CHEMWATCH

Bulletin Board

Contents

AUG. 26, 2022

(click on page numbers for links)

CONTACT US

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

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

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

CHEMWATCH
Bulletin Board
Contents
AUG. 26, 2022

ASIA PACIFIC

The Laws Relating To Zero Emissions In Malaysia

2022-08-17

In December 2021, Malaysia experienced three (3) consecutive days of heavy downpour, constant rain on an unprecedented scale affecting eight states. The country suffered an estimated loss of Ringgit Malaysia Fifteen Billion (RM 15,000,000,000.00) to the Malaysian economy,1 close to seventy thousand (70,000) victims affected2 and most unfortunately, a total of fifty-four (54) deaths and two (2) people missing.3 Described as a one in 100-year weather event,4 was this catastrophe a result of nature running its course, an act of God? Or was it caused by the acts and omissions of mankind?

Experts believe that one of the main causes of the flood is due to climate change. Environmentalist, Dr Renard Siew claims that the flood "is a clear example of an unpredictable weather event as a result of high carbon emissions".5 It is clear that climate change (more specifically, global warming due to carbon emissions) has contributed to this disaster, and many others throughout the globe.

Thus, it is imperative that the necessary remedial action, including the enactment of laws regulating climate change, is taken by those responsible to combat this ever-growing global issue. This article seeks to explore the laws governing carbon emissions in Malaysia.

In Malaysia, the Environmental Quality Act 1974 ("EQA 1974") is the main legislation which governs the protection and conservation of the environment. Section 21 and 51 of the EQA 1974 provides the Minister charged with the responsibility for environment protection, the power to create regulations which specify the acceptable conditions for the emission of environmentally hazardous substances and pollutants as well as regulations prohibiting the emission into the environment of any gaseous matters.

In exercising the powers conferred to it under Section 21 and 51 of the EQA 1974, the Minister has created several regulations which govern carbon emissions in Malaysia, most notably the Environmental Quality (Clean Air) Regulations 2014 ("Clean Air Regulations") which provides that an owner or occupier of a premise involved in any activity or industry listed in the First Schedule of the Clean Air Regulations, including power plants, waste fuel plants, asphalt mixing plants and others,

CHEMWATCH
Bulletin Board
Regulatory Update
AUG. 26, 2022

shall incorporate measures to reduce the emission of air pollutants into the atmosphere in accordance with the Best Available Techniques Economically Achievable.

Read More

Mondaq, 17-08-22

https://www.mondaq.com/waste-management/1222376/the-laws-relating-to-zero-emissions-in-malaysia

South Korea Expands QR Codes Pilot to 39 Household Chemical Products subject to Safety Confirmation

2022-08-18

South Korea's Ministry of Environment (MoE) invited the industry to pilot QR codes for disinfectants last year (CL news). According to the newly disclosed data, in total 143 enterprises involving 227 disinfectant products participated the pilot scheme from October 2021 to June 2022. Building on its success, MoE from June 2022 expanded the use of QR codes to all household chemical products (39 sub-categories) that are subject to safety confirmation under K-BPR. Below is the implementation timeline for your reference.

Read More

Chemlinked, 18-08-22

https://c08-safety-confirmation

South Korea piloted QR codes for disinfectants from Sep 2021 and expanded it to include all listed household products (39 sub-categories) from June 2022.

South Korea to Update Hazard Assessment Results of New Chemical Substances Registered under K-REACH

2022-08-18

On July 22, 2022, South Korea's National Institute of Environmental Research (NIER) issued the NIER Announcement No.2022-317, seeking public comments on the updates of the hazard assessment results of new chemical substances registered under K-REACH. These registered substances were issued with English chemical name, CAS number., corresponding hazard properties, classification and labeling information, as well as the determination of whether it is classified as toxic chemical substance. The public consultation has ended on August 11, 2022.

The proposed updates include:

- Adding 51 substances (Given No.2022-172~2022-223) as new chemical substances with the corresponding hazard assessment results, none of which is toxic;
- Updating the hazard properties, classification and labeling information of 32 new chemical substances that were previously assessed and registered under K-REACH; and
- Updating chemical names of 5 new chemical substances (Given No.2019-144, 2019-178, 2019-179, 2020-203, 2022-21).

Read More

Chemlinked, 18-08-22

https://chemical.chemlinked.com/news/chemical-news/south-korea-to-update-hazard-assessment-results-of-new-chemical-substances-registered-under-k-reach

South Korea Bans 623 Household Products from Market in H1 2022

2022-08-18

On August 11, 2022, South Korea's Ministry of Environment (MoE) and the Korea Environmental Industry & Technology Institute (KEITI) announced that during the first half of 2022 there were 623 household products1 banned from manufacture, importation and distribution due to violations of safety and labelling standards under the Act on Safety Management of Consumer Chemical Products and Biocides (also called K-BPR).

Read More

Chemlinked, 18-08-22

https://chemical.chemlinked.com/news/chemical-news/south-korea-bans-623-household-products-from-market-in-h1-2022

AMERICA

Canada imposes notification requirements for paint additive

2022-08-18

The Canadian government has imposed notification requirements for certain new uses of the paint additive calcium 2-ethylhexanoate.

Sales from distribution networks and online shopping portals are prohibited.

CHEMWATCH
Bulletin Board
Regulatory Update
AUG. 26, 2022

Canada determined in 2018 that the substance is not harmful at current levels of exposure but could become concerning to human health with increased use, given its potential developmental effects. It therefore proposed to impose significant new activity (Snac) requirements to allow the government to assess the risk of certain new uses before allowing them.

Published in the Canada Gazette on 17 August, the Snac requires notification for the use of calcium 2-ethylhexanoate in a cosmetic or consumer product above 0.1% by weight, with exceptions for stains and coatings that dry as a solid film and have a concentration under 0.5% by weight. Importation above 10kg per year for such uses also requires submission of a significant new activity notice (Snan).

Calcium 2-ethylhexanoate – also called hexanoic acid, 2-ethyl-, calcium salt – is used in Canada as an additive in interior and exterior paints, as a formulant in antifouling paints and as a 'no-rinse' aid in commercial dishwashers. It also has uses in the manufacture of food packaging materials, including resins and printing inks.

Read More

Chemical Watch, 18-08-22

https://chemicalwatch.com/548371/canada-imposes-notification-requirements-for-paint-additive

Washington Advances The Western Front Of Product Regulation

2022-08-17

The state of Washington has become a global player in product regulation. This month, the Department of Ecology issued a determination to restrict or require reporting on the use of five classes of chemicals in products. In some cases, the restrictions may be first-in-class - depending on how Ecology implements the determination - meaning that manufacturers may need to alter their product compositions to continue selling in Washington. Ecology must finalize the determination in a rulemaking by June 1, 2023.

On August 9, 2022, Ecology published a preliminary draft rule to implement the restrictions and reporting requirements Ecology identified in its final determination. Ecology has invited comments on a range of topics, including environmental justice, de minimis thresholds, and

effective dates for material restrictions. Ecology is accepting comments on the draft rule until August 23, 2022, with another opportunity for comment after Ecology publishes the formal draft rule in December 2022.

Background

In 2019, Washington enacted the strongest state chemicals bill in the country. On five-year cycles, Ecology is empowered to take regulatory action to reduce the use of priority chemicals in priority products and packaging. These regulatory actions may include restricting or prohibiting certain uses of priority chemicals, or requiring that manufacturers disclose certain uses of priority chemicals to Ecology. In deciding whether to restrict priority chemicals, Ecology must consider existing uses of a chemical, potential exposures (including exposures to the environment, sensitive species, and subpopulations), and the availability of safer alternatives.

Ecology's recent determination is part of the first "cycle" of restrictions. A new cycle will begin next year, and off-cycle restrictions may also be on the way.

Read More

Mondaq, 17-08-22

https://www.mondaq.com/unitedstates/chemicals/1222486/washington-advances-the-western-front-of-product-regulation

The petrochemical industry is convincing states to deregulate plastic incineration

2022-08-18

The petrochemical industry has spent the past few years hard at work lobbying for state-level legislation to promote "chemical recycling," a controversial process that critics say isn't really recycling at all. The legislative push, spearheaded by an industry group called the American Chemistry Council, aims to reclassify chemical recycling as a manufacturing process, rather than waste disposal — a move that would subject facilities to less stringent regulations concerning pollution and hazardous waste.

The strategy appears to be working. According to a new report from the nonprofit Global Alliance for Incinerator Alternatives, or GAIA, 20 states have passed bills to exempt chemical recycling facilities from waste

CHEMWATCH
Bulletin Board
Regulatory Update
AUG. 26, 2022

management requirements — despite significant evidence that most facilities end up incinerating the plastic they receive.

"These facilities are in actuality waste-to-toxic-oil plants, processing plastic to turn it into a subpar and polluting fuel," the report says. Tok Oyewole, GAIA's U.S. and Canada policy and research coordinator and the author of the report, called for federal regulation to crack down on the plastic industry's "misinformation" and affirm chemical recycling's status as a waste management process.

Read More

Grist, 18-08-22

https://grist.org/accountability/the-petrochemical-industry-is-convincing-states-to-deregulate-plastic-incineration/

In Georgia, the EPA Takes Action Against 'Forever Chemicals'

2022-08-16

The intake pumps that once drew 6 million gallons of water a day from the Oostanaula River now sit mostly dormant in the northwestern Georgia city of Rome.

Local officials contend that years of contamination miles upstream sent toxic perfluoroalkyl and polyfluoroalkyl substances, known as PFAS, into Rome's water supply, rendering it potentially dangerous for the city's roughly 37,000 residents. A water source switch from the Oostanaula and added treatment have reduced the traces of the chemicals running through residents' taps, but they have not eliminated PFAS from the community's water supply.

Test results that found contamination in Rome have echoed in communities across the country as researchers and regulators grapple with concerns over the implications of consuming the ubiquitous chemicals. Now, the Environmental Protection Agency is accelerating the debate. In June, the EPA issued new advisories on PFAS in drinking water that slash the level that regulators consider safe for four chemicals in the family, including two of the most common, PFOA and PFOS.

The EPA health advisories are not legally enforceable. But the agency this year is expected to propose new limits on PFAS in public water systems. If those drinking water regulations mirror the EPA's latest advisories, water

system operators nationwide will need to act to address the presence of those chemicals.

"It's quite an important message," said Philippe Grandjean, a PFAS expert and an adjunct environmental health professor at the Harvard T.H. Chan School of Public Health. "This stuff is everywhere."

Read More

Undark, 16-08-22

https://undark.org/2022/08/16/in-georgia-the-epa-takes-action-against-forever-chemicals/

Homemade and prepackaged baby foods both contain toxic heavy metals: study

2022-08-11

Nearly all baby foods — both store-bought and homemade — that American parents feed their children contain detectable amounts of toxic heavy metals, a new study has found.

The study, conducted by the Healthy Babies Bright Futures alliance, found that 94 percent of pre-packaged foods marketed for babies and toddlers contain heavy metals like lead and arsenic.

As it turns out, however, the exact same percentage applied to homemade purees and pre-packaged "family food" options geared toward the entire family, the study found.

The new findings build upon a 2019 study conducted by the same group, in which 95 percent of store-bought baby foods tested were contaminated with heavy metals.

This time, the alliance — which includes nonprofit organizations, philanthropies and scientists — set out to determine whether homemade options were, in fact, a superior choice.

Read More

The Hill, 11-08-22

https://thehill.com/policy/equilibrium-sustainability/3596933-homemade-and-prepackaged-baby-foods-both-contain-toxic-heavy-metals-study/

CHEMWATCH
Bulletin Board
Regulatory Update
AUG. 26, 2022

EUROPE

Can Europe replace animal testing of chemicals?

2022-08-15

As revisions to the EU's regulatory system look certain to increase toxicity tests on animals, the region ponders whether it will ever be able to conduct chemical safety assessments with alternative methods.

On Sept. 15, 2021, members of the European Parliament overwhelmingly voted in favor of a European Union–wide plan for phasing out the use of animals in research and testing. The plan demands that the European Commission set "ambitious and achievable" objectives and timelines for transitioning to a research system that does not use animals. Highly publicized at the time, the parliament's call to action epitomized political and societal pressure to eliminate animal testing in Europe.

With less fanfare, the commission was also beginning last fall to implement a set of policy initiatives that are part of the European Green Deal, a road map for making the EU carbon neutral by 2050. First presented in December 2019, the initiatives require tougher controls on chemicals—controls that are certain to result in substantially more testing on animals than is currently required.

These contradictory actions encapsulate a debate that has vexed the European chemical community for decades. In theory, assessing chemical safety without using animals means everybody wins: it's cheaper, it's faster, and it allows regulators to scan more substances for potential hazards without causing unnecessary suffering. But in practice, some experts say, testing without animals can come at the cost of protecting human health.

Read More

c&en, 15-08-22

https://cen.acs.org/biological-chemistry/toxicology/Europe-replace-animal-testing-chemicals/100/i28

Styrene concentrations in German and Italian refrigerated dairy products

2022-08-10

Scientists assess styrene levels in polystyrene food packaging, migration into refrigerated dairy products, in 50% ethanol, as well as factors

influencing migration; report styrene migration of 5 to 30 µg/kg food at the best before date; find food contact area, temperature and time rather than fat content influence styrene migration

In the EU, styrene is currently authorized for use in food contact materials without a specific restriction, but the European Commission is currently considering developing a migration limit for styrene into food (FPF reported). In 2016, the US State of California added styrene to its Proposition 65 list of carcinogens (FPF reported), and in 2018 the International Agency for Research on Cancer (IARC) concluded that styrene is "probably carcinogenic to humans" (FPF reported). In an article published on July 17, 2022, in the journal Foods, Valeria Guazzotti and co-authors from the Fraunhofer Institute for Process Engineering and Packaging, Freising, Germany, aimed to evaluate styrene concentrations in dairy products and the main factors influencing migration.

Guazzotti and co-authors purchased 17 dairy products, including yogurt, whipped cream, sour cream, and coffee creamers, with different fat contents packaged in polystyrene (PS) from German and Italian supermarkets in 2021. All but the coffee creamers were indicated to be refrigerated products meaning to have a shelf life of 40 days at 5 °C. The scientists stored the samples at 5 °C (exception: coffee creamer at room temperature) and determined styrene levels in the product on the best before date, as well as partly also 20 days before and 15 days after. For the analysis, they used purge and trap gas chromatography coupled with both mass spectrometry and a flame ionization detector. Styrene concentrations remaining in the packaging after emptying were also assessed by acetone-based extraction experiments.

Read More

Food Packaging Forum, 10-08-22

https://www.foodpackagingforum.org/news/styrene-concentrations-in-german-and-italian-refrigerated-dairy-products

Plastics policy in the UK needs clarity and reform

2022-08-02

Greenpeace and Everyday Plastic publish results from voluntary plastic waste audit of nearly 100,000 UK homes; finds UK households throw away nearly 100 billion pieces of plastic a year, 83% of which is from food and drinks; waste organizations within the country ask for stronger policies and more clarity on existing goals.

CHEMWATCH
Bulletin Board
Regulatory Update
AUG. 26, 2022

On July 13, 2022, Greenpeace and Everyday Plastic, published results from The Big Plastic Count, a national voluntary plastic waste audit of nearly 100,000 UK homes. They found "on average, each household threw away 66 pieces of plastic packaging in one week… [and] if the totals for count week are assumed to be typical, this indicates that UK households are throwing away an estimated 1.85 billion pieces a week, or 96.57 billion pieces a year." Food and drink packaging made up 83% of the 66 pieces with produce packaging and snack wrappers being the two most common items.

Greenpeace and Everyday Plastic asked the UK government to (i) set a target "to almost entirely eliminate single-use plastic in 15 years" with mandates for corporate plastic reporting and an interim target of 50% reduction by 2025; (ii) ban plastic waste exports; (iii) implement deposit return schemes and extended producer responsibility schemes (EPR) for drinks containers that are consistent across the UK; and (iv) "set an immediate moratorium on new incineration capacity."

Read More

Food Packaging Forum, 2-08-22

https://www.foodpackagingforum.org/news/plastics-policy-in-the-uk-needs-clarity-and-reform

INTERNATIONAL

Gambia bans insecticide named Sniper after claims that it is used to smoke fish

2022-08-15

Gambia's Dangerous Chemicals & Pesticides Regulation and Management Board have banned the import, distribution, and sale of the pesticide known as Sniper having immediate effect.

The choice affects importation, storage, distribution, sales, and use.

The decision comes after a popular clip on Whatsapp claimed the chemical was used to smoke fish.

The chemical prevents fish from rotting and attracting insects and pests, according to the audio. The Gambia widely uses the pesticide sniper.

Gambia follows Nigeria as well as other countries in banning the import, distribution, and sale of this substance.

Recent increases in unusual illnesses must be recognized with caution. Most of these diseases are caused by odd home cuisine.

Read More

The Paradise, 15-08-22

https://theparadise.ng/gambia-bans-insecticide-named-sniper-after-claims-that-it-is-used-to-smoke-fish/

CHEMWATCH
Bulletin Board

Consultations on applications for authorisation

2022-08-19

Echa has invited comments on 11 applications for authorisation and one review report. They cover 16 uses of:

- chromium trioxide in different chrome plating processes and for passivation of eloctrolytic tinplates;
- sodium dichromate for passivation of electrolytic tinplates; and
- bis(2-methoxyethyl) ether as a solvent in the manufacture of an active pharmaceutical drug.

The deadline for comments is 12 October.

New substance evaluation conclusion published

Echa has published a substance evaluation conclusion document for n-1-naphthylaniline (NPNA). The substance was added to the community rolling action plan (Corap) list in 2012 following concerns about PBT/vPvB properties and wide dispersive use. During the evaluation, evaluating member state Germany identified additional concerns about carcinogenicity, repeated dose toxicity, reproductive toxicity and dermal exposure of consumers.

Germany concluded that the substance meets the criteria for classification as acute toxic 4 and skin sensitiser 1. It submitted a proposal for harmonised classification of NPNA in April.

CLH intentions

Member states have informed Echa of their intentions to submit CLH proposals for eight chemicals.

Finland will seek harmonised classification as reprotoxic 1B for propylidynetrimethanol. And it will propose harmonised classification for 5-methylhexan-2-one as:

- flammable liquid 3;
- acute toxic 4; and
- reprotoxic 1B.

It intends to submit both proposals on 31 May 2023.

Sweden is due to submit by 22 December proposals to classify calcium bromide, potassium bromide and sodium bromide as:

- reprotoxic 1B;
- lactation;
- STOT SE 3; and
- STOT SE 1.

It will also seek harmonised classification as skin sensitiser 1A and reprotoxic 1B for the substance reactive brown 51. This proposal is due by 23 September.

Finally, Austria will seek harmonised classification for two biocidal active substances. This is for arnica montana, ext. as:

- acute toxic 4; and;
- aquatic chronic 2.

And for reaction mass of bis(N-decyl-N,N-dimethyldecan-1-aminium) carbonate and N-decyl-N,N-dimethyldecan-1-aminium hydrogen carbonate as:

- acute toxic 3;
- skin corrosion 1B;
- eye damage 1;
- aquatic acute 1 (M-factor=10); and
- aquatic chronic 3.

CLH proposals

Denmark has submitted CLH proposals for two substances. For 2,3-epoxypropyl o-tolyl ether it is seeking harmonised classification for:

- skin irritation 2;
- skin sensitisation 1A;
- mutagenic 2; and
- aquatic chronic 2.

And for 3-iodo-2-propynyl butylcarbamate it is seeking harmonised classification for:

- acute toxic 4 and 2;
- eye damage 1;

CHEMWATCH
Bulletin Board
REACH Update
AUG. 26, 2022

- skin sensitisation 1;
- STOT RE 1;
- aquatic acute (M-factor=10); and
- aquatic chronic 1 (M-factor=10).

Read More

Chemical Watch, 19-08-22

https://chemicalwatch.com/548400/echa-round-up

Evaluation of the potential approaches to risk assessment of unintentional chemical mixtures for future UK REACH assessments

2022-08-17

Identifies a recommended approach to address the risks to both the environment and human health from unintentional mixtures of chemicals.

This joint report by the Environment Agency and the UK Health Security Agency identifies a recommended approach to address the risks to both the environment and human health from unintentional mixtures of chemicals under the UK Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) Regulation. This work is important in informing future updates to UK REACH.

Read More

Gov.UK, 17-08-22

https://www.gov.uk/government/publications/evaluation-of-the-potential-approaches-to-risk-assessment-of-unintentional-chemical-mixtures-for-future-

Biochemistry

2022-08-26

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

Plutonium

2022-08-26

Plutonium is a transuranic radioactive chemical element with symbol Pu and atomic number 94. It is an actinide metal of silvery-grey appearance that tarnishes when exposed to air, and forms a dull coating when oxidized. The element normally exhibits six allotropes and four oxidation states. It reacts with carbon, halogens, nitrogen, silicon and hydrogen. When exposed to moist air, it forms oxides and hydrides that expand the sample up to 70% in volume, which in turn flake off as a powder that is pyrophoric. It is radioactive and can accumulate in bones, which makes the handling of plutonium dangerous. [1] Very small amounts of plutonium occur naturally. Plutonium-239 and plutonium-240 are formed in nuclear power plants when uranium-238 captures neutrons. [2]

USES [3]

Plutonium is a key fissile component in modern nuclear weapons; care must be taken to avoid accumulation of amounts of plutonium which approach critical mass, the amount of plutonium which will self-generate a nuclear reaction. Despite not being confined by external pressure as is required for a nuclear weapon, it will nevertheless heat itself and break whatever confining environment it is in. Shape is relevant; compact shapes such as spheres are to be avoided. Plutonium could also be used to manufacture radiological weapons. The plutonium isotope 238Pu is an alpha emitter with a half-life of 87 years. These characteristics make it well suited for electrical power generation for devices which must function without direct maintenance for timescales approximating a human life time. It is therefore used in RTGs such as those powering the Galileo and Cassini space probes. Plutonium-238 was used on the Apollo-14 lunar flight in 1971 to power seismic devices and other equipment left on the Moon, and it was also the power supply of the two Voyager supercraft launched in 1977. Plutonium-239 can also be used as a fuel in a new generation of fast-breeder nuclear weapons, which burn a mixed oxide (MOX) fuel consisting of uranium and plutonium.

IN THE ENVIRONMENT [4]

- Plutonium released during atmospheric testing of nuclear bombs, which ended in 1980, is the source of most of the plutonium in the environment worldwide.

- Plutonium is also released to the environment from research facilities, waste disposal, nuclear fuel reprocessing facilities, nuclear weapons production facilities, and accidents at facilities where plutonium is used.
- Plutonium can be transported in the atmosphere.
- It can be deposited on land or water by settling or by precipitation.
- Plutonium can stick to particles in soil, sediment, and water.
- Plutonium will undergo radioactive decay in the environment.

SOURCES & ROUTES OF EXPOSURE

Sources of Exposure [4]

- Everyone is exposed to very low levels of plutonium in air, and possibly in drinking water and food.
- Exposure to higher levels could occur from an accidental release during its use.
- Exposure during transport and disposal is unlikely because transport containers are virtually indestructible by accident or fire; disposal sites are deep underground and away from the public.
- Workers at nuclear facilities using plutonium may be exposed to higher levels of it.
- People who live near facilities that use plutonium in their operations may be exposed to it from accidental releases to the air.

Routes of Exposure [5]

- Inhalation – The exposure route of primary concern for workers and the general population.
- Oral – Minor route of exposure.
- Dermal – Minor route of exposure

HEALTH EFFECTS [3]

- The alpha radiation plutonium emits does not penetrate the skin, but can irradiate internal organs it is inhaled or ingested.
- Extremely small particles of plutonium on the order of micrograms can cause lung cancer if inhaled into the lungs.
- Considerably larger amounts may cause acute radiation poisoning and death if ingested or inhaled; however, so far, no human is known

CHEMWATCH
Bulletin Board
Hazard Alert
AUG. 26, 2022

to have died because of inhaling or ingesting plutonium and many people have measurable amounts of plutonium in their bodies.

- When people breathe it in, plutonium may remain in the lungs or move to the bones or organs. Generally, it stays in the body for a long time and continually exposes body tissues to radiation. After a few years this could result in the development of cancer.
- Furthermore, plutonium may affect the ability to resist disease and the radioactivity from plutonium may cause reproductive failure.

SAFETY [6]

First Aid Measures

- Inhalation: Remove from exposure area to a restricted area with fresh air as quickly as possible. If breathing has stopped, perform artificial respiration by administering oxygen; mouth-to-mouth resuscitation should be avoided to prevent exposure to the person rendering first aid. Any evidence of serious contamination indicates that treatment must be instituted. (Inhalation of radioactive particles may indicate that other parts of the body were also contaminated, such as the digestive tract, skin and eyes.) If time permits, wipe the face with wet filter paper, force coughing and blowing of the nose. Get medical attention immediately. The victim may be contaminated with radioactive particles. Thorough decontamination should be started before the victim is moved to the medical area. Any personnel involved in rendering first aid must be monitored for radioactivity and thoroughly decontaminated if necessary.
- Skin Contact: Remove victim to a suitable area for decontamination as quickly as possible. Remove clothing and shoes immediately. Thoroughly wash the victim with soap and water, paying particular attention to the head, fingernails and palms of the hands. Upon completion of washing, monitor the victim for radioactivity. It is imperative that the skin should be decontaminated as quickly as possible. Minute skin injuries greatly increase the danger of isotope penetration into the victim; shaving should not be attempted. If water and soap have been inadequate in removing the radioactive compound, decontaminating compounds consisting of surfactants and absorbent substances may be effective. Complexing reagents may also be of use. The use of organic solvents is to be avoided, as they may increase the solubility and absorption of the radioactive substance. Skin contamination with radioactivity may be an indication that other parts of the body have been exposed. Contaminated clothing must

be stored in an airtight, chemically compatible container for later decontamination or disposal. The water used to wash the victim must be stored in an airtight, chemically compatible container for later disposal. Any personnel involved in rendering first aid to the victim must be monitored for radioactivity and decontaminated if necessary.

- Eye Contact: Remove victim to a restricted area for decontamination. Thoroughly wash eyes with large amounts of water, occasionally lifting the upper and lower lids (approximately 15 minutes). Following the water treatment, provide an isotonic solution. Do not use eyebaths, rather provide a continuous and copious supply of fluid. Monitor the victim for radioactivity. If activity is present, rewash the eyes, and remonitor until little or no radioactivity is present. Get medical attention immediately. Any water used to wash the victim's eyes must be stored in an airtight, chemically compatible container for later disposal. Any other articles that are used to decontaminate the victim must also be stored in similar containers for later decontamination or disposal. Any personnel involved in rendering first aid to the victim must be monitored for radioactivity and decontaminated if necessary.
- Ingestion: In the case of ingestion of radioactive substances, the mouth should be rinsed out immediately after the accident, care being taken not to swallow the water used for this purpose. Vomiting should be induced either mechanically, or with syrup of ipecac. Do not induce vomiting in an unconscious person. Lavage may be useful. Care should be taken to avoid aspiration. The vomitus and lavage fluids should be saved for examination and monitoring. Get medical attention immediately. The gastric fluids and fluids used for lavage must be stored in airtight, chemically compatible containers for later disposal. The victim must be monitored for radioactivity and decontaminated, if necessary, before being transported to a medical facility. Any personnel involved in rendering first aid to the victim must be monitored for radioactivity and decontaminated if necessary.

Fire Information

- Negligible fire hazard in bulk form; however, dust, powder, or fumes are flammable or explosive when exposed to heat or flames.
- Small fires should be extinguished with Metal-X (Class D) fire extinguisher.
- Do not move damaged containers; move undamaged containers out of fire zone. Contact the local, State, or Department of Energy radiological response team. Use suitable agent for surrounding fire. Cool containers with flooding amounts of water, apply from as far a

CHEMWATCH
Bulletin Board
Hazard Alert
AUG. 26, 2022

distance as possible. Avoid contamination of water sources and sewers. Avoid breathing dusts or vapours, keep upwind. Keep unnecessary people out of area until declared safe by radiological response team.

Exposure Controls and Personal Protection

- At a minimum, provide process enclosure ventilation. Depending upon work activities, a more stringent ventilation system may be necessary to comply with exposure limits.
- A High Efficiency Particulate Air (HEPA) filtration system may be required for handling and storing this material.
- One method of controlling external radiation exposure is to provide adequate shielding. The absorbing material used and the thickness required to attenuate the radiation to acceptable levels depends on the type of radiation, its energy, the flux and the dimensions of the source.
- Alpha Particles: For the energy range of alpha particles usually encountered, a fraction of a millimetre of any ordinary material is sufficient for absorbance. Thin rubber, acrylic, stout paper, or cardboard will suffice.
- Beta Particles: Beta particles are more penetrating than alpha, and require more shielding. Materials composed mostly of elements of low atomic number such as acrylic, aluminium and thick rubber are most appropriate for the absorption of beta particles. For example, 1/4 inch of acrylic will absorb all beta particles up to 1 MeV.
- Gamma Rays: The most suitable materials shielding gamma radiation are lead and iron. The thickness required will depend on whether the source is producing narrow or broad beam radiation. Primary and secondary protective barriers may be required to block all radiation.
- Eye Protection: Employee must wear appropriate eye protection that will not allow the introduction of particles into the eyes. Contact lenses should not be worn.
- Clothing, glove and eye protection equipment will provide protection against alpha particles, and some protection against beta particles, depending on thickness, but will not shield gamma radiation.
- Clothing: Overgarments, including head coverings and foot covering, should be worn by any employee engaged in handling radioactive substances. These garments are also recommended even if the employee is working with a "glovebox" containment system. Certain clothing fibres may be useful in dosimetry so clothing should be kept.

In the event of an accident, large scale release or a large scale clean-up, full protective clothing will be necessary.

- Gloves: Employee must wear appropriate protective gloves to prevent contact with this substance. Used gloves may present a radioactive contamination hazard and should be disposed of as radioactive waste.
- Respirator: Respirators should provide protection for the respiratory tract against inhalation of most of the radioactive particles encountered in the workplace. Respirators will not offer protection against beta and gamma radiation, but will block alpha particles. Respiratory equipment must be jointly certified by NIOSH/MSHA. The following respiratory protection is recommended. Lower levels of protection may be appropriate depending on containment systems. Consult a qualified health physicist for more information.
- General conditions: Type 'C' supplied-air respirator with a full face-piece operated in pressure-demand or other positive pressure mode or with a full face piece, helmet or hood operated in continuous-flow mode.
- Self-contained breathing apparatus with a full face piece operated in pressure-demand or other positive pressure mode.
- For firefighting and other immediately dangerous to life or health conditions: Self-contained breathing apparatus with full face piece operated in pressure-demand or other positive pressure mode.
- Supplied-air respirator with full face piece and operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.

REGULATION

United States [2]

The U.S. Nuclear Regulatory Commission (USNRC) has recommended the following radiation exposure limits for the general public and for workers:

CHEMWATCH
Bulletin Board
Hazard Alert
AUG. 26, 2022

General public	0.1 rem/year for the general public and 0.5 rem/year for people who work with patients in nuclear medicine. These regulations are for all forms of radiation combined, so they are not only for plutonium.
Workers	5 rem/year for workers in industries where exposure to radiation may occur and 0.5 rem for the pregnancy period following the declaration of pregnancy by a woman in an industry where exposure to radiation may occur.

These recommended radiation exposure limits are for all forms of radiation combined and are not specific to plutonium. The limits are expressed in units called rem (roentgen equivalent man). A rem is a radiation unit that expresses the radiation equivalent dose to a particular organ or tissue. The limits on equivalent dose are used to calculate the limits on the amount of radioactive substances that can be inhaled or ingested.

REFERENCES

1. https://en.wikipedia.org/wiki/Plutonium
2. http://www.atsdr.cdc.gov/phs/phs.asp?id=646&tid=119
3. http://www.lenntech.com/periodic/elements/pu.htm
4. http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=647&tid=119
5. http://www.atsdr.cdc.gov/toxguides/toxguide-143.pdf
6. http://science.energy.gov/~/media/nbl/pdf/price-lists/SDS/SDS-Plutonium_Metal.pdf

Breakthrough in search for tinnitus cure

2022-08-12

After 20 years searching for a cure for tinnitus, researchers at the University of Auckland are excited by 'encouraging results' from a clinical trial of a mobile-phone-based therapy.

The study randomized 61 patients to one of two treatments, the prototype of the new 'digital polytherapeutic' or a popular self-help app producing white noise.

On average, the group with the polytherapeutic (31 people) showed clinically significant improvements at 12 weeks, while the other group (30 people) did not. The results have just been published in Frontiers in Neurology.

"This is more significant than some of our earlier work and is likely to have a direct impact on future treatment of tinnitus," Associate Professor in Audiology Grant Searchfield says.

Key to the new treatment is an initial assessment by an audiologist who develops the personalized treatment plan, combining a range of digital tools, based on the individual's experience of tinnitus.

"Earlier trials have found white noise, goal-based counseling, goal-oriented games and other technology-based therapies are effective for some people some of the time," says Dr. Searchfield.

"This is quicker and more effective, taking 12 weeks rather than 12 months for more individuals to gain some control."

There is no pill that can cure tinnitus.

"What this therapy does is essentially rewire the brain in a way that de-emphasizes the sound of the tinnitus to a background noise that has no meaning or relevance to the listener," Dr. Searchfield says.

Audiology research fellow Dr. Phil Sanders says the results are exciting and he found running the trial personally rewarding.

"Sixty-five percent of participants reported an improvement. For some people, it was life-changing—where tinnitus was taking over their lives and attention."

Some people didn't notice an improvement and their feedback will inform further personalisation, Dr. Sanders says.

There is no pill that can cure tinnitus.

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

Tinnitus is a phantom noise and its causes are complex. It has so far defied successful treatment.

While most people experience tinnitus, or ringing in the ears at least on occasions, around five percent experience it to a distressing degree. Impacts can include trouble sleeping, difficulty carrying out daily tasks and depression.

Dr. Searchfield says seeing his patients' distress and having no effective treatment to offer inspired his research. "I wanted to make a difference."

The next step will be to refine the prototype and proceed to larger local and international trials with a view to FDA approval.

The researchers hope the app will be clinically available in around six months.

Medical Xpress, 12 August 2022

https://medicalxpress.com

Worse Than Smoking – Bad Sleep Can Worsen Lung Disease

2022-08-14

Some lung disease patients do worse than others. Could sleep be the cause?

According to a study conducted by University of California, San Francisco (UCSF) researchers, poor or disrupted sleep may have a greater effect than smoking history in individuals with progressive lung disease.

The study found that insufficient sleep can increase a COPD patient's chance of a flare-up by up to 95% when compared to individuals who get sufficient sleep. These flare-ups, which manifest with increased breathlessness and coughing, may eventually result in irreparable lung damage, hasten the course of the disease, and increase mortality.

The research findings were published in the journal SLEEP. According to lead author Aaron Baugh, MD, a clinical resident at the UCSF Division of Pulmonary, Critical Care, Allergy and Sleep Medicine and the Cardiovascular Research Institute, these may partly explain why African American patients with COPD often do worse than white patients.

"African Americans are over-represented in low-income neighborhoods, where people are less likely to have good quality sleep. They may live

"Sleep should be considered both in the clinic and at the wider community/ neighborhood level, where the structural factors that contribute to worse sleep can be addressed."

in crowded spaces with multiple roommates and have less comfortable sleeping conditions, such as a couch, and they may work in a job with a varying schedule that lends itself to sleep disruption," said Baugh, noting that research shows sleep deprivation is associated with a drop in infection-fighting antibodies and protective cytokines.

The researchers monitored 1,647 patients with proven COPD who were recruited in the nationwide, multi-center SPIROMICS study, which was established to track disease progression and assess treatment efficacy. The researchers examined the occurrence of flare-ups—defined as a temporary exacerbation of symptoms that need treatment—with self-reported information on sleep quality across a three-year period.

Poor Sleep Raises Risk of Flare-Ups From 25% to 95%

At the start of the study, the average age of the participants was 65 and the average stage of the disease was moderate. Over half of the participants (57%) were male; 80% were white and 14% were African American. All were current or former smokers, who underwent at least one sleep evaluation at enrollment. The researchers found that compared to participants with optimal sleep, those at the base level of poor sleep had a 25% increased chance of a flare-up within the next year, rising to almost 95% within the next year for those with the worst sleep.

This may amount to a more pronounced effect than the impact of smoking over a 40-year period, versus a 60-year period, said Baugh.

As expected, more African Americans reported poor sleep than did white participants: 63% versus 52%.

"While factors like health insurance coverage or respiratory hazards may play important roles in the severity of the disease, poor sleep may gain even more significance when African Americans' social status improves," said Baugh. "This can lead to a kind of paradox; in reducing one risk factor, a new risk factor – poor sleep – may take its place."

Yet-to-be published data will show that African Americans have worse sleep even when socio-economic factors and severity of COPD are accounted for, Baugh said.

Senior author and pulmonologist Neeta Thakur, MD, of the UCSF School of Medicine, said that questions about sleep are often overlooked by physicians evaluating patients with COPD. "Sleep hygiene and sleep aids may significantly improve their health," she said. "Sleep should be considered both in the clinic and at the wider community/neighborhood

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

level, where the structural factors that contribute to worse sleep can be addressed."

Sci Tech Daily, 14 August 2022

https://scitechdaily.com

Ants can be better than pesticides for growing healthy crops, study finds

2022-08-17

Ants can be more effective than pesticides at helping farmers produce food, according to new research. They are better at killing pests, reducing plant damage and increasing crop yields, according to the first systematic review of ants' contributions to crop production.

Ants are generalist predators and hunt pests that damage fruits, seeds and leaves, leading to a drop in crop yields. A greater diversity of ants generally provides more protection against a wider range of pests, the study found.

The analysis looked at 17 crops, including citrus, mango, apple and soya bean in countries including the US, Australia, the UK and Brazil. "In general, with proper management, ants can be useful pest controls and increase crop yield over time. Some ant species have similar or higher efficacy than pesticides, at lower costs," researchers wrote in the paper published in Proceedings of Royal Society B.

The Brazilian team looked at 26 species, most of them tree ants, which nest on plants or the ground but often climb plants. They found ants do best in diversified farming systems such as agroforestry (where trees and crops are grown on the same land) and shade-grown crops because there are more nesting sites and food resources for them.

Lead researcher Dr Diego Anjos, from the Federal University of Uberlândia, said: "Our study encourages farmers to use more sustainable practices such as biological control provided by ants and practices of shaded crops as a way to naturally promote ants in crop systems."

The role of ants in agriculture is not yet completely clear because they can also be a problem. Pests such as mealybugs, aphids and whiteflies, which produce a sugary water called honeydew, are generally more common when ants are around. This is because the ants feed on honeydew, and so essentially "farm" aphids like livestock, protecting them from predators in return.

Harnessing natural insect power can, with proper management, have higher efficacy than resorting to harmful chemicals.

Researchers say nature-friendly management practices such as providing an alternative source of sugars (on the ground, near a tree's trunk or on its branches) can interrupt this relationship. The ants are distracted and can continue to reduce the number of other pests such as caterpillars and beetles, which do not produce honeydew.

The paper looked at most insect species that are considered pests around the world, covering 30 species across 52 studies. The data came from studies comparing groups of plants with ants set against plants where the ants were removed (mechanically or chemically), which strongly indicates the ants were responsible for the changes observed.

There are more ants than any other insect, making up half of the planet's insect biomass. There are at least 14,000 known species of ant, with many more likely to remain unknown. Citrus growers in China have used ants in farming for centuries, and the insects have also been used to help control forest pests in Canada, cocoa pests in Ghana and crop pests in Nigeria.

Ants found in the Pacific islands of Fiji can cultivate and grow at least six species of plant, as part of a mutually beneficial relationship that dates back 3 million years, according to research published in Nature.

Dr Patrick Milligan, from the University of Nevada Pringle Lab, was not involved in the study but said the findings were "both heartening and not at all surprising". He added: "They offer a neat and tidy description of ant-derived benefits that are ubiquitous across ecological and agricultural systems.

"This is essentially another option in our farming toolset that can allow agriculture to move away from pesticides – which really damage neighbouring insect communities – but still improve crop yields."

Prof Adam Hart from the University of Gloucestershire, also not involved in the research, said it was confirmation of the important role ants have as pest controllers. "Many of us have been talking about ants as natural pest controllers. But, as with anything, it is usually more complex than we think once we start digging deeper.

"The research suggests it may be profitable to move ant colonies into crop areas, and to do things to encourage the presence of ants. However, we need to be cautious – it isn't all ants, or all crop systems, and they can have a cost. It's all about developing a greater understanding of how ants interact with crop pests and other organisms.

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

"A big take-home message for me is that we need to understand even more about fine-scale interactions if we are to farm better. In other words, we need more ecologists."

The Guardian, 17 August 2022

https://theguardian.com

Notorious dark-matter signal could be due to analysis error

2022-08-16

Physicists have shown that an underground experiment in South Korea can 'see' dark matter streaming through Earth — or not, depending on how its data are sliced. The results cast further doubt on a decades-old claim that another experiment has been detecting the mysterious substance.

The latest study, published on the arXiv preprint server on 10 August1, reports that a certain type of data analysis by the COSINE-100 detector can produce seasonal fluctuations in the results. Physicists had proposed a similar fluctuation as a signature of dark matter, the invisible but pervasive stuff thought to be five times more abundant in the Universe than ordinary matter.

"If you apply the wrong method, you can see a fluctuation in their data where there wasn't one," says Nicola Rossi, an experimental particle physicist at the Gran Sasso National Laboratory near L'Aquila, Italy, who first suggested this explanation in 20202.

Observations that physicists have so far failed to replicate could be the result of misinterpreted data.

Dark-matter signal

For more than two decades, the experiment now known as DAMA/LIBRA, which is also at the Gran Sasso National Laboratory, has been reporting yearly fluctuations in flashes registered by the sodium iodide crystals of its detector3. The number of these events peak in June and bottom out in December, just as physicists would expect if particles of dark matter are suffusing the Milky Way. That's because, as Earth orbits the Sun, its velocity in the Galaxy peaks in June, so that more particles from the dark-matter halo would hit the DAMA/LIBRA detector at that time — just as greater numbers of flying insects hit a car's windscreen when the car moves faster.

But none of the many other dark-matter experiments — based on various other technologies — has so far seen signals compatible with DAMA/LIBRA's. So, to put the claim to the ultimate test, in the mid-

2010s, physicists began to build detectors made of the same type of sodium iodide crystal. Preliminary results from two of these experiments, COSINE-100 Yangyang underground laboratory in South Korea and ANAIS-112 at the Canfranc Underground Laboratory in the Spanish Pyrenees, failed to reproduce the windscreen effect.

Even though most of the physics community had discounted the DAMA/LIBRA results as probably spurious, the question of why the Italian experiment was seeing a periodic up-and-down in its recorded events remained. Over the years, the collaboration has convincingly rebuffed a number of proposed explanations.

Changing background

In 2020, while reading papers by the DAMA/LIBRA collaboration, Rossi and his colleagues noticed that the fluctuations reported were only those that occurred over a supposed 'background' of events that the team discounted as experimental artefacts, such as sources of radioactivity in the laboratory or in the detector itself.

But unless the background was absolutely constant throughout the year, this could be "a dangerous approach", Rossi and his co-authors wrote. The windscreen effect should add a sinusoidal term to the background. But the precise way in which a background is modelled and subtracted could affect how the data are interpreted, and potentially create a spurious dark-matter signal.

To subtract the background flashes, the DAMA/LIBRA team averaged them out over every year, which could have made the number of remaining events look like a sawtooth wave. And because real-life data points are noisy, it could be easy, Rossi and his colleagues wrote in their 2020 report, to confuse the fluctuations with the type of sine wave expected from dark matter. The researchers also used simulated data to show that they could create a fake dark-matter signal if the number of background flashes was slowly increasing over time.

Result recreated

The COSINE-100 collaboration has now carried out a similar analysis of the real-world data collected by its crystals. "We can generate a DAMA-like signal with our analysis, but our timing is the opposite direction," says Hyun Su Lee, a physicist at the Institute for Basic Science in Daejeon, South Korea, who is a co-leader of COSINE-100. In other words, as the backgrounds at the South Korea-based experiment naturally abate, its

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

'dark matter' count is highest around early December and lowest around early June.

This leaves a dilemma. Dark-matter detectors and other physics experiments must often contend with impurities in their radioactive materials, but as these age and the radioactive isotopes decay away, the background tends to become quieter, not louder. "Increasing background is pretty unnatural," says Lee. Still, Rossi and his team suggest that some effects, such as radioactive impurities slowly creeping into the detector from outside, could, in principle, cause an increasing-background effect.

Either way, that the data analysis created a spurious fluctuation "strikes me as a potentially good — and maybe even likely — explanation" for the DAMA/LIBRA claims, says Dan Hooper, a specialist in dark-matter theory at the University of Chicago in Illinois.

Because the DAMA/LIBRA detector was built decades ago and has been kept underground ever since, radioactive backgrounds are more stable than in recently-built experiments, says Rita Bernabei, a physicist at the Tor Vergata University of Rome and spokesperson for DAMA/LIBRA. "If any small hypothetical contribution from a decreasing rate were there, it might decrease the observed modulation amplitude, but it would never produce positive signal as we observe," she adds. The collaboration has also rebuked Rossi's group's arguments in a paper4 that calls their assumptions "untenable" and their conclusions "worthless".

The physics community has repeatedly called on the DAMA/LIBRA team to reveal more of its data and, in particular, to provide the total counts of flashes. Bernabei says this "does not add any useful information." But the added transparency could work to the collaboration's advantage, says Rossi: if the full background count does turn out to be constant in time, it would add credibility to the team's claim of seeing a sinusoidal fluctuation. "If the DAMA collaboration had been more open, this could have been figured out a long time ago," says Hooper.

Meanwhile, attempts to replicate the dark-matter detections press on. Earlier this month, ANAIS-112 completed five years of data collection and is working on an analysis, says spokesperson Maria Luisa Sarsa of the University of Zaragoza in Spain. The data are sensitive enough that they could potentially exclude the DAMA/LIBRA result with a high statistical confidence. In a few years, that confidence could rise to five standard

deviations, which is commonly the threshold for a physics result to be considered solid.

Nature, 16 August 2022

https://nature.com

How America's First 'Heat Officers' Are Cooling Miami and Los Angeles

2022-08-15

Marta Segura has seen firsthand how heat can harm a person. She grew up in Northern California, where her mother worked in the steamy canneries of San José, and her father in the fields. "Both were exposed to extreme heat in their workplace, and I saw them suffer as a consequence," she says. "My dad once almost died in the fields as a result." Segura remembers that her mother organized other workers, particularly women who "could not even go to the restroom without authorization from the foreman," which limited their water intake.

The temperatures that plagued Segura's parents decades ago have only gotten worse. About a fifth of the most populated cities in the world could warm by more than 4°C by 2050. About a quarter could warm by more than 7°C by 2100, a magnitude of change that would alter life in dramatic ways.

Researchers estimate that heat is responsible for 12,000 premature deaths annually in the US, a toll that could rise to 97,000 by 2100. And yet, drive through California's agricultural areas on a hot summer day, and you'll see hundreds of workers plucking strawberries and tomatoes in the midday blazing sun.

Segura now has a chance to do something about this. In June 2022, she was appointed Chief Heat Officer for Los Angeles, the first Latina in the US to hold such a job. She follows in the footsteps of long-term city planner Jane Gilbert, who became Miami-Dade County's — and the world's first — heat officer last year. The cities of Santiago, Athens, Freetown in Sierra Leone, and Phoenix have all created similar positions. More plan to follow suit.

The need is extremely urgent. Wildfires and hurricanes may grab the big headlines, but heat is actually the deadliest weather phenomenon in the US. In California alone, heat has caused some 3,900 deaths over the past decade, which is why, when FEMA recently declared Los Angeles County

For the first time, two US cities are treating extreme heat as a crisis — and dealing with it accordingly.

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

the area most at risk for natural disasters in the country, it did so not only because of wildfire and earthquake threats, but also because of heat waves — and the city's low resilience to them. According to UCLA's Heat Risk Map, Los Angeles experiences more weather-related emergencies than any other city in California, even more than Arizona. "Extreme heat is our primary climate hazard," Segura says.

How hard this heat hits you depends largely on your zip code. While the wealthy can afford swimming pools and insulated windows for their villas in tree-lined Beverly Hills, temperatures in the poorer areas of the city are higher by an average of 10 to 15 degrees Fahrenheit. These areas are often home to people of color — a recent study published in Nature showed that Black and Hispanic residents are twice as likely to be exposed to urban heat islands.

This is why Segura plans to focus on "historically neglected communities that also suffer from immense pollution. Black and brown communities experience the most comorbidities like kidney disease, heart failure, asthma and COPD. So when you combine all these factors, those are the communities where we see increased hospitalizations and premature deaths as a result of extreme heat."

While Americans over the age of 65 and patients with cardiovascular and respiratory illnesses are most at risk, it would be a mistake to think that heat only harms the elderly. Segura mentions that "a young UPS worker died of a heat stroke two weeks ago in Los Angeles."

Because of the urgency of the threat, Segura is going for "the easy wins" in her first summer on the job: a campaign to educate Angelenos about the risks and first signs of heat-related illnesses; air conditioning units for underserved communities; and a "cooling network" of shops, department stores and fast-food chains at which people can come in and cool down, "so that everybody who starts feeling overheated on their way to the bus stop knows: I can get a glass of cool water here and sit down in a cooled space to recover at no cost." Los Angeles also plans to plant thousands more trees, especially in historically neglected communities.

These efforts aren't taking place in a vacuum. Los Angeles is a charter member of the C40 Cool Cities Network, a coalition of nearly 100 cities that crowdsource solutions, discuss best practices and share information. These ideas are collected in the C40 urban cooling toolbox, where they're broken down into six categories: Green infrastructure (such as trees, green roofs, permeable pavements), blue infrastructure (drinking fountains, public swimming pools and other forms of water cooling), gray infrastructure

(cool roofs, cool pavements, passive cooling in buildings), communication (outreach, cooling centers and campaigns), policy (climate design guidelines, heat emergency response plans, cooling tax rebate programs) and urban development (urban geometry, building materials).

The list makes the challenge obvious. To tackle the heat problem, nearly all of a city's departments — from health to parks to buildings to environmental protection — need to subscribe to the same goal. Segura has been tasked with designing a budget to realize these objectives. Until such a budget has passed, she needs to rely on building relationships with the relevant decision-makers. But she is convinced that the City of Los Angeles has identified heat resilience as a priority. "We all have the same goal," Segura says. Mayor Eric Garcetti launched L.A.'s "Green New Deal" in 2015, pledging to lower the city's average temperature by three degrees over the next 20 years. That's a target he's likely to miss, not least because Los Angeles is part of the larger, warming world.

And yet, there is a lot a city can do. Some of the tools are universal; others are specific to each city. In Miami-Dade, for instance, Segura's counterpart Jane Gilbert has been serving as Heat Officer for more than a year. "For us, the biggest problems aren't just the extremely hot days," Gilbert says via Zoom in her sleeveless blouse, already facing 82 degrees Fahrenheit at 10 a.m. "Unlike California, we have a chronic heat problem. For instance, last summer, we had over 30 days in a row with the heat index over a hundred degrees Fahrenheit. Combined with the high humidity, a lot of people struggle."

After she started her job, Gilbert first engaged in "listening tours," speaking with residents, doctors and emergency personnel. Because the warm temperatures attract tourists year-round, Gilbert learned to worry about out-of-town visitors. "We are a party town," Gilbert says, "and this increases the risk that tourists might not pay attention to their water hydration."

Even knowing how many residents die of heat exposure is tricky, since heat-related deaths are often not recorded as such. "How do we even measure heat deaths?" Gilbert asks, "Heat as such is not the cause of death, but it will be a heart attack or something like that."

From the vulnerability analysis she completed in her first year on the job, Gilbert has learned which areas of Miami have the highest temperatures and are therefore most at risk. She aims to increase the tree canopy in these areas from less than 10 percent to at least 30 percent by 2032. She also discovered that several nursing homes and public shelters don't have backup generators, which could be used for cooling in case of a power

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

outage. "Hurricanes and floods come with a bigger price tag," she says about why awareness of heat risks is only growing slowly, "but heat waves kill people, too."

Oregon was the first state to pass a law forcing employers to provide outdoor workers with cool water, rest breaks and shade when temperatures reach 80 degrees. "We have over 300,000 outdoor workers in Miami-Dade county who are exposed every day, plus the homeless population," says Gilbert. "We have to protect them." But a proposed law resembling Oregon's recently failed in Florida.

"So we have to focus on what we can do here, on the ground," Gilbert says pragmatically. She makes a case for naming heatwaves like tornados so the danger can be recognized and communicated more widely. (The Spanish city of Sevilla just started doing that.) But she also recognizes that the current system, which sounds the alarm when thermometers hit 108 degrees, doesn't suffice. "Just this week, a three-year-old girl died of heat stroke while being left in a car," she says.

The truth is that few communities are prepared. Miami has spent a decade prioritizing hurricane and flood prevention while underestimating heat risks. "The mayor has charged me with raising public awareness on the level of our hurricane preparedness efforts." Yet Gilbert's office has not been invested with much power or money. She has only one employee and hardly any budget. "But I report directly to the mayor," she says emphatically. "When I reach out to other departments, they know I'm speaking for the mayor, Daniella Levine Cava, and she regards this topic as a priority."

Her next big focus is on housing, "really helping homeowners and renters access energy efficiency, retrofits to reduce their bills. Our building department is looking to get a building code amendment to require cool roofs on larger commercial buildings. Going forward, all county-funded buildings will require a cool roof and higher efficiency standards."

Miami and Los Angeles are both part of the "cool roadways partnership," a group of 25 cities that aim to install cooler building materials. The group wants to use its power not just to exchange information about which materials work best, but also to negotiate better prices for the often costly materials. "We're trying to leverage the purchasing power of these 25 cities instead of each city following their own effort," says Greg Spotts, Chief Sustainability Officer of Streets LA. "That's going to be a game-changer."

Like Segura, Gilbert's perspective on her new job has been influenced by her past. Initially from Connecticut, she studied environmental science at Barnard College in New York and moved to Miami 27 years ago, drawn by the tropical climate. "My system just does better in the heat," she says. In between, she spent several years working in Central and South America for environmental NGOs, to protect Indigenous people and the rain forests. One could say she was addressing some of the root causes of climate change before working in community development and becoming Miami's Chief Resilience Officer in 2016.

Next month, she will be on the streets of Miami again on a Saturday, giving away 2,000 trees to low-income residents. "I still love the heat," she says with a sigh. "But it's almost getting too much, even for me."

Reasons to be Cheerful, 15 August 2022

https://reasonstobecheerful.world

New study combines lithophane and 3D printing to enable individuals to 'see' data regardless of level of eyesight

2022-08-18

A research team led by Baylor University chemists has taken a groundbreaking step forward in eliminating the exclusion of individuals with blindness from chemistry education and experiences. In an article published today in Science Advances, the researchers detail how they used lithophane—an old-fashioned art form—and 3D printing to turn scientific data into tactile graphics that glow with video-like resolution, enabling universal visualization of the same piece of data by both blind and sighted individuals.

Although the lithophane is an ancient artistic medium, it has never been used—until now—to represent scientific data and imagery in a quantitative, controlled manner for tactile visualization and tactile integration.

The Baylor study, titled "Data for all: Tactile graphics that light up with picture-perfect resolution," compared how blind and sighted people interpreted lithophane data by touch or eyesight. The participant cohorts tested the five lithophane forms—gel electropherograms, micrographs, electronic and mass spectra, and textbook illustrations—interpreting all five lithophanes by tactile sensing or eyesight at 79% overall accuracy, according to the study.

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

3D-printed litho-phanes can help optically impaired scientists "see" data, such as from protein separation gels, with their fingertips.

The researchers focused on creating and testing lithophanes of data found in the chemical sciences because of the explicit and systematic exclusion of students with blindness from chemistry, which the researchers noted "can be viewed as a virtue by educators, parents, peers or self, on the basis of laboratory safety and the 'visual' nature of chemistry."

"This research is an example of art making science more accessible and inclusive. Art is rescuing science from itself," said Bryan Shaw, Ph.D., professor of chemistry and biochemistry, who leads the Shaw Research Group at Baylor and is corresponding author on the journal article. "The data and imagery of science—for example, the stunning images coming out from the new Webb telescope—are inaccessible to people who are blind. We show, however, that thin translucent tactile graphics, called lithophanes, can make all of this imagery accessible to everyone regardless of eyesight. As we like to say, 'data for all.'"

New use for old art form

Likely created in China as early as the sixth century and popularized in Europe in the 1800s, lithophanes are thin engravings made from translucent materials (first porcelain and wax, now plastic) and initially appear opaque in ambient light. However, when backlit by any light source—from a ceiling light to sunlight—a lithophane glows like a digital image, with the scattering of light through the translucent material causing thinner regions to appear brighter and thicker regions to appear darker. Using free online software to convert a two-dimensional image to a 3D topograph, scientists in this study used 3D printing for the lithophanes.

"The idea of lithophanes was a concept Dr. Shaw had been playing around with, and I thought it was an amazing opportunity to help a group of individuals that have been stigmatized in the field of chemistry," said co-lead author Jordan Koone, a doctoral candidate in chemistry at Baylor and member of Shaw's lab. "It has been awesome to see blind people, who have been told their entire life they could not excel in the fields of science, interpret data just as easily as a sighted person."

The participant cohorts included sighted students with or without blindfolds and five persons with blindness who have experienced total blindness or low vision since childhood or adolescence. Four of these individuals with blindness have earned Ph.D. degrees in chemistry before testing, and the fifth person is an undergraduate student at Baylor who experienced complete vision loss as a senior in high school. These blind persons are co-authors of this study but did not participate in the design of the specific datasets.

"Before working on the lithophane project, I believed research was limited to experiments done in a laboratory setting," said co-lead author Chad Dashnaw, a doctoral candidate in chemistry at Baylor also in Shaw's lab. "But research is just trying to answer unanswered questions, and our work here is answering a very important one: Can blind persons be a part of STEM? Lithophanes provide a data format that can be universally shared between sighted and blind individuals making STEM more accessible to those who have previously been overlooked."

The study found that the average test accuracy for all five lithophanes was:

- 96.7% for blind tactile interpretation,
- 92.2% for sighted interpretation of backlit lithophanes, and
- 79.8% for blindfolded tactile interpretation.

Sighted participants were able to accurately interpret digital images on a computer screen at 88.4% by eyesight. For 80% of questions, the blind chemists' tactile accuracy was equal or superior to visual interpretation of lithophanes, suggesting that lithophanes could function as a shareable data format. In fact, Shaw said some of the blind chemists in the study has such tactile sensitivity that they could feel tactile features of the data that sighted individuals could barely see themselves.

'Seeing' datasets for first time

Study co-author Hoby B. Wedler, Ph.D., an entrepreneur, chemist and CEO of the Wedland Group in Petaluma, Calif., first interpreted lithophane data while on a Zoom call with Shaw. For his study co-authors and fellow chemists, this was a most meaningful moment as Wedler, who was born blind but earned a Ph.D. in theoretical chemistry, saw data for first time by touching high-resolution tactile graphics.

"You can look at this, and it looks exactly what I feel," Wedler said. "I've never felt a mass spec. I never thought I would be able to talk through an analytical dataset like this. The sky is the limit here."

"They were so excited to finally see the data and imagery that they had heard about for so long. And they did see this data. Because you see with your mind, not your eyes," Shaw said.

One of the most notable co-authors of the study was Baylor undergraduate student and researcher, Noah Cook. Cook finished his first semester at Baylor this past spring, despite losing all of his vision during his senior year in high school.

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

"The five blind co-authors on this project are some of the most interesting and hardworking individuals I have ever had the pleasure to work with," Dashnaw said. "For years they have heard of things like SDS-PAGE or mass spectra. but they had never had the opportunity to observe one for themselves, let alone interpret it. The lithophanes gave them that opportunity. They were able to in detail explain exactly what they were feeling, and it matched up perfectly with what we were seeing."

Opening chemistry to grades K-12

This latest study involving Shaw's group extends Baylor research to remove barriers to the study and discipline of chemistry for K-12 students with blindness or low vision.

Shaw recently was awarded a $1.3 million grant from the National Institutes of Health (NIH) for a first-of-its-kind early intervention project that opens laboratory work and provides tactile chemistry education materials and equipment. Combining high-tech and low-tech approaches, the project blends robotics and technology with educational materials and "lab hacks" that enable students with blindness and low vision to take part in the same roles and routines as their sighted counterparts, including the use of lithophanes.

"The neat thing about the tactile graphics that light up with picture-perfect resolution is that everything I can see with my eyes, another person who is blind can feel with their fingers. So it makes all of the high-resolution imagery and data accessible and shareable, regardless of eyesight. We can sit around with anyone, blind or sighted, and talk about the exact same piece of data or image," Shaw said.

Shaw and his collaborators are focusing their project initially on high school students by developing a pilot program for 150 TSBVI students to participate in education and curriculum and train on materials on both the school campus and within Shaw's lab at Baylor. The pilot is expected to launch this fall, with the full program expected to begin in spring 2023 through 2027. In the future, the team hopes to scale the program to include resources for children just beginning the study of science.

Beyond chemistry

The lithophane data format or LDF, and the data for all movement, goes beyond chemistry or science and can be used for any subject matter, from art, history, philosophy and wherever imagery or graphics are used, Shaw

said. With this latest research, the path to shareable and accessible data is available to anyone with tactile senses.

For doctoral candidates Koone and Dashnaw, the research highlights one of Baylor's core values: to facilitate the discovery of new knowledge and research that is for the betterment of humanity.

"Most of the research I do on a daily basis won't have a significant impact on the scientific community. However, the lithophane project allows for real change in real time," Dashnaw said. "We are making STEM more accessible to people with vision impairment and calling attention to their systemic exclusion."

Tech Xplore, 18 August 2022

https://techxplore.com

New supramolecular plastic heals itself in an instant

2022-08-16

Scientists experimenting with next-generation plastics at Finland's University of Turku have developed a form of the material with some impressive capabilities, most notably an ability to quickly break down after use. The eco-friendly "supramolecular" plastic is therefore highly recyclable and, with careful tuning of its water content, can be turned into an adhesive or even instantly self-heal when damaged.

The reason conventional plastics persist in the environment for so long is the incredibly strong chemical connections between the monomers within them. These particles link up to form polymers through what are known as covalent bonds, but scientists hope to fashion more environmentally forms of the material based on non-covalent bonds instead.

These weaker connections are better suited to degradation and recycling of the material, but do come at a cost in terms of mechanical performance. We have looked at some interesting examples of these "supramolecular" materials in the form of hybrid polymers for drug delivery, self-assembling plastics and adhesives that work at extreme temperatures.

By leveraging a technique called liquid-liquid phase separation (LLPS), the authors of the new study say they've now developed a supramolecular plastic with the mechanical strength of conventional plastic. The material contains non-covalent bonds of high strength that are reversible, which enables it to be degraded or recycled after use, along with some other useful properties.

By reworking the bonds within the material, scientists have produced a supramolecular plastic with comparable mechanical strength to conventional plastic.

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

The plastic features a "remarkable" ability to be stretched and deformed with low water content, while increasing that water content turns it into an adhesive. Further, this higher water content enables the plastic to self-heal instantly when broken into pieces.

"Comparable with conventional plastics, our new supramolecular plastics are smarter as they not only retain the strong mechanical property but also reserve dynamic and reversible properties that made the material self-healable and reusable," explained study author Dr Jingjing Yu.

Self-healing polymers are a promising technology with wide-ranging potential, and could in the future be found in car paint that repairs its own scratches, iPhone cases that fix themselves and next-generation batteries. The scientists believe using their approach to combine this property with easier degradability and recyclability opens up some exciting new pathways around eco-friendly supramolecular plastics.

"Emerging evidence has shown that LLPS could be a significant process during the formation of cell compartments," Li said. "Now, we advanced this bio- and physical-inspired phenomenon to tackle the grand challenge for our environment. I believe that more interesting materials will be explored with the LLPS process in the near future."

The research was published in the journal Angewandte Chemie.

New Atlas, 16 August 2022

https://newatlas.com

Graphene as 'the philosopher's stone': Turning waste into gold

2022-08-17

Throughout history, alchemists believed in the existence of the philosopher's stone: a substance that could turn cheap substances into precious gold. Now scientists from The University of Manchester, Tsinghua University in China and the Chinese Academy of Sciences have shown that graphene can be a kind of philosopher's stone, allowing gold extraction from waste containing only trace amounts of gold (down to billionth of a percent).

This new, seemingly magical application of graphene works quite straightforwardly: add graphene into a solution containing traces of gold and, after a few minutes, pure gold appears on graphene sheets, with no

The research shows that 1 gram of graphene can be sufficient for extracting nearly 2 grams of gold.

other chemicals or energy input involved. After this you can extract your pure gold by simply burning the graphene off.

The research, published in Nature Communications, shows that 1 gram of graphene can be sufficient for extracting nearly 2 grams of gold. As graphene costs less than $0.10 per gram, this can be very profitable, with gold priced at around $70 per gram.

Dr. Yang Su from Tsinghua University, who led the research efforts, said, "This apparent magic is essentially a simple electrochemical process. Unique interactions between graphene and gold ions drive the process and also yield exceptional selectivity. Only gold is extracted with no other ions or salts."

Gold is used in many industries including consumer electronics (mobile phones, laptops etc.) and, when the products are eventually discarded, little of the electronic waste is recycled. The graphene-based process with its high extraction capacity and high selectivity can reclaim close to 100% of gold from electronic waste. This offers an enticing solution for addressing the gold sustainability problem and e-waste challenges.

"Graphene turns rubbish into gold, literally," added Professor Andre Geim from The University of Manchester, another lead author and Nobel laureate responsible for the first isolation of graphene.

"Not only are our findings promising for making this part of the economy more sustainable, but they also emphasize how different atomically-thin materials can be from their parents, well-known bulk materials," he added. "Graphite, for example, is worthless for extracting gold, while graphene almost makes the philosopher's stone."

Professor Hui-ming Cheng, one of the main authors from the Chinese Academy of Sciences, said, "With the continuing search for revolutionary applications of graphene, our discovery that the material can be used to recycle gold from electronic waste brings additional excitement to the research community and developing graphene industries."

Phys Org, 17 August 2022

https://phys.org

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

Silk offers an alternative to some microplastics

2022-08-17

Microplastics, tiny particles of plastic that are now found worldwide in the air, water, and soil, are increasingly recognized as a serious pollution threat, and have been found in the bloodstream of animals and people around the world.

Some of these microplastics are intentionally added to a variety of products, including agricultural chemicals, paints, cosmetics, and detergents — amounting to an estimated 50,000 tons a year in the European Union alone, according to the European Chemicals Agency. The EU has already declared that these added, nonbiodegradable microplastics must be eliminated by 2025, so the search is on for suitable replacements, which do not currently exist.

Now, a team of scientists at MIT and elsewhere has developed a system based on silk that could provide an inexpensive and easily manufactured substitute. The new process is described in a paper in the journal Small, written by MIT postdoc Muchun Liu, MIT professor of civil and environmental engineering Benedetto Marelli, and five others at the chemical company BASF in Germany and the U.S.

A team of scientists at MIT and elsewhere has developed a system based on silk that could provide an inexpensive and easily manufactured substitute for microplastics.

The microplastics widely used in industrial products generally protect some specific active ingredient (or ingredients) from being degraded by exposure to air or moisture, until the time they are needed. They provide a slow release of the active ingredient for a targeted period of time and minimize adverse effects to its surroundings.

For example, vitamins are often delivered in the form of microcapsules packed into a pill or capsule, and pesticides and herbicides are similarly enveloped. But the materials used today for such microencapsulation are plastics that persist in the environment for a long time. Until now, there has been no practical, economical substitute available that would biodegrade naturally.

Much of the burden of environmental microplastics comes from other sources, such as the degradation over time of larger plastic objects such as bottles and packaging, and from the wear of car tires. Each of these sources may require its own kind of solutions for reducing its spread, Marelli says. The European Chemical Agency has estimated that the intentionally added microplastics represent approximately 10-15 percent of the total amount in the environment, but this source may be relatively

easy to address using this nature-based biodegradable replacement, he says.

"We cannot solve the whole microplastics problem with one solution that fits them all," he says. "Ten percent of a big number is still a big number. … We'll solve climate change and pollution of the world one percent at a time."

Unlike the high-quality silk threads used for fine fabrics, the silk protein used in the new alternative material is widely available and less expensive, Liu says. While silkworm cocoons must be painstakingly unwound to produce the fine threads needed for fabric, for this use, non-textile-quality cocoons can be used, and the silk fibers can simply be dissolved using a scalable water-based process.

The processing is so simple and tunable that the resulting material can be adapted to work on existing manufacturing equipment, potentially providing a simple "drop in" solution using existing factories.

Silk is recognized as safe for food or medical use, as it is nontoxic and degrades naturally in the body. In lab tests, the researchers demonstrated that the silk-based coating material could be used in existing, standard spray-based manufacturing equipment to make a standard water-soluble microencapsulated herbicide product, which was then tested in a greenhouse on a corn crop. The test showed it worked even better than an existing commercial product, inflicting less damage to the plants, Liu says.

While other groups have proposed degradable encapsulation materials that may work at a small laboratory scale, Marelli says, "there is a strong need to achieve encapsulation of high-content actives to open the door to commercial use. The only way to have an impact is where we can not only replace a synthetic polymer with a biodegradable counterpart, but also achieve performance that is the same, if not better."

The secret to making the material compatible with existing equipment, Liu explains, is in the tunability of the silk material. By precisely adjusting the polymer chain arrangements of silk materials and addition of a surfactant, it is possible to fine-tune the properties of the resulting coatings once they dry out and harden. The material can be hydrophobic (water-repelling) even though it is made and processed in a water solution, or it can be hydrophilic (water-attracting), or anywhere in between, and for a given application it can be made to match the characteristics of the material it is being used to replace.

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

In order to arrive at a practical solution, Liu had to develop a way of freezing the forming droplets of encapsulated materials as they were forming, to study the formation process in detail. She did this using a special spray-freezing system, and was able to observe exactly how the encapsulation works in order to control it better. Some of the encapsulated "payload" materials, whether they be pesticides or nutrients or enzymes, are water-soluble and some are not, and they interact in different ways with the coating material.

"To encapsulate different materials, we have to study how the polymer chains interact and whether they are compatible with different active materials in suspension," she says.

The payload material and the coating material are mixed together in a solution and then sprayed. As droplets form, the payload tends to be embedded in a shell of the coating material, whether that's the original synthetic plastic or the new silk material.

The secret to making the material compatible with existing equipment, Liu explains, is in the tunability of the silk material. By precisely adjusting the polymer chain arrangements of silk materials and addition of a surfactant, it is possible to fine-tune the properties of the resulting coatings once they dry out and harden.

The material can be hydrophobic (water-repelling) even though it is made and processed in a water solution, or it can be hydrophilic (water-attracting), or anywhere in between, and for a given application it can be made to match the characteristics of the material it is being used to replace.

In order to arrive at a practical solution, Liu had to develop a way of freezing the forming droplets of encapsulated materials as they were forming, to study the formation process in detail. She did this using a special spray-freezing system, and was able to observe exactly how the encapsulation works in order to control it better. Some of the encapsulated "payload" materials, whether they be pesticides or nutrients or enzymes, are water-soluble and some are not, and they interact in different ways with the coating material.

"To encapsulate different materials, we have to study how the polymer chains interact and whether they are compatible with different active materials in suspension," she says. The payload material and the coating material are mixed together in a solution and then sprayed. As droplets

form, the payload tends to be embedded in a shell of the coating material, whether that's the original synthetic plastic or the new silk material.

The new method can make use of low-grade silk that is unusable for fabrics, and large quantities of which are currently discarded because they have no significant uses, Liu says. It can also use used, discarded silk fabric, diverting that material from being disposed of in landfills.

Currently, 90 percent of the world's silk production takes place in China, Marelli says, but that's largely because China has perfected the production of the high-quality silk threads needed for fabrics. But because this process uses bulk silk and has no need for that level of quality, production could easily be ramped up in other parts of the world to meet local demand if this process becomes widely used, he says.

The research team also included Pierre-Eric Millard, Ophelie Zeyons, Henning Urch, Douglas Findley and Rupert Konradi from the BASF corporation, in Germany and in the U.S. The work was supported by BASF through the Northeast Research Alliance (NORA).

The Brighter Side of News, 17 August 2022

https://thebrighterside.news

'Forever chemicals' destroyed by simple new method

2022-08-18

PFAS, a group of manufactured chemicals commonly used since the 1940s, are called "forever chemicals" for a reason. Bacteria can't eat them; fire can't incinerate them; and water can't dilute them. And, if these toxic chemicals are buried, they leach into surrounding soil, becoming a persistent problem for generations to come.

Now, Northwestern University chemists have done the seemingly impossible. Using low temperatures and inexpensive, common reagents, the research team developed a process that causes two major classes of PFAS compounds to fall apart, leaving behind only benign end products.

The simple technique potentially could be a powerful solution for finally disposing of these harmful chemicals, which are linked to many dangerous health effects in humans, livestock and the environment.

"PFAS has become a major societal problem," said Northwestern's William Dichtel, who led the study. "Even just a tiny, tiny amount of PFAS causes negative health effects, and it does not break down. We can't just wait

"Recently, the EPA revised its recommendations for PFOA essentially down to zero," Dichtel said. "That puts several PFAS into the same category as lead."

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

out this problem. We wanted to use chemistry to address this problem and create a solution that the world can use. It's exciting because of how simple—yet unrecognized—our solution is."

Dichtel is the Robert L. Letsinger Professor of Chemistry in Northwestern's Weinberg College of Arts and Sciences. Brittany Trang, who conducted the project as a part of her recently completed doctoral thesis in Dichtel's laboratory, is the paper's co-first author.

'The same category as lead'

Short for per- and polyfluoroalkyl substances, PFAS has been in use for 70 years as nonstick and waterproofing agents. They are commonly found in nonstick cookware, waterproof cosmetics, firefighting foams, water-repellent fabrics and products that resist grease and oil.

Over the years, however, PFAS has made its way out of consumer goods and into our drinking water and even into the blood of 97% of the U.S. population. Although the health effects are not yet fully understood, PFAS exposure is strongly associated with decreased fertility, developmental effects in children, increased risks of various types of cancer, reduced immunity to fight infections and increased cholesterol levels. With these adverse health effects in mind, the U.S. Environmental Protection Agency (EPA) recently declared several PFAS as unsafe, even at trace levels.

"Recently, the EPA revised its recommendations for PFOA essentially down to zero," Dichtel said. "That puts several PFAS into the same category as lead."

Unbreakable bonds

Although community efforts to filter PFAS from water have been successful, there are few solutions for how to dispose of PFAS once it is removed. The few option that are now emerging generally involved PFAS destruction at high temperatures and pressures or other methods that require large energy inputs.

"In New York state, a plant claiming to incinerate PFAS was found to be releasing some of these compounds into the air," Dichtel said. "The compounds were emitted from the smokestacks and into the local community. Another failed strategy has been to bury the compounds in landfills. When you do that, you are basically just guaranteeing that you will have a problem 30 years from now because it's going to slowly leach out. You didn't solve the problem. You just kicked the can down the road."

The secret to PFAS's indestructibility lies in its chemical bonds. PFAS contains many carbon-fluorine bonds, which are the strongest bonds in organic chemistry. As the most electronegative element in the periodic table, fluorine wants electrons, and badly. Carbon, on the other hand, is more willing to give up its electrons.

"When you have that kind of difference between two atoms—and they are roughly the same size, which carbon and fluorine are—that's the recipe for a really strong bond," Dichtel explained.

Pinpointing PFAS' Achilles' heel

But, while studying the compounds, Dichtel's team found a weakness. PFAS contains a long tail of unyielding carbon-fluorine bonds. But at one end of the molecule, there is a charged group that often contains charged oxygen atoms. Dichtel's team targeted this head group by heating the PFAS in dimethyl sulfoxide—an unusual solvent for PFAS destruction—with sodium hydroxide, a common reagent. The process decapitated the head group, leaving behind a reactive tail.

"That triggered all these reactions, and it started spitting out fluorine atoms from these compounds to form fluoride, which is the safest form of fluorine," Dichtel said. "Although carbon-fluorine bonds are super strong, that charged head group is the Achilles' heel."

In previous attempts to destroy PFAS, other researchers have used high temperatures—up to 400 degrees Celsius. Dichtel is excited that the new technique relies on milder conditions and a simple, inexpensive reagent, making the solution potentially more practical for widespread use.

After discovering the PFAS degradation conditions, Dichtel and Trang also discovered that the fluorinated pollutants fall apart by different processes than generally assumed. Using powerful computational methods, collaborators Ken Houk at UCLA and Yuli Li, a student at Tianjin University who virtually visited Houk's group, simulated the PFAS degradation. Their calculations suggest that PFAS falls apart by more complex processes than expected. Although it was previously assumed that PFAS should fall apart one carbon at a time, the simulation showed that PFAS actually falls apart two or three carbons at a time—a discovery that matched Dichtel and Trang's experiments. By understanding these pathways, researchers can confirm that only benign products remain. This new knowledge also could help guide further improvements to the method.

CHEMWATCH
Bulletin Board
Gossip
AUG. 26, 2022

"This proved to be a very complex set of calculations that challenged the most modern quantum mechanical methods and fastest computers available to us," said Houk, a distinguished research professor in organic chemistry. "Quantum mechanics is the mathematical method that simulates all of chemistry, but only in the last decade have we been able to take on large mechanistic problems like this, evaluating all the possibilities and determining which one can happen at the observed rate. Yuli has mastered these computational methods and worked with Brittany long distance to solve this fundamental but practically significant problem."

Ten down, 11,990 to go

Next, Dichtel's team will test the effectiveness of its new strategy on other types of PFAS. In the current study, they successfully degraded 10 perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkyl ether carboxylic acids (PFECAs), including perfluorooctanoic acid (PFOA) and one of its common replacements, known as GenX—two of the most prominent PFAS compounds. The U.S. EPA, however, has identified more than 12,000 PFAS compounds.

Although this might seem daunting, Dichtel remains hopeful.

"Our work addressed one of the largest classes of PFAS, including many we are most concerned about," he said. "There are other classes that don't have the same Achilles' heel, but each one will have its own weakness. If we can identify it, then we know how to activate it to destroy it."

Dichtel is a member of the Institute for Sustainability and Energy at Northwestern's Program on Plastics, Ecosystems and Public Health; the Center for Water Research and the International Institute for Nanotechnology

The study, "Low-temperature mineralization of perfluorocarboxylic acids," is published on August 19 in the journal Science.

Phys Org, 18 August 2022

https://phys.org

Hydrogel bandage uses ultrasound to better stick to the skin

2022-08-12

Getting a bandage to stick to your skin can sometimes be difficult, particularly if that skin is wet. This isn't a problem with an experimental new wound dressing however, which uses ultrasound-induced microbubbles to better bond with the skin.

Developed by a team led by Canada's McGill University, the dressing itself takes the form of a thin sheet of clear hydrogel – it's made of either polyacrylamide or poly(N-isopropylacrylamide) polymers, along with seaweed-derived alginate gel. That hydrogel is combined with a liquid primer containing chitosan or gelatin nanoparticles, or cellulose nanocrystals.

Whatever the combination, once the primer and hydrogel have been applied to the wound, a small ultrasound transducer is brought into contact with them. The ultrasound waves travel through the hydrogel and induce cavitation in the primer, producing many microbubbles which push the primer molecules down into the skin.

As a result, the dressing sticks to the skin much better than a traditional adhesive-backed bandage – the greater the intensity of the ultrasound, the better the dressing sticks. And once the wound has healed, the bonding process can be reversed, to remove the hydrogel.

We're told that the addition of a thin rubber layer on top of the hydrogel would help protect it, and keep it from drying out. Ultimately, along with its use for wound treatment, it is believed that the technology could also be utilized to deliver medication through the skin … and the possibilities don't stop there.

"By merging mechanics, materials and biomedical engineering, we envision the broad impact of our bioadhesive technology in wearable devices, wound management, and regenerative medicine," said the lead scientist, McGill's Prof. Jianyu Li.

A paper on the research – which also involves scientists from the University of British Columbia and Switzerland's ETH Zurich institute – was recently published in the journal Science.

New Atlas, 12 August 2022

https://newatlas.com

The hydrogel could also be utilized in applications such as transdermal drug delivery.

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

Laser-extracted cold-brew coffee could be a Monday-morning game changer

2022-08-07

Researchers in Germany have created a laser-powered extraction system that pumps out cold-brew about 300 times faster than traditional methods. Arguably superior in flavor, aroma and caffeination, cold-brew coffee may soon be convenient too.

It's a broad church, coffee, and one that welcomes all comers. From the building site break-room's styrofoam cup of instant, softened off with milk and sugar, to the treacle-thick, spoon-levitating Turkish dessert, to the unbearably hipster deconstructed latte, it's an energizing pick-me-up that can be as sacred or profane as you feel on a given day.

Cold-brew coffee sits very much at the more sacred end of the scale, because it takes so damn long to make. Steeping coffee beans in cold water extracts up to three times more caffeine than drip-filtering with hot water. It's less bitter and acidic, making for a more approachable drink from a wider range of beans, and proponents claim it's more aromatic as well.

The Japanese have been cold-brewing coffee for centuries – but then, perhaps they were a bit more patient than the rest of us. A cold-brew takes up to around 24 hours to steep, which is fine if you're organized enough to put a big jar in the fridge on Saturday, but it's no consolation to a bleary-eyed soul groping around the kitchen completely unprepared on a Monday morning. State-of-the-art equipment can reduce that to around 12 hours, but still, planning remains a key ingredient.

Enter a chemistry research team from Germany's Universitat Duisberg Essen (UDE), which has developed and demonstrated an ultra-fast, laser-charged cold-brew process that takes just a few minutes, delivering the flavor and much of the chemistry of a cold-brew in record time.

The technique is derived from the laser synthesis and processing of colloids (LSPC) field, a method typically used to blast apart metal solids in solvent solutions and create solutions of suspended nanoparticles. The researchers took a neodymium-doped yttrium aluminum garnet (Nd:YAG) laser, tuned to 532 nanometers, and created 125-picojoule pulses lasting just 10 picoseconds. They pulsed it through a solution of ground coffee mixed in with water, some 80,000 times per second, for three minutes, never raising the temperature by more than a few degrees.

Laser-irradiated coffee: very close to cold brew, but much, much faster.

The resulting solution was filtered and compared against a 24-hour cold brew and a cup of hot drip-filter coffee. Acidity in the laser-coffee was almost identical with the 24-hour cold brew, and significantly less than the hot coffee. The important aromatic trigonelline was highest in the cold-brew, lowest in the hot-brew, and somewhere in between in the laser coffee. No substances were found in the laser coffee that weren't already in the hot or cold brews.

Caffeine levels were closer to hot coffee in these experiments, but the researchers note that the laser technique extracts caffeine extremely quickly, and both caffeine and trigonneline levels could likely be brought up to cold-brew equivalence with a couple of extra minutes under the laser. Other volatile aromatic compounds like pyridine and diphenolwere were present only in the cold-brew and laser-brew – they evaporate off when you make a hot coffee, contributing to that gorgeous hot-brew smell but disappearing from the flavor profile.

"In summary," reads a study published in the journal Nature, "we recorded a similar [chemical] profile for all coffee variants. The cold brew and the ps-laser-brew show the highest alkaloids' concentration, while their amount in the hot variants is decreased ... The chemical composition of ps-laser-extracted coffee is very similar to conventional cold-brew coffee."

No subjective taste or olfactory testing was done at this stage, and the researchers note that more in-depth chemical analysis will be needed to meet food safety regulations. They also note that there's some fiddling to be done with the laser's parameters, and other refinements to the process they'd like to try.

But the team has its sights firmly set on commercialization, hoping to develop laser-extracted coffee systems for cafes, and event and reception centers. The technique could also have interesting effects on tea and matcha, and the researchers don't plan to stop there. "Cold-brew coffee is just the beginning, said Dr. Anna Rosa Ziefuss, lead author on the study, in a press release. "We are currently working on the development of other recipes for cold soft drinks."

Given how quickly the latest trends in coffee-making can sweep across the more man-bunned and moustachioed suburbs, we can see laser-coffee getting a solid run if Ziefuss and her team can get an effective system into production at a reasonable price.

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

The research paper is open access in the journal Nature.

New Atlas, 7 August 2022

https://newatlas.com

Evolution Only Thinks About One Thing, and It's Crabs

2022-08-13

In 1989, paleontologist Stephen Jay Gould proposed a thought experiment: What would the world look like if we turned back time and replayed the evolutionary tape? "I doubt that anything like Homo sapiens would ever evolve again," he concluded. Maybe not. But crabs might.

Evolution just can't stop creating crabs. Believe it or not, the flat-and-wide body plan has evolved at least five different times. The process is called carcinization, and it's inspired comics, memes and entire subreddits.

Still, biologists don't know why crabs keep evolving. Figuring it out would satisfy the online masses, sure, but it would also be a step toward solving other important scientific mysteries. For instance, why some species share evolutionary paths while others forge unique ones (looking at you, platypus).

What Are Crabs Anyway?

Crabs belong to a group called meiurans, which includes brachyurans (or "true crabs") and anomurans (or "false crabs"). At first glance, the differences between the two subgroups are subtle; the most obvious is that brachyurans walk on four pairs of legs while anomurans walk on three. Yet they're actually separated by hundreds of millions of years of evolution. What's more, each has evolved crabby body plans multiple times.

The earliest meiurans probably looked like squat lobsters, says Javier Luque, an evolutionary biologist at Harvard University and Florida International University. As they carcinized, they widened, flattened and hardened their bodies. They also shrank and tucked their segmented abdomens underneath their shield-like shells.

That transition can be dramatic, like when king crabs evolved from hermit crabs. "You look at them and you think, 'what the hell?'" says Joanna Wolfe, also at Harvard. Seriously: Hermits and king crabs couldn't look more different. The fact that hermits carcinized — and that this happened at least four other times — is jaw-dropping.

Crab-like body plans have evolved independently at least five times. Biologists are still trying to figure out why.

It's not clear why crustaceans keep doing this, but it might relate to mobility and predation, Wolfe and Luque say. Shortening and widening the body stabilizes their stance. That could allow for the sideways walking the group is famous for and help them invade dry land.

Crabbiness could also stave off predation; the crustaceans tuck their scrumptious tail under a protective shell, and can squeeze their disc-like bodies into narrow cracks. The reverse seems true, too. Species that avoid predation by other means, such as by co-opting snail shells or burrowing, often lose crab-like body plans or never evolve them in the first place.

Uno Reverse

Carcinization isn't a one-way street. Crabs decarcinized at least seven times, leading to weirdos like tick-shaped frog crabs and symbiotic porcelain crabs. The poster child of decarcinized oddballs, though, might be an extinct crustacean called Callichimaera perplexa. Luque says the 90-million-year-old creature is "stuck in puberty" and PBS Eons called it the "Baby Yoda" of crabs.

That's because crustaceans spend their infancy as swimming larvae called zoea. The newborns have long tails, round heads and beady eyes. Typically, once they're mature, they settle to the seafloor and shapeshift into crab-like forms. C. perplexa, however, maintains its juvenile qualities even as an adult, wading through water like a big larval baby.

With bulbous eyes, paddling legs and long predatory mouthparts, "it's the platypus of the crab world," says Luque. "And it holds an important key for understanding crab evolution." Perhaps crabs gain and lose their form so frequently because they can flexibly time when and if to metamorphose.

To find out, Wolfe and Luque are shoring up the fragmented fossil record, refining evolutionary trees and identifying adaptive benefits that could favor crabbiness. They're also leveraging modern tools like high-powered X-rays and genetics. "It's a complicated story," Wolfe says. "But that's okay, because that's evolution."

Evolution Is a Tinkerer

Memes portray crabs as the optimal body form, but carcinization might not be entirely adaptive. Instead, it could reflect constraints — like deep-rooted genes and developmental patterns that funnel meiurans into a small set of possible body plans. "Maybe it's something else entirely that has driven this repeated evolution, [something] that isn't just adaptation

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

by natural selection," says evolutionary biologist Jonathan Losos of Washington University in St. Louis.

For example, Wolfe and Luque hypothesize that the segmented abdomen and protective shell are inextricably linked — a phenomenon called evolutionary integration. If natural selection favored small and hidden abdomens, then the shell could have just flattened as a byproduct.

Evolution is a tinkerer, not an engineer. It can jury-rig different inventions with a single Lego set, say, but it's limited by the pieces (in this case, genes and body plans) available in the box. It's entirely possible that the entire crab phenotype evolved simply because one component is beneficial while the others are evolutionarily integrated and forced to tag along.

Variations On a Theme

And carcinization is just one example of convergent evolution, "when two species evolve to become more similar," Losos says. Convergence can cause whole bodies and lifestyles to align, like in the genus of lizards commonly known as anoles that Losos studies. But crabs show that it can also be more nuanced. Despite sharing similarities, crabs are strikingly diverse. They live on land or sea, can be microscopic or larger than a human, and claim ecological niches as disparate as burrowers and parasites.

There must be some benefit unifying this astonishing biodiversity, Losos says. But his bigger question is why convergent evolution produces facsimiles in some cases while allowing diversity in others: "That's a very interesting question which, as far as I'm aware, hasn't been addressed very much."

Losos says that people are amazed when they first learn of convergent evolution — but crabs take that fanfare to a new level. They appear in cartoons, astrology and even a dancing crab rave video that's amassed over 200 million YouTube views (goodbye Lofi Beats Girl, hello 10-hour crab rave).

We love them because of how different they are from us. "And yet, we can see ourselves in there a little bit." Luque says. "They're so beautifully weird." Wolfe adds that crab ubiquity in pop culture is why carcinization is so

shocking to most people: "Everyone thinks they know what a crab is, and then they're wrong."

Discover Magazine, 13 August 2022

https://www.discovermagazine.com

Why thinking hard makes us feel tired

2022-08-11

It's not just in your head: a desire to curl up on the couch after a day spent toiling at the computer could be a physiological response to mentally demanding work, according to a study that links mental fatigue to changes in brain metabolism.

The study, published on 11 August in Current Biology1, found that participants who spent more than six hours working on a tedious and mentally taxing assignment had higher levels of glutamate — an important signalling molecule in the brain. Too much glutamate can disrupt brain function, and a rest period could allow the brain to restore proper regulation of the molecule, the authors note. At the end of their work day, these study participants were also more likely than those who had performed easier tasks to opt for short-term, easily won financial rewards of lesser value than larger rewards that come after a longer wait or involve more effort.

The study is important in its effort to link cognitive fatigue with neurometabolism, says behavioural neuroscientist Carmen Sandi at the Swiss Federal Institute of Technology in Lausanne. But more research — potentially in non-human animals — will be needed to establish a causal link between feelings of exhaustion and metabolic changes in the brain, she adds. "It's very good to start looking into this aspect," says Sandi. "But for now this is an observation, which is a correlation."

Tired brain

Previous research has demonstrated effects of mental strain on physiological parameters such as heart-rate variability and blood flow, but these tend to be subtle, says Martin Hagger, a health psychologist at the University of California, Merced. "It's not like when you're exercising skeletal muscle," he says. "But it is perceptible."

Cognitive neuroscientist Antonius Wiehler at the Paris Brain Institute and his colleagues thought that the effects of cognitive fatigue could be due to metabolic changes in the brain. The team enrolled 40 participants and

Difficult tasks can lead to build-up of a signalling molecule in the brain, triggering fatigue.

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

assigned 24 of them to perform a challenging task: for example, watching letters appear on a computer screen every 1.6 seconds and documenting when one matched a letter that had appeared three letters ago. The other 16 participants were asked to perform a similar, but easier task. Both teams worked for just over six hours, with two ten-minute breaks.

While the study participants focused on their work, Wiehler and his team used a technique called magnetic resonance spectroscopy to measure levels of glutamate in a region of the brain called the lateral prefrontal cortex.

The prefrontal cortex is the home of cognitive control — the part of the brain that allows people to suppress their impulses. "If you get stung by an insect, you want to scratch," says Wiehler. "If you're stopping this reflex, that would be cognitive control." It's also the system that humans rely on to choose tempting short-term rewards, such as an unhealthy snack, over long-term gains.

The researchers found that participants who laboured on the more difficult task had accumulated more glutamate in this region of the brain by the end of the day than had those who worked on the easier task. And, given a choice between an immediate cash reward and a larger reward that would come months later, they were more likely to choose the smaller, short-term reward than they were at the start of the day.

Wiehler now hopes to use this system to learn more about how to recover from mental exhaustion. "It would be great to find out more about how glutamate levels are restored," he says. "Is sleep helpful? How long do breaks need to be to have a positive effect?" Studies of cognitive fatigue could also be key to understanding how workers react to — and recover from — high-stakes mental work such as air-traffic control, in which even a brief loss of focus can cost lives.

And now that a system has been established to measure metabolic changes in response to mental fatigue, Hagger hopes that other researchers will try the approach. "Means to detect this have hitherto not been sensitive enough, so this research paves the way for future researchers to explore cognitive fatigue," he says.

That research — and particularly animal studies, in which glutamate levels can be experimentally altered — could unpick the molecular mechanisms

that cause the molecule to accumulate during difficult mental work and how that affects brain activity, says Sandi. "This is the tricky part."

Nature, 11 August 2022

https://nature.com

Bizarre Underwater Snow Gives Clues About the Icy Shell of Jupiter's Moon Europa

2022-08-15

Below the thick icy crust of Jupiter's moon Europa is a massive, global ocean where the snow floats upwards onto inverted ice peaks and submerged ravines. Bizarre underwater snow is known to occur below ice shelves on Earth, but new research shows that the same is likely true for Jupiter's moon. In fact, it may play a role in building Europa's ice shell.

The underwater snow is much purer than other kinds of ice. This means Europa's ice shell could be much less salty than previously thought. That's crucial information for mission scientists preparing NASA's Europa Clipper spacecraft, which will use radar to scan beneath the ice shell to see if Europa's ocean could be hospitable to life. The new information is important because salt trapped in the ice can affect what and how deep the radar will see into the ice shell. Being able to predict what the ice is made of will help scientists make sense of the data.

NASA's Europa Clipper spacecraft [...] will use radar to scan beneath the ice shell to see if Europa's ocean could be hospitable to life.

The study was led by The University of Texas at Austin, which is also leading the development of Europa Clipper's ice-penetrating radar instrument. Knowing what kind of ice Europa's shell is made of will also help determine the salinity and habitability of its ocean. The study was published in the August edition of the journal Astrobiology.

"When we're exploring Europa, we're interested in the salinity and composition of the ocean, because that's one of the things that will govern its potential habitability or even the type of life that might live there," said the study's lead author Natalie Wolfenbarger, a graduate student researcher at the University of Texas Institute for Geophysics (UTIG) in the UT Jackson School of Geosciences.

Europa is a rocky world that is surrounded by a global ocean and a miles-thick ice shell. It is about the size of the Earth's moon. Previous research indicates the temperature, pressure, and salinity of Europa's ocean nearest to the ice is similar to what you would find beneath an ice shelf in Antarctica.

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

Knowing this, the current research investigated the two distinct processes by which water freezes under ice shelves: congelation ice and frazil ice. Congelation ice grows directly from under the ice shelf. Frazil ice forms as ice flakes in supercooled seawater which float upwards through the water, settling on the bottom of the ice shelf.

Both ways make ice that's less salty than seawater. When scaled up to the size and age of Europa's ice shell, Wolfenbarger found that the ice would be even less salty. Moreover, according to her calculations, frazil ice – which keeps only a tiny fraction of the salt in seawater – could be very common on Europa. That could mean its ice shell might be orders of magnitude purer than previous estimates. This difference affects everything from its strength, to how heat moves through it, and forces that might drive a kind of ice tectonics.

"This paper is opening up a whole new batch of possibilities for thinking about ocean worlds and how they work," said Steve Vance, a research scientist at NASA's Jet Propulsion Laboratory (JPL) who was not involved in the study. "It sets the stage for how we might prepare for Europa Clipper's analysis of the ice."

According to co-author Donald Blankenship, the research is validation for using the Earth as a model to understand the habitability of Europa. Blankenship is a senior research scientist at UTIG and principal investigator for Europa Clipper's ice-penetrating radar instrument.

"We can use Earth to evaluate Europa's habitability, measure the exchange of impurities between the ice and ocean, and figure out where water is in the ice," he said.

Sci Tech Daily, 15 August 2022

https://scitechdaily.com

Plasma reactors could create oxygen on Mars

2022-08-16

Last year, NASA achieved something science fiction writers have been dreaming about for decades: It created oxygen on Mars. A microwave-size device attached to the agency's Perseverance rover converted carbon dioxide into 10 minutes of breathable oxygen. Now, physicists say they've come up with a way to use electron beams in a plasma reactor to create far more oxygen, potentially in a smaller package.

Approach splits atmospheric carbon dioxide, but still has kinks to work out.

The technique might someday not just help astronauts breathe on the Red Planet, but could also serve as a way to create fuel and fertilizer, says Michael Hecht, an experimental scientist at the Massachusetts Institute of Technology. But Hecht, who leads the oxygenmaking rover instrument, says the new approach still has a number of challenges to overcome before it can hitch a ride to our solar neighbor.

When Perseverance landed in Jezero crater in 2020, it carried the Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE). The device draws in martian air, which is 95% carbon dioxide. By pumping a current between two oppositely charged electrodes in an electrochemical cell, MOXIE can split the carbon dioxide into carbon monoxide and oxygen ions. The oxygen ions then combine with each other to produce oxygen gas.

The experiment has been a successful proof of concept. But to work, MOXIE needs to pressurize and heat martian air—requiring extra parts that consume energy and make it bulky.

Vasco Guerra, a physicist at the University of Lisbon, thought a plasma reactor might be a better approach. A beam of electrons, accelerated to a specific energy level, can split carbon dioxide into its component ions, or plasma, just like MOXIE.

Moreover, a plasma reactor would be well-suited to the martian atmosphere, which is about 100 times thinner than Earth's. Creating and accelerating a beam of electrons in the thin air is much easier, Guerra says. "There is an ideal pressure for plasma operation," he says. "Mars has precisely this correct pressure."

In the lab, he and his colleagues pumped air designed to match the pressure and composition of Mars into metal tubes. Unlike MOXIE, they didn't need to compress or heat the air. Yet, by firing an electron beam into the reaction chamber, they were able to convert about 30% of the air into oxygen. They estimate that the device could create about 14 grams of oxygen per hour: enough to support 28 minutes of breathing, the team reports today in the Journal of Applied Physics.

Guerra's team still needs to solve some practical problems, Hecht notes. To work on Mars, the plasma device would need a portable power source and a place to store the oxygen it makes, all of which could make it just as—if not more—bulky than MOXIE, he says. If space agencies were willing to spend millions of dollars developing it—as NASA did with MOXIE—the plasma approach could mature, Hecht says. He especially likes how the

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

electron beam could be tuned to split other atmospheric molecules, such as nitrogen, to create fertilizer. "There's nothing wrong with the plasma technique other than it's a lot less mature [than MOXIE]," he says.

Science, 16 August 2022

https://science.org

A way to recycle polystyrene into more valuable products

2022-08-16

A team of researchers at Virginia Tech working with one colleague from Dongbei University of Finance and Economics and another from Santa Clara University has developed a process for recycling polystyrene that involves the capture of valuable products. In their paper published in Proceedings of the National Academy of Sciences, the group describes their process and how it could be used in large-scale applications.

As the researchers note, hundreds of millions of tons of plastics are produced around the world every year and approximately 40% of them are short-term use, which means they wind up in landfills instead of being recycled. In this new effort, the researchers have taken a different approach. Instead of attempting to process one type of plastic—polystyrene—so that it can be used again, they have treated it to allow the removal of its valuable materials for use in other applications.

Polystyrene is made from monomers of aromatic hydrocarbon styrene. The plastic in its most basic form is hard, clear and brittle. It is used to make a wide variety of products, most typically Styrofoam packaging and bottles.

The work involved using chemical reactions to extract useful or valuable materials from a polystyrene sample. The process they developed involves inexpensive chemicals along with ultraviolet light irradiation. The researchers also note that their process reduced the plastic to its aromatic components. Then, by adding certain solvents, they could extract a desired material, such as diphenylmethane, which is far more valuable than the plastic from which it came. The researchers note that their process also produces a type of raw gasoline and asphalt as byproducts.

The researchers tested their process on samples of polystyrene collected from a local landfill and found it worked as desired. They suggest their process is easily scalable and even went so far as to calculate the cost of building a plant capable of producing products such as 4-oxo-4-

The process they developed involves inexpensive chemicals along with ultraviolet light irradiation.

phenyl-butyric acid, 1,2-diphenylmethane, benzophenone, in addition to diphenylmethane—$1.28 million. They conclude that their decomposition and upcycling strategy is viable; not only would it reduce the amount of plastic piling up around the world, it would provide a financial incentive to do so.

Phys Org, 16 August 2022

https://phys.org

Why are bigger animals more energy-efficient? A new answer to a centuries-old biological puzzle

2022-08-19

If you think about "unravelling the mysteries of the universe", you probably think of physics: astronomers peering through telescopes at distant galaxies, or experimenters smashing particles to smithereens at the Large Hadron Collider.

When biologists try to unravel deep mysteries of life, we too tend to reach for physics. But our new research, published in Science, shows physics may not always have the answers to questions of biology.

For centuries scientists have asked why, kilo for kilo, large animals burn less energy and require less food than small ones. Why does a tiny shrew need to consume as much as three times its body weight in food each day, while an enormous baleen whale can get by on a daily diet of just 5-30% of its body weight in krill?

While previous efforts to explain this relationship have relied on physics and geometry, we believe the real answer is evolutionary. This relationship is what maximises an animal's ability to produce offspring.

How much do physical constraints shape life?

The earliest explanation for the disproportionate relationship between metabolism and size was proposed nearly 200 years ago.

In 1837, French scientists Pierre Sarrus and Jean-François Rameaux argued energy metabolism should scale with surface area, rather than body mass or volume. This is because metabolism produces heat, and the amount of heat an animal can dissipate depends on its surface area.

Living organisms cannot defy the laws of physics. Yet evolution has proven to be remarkably good at finding ways to overcome physical and geometric constraints.

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

In the 185 years since Sarrus and Rameaux's presentation, numerous alternative explanations for the observed scaling of metabolism have been proposed.

Arguably the most famous of these was published by US researchers Geoff West, Jim Brown and Brian Enquist in 1997. They proposed a model describing the physical transport of essential materials through networks of branching tubes, like the circulatory system.

They argued their model offers "a theoretical, mechanistic basis for understanding the central role of body size in all aspects of biology".

These two models are philosophically similar. Like numerous other approaches put forward over the past century, they try to explain biological patterns by invoking physical and geometric constraints.

Evolution finds a way

Living organisms cannot defy the laws of physics. Yet evolution has proven to be remarkably good at finding ways to overcome physical and geometric constraints.

In our new research, we decided to see what happened to the relationship between metabolic rate and size if we ignored physical and geometric constraints like these.

So we developed a mathematical model of how animals use energy over their lifetimes. In our model, animals devote energy to growth early in their lives and then in adulthood devote increasing amounts of energy to reproduction.

We used the model to determine what characteristics of animals result in the greatest amount of reproduction over their lifetimes – after all, from an evolutionary point of view reproduction is the main game.

We found that the animals that are predicted to be most successful at reproducing are those that exhibit precisely the kind of disproportionate scaling of metabolism with size that we see in real life!

This finding suggests disproportionate metabolic scaling is not an inevitable consequence of physical or geometric constraints. Instead, natural selection produces this scaling because it is advantageous for lifetime reproduction.

The unexplored wilderness

In the famous words of Russian-American evolutionary biologist Theodosius Dobzhansky, "nothing makes sense in biology except in the light of evolution".

Our finding that disproportionate scaling of metabolism can arise even without physical constraints suggests we have been looking in the wrong place for explanations.

Physical constraints may be the principal drivers of biological patterns less often than has been thought. The possibilities available to evolution are broader than we appreciate.

Why have we historically been so willing to invoke physical constraints to explain biology? Perhaps because we are more comfortable in the safe refuge of seemingly universal physical explanations than in the relatively unexplored biological wilderness of evolutionary explanations.

The Conversation, 19 August 2022

https://thecoinversation.com

What is the maximum number of moons that Earth could have?

2022-08-19

In a recent study published in Earth and Planetary Astrophysics, a team of researchers from the University of Texas at Arlington, Valdosta State University, Georgia Institute of Technology, and the National Radio Astronomy Observatory estimated how many moons could theoretically orbit the Earth while maintaining present conditions such as orbital stability. This study opens the potential for better understanding planetary formation processes which could also be applied to identifying exomoons possibly orbiting Earth-like exoplanets, as well.

"In an earlier work, I examined planet packing for the Alpha Centauri binary," said Dr. Billy Quarles, an Assistant Professor of Astronomy and Astrophysics at Valdosta State University, and a co-author on the study. "In that case, I developed an estimate for the number of planets that could exist within each star's habitable zone. In that scenario, the habitable zone provided natural boundary conditions, where I was able to use the same dynamical formalism for the problem of moons (using the Earth-sun system as a binary). To define the outer boundary, one of my co-authors developed a scheme that we could use. Combining these ideas,

While there are over 200 moons in our solar system, only three orbit terrestrial (rocky) planets: our moon (Luna) around the Earth, and Phobos and Deimos around Mars.

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

we expected that >10 Ceres-, 6 Pluto-, and 4 Luna-sized objects would be possible (i.e., Table 2 from our paper)."

While there are over 200 moons in our solar system, only three orbit terrestrial (rocky) planets: our moon (Luna) around the Earth, and Phobos and Deimos around Mars. The remaining 200+ moons orbit all the gas giants, to include Jupiter, Saturn, Uranus, and Neptune. As the study notes, this large difference is expected since "they experience different formation mechanisms and orbital evolution processes." The study discusses how the maximum allowable number of moons that could exist around Earth depends on the assumed sizes of the moons themselves. In this case, the researchers used Ceres-, Pluto-, and Luna-sized objects to determine how many of each could successfully orbit Earth. The results showed that orbital stability could be maintained with satellites up to 7 ± 1 Ceres-mass, 4 ± 1 Pluto-mass, and 3 ± 1 Luna-mass moons.

"The surprise was that the lower mass prototypes were more limited, which we ascribe to their increased scattering probability (from a lower inertia)," said Quarles. "The perturbations from neighboring moons are enough to cause substantial scattering within a few thousand years. We had to reduce the number of moons to account for this."

As seen with Jupiter's Galilean Moons, small satellites orbiting a much larger planetary body can result in what's known as tidal heating, where the constant stretching and compressing the much smaller satellite experiences leads to interesting results, to include volcanism on Io and an interior ocean on Europa. But could a multi-moon system with Earth experience these same results, as well?

"Tidal heating of the moons themselves may be possible, but it is unclear to the extent of the heating without performing detailed simulations," said Dr. Quarles. "It is tempting to suggest that the innermost moon could resemble Io, but its tidal heating is in part due to mean motion resonances with the other Galilean moons. In our systems, mean motion resonances largely destabilize the satellite system because the sun adds to each moon's eccentricity growth and eventual scatter."

Along with the potential for tidal heating, this study also potentially broadens the search for exomoons that orbit exoplanets. Unfortunately, while the number of confirmed exoplanets is in the thousands, the number of confirmed exomoons is currently less than a fraction of that number.

"Currently we have 2 exomoon candidates (Kepler-1625b-i and Kepler-1708b-i), but their respective host planet is similar to Jupiter," said Dr. Quarles. "The candidate moons are also both larger than the Earth. These more exotic cases may be easier to identify in a similar way Hot Jupiters were easier to spot over smaller planets in the early days of exoplanets. However, multiple planet systems were discovered soon after the first bone-fide exoplanets. We expect something similar for exomoons. When we have multiple candidate exomoons orbiting the same planet, then our work will have more utility. The constraints we find are pretty optimistic, where more realistic conditions will probably limit the number of moons further. In photometric measurements, background objects could mimic the transit signal of a candidate exomoon, and our work gives a physical basis to constrain the number of expected moons when testing different hypotheses."

Dr. Suman Satyal, an Adjunct Assistant Professor of Physics at the University of Texas at Arlington and lead author on the study, said that since Earth can have more than one moon, this "increases the probability" of detecting exomoons. "This should give an idea to exomoon observers the upper limit of the number of moons around Earth-mass planet orbiting sun-like star," he said.

How many exomoons are there in the cosmos, and is there an Earth-like exoplanet with multiple exomoons capable of supporting life? Only time will tell.

Phys Org, 19 August 2022

https://phys.org

Pesticide exposure makes it harder for bees to walk in a straight line

2022-08-18

Bees, long despised for stinging humans and pets, but loved by horticulturalists for their life giving goodness, are under attack like never before.

In June research identified a dangerous variant of the deformed wing virus is on the rise worldwide. The virus infects honeybees, causing their wings to atrophy and the animals to die.

Also that month the varroa mite, a major honeybee parasite, was discovered in biosecurity surveillance hives at the Port of Newcastle.

"Have you had any insecticides tonight, ma'am."

CHEMWATCH
Bulletin Board
Curiosities
AUG. 26, 2022

Now new research has identified what happens to bees when they are subject to insecticides.

Have you ever struggled to walk in a straight line after having one too many? Well, it seems that honeybees are having similar issues but after getting a dose of insecticides.

"Here we show that commonly used insecticides like sulfoxaflor (kills aphids and lygus) and the neonicotinoid imidacloprid (pesticide that protects seeds of field crops) can profoundly impair the visually guided behaviour of honeybees," said lead author of a new study, Dr Rachel H Parkinson from the University of Oxford.

"Our results are reason for concern because the ability of bees to respond appropriately to visual information is crucial for their flight and navigation, and thus their survival."

Insects have an innate 'optomotor response', which lets them orient themselves back onto a straight trajectory if they steer off-course while walking or flying.

The research, published in Frontiers in Insect Science, challenged this optomotor response of walking honeybees by putting them in front of video screens of vertical lines which tricked them into thinking they'd moved off course.

The vertical bars would move from left to right, or right to left which 'tricks' the bee into thinking it's been blown off-course and needs to perform a corrective turn.

The team of researchers looked at four groups of between 20-30 bees. The control had access to normal sugar water to drink, while the other three had different forms of insecticides added. One group had 50 parts per billion of imidacloprid, another had 50 parts per billion sulfoxaflor, and the last had 25 parts per billion of imidacloprid and 25 parts per billion of sulfoxaflor together.

Unfortunately, the bees which had been exposed to the insecticide performed worse as they turned to get back on track. Bees exposed to pesticides seemed to have shallower turns and sometimes only turned one way. The asymmetry between left and right turns for example was 2.4 times greater for those bees exposed to pesticides.

After this experiment, the researchers then had a look at the bee brains to look at the damage. Using molecular techniques, the team found that

pesticide-exposed bees tended to have an elevated proportion of dead cells in parts of the brain's optic lobes, which is important for processing visual input.

Key genes for detoxification were also dysregulated after exposure. However these brain changes were relatively weak and highly variable across bees, and unlikely to be the sole explanation for the strong visual issues in the original experiment.

"Neonicotinoid and sulfoximine insecticides activate neurons in the insect brain and are not always recycled fast enough to prevent toxicity," said Parkinson.

This research comes on the heels of a slew of other research in recent years suggesting that pesticides impair baby bee brain development, or it can make them antisocial and lazy, and many scientists are asking for them to be banned.

Cosmos, 18 August 2022

https://cosmosmagazine.com

CHEMWATCH
Bulletin Board

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

CHEMICAL EFFECTS

Cytotoxicity and Antibacterial Activity of Toothpastes and Mouthwashes Available in the Iranian Market

Toxic Substances Control Act (TSCA) Implementation: How the Amended Law Has Failed to Protect Vulnerable Populations from Toxic Chemicals in the United States

ENVIRONMENTAL RESEARCH

Long-term exposure to ambient air pollution and greenness in relation to pulmonary tuberculosis in China: A nationwide modelling study

The environmental pollution caused by cemeteries and cremations: A review

PHARMACEUTICAL/TOXICOLOGY

Percutaneous absorption and exposure risk assessment of organophosphate esters in children's toys

Emerging Plasticizers in South China House Dust and Hand Wipes: Calling for Potential Concern?

Unconventional Oil and Gas Development Exposure and Risk of Childhood Acute Lymphoblastic Leukemia: A Case-Control Study in Pennsylvania, 2009-2017

OCCUPATIONAL

In vivo and in vitro toxicity of a stainless-steel aerosol generated during thermal spray coating

Translating nanoparticle dosimetry from conventional in vitro systems to occupational inhalation exposures

Urinary glyphosate kinetics after occupational exposure