netherlands and I-TECH Lyon in France to enhance the durability of the mycelium fabric. To move from prototype to production line, the fabric must meet quality requirements set by VW to ensure the material lasts for the life of the vehicle.

It's a challenge that Gottschling believes will be met in the coming decade.

"We already see the material as one of the high-quality materials for interior applications that will be possible in the future," she said.

When life gives you tomatoes

Mushrooms aren't the only food with the potential to spin a sustainable-yarn revolution. Tomato stems have a hidden talent too, according to Dr. Ozgur Atalay and Dr. Alper Gurarslan of Istanbul Technical University in Turkey.

Seeing tomato vines left to wither in the fields after the crop was harvested, Atalay and Gurarslan began to investigate whether the stems could be transformed into sustainable fibers.

Tests proved that the agricultural waste could indeed be turned into yarn. But Atalay and Gurarslan were determined to go a step further. They wanted to use tomato stems to create a type of yarn for garments that monitor heart beats, respiratory rates and joint movements.

The two researchers lead a project to create this kind of electrically conductive apparel using—for the first time—sustainable materials. Called SMARTWASTE, the project runs for four years until the end of 2026 and also involves academic and research organizations from Germany, Italy, the Netherlands and Poland.

"The beauty of the project is that we are starting from waste," said Atalay. "We are taking agricultural waste and not just creating regular textiles but something much more valuable."

While cost estimates will follow later in the project when design partners work on creating actual products, he signaled that smart clothing will be a good deal more expensive than the ordinary kind.

A smart textile shirt could cost as much as €1,000, according to Atalay.

The specialized material, limited production runs and research and development needed to create wearable technologies that are durable, washable and comfortable all contribute to the price tag.

Advancements in technology should eventually lead to lower production costs and consumer prices.

Seeds of poplar success

The Turkish countryside has also inspired a second strand to the project. Turkey's abundant poplar trees and—more specifically—their white, fluffy cotton-like seeds prompted Gurarslan to investigate whether they could be a sustainable textile source.

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While their fibers have been dismissed as too short to make a yarn, the seeds have three particular properties that appeal to the textile industry: a hollow, pipe-like structure that can trap heat to provide thermal qualities, an antibacterial nature and water resistance.

The network of SMARTWASTE experts has blended the seeds with recycled polyester to make a nonwoven fabric that the team intends to turn into textile products with enhanced thermal properties.

The researchers hope this is just the start of a far-reaching transformation of textiles.

"Our goal is to train the next generation of researchers and innovators in sustainable textiles," said Atalay.

Phys Org, 1 May 2024

https://phys.org

Extra-strong spore-loaded plastic eats itself when it hits landfill

2024-04-30

Scientists have demonstrated a creative solution to plastic pollution, one of our most pressing environmental problems. Plastic was embedded with spores of plastic-eating bacteria that are activated when dumped in landfill, biodegrading 90% of the material in five months. Weirder still, this actually made the plastic tougher and stronger during use.

Plastic is a strong, versatile material, but the same properties that make it useful also make it hard to dispose of. It famously takes decades or centuries to degrade, so huge amounts of plastic waste are clogging up landfill and oceans.

Intriguingly, it seems like nature is adapting, as it so often does. In recent years scientists discovered bacteria that have evolved the ability to break down plastic, isolated the enzymes that do it, and even ramped up their efficiency. This could potentially make for more efficient recycling centers where plastic is treated with enzymes and bacteria. But what about plastic that doesn't make it to these facilities? Thermoplastic polyurethane (TPU) is a tough type of plastic commonly used to make things like shoes, sporting goods, phone cases and car parts, but can't currently be recycled.

So for the new study, the team investigated a new potential method to dispose of TPU – embedding spores of the plastic-eating bacteria Bacillus

subtilis right into the plastic itself. Ideally, you'd be able to use the plastic products as normal, without them breaking down too early, and only when they were dumped in landfill or natural environments would they start biodegrading.

The first problem to overcome is that the high heat used to produce plastic would kill off most bacterial spores. So the researchers genetically engineered the microbes to withstand that heat, and found that 96 to 100% of the edited bacteria survived at the plastic processing temperature of 135 °C (275 °F), compared to just 20% of unedited bugs.

Next, they tested how well the bacteria would break down the plastic, a process that's triggered by nutrients and moisture in the soil. At concentrations of up to 1% of the plastic's weight, the bacteria broke down over 90% of the material within five months of being buried in compost.

It's easy to assume that giving plastic its own Achille's heel will only make it weaker during use, but it turns out the opposite is true. Plastic made with the spores was found to be up to 37% tougher and had up to 30% higher tensile strength than regular TPU, with the team hypothesizing that the spores act as a reinforcing filler.

The researchers say that this technique, which is potentially scalable, could open up a new way to dispose of unrecyclable TPUs, while making them tougher and stronger during use. Combine it with a few other methods and we might make some progress towards tackling the plastic pollution problem.

The research was published in the journal Nature Communications.

New Atlas, 30 April 2024

https://newatlas.com

Plastic Food Packaging May Contain Harmful Chemicals That Affect Hormones and Metabolism

2024-04-24

Plastic is a very complex material that can contain many different chemicals, some of which can be harmful. This is also true for plastic food packaging.

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"We found as many as 9936 different chemicals in a single plastic product used as food packaging," said Martin Wagner, a professor at NTNU's Department of Biology.

Wagner has been working with chemicals in plastic products for several years. He is part of a research group at NTNU that has now published its findings in the Environmental Science & Technology journal. PhD candidates Molly McPartland and Sarah Stevens from NTNU are the lead authors of both studies.

Interfering with hormones and metabolism

In one study, the researchers looked at 36 different plastic products that are used to package food. These products came from five countries; the United States, the United Kingdom, South Korea, Germany and Norway.

"In most of these plastic products, we found chemicals that can affect the secretion of hormones and metabolism," Wagner said.

These functions are absolutely vital. Hormones are the body's messengers. They are secreted from various different glands and enable the different organs to communicate with each other. Metabolism is sum of the various processes that enable the body to use nutrients to provide the body with energy and substances it needs to function.

Affects body signals

In the second study, researchers looked at different combinations of plastic chemicals to see the possible effect they have on G-protein-coupled receptors. These receptors play an important role in the transmission of signals in the body.

"We identified 11 chemical combinations from plastic products that affect these signal receptors," says Associate Professor Wagner.

The researchers have found new ways in which these chemical mixtures can affect the transmission of signals in the body.

Absorbed by the body

"These and previous findings show that plastic exposes us to toxic chemicals. They support the theory that we need to redesign plastic to make it safer," Wagner said.

Previously, it was uncertain whether the chemicals could be released into the environment under normal conditions, or whether they remain bound

in the plastic. However, a few years ago, another research group proved that most plastic products leach chemicals when submerged in water.

Wagner was also part of this research group. During the study, they found chemicals that can affect fertility in humans.

Because plastic contains so many different chemicals, researchers still can only identify a few of them at a time. This means we still know very little about the effects that most of these chemicals have.

Technology Networks, 24 May 2024

https://technologynetworks.com

Clumps of an otherwise non-toxic molecule inhibit strep's DNA-cleaving enzymes, researchers discover

2024-04-30

An entirely new approach to inhibiting DNA-cleaving enzymes works through the aggregation of an otherwise non-toxic molecule. This Kobe University discovery may lead to a much-needed method for curbing Streptococcus growth.

Enzymes are the body's tools to make almost all reactions happen. But the same is true for bacteria like Streptococcus, which causes toxic shock syndrome, a rapidly progressing and deadly condition. When the body's white blood cells try to capture the bacteria by casting nets made out of their own DNA, Streptococcus uses a DNA-cleaving enzyme to cut through the net.

Blocking this enzyme has been a hot target for the development of drugs for the fight against the disease, but nothing has been found that is specific to the DNA-cleaving enzyme and that doesn't harm the body in other ways.

Kobe University biochemical engineer Maruyama Tatsuo thinks he and his team may have found an approach.

While doing research on a drug called "Mn007," they noticed that it had the ability to inhibit a bovine DNA-cleaving enzyme that is functionally very similar to the one used by Streptococcus. Maruyama explains, "It was a coincidence, but we discovered that only aggregates (clumps) of Mn007 inhibit the enzyme. This is a completely new mechanism for inhibition and so we decided to investigate if this might be a promising candidate for the treatment of streptococcal infections."

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Their results, published in the journal JACS Au, are promising and curious. They first confirmed that it is really only aggregates that inhibit the enzyme, that the action is specific to this particular DNA-cleaving enzyme, and that it is not mediated by interaction with the DNA or other substances.

Next, the Kobe University team made sure that Mn007 could also inhibit the bacterial enzyme. And finally, they tried whether this could, in principle, be applied to Streptococcus infections.

Knowing from previous studies that Mn007 is not toxic to the body's cells, they grew the bacteria in human blood containing white blood cells and added Mn007 to some of the samples. And indeed, when the drug was present, the bacteria showed significantly less growth than without it, indicating that aggregates of Mn007 helped the white blood cells reign in the bacteria's growth.

These lab studies open an exciting door to further research. First, even though they discovered a completely new mechanism of inhibiting the activity of the DNA-cleaving enzyme, also called a "DNase," nobody knows yet what this mechanism behind the specific inhibition by the aggregates is.

Maruyama says, "Currently, the research group is trying to understand how Mn007 aggregates interact with the DNase and inhibit its enzymatic activity by simulating the behavior of the molecule."

But a bigger question looms on the horizon: whether the drug can actually be applied as an effective treatment. The researchers write, "Mn007 would be the first case of a DNase inhibitor applied for therapeutic use. Because Streptococcus pyogenes infections worsen rapidly (within a few days), even temporary suppression of bacterial growth would significantly improve patient outcomes."

They close by saying, "We believe that molecular aggregation will provide a rational approach for the discovery and development of novel inhibitors for those enzymes, leading to a new strategy in drug development."

Phys Org, 30 April 2024

https://phys.org

Missing link in species conservation: Pharmacists, chemists could turn tide on plant, animal extinction

2024-04-30

"Medicinal chemistry expertise is desperately needed on the frontlines of extinction," said Timothy Cernak, assistant professor of medicinal chemistry at the U-M College of Pharmacy. "Animals are dying at staggering rates, but they don't have to. Modern bioscience has achieved enormous breakthroughs in treating disease in humans, and the same medications, and the science behind them, can be applied in the wild."

Local and global efforts to reduce environmental damage are underway, but they are too slow to save the many ailing populations in the wild, he said.

"We are in the middle of a mass extinction. We are chasing mass die-offs around the world. Lowland gorillas, Argentinian penguins, the akikiki bird in Hawaii, loggerhead turtles in Florida. The list goes on, and many precious plants are also hanging by a thread," he said. "So it's critical to bring the power of modern pharmaceuticals and the dosing expertise of medicinal chemistry into conservation efforts."

Cernak and a team of young scientists, including a local high school student, make the case for establishing and nurturing the emerging field of conservation medicine in a research article published this week in the Journal of Medicinal Chemistry.

"It's hard-core science. It's bringing the lens of medicinal chemistry and modern pharmaceuticals into the conversation to save other species," Cernak said. "Drivers of the current mass extinction include habitat loss, global warming and overharvesting, but one specific root cause -- wildlife disease -- seems ripe for intervention. Medicinal chemistry is that intervention."

Cernak, in one of many roles and research projects, receives samples of dead and ailing species from around the world. Using the same methods and models used to find compounds that work against human disease, his lab at U-M, which recently brought a veterinarian on board, tests chemical compounds on samples to see which ones respond to disease-causing organisms. A major focus is fungus, the single-largest killer of amphibians.

In their paper, the authors propose a new role for chemistry and pharmacy on the frontlines of preventing extinction: "A long-term solution to mass extinction is to fix climate change and habitat loss using new technologies

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and new policies. As a bandage for the short term, chemistry in service of endangered species is needed.

"Medicinal chemists interested in preventing extinction are encouraged to talk to zookeepers, foresters, veterinarians, entomologists, wildlife rehabilitators and conservationists to learn about the challenges and solutions where conservation medicine could make an impact, and to share their wisdom from the frontlines of drug discovery."

Cernak is pushing for a new, impactful field of science.

"At the higher level, my mission is to have pharmaceutical companies be involved in this space and young scientists view this as the field they want to go into -- a field that doesn't really exist at this point," he said. "A more immediate goal is fundraising and more research as the field and the value of the field is established."

From deadly fungus decimating Panamanian golden frogs, cancerous tumors killing loggerhead turtles and the numerous pests and illnesses sickening plants such as the hemlock tree, there is no shortage of challenges for conservation medicine to tackle.

One of those challenges may be preventing a disease from threatening public health.

"In January, 96% of sea lion pups in Argentina died in January from avian flu. If it reaches humans, what are we going to do?" Cernak said. "There may be just five akikiki songbirds left in the wild. They are dying from malaria and pox, diseases that can be treated in humans."

Studying wildlife diseases could also provide critical insights to medicinal chemists focused on human health, he said, and possibly a new paradigm where drug development and dosing prediction models, which are currently trained heavily on pharmacokinetics in rodents, could be diversified.

"The problem is that too often, conservationists who are trying desperately to treat and save dwindling populations aren't equipped with the latest pharmaceutical science and tools," he said. "Given current knowledge gaps, they may not know which drug will work best or what the right dosage might be for an endangered species."

Bringing chemists and pharmacists into the conservation fold isn't meant to diminish veterinarians and conservation groups, but to blend their

experience and expertise and achieve the same goals of saving lives -- and the ecosystem, Cernak said.

"Modern medicine could prevent the extinction of endangered species. Wildlife disease is a major driver of the current mass extinction yet therapeutic intervention in nonhuman species remains poorly understood," he said. "In zoos, botanical gardens and animal rehabilitation centers, many diseases are treatable, but the understanding of medicine for endangered species lags far behind our current understanding of human medicine."

At this moment, Cernak's lab is not only researching faster, safer pharmaceutical development for humans but also testing the Panamanian golden frogs afflicted with a fungus that threatens their existence.

Cernak supports the Centers for Disease Control and Prevention's concept of One Health, which recognizes the connection between the health of people, animals and the environment.

"We look at plants and animals the same," he said. "The concept of One Health Pharmacy -- plants, humans and animals -- is we treat any that are sick or in need."

Cernak's lab has advanced the use of artificial intelligence and other technology in speeding up the process of drug discovery. He said that only increases the opportunities to help animals and plants sooner than later.

"Streamlining drug and agrochemical discovery with automation and artificial intelligence is likely to usher in a future era of accelerated medicinal invention tailored to specific patient populations," Cernak and team wrote in their paper.

"While it may still be decades away, one can imagine a future where it is possible to feed a chatbot prompts like, 'Invent a single-dose antiviral for elephant endotheliotropic herpesvirus with optimal pharmacokinetic properties for Asian elephants.' Exciting applications of medicinal chemistry on threatened and endangered species are beginning to offer hope."

Cernak's co-authors include: Tesko Chaganti, a student at Canton High School, Canton, Michigan; Chun-Yi Tsai, a graduate student in U-M's Department of Chemistry; Yu-Pu Juang, a postdoctoral researcher in the

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Cernak Lab; and Mohamed Abdelalim, a visiting research investigator at U-M.

Science Daily, 30 April 2024

https://sciencedaily.com

Harnessing Hydrogen: Unveiling Platinum's Role in Clean Energy Catalysts

2024-04-30

Researchers elucidate mechanisms for controlling the surface oxidation processes that affect the performance of platinum catalysts in alkaline media.

Platinum (Pt) electrodes are crucial for clean power technologies like hydrogen fuel cells and electrolysis. However, the surface oxidation that occurs during such processes degrades catalyst performance and stability. To address this, researchers investigated the mechanisms of surface oxidation on Pt surface in alkaline media, a previously unexplored avenue of research. Their experiments revealed crucial insights that can aid in the development of next-generation catalysts, paving the way for a carbon-neutral society.

Hydrogen Fuel Cells and Electrolysis

The pursuit of carbon neutrality drives the exploration of clean energy sources, with hydrogen fuel cells emerging as a promising avenue. In these cells, hydrogen undergoes an electrochemical reaction with oxygen to produce electricity and water. Also, the reverse of this process, called electrolysis, can be used to split the abundantly available water to produce hydrogen and oxygen. These two technologies can work in tandem to provide a clean and renewable source of energy. A pivotal element in these two technologies is the platinum (Pt) electrode.

Challenges in Fuel Cell Technology

Hydrogen fuel cells consist of two electrodes: an anode and a cathode, with an electrolyte between them. Pt serves as a fundamental catalyst in low-temperature fuel cells, such as alkaline fuel cells and polymer electrolyte fuel cells (PEFCs). Pt has a high activity for the oxygen reduction reaction (ORR), which is crucial for fuel cells, in alkaline and acidic conditions at the operating voltage of PEFC cathodes. However, this also leads to oxide formation on the surface, which roughens and

dissolves the Pt layer, ultimately degrading the cathodes and affecting performance and stability.

Understanding surface oxide formation mechanisms is thus crucial for developing Pt cathode catalysts that work well in alkaline conditions. Studies have shown that the oxide formation on the Pt surface depends on the electrode potential, the electrolyte, and the electrical double layer (EDL). While studies have investigated the oxide formation and reduction on the Pt surface in acidic media, few of them have addressed the same in alkaline media, present in fuel cells and electrolyzers with anion exchange membranes.

Advancements in Alkaline Media Research

To address this gap, a team of researchers led by Professor Masashi Nakamura from the Graduate School of Engineering, Chiba University, Japan, dug deep into the oxide formation mechanisms on Pt surfaces in alkaline media.

"In a previous study, we reported that interfacial hydrophobic ions with long alkyl chains can enhance ORR. This suggests that it is possible to construct an interfacial reaction field that not only activates the ORR but also improves the durability of Pt electrodes by using optimal interfacial ions," explains Prof. Nakamura.

The study also included contributions from Dr. Tomoaki Kumeda and Professor Nagahiro Hoshi, both from the Graduate School of Engineering at Chiba University, along with Dr. Osami Sakata from the Center for Synchrotron Radiation Research at Japan Synchrotron Radiation Research Institute. Their findings have been published in the Journal of the American Chemical Society.

Innovative Techniques and Findings

The team investigated the oxide formation on the Pt (111) surface in alkaline aqueous solutions containing different cations, namely Lithium cation (Li+), Potassium (K+) cation and Tetramethylammonium cation (TMA+), using advanced methods like X-ray crystal truncation rod (CTR) scattering, gold nanoparticle-based surface-enhanced Raman spectroscopy (GNP-SERS), and infrared reflection absorption spectroscopy (IRAS).

"Studies have shown that a combination of vibrational spectroscopy and X-ray diffraction is effective for elucidating surface oxidation processes," adds Prof. Nakamura.

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X-ray CTR revealed that oxide formation results in surface buckling and Pt extraction. SERS and IRAS measurements revealed the potential and cation-dependent formation of three oxide species, namely infrared (IR)-active adsorbed hydroxide OH (OHad), Raman active adsorbed water (H2O)ad, and Raman-active oxygen (Oad). The team found that hydrophilic cations like Li+ stabilize IR-active OHad, thus preventing harmful oxide formation, while moderate hydrophilicity of K+ has no protective effect.

Interestingly, bulky hydrophobic cations such as TMA+ also reduce irreversible oxidation, similar to Li+. Notably, the team also found that the electrostatic repulsion between Raman-active (H2O)ad and neighboring Raman-active Oad facilitates Pt extraction.

Conclusion and Implications for Clean Energy

These results suggest that interfacial cations play an essential role in oxide formation on Pt surfaces, which can be controlled by selecting appropriate cations.

Elaborating on these results, Prof. Nakamura remarks: "These insights are crucial for understanding the surface oxidation mechanisms and the EDL structure, which can be beneficial for achieving high-performance and stable Pt electrocatalysts for use in next-generation electrochemical devices."

Overall, this study takes us a step further in achieving a zero-carbon future powered by abundant and clean hydrogen.

Sci Tech Daily, 30 April 2024

https://scitechdaily.com

CHEMWATCH

Bulletin Board

Technical Notes

MAY. 03, 2024

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CHEMICAL EFFECTS

γ-Oryzanol from Rice Bran Antagonizes Glutamate-Induced Excitotoxicity in an In Vitro Model of Differentiated HT-22 Cells

Hues of risk: investigating genotoxicity and environmental impacts of azo textile dyes

Identification of early events in nitrogen mustard pulmonary toxicity that are independent of infiltrating inflammatory cells using precision cut lung slices.

ENVIRONMENTAL RESEARCH

Research on the purification effect of major pollutants in water by modular constructed wetlands with different filler combinations

Removal effect of pollutants from stormwater runoff in shallow bioretention system with gramineous plants

PHARMACEUTICAL/TOXICOLOGY

Characterization of Per- and Polyfluoroalkyl Substances (PFAS) and Other Constituents in MSW Landfill Leachate from Puerto Rico

Interpretation of specification for service of cancer screening for workers

OCCUPATIONAL

Effect of exposure to disinfection by-products during swimming exercise on asthma-related immune responses

Short-term exposures to PM2.5, PM2.5 chemical components, and antenatal depression: Exploring the mediating roles of gut microbiota and fecal short-chain fatty acids.

Biochemical and molecular-level effects of co-exposure to chlorpyrifos and lambda-cyhalothrin on the earthworm (Eisenia fetida)