CHEMWATCH

Bulletin Board

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OCT. 11, 2024

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ASIA PACIFIC

Calling for information on oxadiazon weedkillers

2024-10-24

We need information on the herbicide oxadiazon to ensure the current rules for use are appropriate.

The substance can be used to stop weeds growing among specific fruit crops and in some public spaces, such as sports fields, verges, and lawns.

Some of the oxadiazon products commonly used in New Zealand are:

- Exadia
- Foresite
- Bowsar
- Oracle
- Weed Weapon Preventer

Oxadiazon is being reviewed as part of our reassessments work plan.

Find out more about our reassessments work plan

This plan lists the chemicals we will reassess next to ensure existing rules and safety guidelines are still suitable for how they are being used.

Submissions close at 11.59 pm Tuesday, 19 November 2024.

Read More

EPA NZ, 03-10-24

https://www.epa.govt.nz/public-consultations/open-consultations/call-for-information-on-oxadiazon/

Hydrofluorocarbon import permits decided

2024-10-03

We have now released our decision on allocations for special permits to import hydrofluorocarbons (HFCs) in 2025.

HFCs are a group of harmful greenhouse gases used in heat pumps, air conditioning, and refrigeration. They have a global warming potential up to 1300 times higher than carbon dioxide.

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We have been reducing the limit for importing these gases every two years, in line with Ozone Layer Protection Regulations. We reduced the import limits by 15 percent for 2025.

This year we received 15 applications, requesting around 50 percent more than the volume available for allocation in 2025.

Read More

EPA NZ, 03-10-24

https://www.epa.govt.nz/hazardous-substances/certificates-permits-and-permissions/hydrofluorocarbon-gases-hfcs-import-and-export/types-of-import-permit-and-how-to-apply/

Significant restrictions for herbicide chlorthal-dimethyl

2024-10-03

We have significantly restricted the use of chlorthal-dimethyl (also known as DCPA) because of concerns about its effects on fetal development.

The new rules for chlorthal-dimethyl products took effect from 13 September 2024 and include:

- restricted to use on onion, garlic, and shallot crops before they emerge from the soil
- pregnant individuals or individuals who may be pregnant must not use the substance or enter a site where it's been used
- wide buffer zones must be used to further protect the public from spray

The three products containing chlorthal-dimethyl that are registered for use in New Zealand are:

- Dacthal
- Deramot Xtra
- Chlor-Back 75WG

Our next steps are to gather and analyse all information on how, where, and in what other ways these weedkillers are used, before we carry out a full review that may lead to further restrictions or a ban.

Read More

EPA NZ, 03-10-24

https://www.epa.govt.nz/hazardous-substances/substance-approvals-and-group-standards/reassessments-and-changes-to-approvals/restrictions/chlorthal-dimethyl-dcpa-weedkiller/

Treated seed consultation period extended

2024-10-03

The deadline for making a submission on a proposed new group standard for treated seed has been extended to 5pm on Monday, 31 March 2025.

The original deadline was 9 October 2024.

We want to change how treated seed is regulated in New Zealand and have been working with government and industry stakeholders to develop a new approach.

Our aim is to streamline rules around importing, manufacturing, supplying, storing, using, or disposing of treated seed.

This will reduce the risk of treated seed that contains active ingredients we have not assessed being imported into New Zealand.

Read More

EPA NZ, 03-10-24

https://www.epa.govt.nz/public-consultations/open-consultations/proposed-group-standard-for-treated-seed/

AMERICA

Researchers argue US regulatory frameworks are outdated, lag behind advancements in toxicology

2024-09-24

In a recent peer-reviewed opinion piece published in Frontiers in Toxicology, researchers Maricel Maffini and Laura Vandenberg argue that while scientific advancements in toxicology have surged forward, regulatory frameworks in the United States have not kept pace. The authors argue that this disconnect between science and regulation could have dire consequences for public health, particularly in how the risks of

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synthetic chemicals like endocrine disruptors and persistent chemicals are managed.

Maffini and Vandenberg highlight that "current hazard identification approaches" overseen by agencies such as the Food and Drug Administration and Environmental Protection Agency, "rely on outdated principles and expectations. For example, common testing approaches assume that chemicals are quickly eliminated from the body, something that many PFAS and other persistent organic pollutants have disproven."

Other assumptions in hazard testing that they argue are erroneous include "that testing chemicals one at a time is appropriate to understand how chemicals act under real-world conditions", and that "testing on adult animals (or in cultured cells) has been proven to predict effects on developing animals". Other research backs up their claims (FPF reported).

These assumptions and others in the current regulatory hazard testing regime fail to capture the full range of health impacts associated with modern chemical exposures. They argue that "long-held assumptions… should be complemented—if not completely replaced—with modern scientific principles of toxicology including mixture toxicology, endocrinology, physiology, and immunology."

The authors call for an urgent modernization of risk management systems, advocating for "nimbler" testing "to account for the growth in knowledge of these fields over the last three decades and the new knowledge that is yet to come as well as the complexity of chemical exposures and new chemistries." Maffini and Vandenberg caution that without such updates, the public remains vulnerable to the subtle yet significant effects of chemical exposures that the current testing regime may overlook.

Read More

FPF, 18-09-24

https://www.foodpackagingforum.org/news/researchers-argue-us-regulatory-frameworks-are-outdated-lag-behind-advancements-in-toxicology

Georgia chemical plant fire forces over 90K residents to shelter in place

2024-09-30

A weekend fire that sent a massive plume of dark smoke into the Georgia sky has led to complaints about a strong chemical smell and haze several

miles away across metro Atlanta, where some schools canceled outdoor activities and residents living near the fire sheltered at home.

More than 90,000 people east of Atlanta were told to keep sheltering in place Monday, a day after the chemical plant fire.

The haze and chemical smell had spread to Atlanta by Monday, prompting firefighters to use detectors to check the air quality in various parts of the city, Mayor Andre Dickens said.

"We are sending investigators to the site to determine the cause of this dangerous incident and the safety gaps at the facility that allowed this huge fire to occur," Steve Owens, chairman of the U.S. Chemical Safety and Hazard Investigation Board, said in a statement Monday. "Tens of thousands of people have been put potentially at risk by this catastrophe."

Read More

Global News, 30-09-24

https://globalnews.ca/news/10786606/georgia-chemical-plant-fire-conyers/

Chevron's cancer-causing fuels force EPA to rethink approval

2024-10-01

The EPA plans to reconsider Chevron's approval to produce plastic-based fuels after discovering one fuel's cancer risk could be more than a million times the acceptable level.

Sharon Lerner reports for ProPublica.

In short:

- The EPA approved Chevron in 2022 to make 18 plastic-based fuels, some with a very high cancer risk.
- The agency now admits there may have been an error in its original decision after environmental groups raised concerns.
- Chevron has not yet begun making the chemicals, but litigation is ongoing regarding their potential health risks.

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Read More

EHN, 01-10-24

https://www.ehn.org/chevron-s-cancer-causing-fuels-force-epa-to-rethink-approval-2669296564.html

Fluoride in water poses 'unreasonable risk' to children, federal court rules

2024-09-30

A federal court has recently ruled that fluoride in drinking water poses "an unreasonable risk" to children, and ordered the United States Environmental Protection Agency to take regulatory action to eliminate the risk.

The United States District Court of the Northern District of California recently ordered the agency to take the action after a seven-year battle in federal court.

Roughly 75% of the population of the United States drinks water that has been voluntarily fluoridated by their communities.

Senior Judge Edward Chen wrote in the decision that the claims of safety made by the American Dental Association and the US Centers for Disease Control for over 75 years were not supported by the evidence.

"The Court finds that fluoridation of water at 0.7 milligrams per liter ("mg/L") – the level presently considered "optimal" in the United States – poses an unreasonable risk of reduced IQ in children…the Court finds there is an unreasonable risk of such injury, a risk sufficient to require the EPA to engage with a regulatory response," Chen wrote. "In all, there is substantial and scientifically credible evidence establishing that fluoride poses a risk to human health; it is associated with a reduction in the IQ of children and is hazardous at dosages that are far too close to fluoride levels in the drinking water of the United States … Reduced IQ poses serious harm. Studies have linked IQ decrements of even one or two points to, e.g., reduced educational attainment, employment status, productivity, and earned wages."

While the ruling did not specify what measures the EPA must adopt, under the Toxic Substances Control Act (TSCA), once the court rules that a chemical poses an unreasonable risk, the EPA is obligated by law to restrict or eliminate the risk.

"One thing the EPA cannot do, however, in the face of this Court's finding, is to ignore that risk," Chen wrote. "There is little dispute in this suit as to whether fluoride poses a hazard to human health. Indeed, EPA's own expert agrees that fluoride is hazardous at some level of exposure. And ample evidence establishes that a mother's exposure to fluoride during pregnancy is associated with IQ decrements in her offspring."

Read More

The Sentinel, 30-09-24

https://sentinelksmo.org/fluoride-poses-unreasonable-risk-to-children/

If NC won't protect water quality, the EPA should | Opinion

2024-10-04

One of the mysteries of government is why people become public servants when they don't want to serve the public.

Such people don't see it that way. They say they work for the government to keep it from inhibiting the public's freedom – particularly the freedom of giant businesses to operate with minimal taxes and regulation.

This serving the public by not protecting the public mentality is what drives the Republican-controlled state legislature. You may experience the effects in your next glass of water.

Republican state lawmakers are intent on obstructing rules that protect water quality under the federal Clean Water Act. They've lifted protections from millions of acres of state wetlands that help to filter stormwater that flows into state waterways. They've even stymied the adoption of standards that would keep dangerous chemicals from being discharged into state rivers.

Read More

The Charlotte Observer, 04-10-24

https://www.msn.com/en-us/news/us/if-nc-won-t-protect-water-quality-the-epa-should-opinion

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EUROPE

Despite stricter regulations, Europe has issues with tattoo ink ingredients

2024-10-03

Recently, chemists at Binghamton Univrsity learned that many tattoo inks in the US contain different pigments than those listed, or unlisted additives. One might expect the European Union, with its stricter regulations, to have fewer issues on that score, but according to a new paper published in the journal Analyst, that's not the case, particularly for green and blue tattoo inks. Most had components that were not listed on the label, and some included banned ingredients.

"Our work cannot say anything about the safety of tattoos, but we think it's an important first step in addressing the question 'Are tattoos safe?'" said co-author John Swierk, a chemist at Binghamton University. "If we don't know what's in a bottle of tattoo ink, then we cannot figure out what might be causing an adverse event in the near and long term, whether that's an allergic reaction or something more serious. As a team, we aren't anti-tattoo, we just believe that clients and artists have a right to know what's in the inks they are using."

As previously reported, typical tattoo ink contains one or more pigments (which give the ink its color) within a "carrier package" to help deliver the pigments into the skin. The pigments are the same as those used in paints and textiles. They can be either small bits of solids or discrete molecules, such as titanium dioxide or iron oxide (for white or rust-brown colors, respectively). As for the carrier packages, most ink manufacturers use grain or rubbing alcohol, sometimes with a bit of witch hazel added to the mix to help the skin heal after the tattooing process. There may also be other additives to adjust the viscosity and keep pigment particles suspended in the carrier package.

Read More

ARS Technica, 03-10-24

https://arstechnica.com/science/2024/10/despite-stricter-regulations-europe-has-issues-with-tattoo-ink-ingredients/

Status of reusable food packaging in Europe

2024-10-02

Despite environmental challenges associated with single-use packaging, reusable packaging systems are still in their infancy and face significant challenges when it comes to large-scale implementation. To address this evolving landscape, InOff Plastic in collaboration with Zero Waste Europe, New ERA, and Planet Reuse published the first edition of the European Reuse Barometer on September 23, 2024. It provides a detailed assessment of the current state of reusable packaging in Europe and offers insights into recent improvements, ongoing challenges, and potential strategies for accelerating the widespread adoption of reuse systems.

The main objective of the report is to accelerate the development and scaling of reusable packaging systems across Europe. Through its findings, the European Reuse Barometer seeks to provide stakeholders – legislators, businesses, consumers, and investors – with the necessary information to focus their efforts on building effective reuse systems.

The research draws on data collected from 90 European reuse providers, tracking key indicators such as economic performance, environmental impact, and social engagement. The report showcases a variety of businesses, outlining their unique models, challenges, and successes. It emphasizes that while many new businesses have emerged in recent years, the continued growth of the sector will depend on support from legislators, producers, consumers, and investors alike (FPF reported).

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FPF, 02-10-24

https://www.foodpackagingforum.org/news/status-of-reusable-food-packaging-in-europe

INTERNATIONAL

Despite stricter regulations, Europe has issues with tattoo ink ingredients

2024-10-03

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ARS Technica, 03-10-24

https://arstechnica.com/science/2024/10/despite-stricter-regulations-europe-has-issues-with-tattoo-ink-ingredients/

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FPF, 02-10-24

https://www.foodpackagingforum.org/news/status-of-reusable-food-packaging-in-europe

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REACH Update

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Consultations on harmonised classification and labelling

2024-10-02

We are looking for comments on the harmonised classification and labelling (CLH) proposals for:

- milbemectin (ISO); Reaction mass of (2aE,4E,8E)-(5′ S,6R,6′ R,11R,13 R,15S,17aR,20R,20aR,20bS)-6′ -ethyl-3′ ,4′ ,5′ ,6,6′ ,7,10,11,14,15,17a, 20,20a,20b-tetradecahydro-20,20b-dihydroxy-5′ ,6,- 8,19-tetramethylspiro[11,15-methano-2H,13H,17H-furo[4,3,2- pq][2,6]benzodioxacyclooctadecin-13,2′ -[2H]pyran]-17-one and (2aE,4E,8E)-5′ S,6R,6′ R,11R,13R,15S,17aR,20R,20aR,20 bS)-3′ ,4′ ,5′ ,6,6′ ,7,10,11,14,15,17a,20,20a,20b-tetradecahydro- 20,20b-dihydroxy-5′ ,6,6′ ,8,19-pentamethylspiro[11,15-methano- 2H,13H,17H-furo[4,3,2-pq][2,6]benzodioxacyclooctadecin-13,2′ -[2H] pyran]-17-one;[Reaction mass of milbemycin A3 (CAS No 51596-10-2) and milbemycin A4 (CAS No 51596-11-3)] (EC -, CAS 1799297-76-9); and
- strontium decanoate, branched; strontium neodecanoate; [1] strontium di(acetate); [2] strontium tartrate; strontium (2R,3R)-2,3- dihydroxybutanedioate [3] strontium oxalate; [4] strontium chloride; [5] strontium nitrate; [6] strontium sulphate; [7] strontium carbonate; [8] strontium hydrogen phosphate; [9] strontium hydroxide; [10] strontium 5-[bis(carboxymethyl)amino]-2-carboxy-4-cyano-3- thiopheneacetate [11] (EC - [1]; 208-854-8 [2]; 212-774-9 [3]; 212-415-6 [4]; 233-971-6 [5]; 233-131-9 [6]; 231-850-2 [7]; 216-643-7 [8]; 236-615-8 [9]; 242-367-1 [10]; - [11], CAS 106705-37-7 [1]; 543-94-2 [2]; 868-19-9 [3]; 814-95-9 [4]; 10476-85-4 [5]; 10042-76-9 [6]; 7759-02-6 [7]; 1633-05-2 [8]; 13450-99-2 [9]; 18480-07-4 [10]; 135459-87-9 [11])

Have your say by 29 November 2024.

Read More

ECHA, 02-10-24

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

REACH Update

OCT. 11, 2024

Exchange of information under PIC reported for 2022-2023

2024-10-02

Our fifth biennial report on the exchange of information under the Prior Informed Consent (PIC) Regulation shows that numbers of export notifications sent from the European Union to non-EU countries remained on similar levels as previous years, with around 19 000 transmitted export notifications to circa 150 importing countries.

The report also gives a summary of the notifications for final regulatory actions that the EU submitted to the Rotterdam Convention Secretariat about banned or severely restricted chemicals that qualify for PIC notifications, as well as details on explicit consent responses and information exchange on ad hoc basis.

Read More

ECHA, 02-10-24

https://echa.europa.eu/regulations/prior-informed-consent-regulation/reporting-on-information-exchange

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Janet's Corner

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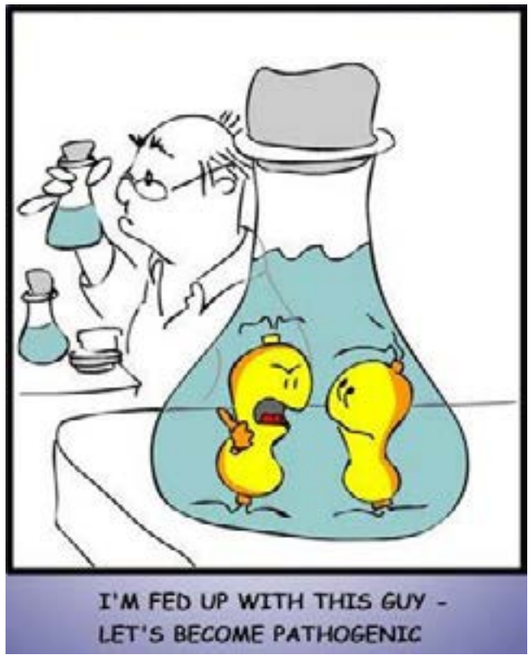
Pathogenic

2024-10-11



http://www.themicrobiologyblog.com

Arsine

2024-10-11

USES [2,3]

Arsine is used as a doping agent in the semiconductor industry and in the manufacture of crystals for fiberoptics and computer chips. It is used infrequently in galvanizing, soldering, etching, burnishing, and lead plating. It was also investigated as a warfare agent during World War II, but it was never used on the battlefield.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

Arsine gas is formed when arsenic-containing materials react with freshly formed hydrogen in water or acids. Exposure may result when arsenic containing metals (i.e., metal vats) undergo acid washes. Unintentional exposures have also occurred during refining of ores (e.g., lead, copper, zinc, iron, and antimony ores) that contain arsenic.

Routes of Exposure

- Inhalation is the major route of exposure. The odour threshold of arsine is 10-fold greater than the Occupational Safety and Health Administration (OSHA) permissible exposure limit. Odour is not an adequate indicator of arsine's presence and does not provide reliable warning of hazardous concentrations. Arsine is heavier than air and hazardous concentrations may develop quickly in enclosed, poorly ventilated, or low-lying areas.
- Skin/Eye Contact: There is little information about direct toxic effects of arsine on the skin or eyes, or about absorption through the skin. Exposure to liquefied arsine (the compressed gas) can result in frostbite.
- Ingestion of arsine itself is unlikely because it is a gas at room temperature. However, metal arsenides are solids that can react with acidic gastric contents, releasing arsine gas in the stomach.

Arsine is an inorganic compound with the formula AsH3. This flammable, pyrophoric, and highly toxic gas is one of the simplest compounds of arsenic. Arsine has a garlic-like or fishy odour that can be detected at concentrations of 0.5 ppm and above. Because arsine is non-irritating and produces no immediate symptoms, persons exposed to hazardous levels may be unaware of its presence. Arsine is water soluble. Arsine is formed when arsenic comes in contact with an acid. [1,2]

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HEALTH EFFECTS [4]

Acute Health Effects

After absorption by the lungs, arsine enters red blood cells (RBC) where different processes may contribute to haemolysis and impairment of oxygen transport. Inhibition of catalase may lead to accumulation of hydrogen peroxide which, as an oxidiser, destroys red cell membranes and may contribute to arsine-induced conversion of Fe+2 to Fe+3, which also impairs oxygen transport. Arsine preferentially binds to haemoglobin, and is oxidised to an arsenic dihydride intermediate and elemental arsenic, both of which are haemolytic agents. Arsine toxicity involves depletion of reduced glutathione. Therefore, people deficient in the enzyme glucose-6-phosphate-dehydrogenase (G6PD) are more susceptible to haemolysis following arsine exposure. Pre-existing cardiopulmonary or renal conditions, iron deficiency, and/or pre-existing anaemia may result in more severe outcomes if haemolysis occurs. Contact with the skin or eyes is not expected to result in systemic toxicity. Ingestion of arsine is unlikely, but ingestion of metallic arsenides can lead to arsine gas production and toxicity.

Carcinogenicity

There are no data on the carcinogenicity of arsine in humans or in experimental animals. However, arsine is oxidised to the same trivalent and pentavalent forms of arsenic as those seen after drinking-water or inhalation exposure to arsenic compounds known to present a cancer hazard. The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the Environmental Protection Agency (EPA) have classified inorganic arsenic as a human carcinogen based on sufficient evidence from human data.

Other Effects

A garlic odour may be present on the breath. Delayed accumulation of fluid in the lungs may occur after massive exposure. Dyspnoea may be due to lack of oxygen secondary to haemolysis. Children may be more vulnerable to gas exposure because of relatively higher minute ventilation per kg and failure to recognise the need to promptly evacuate an area when exposed.

Nausea, vomiting, and crampy abdominal pain are among the first signs of arsine poisoning. Onset varies from a few minutes to 24 hours after exposure.

SAFETY

First Aid Measures [5]

- Eye Contact: Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
- Skin Contact: After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.
- Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.
- Ingestion: Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Workplace Controls & Practices [4]

- Use an explosion-proof local exhaust system.
- Local exhaust and general ventilation must be adequate to meet exposure standards.
- Use explosion proof equipment and lighting.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling arsine:
Hand protection: Neoprene rubber.

- **Eye protection:** Wear safety glasses when handling cylinders; vapour-proof goggles and a face shield during cylinder change out or whenever contact with product is possible. Select eye protection in accordance with OSHA 29 CFR 1910.133.

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- **Skin and body protection:** Wear metatarsal shoes and work gloves for cylinder handling, and protective clothing where needed. Wear appropriate chemical gloves during cylinder change out or wherever contact with product is possible. Select per OSHA 29 CFR 1910.132, 1910.136, and 1910.138.
- **Respiratory protection:** When workplace conditions warrant respirator use, follow a respiratory protection program that meets OSHA 29 CFR 1910.134, ANSI Z88.2, or MSHA 30 CFR 72.710 (where applicable). Use an air-supplied or air-purifying cartridge if the action level is exceeded. Ensure that the respirator has the appropriate protection factor for the exposure level. If cartridge type respirators are used, the cartridge must be appropriate for the chemical exposure (e.g., an organic vapour cartridge). For emergencies or instances with unknown exposure levels, use a self-contained breathing apparatus (SCBA).
- **Thermal hazard protection:** Wear cold insulating gloves when transfilling or breaking transfer connections.

REGULATION

United States

OSHA: The United States Occupational Safety & Health Administration has set the following Permissible Exposure Limits (PEL) for arsine of:

General Industry: 29 CFR 1910.1000 Z-1 Table -- 0.05 ppm, 0.2 mg/m3 TWA

Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 0.05 ppm, 0.2 mg/m3 TWA

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for arsine of 0.005 ppm, 0.016 mg/m3 TWA

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for arsine of 0.002 mg/m3 Ceiling (15 min); Potential Carcinogen

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2. http://www.atsdr.cdc.gov/mmg/mmg.asp?id=1199&tid=278
3. http://emergency.cdc.gov/agent/arsine/facts.asp

4. http://www3.epa.gov/airtoxics/hlthef/arsenic.html
5. http://praxair.com/~/media/praxairus/Documents/SDS/Arsine%20AsH3%20Safety%20Data%20Sheet%20SDS%20P4565.pdf?la=en
6. https://www.osha.gov/dts/chemicalsampling/data/CH_219590.html
7. http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/639/Workplace_Exposure_Standards_for_Airborne_Contaminants.pdf

PFAS "Forever Chemicals" Linked to Sleep Disturbances

2024-10-05

Exposure to certain per- and poly-fluoroalkyl substances (PFAS) chemicals is linked to sleep disturbances, according to researchers from the Keck School of Medicine of the University of Southern California. Published in Environmental Advances, their study identified four types of PFAS significantly associated with reduced sleep quality.

Sleep disorders are linked to various health conditions

PFAS are a group of man-made chemicals used in various industrial and consumer products for their water- and stain-resistant properties. They are commonly found in items like non-stick cookware, waterproof clothing, food packaging and firefighting foams. PFAS, often referred to as "forever chemicals", break down very slowly in the environment and can accumulate in human bodies over time.

Exposure to PFAS has been linked to health issues such as hormonal disruption, weakened immune systems and increased risk of certain cancers. Emerging research has also associated PFAS exposure with increased sleep disturbances, although studies using data from the US National Health and Nutrition Examination Surveys showed mixed results.

Sleep disorders encompass a range of conditions that impact normal sleep patterns. The most common sleep disorder, insomnia, affects around one-third of adults, potentially impacting their physical, mental and emotional wellbeing. Long-term sleep disturbances are associated with negative impacts on various parts of the body, including the heart, liver and brain.

"Because the body needs sleep every day, if PFAS might be interfering with your sleep, that may affect you more immediately than other chronic health issues. Long-term, poor sleep has been connected to outcomes including neurological and behavioral problems, type 2 diabetes and Alzheimer's disease," said first author Dr. Shiwen Li, a postdoctoral researcher in the department of population and public health sciences at the Keck School of Medicine.

Understanding how PFAS exposure may potentially impact sleep health is vital for developing strategies to reduce risks and protect overall public health.

Certain PFAS types are linked with sleep disturbances

Blood samples were collected from 144 participants who were part of the USC Children's Health Study, along with data on their sleep patterns using self-reported forms. Two sets of measurements were taken several years apart, with around half of the participants contributing to both. Plasma PFAS levels were calculated using liquid-chromatography high-resolution mass spectrometry.

To explore how PFAS chemicals might affect sleep, researchers used two large databases, The Comparative Toxicogenomics Database and Toxicology in the 21st Century, to look for possible genetic connections. They then ran a mediation analysis using protein data to confirm the results from the earlier computer analysis.

Out of the seven types of PFAS measured, four were significantly associated with reduced sleep or a worse quality of sleep: PFDA, PFHxS, PFOA and PFOS.

For the first 3 types of PFAS, participants with blood levels in the highest third of the group slept around 80 minutes less per night on average compared to those in the lowest third. High combined PFAS levels were also associated with shorter sleep duration. Elevated PFOS concentrations were linked to self-reported difficulties falling asleep, staying asleep, waking frequently or feeling tired during the day.

"What we measured in the blood is likely driven by exposure since birth, or even prenatal exposures," said Li.

All four "forever chemicals" are classified as legacy PFAS. These have been largely phased out in favor of similar compounds with unknown safety profiles, although they were widely used from the 1950s to the early 2000s.

The biological mechanism behind PFAS and sleep disruptions

Li and the team identified over 600 genes that were affected by PFAS and were also implicated in sleep disorders. Using the participant's blood samples, they then profiled a panel of proteins to confirm which genes may contribute to the pathogenesis of PFAS-related sleep concerns.

Of the 600 identified genes, 7 were found to be activated by PFAS. One important factor that appeared to play a critical role was an immune-orientated gene called HSD11B1.This gene helps to produce the hormone cortisol, important for regulating the rhythm of sleep and wakefulness.

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"If the expression of the protein encoded by HSD11B1 is disrupted, that means that cortisol levels could also be disrupted. That, in turn, affects sleep," said Li.

Cathepsin B was also highlighted as playing a role in PFAS's effects on sleep. The enzyme produced by this gene is a precursor to amyloid beta proteins, known to form plaques in the brains of Alzheimer's patients. Elevated levels of this enzyme have been linked to cognitive decline in Alzheimer's disease, which is similarly connected to sleep disturbances.

Impacting closer regulations of "forever chemicals"

Sleep is crucial for brain health and understanding factors that may affect it is vital for reducing the risk of several health concerns. These results may contribute to the closer regulation of these "forever chemicals" in the environment.

"Sleep quality is an issue that affects almost everybody, so the impact of PFAS on sleep may have policy implications," said Li.

Future large-scale epidemiologic studies are needed to confirm the team's results. Li and colleagues are planning to pursue further investigations into the genes identified in the study and the associations between PFOS and brain development.

Technology Networks, 5 October 2024

https://technologynetworks.com

Do 'Forever Chemicals' Leak Into Your Frozen Foods in the Microwave? Experts Respond

2024-10-05

These particular chemicals are raising growing concerns. Here's what experts caution when zapping your frozen foods in the microwave.

When it's too hot to cook, or you've been so busy that the spinach you bought last weekend has wilted, it's always a win to remember the bag of vegetables you've got in the freezer—especially when they're the three-minute, steam-in-bag kind.

But rightfully so, many Americans are growing increasingly concerned about "forever chemicals," also known as per- and polyfluoroalkyl substances (PFAS). More and more research reveals how prevalently PFAS lurk in our water, the air, our food, and, yes, the packaging it comes in.

According to the National Institutes of Health (NIH), PFAS are a large group of man-made chemicals used globally in consumer products since the 1950s. You'll find them in everything from non-stick pans and stain-resistant carpets to food packaging and firefighting foam. These chemicals are notorious for their durability—they don't break down, so they persist in the environment and, unfortunately, make their way into our food supply.

The health risks associated with PFAS are serious. "PFAS have been shown to disrupt hormones, weaken bones, and cause illness even at low levels of exposure," explains Beth Czerwony, MS, RD, CSOWM, LD, a clinical registered dietician at the Cleveland Clinic Center for Human Nutrition.

Given the serious concerns about PFAS contamination, the US Food and Drug Administration (FDA), which oversees the safety of food ingredients and packaging, took significant steps in February 2024. It declared that materials containing PFAS, specifically those used for grease-proofing, will no longer be permitted in food packaging. This eliminates a major source of PFAS exposure from everyday items like fast-food wrappers, microwave popcorn bags, take-out containers and pet food bags.

This move marks a monumental win for public health, but it's also worth learning ways to protect yourself and your family. Ahead, experts share what you need to know about PFAS when it involves steaming those frozen vegetables in their microwaveable packaging.

Is it safe to steam frozen vegetables?

The short answer is yes, but with a caveat. "While there is no harm in microwaving foods themselves, heating foods in containers not made to be exposed to high temperatures can lead to the PFAS being leached into the foods you are consuming," warns Czerwony.

According to the United States Department of Agriculture (USDA), some packaging materials used by consumers are not safe. Czerwony brings this home with a relatable example: "Think when Mom would put leftovers in a margarine container, and then you'd reheat them for lunch the next day." To ensure safety, she advises using containers specifically marked as food-safe. These are designed to withstand high temperatures without releasing any harmful substances.

While some plastic containers are labeled microwave-safe, some experts still recommend using glass or ceramic bowls as a precaution. This way,

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you can steam your vegetables without worrying about potential chemical leaching.

Do frozen vegetables have PFAS?

When it comes to PFAS, we are often concerned about their presence in packaging—but what about the food inside? A team of researchers in one of Italy's agriculture capitals sought to answer this question in a study published in the peer-reviewed scientific journal Food Chemistry in June 2023.

The study revealed that ready-to-eat vegetables typically exhibit higher levels of PFAS than their fresh and frozen counterparts. This increase is likely due to the extensive processing and packaging that ready-to-eat items undergo. On the other hand, frozen vegetables exhibited significantly lower PFAS levels, consistently meeting the safety guidelines set by the European Commission.

The study also indicated that organic ready-to-eat vegetables might contain lower levels of PFAS, possibly due to the absence of pesticides in organic farming. However, as this research is the first of its kind, the authors call for more studies to confirm these initial findings and to fully understand PFAS levels in different types of vegetables.

Does heat break down PFAS?

One of the trickiest aspects of PFAS is their resistance to breaking down under typical environmental conditions, which is why they are often called "forever chemicals." Cooking or heating food does not degrade these chemicals, which means they remain in the environment and food products irrespective of temperature changes. This persistence is what makes PFAS particularly concerning and challenging to manage.

How do I avoid eating PFAS with my food?

Reducing your exposure to PFAS through your diet involves a few proactive steps:

Choose fresh and frozen foods wisely: Opt for fresh, organic or frozen foods less likely to have been in contact with PFAS-containing materials.

Be selective with cookware and storage: Avoid using non-stick cookware, which often contains PFAS. Instead, use alternatives like stainless steel, ceramic, or cast iron. For food storage, opt for glass or stainless steel over plastic containers.

Consider water sources: Since PFAS can contaminate water supplies, consider using a water filter that can remove PFAS from your tap water, especially if you live in an area known to have PFAS contamination.

Stay informed about brands and products: Some companies have committed to reducing or eliminating PFAS from their products and packaging. Supporting these brands can help reduce your overall exposure.

The Healthy, 5 October 2024

https://thehealthy.com

Sunlight turns CO2 and methane into valuable gases for fuel and industry

2024-09-17

Taking a leaf out of the book of plants, scientists have used a photosynthesis blueprint to harness the power of sunlight and turn two of the most destructive greenhouse gases into useful, prized chemicals that can be then used for the production of fuels and play a vital role in manufacturing.

Researchers from McGill University have developed a novel process known as photo-driven oxygen-atom-grafting, which uses gold, palladium and gallium nitride as a catalyst to chemically transform carbon dioxide and methane into carbon monoxide and green methanol when exposed to sunlight.

"Imagine a world where the exhaust from your car or emissions from a factory could be transformed, with the help of sunlight, into clean fuel for vehicles, the building blocks for everyday plastics, and energy stored in batteries," said co-first author Hui Su, from McGill's Department of Chemistry. "That's precisely the kind of transformation this new chemical process enables."

While the processes are covered thoroughly in the paper, essentially the method kicks off a chain reaction that sees an oxygen atom detach from the carbon dioxide and hop onto a methane molecule, converting it to green methanol. While it still has its downsides – such as high flammability and practicality, requiring larger fuel-tank sizes – this type of renewable methanol produces between 60-95% less CO2 emissions than conventional fuels. It's also scalable, adaptable to carbon-capture methods of production, and doesn't rely on fossil fuels.

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Carbon monoxide (CO) is also produced as a byproduct, and while being known as the silent killer because of its poisonous and odorless properties, it's also the focus of medical research and how it could help with inflammation and in treating acute lung injury, sepsis and organ transplants.

"By tapping into the abundant energy of the sun, we can essentially recycle two greenhouse gases into useful products," said lead author Chao-Jun Li, a professor in the Department of Chemistry and a Canada Research Chair in Green/Organic Chemistry. "The process works at room temperature and doesn't require the high heat or harsh chemicals used in other chemical reactions,"

In the way that plants convert CO2 and H2O into energy and oxygen, with the aid of sunlight, this novel method in a way does similar, with abundant and readily available resources. The products that catalyze the CO2 and methane aren't cheap, however, they're robust for ongoing photo-driven oxygen-atom-grafting that drives this chemical reaction.

"This innovation offers a promising path towards Canada's target of net-zero emissions by 2050 and turns an environmental challenge into an opportunity for a more sustainable future," said co-first author Jing-Tan Han, a PhD student in the Department of Chemistry.

The study was published in the journal Nature Communications.

New Atlas, 17 September 2024

https://newatlas.com

Certain Plants Could Be Used To Capture Microplastics, Researchers Propose

2024-10-08

Researchers propose using plants as eco-friendly tools to absorb and degrade micro- and nanoplastics in the environment.

Plants can absorb micro- and nanoplastics in their stems and roots, raising concerns about how natural ecosystems cope when plastic particles invade.

However, a Danish-Chinese research team is proposing a new perspective: Why not use plants as an eco-friendly tool to collect and degrade plastic particles?

The concept is explored in a scientific article in the Eco-Environment and Health journal. The lead authors are from Hubei Key Laboratory of Wetland Evolution & Ecological Restoration in China, with contributions from the University of Southern Denmark ecotoxicologist Elvis Genbo Xu from the Department of Biology. The article is freely available online here.

Global plastic production is staggering. So far, 9 billion tons have been produced, but only 9 percent has been recycled, the authors note.

The big question is, what happens to all the plastic we haven't recycled? Much of it has ended up in nature, breaking into smaller pieces over the years. Today, micro- and nanoplastics in the environment are widespread and serious problems because the particles can be absorbed and ingested by animals, plants, and humans.

- We believe plants can effectively supplement existing methods for removing plastic from nature. Many plants absorb or adsorb micro- and nanoparticles, but we need to identify the most effective ones to achieve the best results, says Elvis Genbo Xu.

The research team has studied various plants' ability to uptake micro- and nanoplastics. Their article reports that the fava bean (Vicia faba) can adsorb 100 nm nanoplastic particles via its roots within two days. Adsorption, a process where the particles adhere to the roots, should not be confused with absorption, which is when the particles are taken up into the plant.

Other plants like wheat and lettuce can also bind plastic particles to their roots or absorb them into their leaves or stems, according to the researchers' experiments.

Aquatic plants are of particular interest because they can remove plastic particles from the aquatic environment, where higher concentrations of plastic particles are often found, the researchers write.

The common water hyacinth (Eichhornia crassipes) has shown the ability to adsorb plastic particles, making it and other aquatic plants like duckweed (Lemna minor) suitable for use as filters to capture micro- and nanoplastics in wetlands.

- It would make sense to establish belts of plastic-absorbing plants in areas where nano- and microplastics are known to accumulate, such as along highways where large amounts of microplastics wear off from car tires. The belts could function as a filter, capturing plastic particles before they

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spread to the wider landscape or are washed into streams by rain, says Elvis Genbo Xu, adding:

- Similarly, strategic belts of aquatic plants could be placed in streams or rows of trees could capture plastic particles from upstream and the air.

Optimistic about aquatic environments

Xu emphasizes that getting plants to absorb micro- and nanoplastics is not enough to solve the global problem of plastic pollution. Micro- and nanoplastics are everywhere: in the air, in the water, and in the soil. No one can avoid them, as they are present in the air we breathe and the water we drink. Therefore, many different methods are needed to remove them before they pollute the environment. Bacteria, fungi, and microalgae can also be employed. Letting plants do part of the work is just one of many solutions.

Whether plants will become a widespread solution remains to be seen, but Elvis Genbo Xu is optimistic:

- Our lab experiments have been successful. I am optimistic that we can scale this up to remove particles from the environment—at least from aquatic environments, where aquatic plants have proven very effective.

Other researchers want to use jellyfish

At the Department of Biology, marine biologist and jellyfish researcher Jamileh Javidpour has investigated whether jellyfish could be used to remove micro- and nanoplastics from the aquatic environment.

Jellyfish produce slime, and in laboratory experiments, this slime has proven capable of removing up to 90 percent of nanoplastics in water from treatment plants.

- We've found that jellyfish slime is super effective at removing nano-sized plastic particles. It could be a part of the solution - I can imagine using dried jellyfish slime to create filers for washing machines, for example, says Javidpour.

Technology Networks, 8 October 2024

https://technologynetworks.com

Barnacle-inspired polymers could present new way to design antibiotics, researchers say

2024-10-10

Scientific literature has shown that barnacles that cling to rocks at the seashore use naturally occurring chemicals to clear rock surfaces of bacteria in preparation for laying down their sticky "glue." Since bioengineering professor Abraham Joy's lab had already designed a synthetic polymer that adheres well to wet surfaces, researchers wondered if they could use the material to loosen bacteria from their moorings in other settings, including human tissue and industrial pipes.

"We were thinking, can we use that idea to almost simulate what barnacles are doing and test out materials to see if they have similar actions," says Joy, who became chair of Northeastern University's Department of Bioengineering in January.

"When we did it, we were surprised it works very well" against certain bacterial biofilms, he says.

Biofilms are a collective of microorganisms that can grow on different surfaces and could include bacteria and fungi.

A research paper he co-authored in the Journal of the American Chemical Society showed the polymer was able to remove nearly all the biofilm housing a bacteria that can cause antibiotic resistant infections, Pseudomonas aeruginosa.

"This research tells us that we have potentially a new way of thinking about how to design antibiotics," Joy says.

It's possible that in the future the polymers can be applied in liquid form to biofilms in wounds that are chronic or slow to heal, he says. There could also be industrial applications for clearing bacterial contamination out of pipes and medical devices.

Clearing out the biofilms that house bacteria

Joy says the research is not actually about killing bacteria, but about disrupting the interactions between biofilms that house them and surfaces on which they are living.

"We're not looking at killing the bacteria," he says. "'We're just saying, "How do you address the removal of the biofilms by themselves?"

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"Think of biofilm as a house and bacteria as people inside a house. We're not doing anything to the people in the house. We're just working with the exoskeleton or the scaffolding or structure of the housing. We're just making that housing weaker."

Many forms of bacteria lay down biofilms when they settle on a surface, Joy says.

He says 60% to 80% of wounds have biofilms present, which presents a treatment challenge since the bacteria in biofilms are dormant and do not respond effectively to the cocktail of oral antibiotics typically given in a hospital. Those antibiotics are designed to work on metabolically active bacteria.

"You need something to clear out the biofilms," Joy says.

When that happens the bacteria are exposed and become metabolically active, he says. "Then your conventional drugs can start to work."

Joy says the next step is to apply the polymers, which are a type of polyester, to infected wounds in liquid form to see whether it is effective on live tissues.

"If this is successful, it will be a novel method of addressing wound biofilms," he says.

Targeting Staph and E. coli biofilms

But while the polymer used in his research removed 99% of Pseudomonas aeruginosa biofilm biomass from underwater surfaces, it was not as effective at removing biofilms housing Staph and E. coli.

The composition of the biofilms are different, Joy says, noting that the former contains more carbohydrates while the latter two are more protein based.

"What we're trying to do now is to understand the mechanism of how exactly this works," he says. "We're trying to see what components of the biofilm the polymer is really interacting with."

"Can we change the polymer composition a little bit? Can we design polymers that are specific for Staph aureus biofilms?" Joy asks.

"Our hope is that we can tailor, sometime in the future, polymers that are specific for specific bacteria," he says. "Then you have a powerful tool

that you can use to address multiple scenarios of bacteria in different situations."

A Goldilocks viscosity

"The physical properties of the material have to be just right to enable it to interact well with the components of the biofilm," Joy says.

He says to think of biofilm as grass on the lawn and the polymer as the solution that loosens it so the blades can be pulled out more easily.

"If the polymer is too hydrophobic," or viscous, "it just sits there," says Joy, whose lab tested the polymer solution by applying it at a 10-degree angle. "If it's too hydrophilic," or diluted, "it just washes away" without affecting the biofilm.

"Our hope is that this research will start a conversation about designing antibiotics that take into account the physical and mechanical properties of biofilms," he says.

"Of course we're going to test it clinically, but I also think it gives a new framework to think about how to address the problem."

Phys Org, 10 October 2024

https://phys.org

World's first zinc-ion battery megafactory opens for business

2024-09-03

Sweden's Enerpoly has flung open the doors to its zinc-ion battery megafactory in the north of Stockholm – making it the first manufacturing facility to use this battery technology at a large scale in the world.

Dubbed the Enerpoly Production Innovation Center, the 70,000-sq-ft (6,500-sq-m) factory is designed to achieve a capacity throughput of 100 MWh annually. That'll be in a couple of years though: while the company has begun commissioning already, it's slated to reach full production capacity only in 2026.

According to Enerpoly, this megafactory will serve Europe's needs for safe energy storage, and also utilize an all-European supply chain to boot.

Oh, so you're too good for lithium-ion now?

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If you're wondering why Enerpoly is bothering with zinc-ion and not lithium-ion batteries, it's because the former is a better choice for storage in several ways:

- They use a water-based electrolyte, which makes them non-flammable, and reduces the risk of fires and explosions.
- They're less expensive, because zinc is far more abundant than lithium (which is difficult and expensive to extract), and easier to handle. They can also operate across a wider temperature range and require less maintenance, making them cheaper than lithium-ion options.
- They're more eco-friendly for the same reason. In contrast, extracting lithium currently requires extensive mining as well as the use of massive evaporation ponds before processing even begins.
- They're said to last a whole lot longer. According to the International Zinc Association, a nonprofit trade association which counts Enerpoly as a member, zinc-based batteries can last up to 20 years, while lithium batteries manage about 12 years.

The big asterisk

This all sounds great, except zinc-ion batteries fall behind lithium-ion batteries when it comes to energy density. A quick bit of math looking at Enerpoly's zinc-ion cell shows its energy density is a modest 106.4 Wh/kg. Not that you'd directly compare them, but as a reference point, Tesla's 4680-type battery cell is estimated at somewhere between 244-296 Wh/kg.

So while you won't get the highest energy density possible, you can look forward to cheaper, greener, and easier-to-live-with energy storage from Enerpoly's new plant. The company says its batteries are suited for 2-10 hour durations, discharging energy over moderate periods. That makes them useful for shifting energy loads from peak to off-peak hours and building more resilient power grids.

website, date

https://website

Methane Emissions From Dairy Farms Higher Than Thought, but Conversion Could Reduce Emissions

2024-10-04

New research has found methane emissions from slurry stores on dairy farms may be up to five times greater than official statistics suggest - and

highlights the huge potential for turning them into a renewable energy source.

The study shows that if captured and turned into biogas, emitted methane could be worth more than £400m a year to the dairy sector in saved fuel costs, or around £52,500 for an average-sized dairy farm.

Capture technology already exists, and if rolled out across the EU dairy herd, the conversion of methane to biofuel could reduce emissions equivalent to an estimated 5.8% of the remaining global temperature rise budget, if the temperature were to be kept to 1.5 ' C of warming.

Conducted by the University of East Anglia (UEA) and the International Fugitive Emissions Abatement Association (IFEAA), the research is based on measurements from two dairy farms in Cornwall, England. Together with a growing body of international field research, it suggests that the 'Tier 2' calculations used by countries to report their emissions annually to the Intergovernmental Panel on Climate Change (IPCC) may not be robust.

Current National Inventories of greenhouse gas (GHG) emissions report that enteric emissions - those coming directly from animals' digestive systems - are three to nine times greater than those from manure management, including the storing and spreading of slurry and manure.

However the findings, reported in the journal Environmental Research: Food Systems and an IFEAA Net Zero Methane Hub white paper published today, suggest the balance between enteric emissions and those from manure management could be much closer to 50:50. The authors also call for greater focus from researchers and political leaders on emissions from manure management.

Prof Neil Ward, of the Tyndall Centre for Climate Change Research at UEA, said: "The standard international methodology looks to be underestimating methane emissions from slurry storage.

"Fortunately, we have the technology to turn this problem into a business opportunity for farmers who can reduce energy bills and become energy independent if they capture and make use of methane as a fuel.

"If emissions from manure management are being significantly under-estimated, this not only means that official estimates are inaccurate, but also that priorities around mitigation options might be being distorted.

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"This research therefore represents an urgent call for action and further work to better understand methane emissions from manure management."

The researchers analysed measurements of slurry lagoon emissions from the two farms during 2022-23. The lagoons were covered with airtight covers and the methane captured.

They found slurry lagoons produce far more methane than suggested by official estimates, such as those based on methods developed by the IPCC. Actual emissions from the farms were 145kgs per cow per year and 198kgs per cow per year respectively. This is four to five times higher than the existing official figure of 38kgs per cow reported in the UK's National Inventory.

The resulting recommendations for government include research and development priorities, increasing grants for slurry covers and extending such financial support to associated gas processing equipment.

Prof Penny Atkins, IFEAA CEO, said: "The technology exists for capturing, processing and utilising the methane that is currently lost to the atmosphere and contributing to GHG accumulation, and looks economically promising particularly if an incentives framework for capital investment on farms, coupled with regulatory support, can be implemented.

"The cumulative contribution of methane from dairy farm manure management is significant and this data shows we must act now to curb emissions."

The researchers also suggest simplifying planning and permitting processes, and tax breaks for supply chain investment in methane recovery and use, such as investments by milk processors in supplier farms.

George Eustice, former Secretary of State for Environment, Food and Rural Affairs and chair of IFEAA, added: "Methane is a potent but short-lived Green House Gas and reducing emissions is critical to the pathway to Net Zero and limiting global temperature rises to 1.5 degrees.

"The bad news is that emissions from agriculture are higher than previously thought but the good news is that this methane is easily

captured and used as an alternative to fossil fuels creating an additional income stream for farms."

Technology Networks, 4 October 2024

https://technologynetworks.com

Nature and plastics inspire breakthrough in soft sustainable materials

2024-10-09

Step aside hard, rigid materials. There is a new soft, sustainable electroactive material in town -- and it's poised to open new possibilities for medical devices, wearable technology and human-computer interfaces.

Using peptides and a snippet of the large molecules in plastics, Northwestern University materials scientists have developed materials made of tiny, flexible nano-sized ribbons that can be charged just like a battery to store energy or record digital information. Highly energy efficient, biocompatible and made from sustainable materials, the systems could give rise to new types of ultralight electronic devices while reducing the environmental impact of electronic manufacturing and disposal.

The study will publish on Wednesday (Oct. 9) in the journal Nature.

With further development, the new soft materials could be used in low-power, energy-efficient microscopic memory chips, sensors and energy storage units. Researchers also could integrate them into woven fibers to create smart fabrics or sticker-like medical implants. In today's wearable devices, electronics are clunkily strapped to the body with a wristband. But, with the new materials, the wristband itself could have electronic activity.

"This is a wholly new concept in materials science and soft materials research," said Northwestern's Samuel I. Stupp, who led the study. "We imagine a future where you could wear a shirt with air conditioning built into it or rely on soft bioactive implants that feel like tissues and are activated wirelessly to improve heart or brain function.

"Those uses require electrical and biological signals, but we cannot build those applications with classic electroactive materials. It's not practical to put hard materials into our organs or in shirts that people can wear. We need to bring electrical signals into the world of soft materials. That is exactly what we have done in this study."

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Stupp is the Board of Trustees Professor of Materials Science and Engineering, Chemistry, Medicine and Biomedical Engineering at Northwestern. He also has served over the past decade as director of the U.S. Department of Energy-supported Center for Bio-Inspired Energy Science, where this research began. Stupp has appointments in the McCormick School of Engineering, Weinberg College of Arts and Sciences and Northwestern University Feinberg School of Medicine. Yang Yang, a research associate in Stupp's laboratory, is the paper's first author.

Peptides meet plastics for true innovation

The secret behind the new material is peptide amphiphiles, a versatile platform of molecules previously developed in Stupp's laboratory. These self-assembling structures form filaments in water and have already demonstrated promise in regenerative medicine. The molecules contain peptides and a lipid segment, which drives the molecular self-assembly when placed in water.

In the new study, the team replaced the lipid tail with a miniature molecular segment of a plastic called polyvinylidene fluoride (PVDF). But they kept the peptide segment, which contains sequences of amino acids. Commonly used in audio and sonar technologies, PVDF is a plastic with unusual electrical properties. It can generate electrical signals when pressed or squeezed -- a property known as piezoelectricity. It also is a ferroelectric material, which means it has a polar structure that can switch orientation by 180 degrees using an external voltage. The dominant ferroelectrics in technology are hard materials and often include rare or toxic metals, such as lead and niobium.

"PVDF was discovered in the late 1960s and is the first known plastic with ferroelectric properties," Stupp said. "It has all the robustness of plastic while being useful for electrical devices. That makes it a very high-value material for advanced technologies. However, in pure form, its ferroelectric character is not stable, and, if heated above the so-called Curie temperature, it loses its polarity irreversibly."

All plastics, including PVDF, contain polymers, which are giant molecules typically composed of thousands of chemical structural units. In the new study, the Stupp laboratory precisely synthesized miniature polymers with only 3 to 7 vinylidene fluoride units. Interestingly, the miniature segments with 4, 5 or 6 units are programmed by nature's beta-sheet structures, which are present in proteins, to organize into a stable ferroelectric phase.

"It was not a trivial task," Stupp said. "The combination of two unlikely partners -- peptides and plastics -- led to a breakthrough in many respects."

Not only were the new materials equally ferroelectric and piezoelectric as PVDF, but the electroactive forms were stable, with the ability to switch polarity using extremely low external voltages. This opens the door for low-power electronics and sustainable nanoscale devices. The scientists also envision developing new biomedical technologies by attaching bioactive signals to the peptide segments, a strategy already used in Stupp's regenerative medicine research. This offers the unique combination of electrically active materials that are also bioactive.

Just add water

To create the sustainable structures, Stupp's team simply added water to trigger the self-assembly process. After dunking the materials, Stupp was amazed to find that they achieved the highly sought-after ferroelectric properties of PVDF.

In the presence of an external electric field, ferroelectric materials flip their polar orientation -- similar to how a magnet can be flipped from north to south and back again. This property is a key ingredient for devices that store information, an important feature for artificial intelligence technologies. Surprisingly, the investigators found that "mutations" in the peptide sequence could tune properties related to ferroelectricity or even transform the structures into materials that are ideal for actuation or energy storage known as "relaxor phases."

"Peptide sequence mutations in biology are the source of pathologies or biological advantages," Stupp said. "In the new materials, we mutate peptides to tune their properties for the physical world.

"Using nanoscale electrodes, we could potentially expose an astronomical number of self-assembling structures to electric fields. We could flip their polarity with a low voltage , so one serves as a 'one,' and the opposite orientation serves as a 'zero.' This forms binary code for information storage. Adding to their versatility, and in great contrast to common ferroelectrics, the new materials are 'multiaxial' -- meaning they can generate polarity in multiple directions around a circle rather than one or two specific directions."

Record-breaking low power

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To flip their polarity, even soft ferroelectric materials like PVDF or other polymers typically require a substantial external electric field. The new structures, however, require incredibly low voltage.

"The energy required to flip their poles is the lowest ever reported for multiaxial soft ferroelectrics," Stupp said. "You can imagine how much energy this will save in increasingly energy-hungry times."

The new materials also have innate environmental benefits. Unlike typical plastics, which linger in the environment for centuries, the Stupp laboratory's materials could be biodegraded or reused without the use of harmful, toxic solvents or high-energy processes.

"We are now considering the use of the new structures in non-conventional applications for ferroelectrics, which include biomedical devices and implants as well as catalytic processes important in renewable energy," Stupp said. "Given the use of peptides in the new materials, they lend themselves to functionalization with biological signals. We are very excited about these new directions."

Science Daily, 9 October 2024

https://sciencedaily.com

12 Things That Happen to Your Body When You Take Melatonin

2021-03-25

Melatonin supplements are sold over-the-counter as a remedy for insomnia and trouble sleeping. Sleep experts weigh in on how to use melatonin, whether it really works, and if it's safe.

What happens to your body on melatonin

If you toss and turn in bed on most nights because you have trouble sleeping, you've probably heard of the natural sleep aid melatonin. It's a hormone that's naturally produced by your body that lets you know when it's time for sleep. But, this sleep aid is also available as a supplement to treat various sleep disorders, like insomnia.

Eager for a cure, many people turn to the much-hyped supplement for better sleep. In the U.S., melatonin is sold over-the-counter and—like all vitamins and supplements—is less strictly regulated by the Food and Drug Administration than prescription drugs. Like any vitamin or supplement,

melatonin can have side effects depending on dosage and usage, so proceed with caution (and mention to your doctor that you are using it).

Before you pick up a bottle of melatonin, learn about the effects it can have on the body.

Melatonin helps control sleep

"Naturally produced internal melatonin does not induce sleep—it is the biochemical signal of darkness and tells the brain that it's night, and in humans, night is associated with sleep," says Steven Lockley, PhD, scientific advisor for Lighting Science. Melatonin is released by the body in the hours before bed, helping to regulate our sleep/wake cycle.

Supplements may regulate circadian rhythms

The theory is that supplementing with melatonin can help people who have trouble falling asleep. However, Lockley says melatonin can also help for people who work at night or have jet lag. "Melatonin can make us sleepy but it is not a very good hypnotic unless you are trying to sleep at the 'wrong' circadian phase, such as a shift worker sleeping in the daytime, or trying to sleep at a new time zone after international travel," Lockley says.

It doesn't always work

The science is mixed when it comes to how well melatonin works for general sleep problems. "It is mildly beneficial in the treatment of long-term insomnia or sleep disorders," says Dave Walker, RPh, pharmacist and medical advisory board member of the non-profit MedShadow Foundation that tracks medications and side effects. But if you're a night owl with delayed sleep phase disorder, a study in the journal Sleep does show taking melatonin may help you fall asleep at a more normal time.

Melatonin can cause side effects

Those considering melatonin should be aware of some potential side effects. "Melatonin is not without potential side effects including headaches, depression, daytime sleepiness, dizziness, joint pain, stomach cramps, and irritability," Walker says. Some people have also reported vivid dreams. Although overdoses aren't life-threatening, those using melatonin still need to be wary: "You should be cautious taking higher doses—20 mg to 30 mg doses may be harmful to adults," says Walker.

It can interact with other meds

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Melatonin isn't for everyone. "The supplements can interact with a number of medications, including anticoagulants and antiplatelet drugs, anticonvulsants, contraceptive drugs, diabetes medications, and medications that suppress the immune system (immunosuppressants)," Walker says. In addition, "do not use melatonin if you are pregnant or breastfeeding, or have an autoimmune disorder, a seizure disorder, or depression," confirms Richard Shane, PhD, sleep expert and creator of the sleep program called Sleep Easy. "Melatonin supplements may also increase blood pressure levels in people taking some hypertension medications." Experts recommend you avoid the supplement if you're in the habit of drinking coffee or alcohol in the evening; plus, you shouldn't drive after taking melatonin.

It may affect children's development

Sleep issues are common in children, but sorry parents—melatonin is probably not wise for them. "Children should not be given melatonin unless directed by a physician," Walker says. Lockley agrees: "We do not recommend melatonin for children," he says. Researchers haven't extensively tested the hormone in kids; animal research suggests it may affect reproductive development during puberty. Some studies, including a 2015 review in Sleep Medicine Clinics suggest it could help children with developmental disabilities such as autism. But, for most children, the unknown risks outweigh the potential benefits. Parents who want a fix for their children's sleep troubles should consult a physician.

You may need a different dose

To avoid negative side effects, take the lowest dose that will work for you. "Generally doses of 0.2 mg to 5 mg are recognized as a starting dose range for melatonin supplements," Walker says. "I often see people taking 3 to 5 mg daily. If you don't get results you may increase the dose slowly over a period of days or weeks." Shane suggests a dosage of 1 to 3mg. But because the FDA doesn't regulate supplements, different brands may not have the same potency—even if their label says they do, a 2017 study in the Journal of Clinical Sleep Medicine shows. Because of this, you should be conservative in your dosage, especially when first taking it.

It can mess up sleep if taken at the wrong time

Melatonin supplements may not work the way you think they do—you can't just pop one before bed. "Taking melatonin at bedtime may not work for you at all since melatonin is a sleep-regulating hormone, not a sleeping pill," Walker says. "It should be taken at a time that will enhance

your normal, naturally occurring melatonin levels. These generally increase when nightfall approaches, depending on the season. The usual peak is between 7 p.m. and 9 p.m. for most people. So taking it 30 to 90 minutes before bedtime works for some people. Those with different types of sleep disorders may benefit by taking it two to three hours before bedtime."

Different types affect the body similarly

At the drugstore, it can be overwhelming to see the different brands and types of melatonin supplements. "Melatonin is available as tablets, capsules, gummies, chewable tablets, and even mouth sprays. I'm not aware that any form is better than another," Walker says. But again, "since melatonin is sold as a supplement, it is not FDA-approved or monitored, and there can be wide variation from one manufacturer to another," he says. "Pick a reliable brand and stick to it if it seems to work for you." Shane recommends Best Rest by Pure Encapsulations. "It contains melatonin and a combination of other sleep-inducing ingredients," he says.

Long-term effects on the body are unknown

Melatonin supplements are safe, but it's still probably best to only take them until your sleep schedule is back on track. Less is known about long-term safety, according to the National Center for Complementary and Integrative Health. "Melatonin is considered safe to take for short-term use to help control disrupted sleep cycles for a few days, weeks or months," Walker says. "Its overall effectiveness in long-term use is questionable." Also, if melatonin doesn't seem to be working for you, stop taking it. As always, talk to your doctor about any ongoing sleep problems you're having in order to work out the best solution for you.

How to help your natural melatonin work

Although supplements may help, there are also other (less costly) ways to boost your body's natural melatonin. "You can increase melatonin production by getting exposure to sunlight in the morning and afternoon," Shane says. "Blue light from your computer or phone interferes with the brain's production of melatonin, so stop using computer and phone one hour before bedtime, and stay at least six feet away from your television screen."

Lockley explains it might not be the level of melatonin itself that needs adjusting; this varies between people. But rather, it's the duration and timing of its release. "In the hours before sleep, we want to reduce the intensity and the blue-content to help the brain think it's night and induce

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sleep," he says. Turn lights low and follow a relaxing evening routine. In addition, Shane recommends a pre-bedtime snack of foods rich in melatonin, such as goji berries, walnuts, almonds, pineapple, bananas, and oranges.

The Healthy, 25 March 2024

https://thehealthy.com

Nobel chemistry winner sees engineered proteins solving tough problems

2024-10-10

Whether it's battling tumors or breaking down plastic, American scientist David Baker, co-recipient of this year's Nobel Prize in Chemistry, has an answer: engineering proteins that don't naturally exist—a concept once dismissed as "crazy."

Today, proteins with novel functions are flowing steadily out of his lab, with an endless list of potential applications ranging from ultra-targeted therapies to the development of new vaccines.

"Across the range of problems that we face today in medicine and health, sustainability, energy, and technology, I think the potential for protein design is enormous," Baker told AFP via video call from Seattle, hours after learning of his Nobel win alongside two other laureates.

Proteins are organic molecules that play a fundamental role in almost every function of living organisms, from muscle contraction and food digestion to neuron activation and more.

"The ones in nature evolved to solve all the problems that were faced during natural selection," explained the 62-year-old University of Washington professor.

"But humans face new problems today," added the biochemist and computational biologist.

"We're heating up the planet, so we need new solutions in ecology and sustainability. We live longer, so there's new diseases which are relevant, like Alzheimer's disease. There's new pathogens like coronavirus."

Rather than leave these problems up to evolution—a "brutal" solution that would take a very, very long time—"with new proteins, we can solve those problems, but in a very short time," he said.

From fringe to mainstream

All proteins are composed of chains of amino acids, whose sequence dictates their shape—and ultimately their function.

For decades, scientists have tried to determine protein structures based on these amino acid sequences.

In the late 1990s, Baker made strides towards solving this problem with a computer software he developed called Rosetta.

His success prompted a shift his focus to the reverse approach: starting with a desired shape and using Rosetta to identify the corresponding amino acid sequence. This sequence can then be introduced into bacteria, which synthesize the new protein that can be harvested and studied.

In 2003, he published his breakthrough finding—the creation of the first-ever protein not found in nature—though it still lacked a defined function.

"Then we started trying to design proteins that actually would do useful things," Baker recalled. "And that's when people, I think, really started thinking it was crazy."

But "for the last 20 years -— and really, most recently, the last five years -— we've been able to make proteins that do all kinds of amazing things," he said. Rosetta meanwhile has been progressively improved to incorporate artificial intelligence.

"I think what's kind of funny now is that the lunatic fringe, which pretty much no one was doing, has now entered the mainstream," he added with a laugh.

Keys that fit locks

How do scientists decide what shape a new protein needs to achieve the desired function?

Baker gives the example of a tumor. "We know some protein that's on the surface of that tumor, and we know its shape. What we do is we design a protein that acts like a key fitting into a lock," he explained.

Another application: breaking down plastic. In this case, a protein is designed to attach itself to the plastic molecule, accompanied by chemical compounds to "cut" it.

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In medicine, this technology has already been used in a COVID-19 vaccine approved in South Korea. Researchers are also exploring its potential to create new materials.

"In biology, we have tooth and bone, we have shells, which are made by proteins interacting with inorganic compounds like calcium carbonate or calcium phosphate," says Baker, envisioning proteins interacting with other compounds to create entirely new materials with unique properties.

Greenhouse gas capture, a universal flu vaccine, improved antivenom—Baker's wish list goes on and on.

"As protein design becomes more powerful, I'm incredibly excited about all the problems that we will be able to solve."

Phys Org, 10 October 2024

https://phys.org

The scale of the problem of replacing 'forever chemicals' PFAS

2024-10-10

Nearly 15,000 substances are thought to belong to the family of per- and polyfluoroalkyl substances (PFAS), which have been linked to a range of environmental and health problems. However, these compounds have become a vital, but largely unsung, part of modern life and are used in a vast array of ways. Plans are afoot in many countries to phase out many of these chemicals, but while it is relatively simple to replace them in some products, it is much harder in others.

Clothing

PFAS are attractive for clothing, especially raincoats, children's apparel and athleticwear, because they confer water- and stain- resistance and make garments more breathable. Recognition of the harmful effects of PFAS has meant that some manufacturers are already moving away from them.

Several big-name outdoor clothing manufacturers are pledging to go totally PFAS-free. For example, Patagonia – a major US retailer of outdoor recreation clothing – has promised to convert all of its durable water-repellent membranes and finishes to non-fluorinated alternatives by 2025. In spring 2024, about 96% of its materials by weight were water-proofed without PFAS. There is no one-size-fits-all solution in clothing, however. One PFAS alternative might work on nylon but not on polyester, Patagonia explains.

A few years ago the clothing conglomerate VF, which owns various well-known American clothing brands like The North Face and Timberland, announced plans to phase out PFAS by 2025. The company says its chemical management system screens suppliers to ensure that substances of concern don't enter VF's supply chains.

However, some manufacturers such as WL Gore & Associates – the US multinational that developed the waterproof, breathable Gore-Tex material containing PTFE – have found eliminating PFAS tricky. Gore & Associates' original target for completely removing such compounds from its waterproof clothing was the end of 2023, but the company says it proved impossible to meet that. It now claims to be on track to transition the vast majority of its consumer portfolio by end of 2025.

While Gore & Associates states that PTFE is not a perfluorochemical of environmental concern and does not degrade into such substances,

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growing research suggests that many of the compounds used to make PTFE may also pose health risks.

While substitutions of many PFAS in clothing is being welcomed, some experts are concerned that there's little transparency about what these alternatives are as they are often labelled trade secrets.

Electronics

PFAS have found their way into many electronics, including smartphones. This is because they're heat resistant and flame retardant, hydrophobic, and also display thermal insulation as well as friction-reducing properties. Unfortunately, they're particularly tricky to replace in electronic products.

Fluoropolymers have excellent resistance to strong acids and bases used to produce electronics like circuit boards. Epoxy laminates and polyimides are two possible substitutes, as well as less common options that include liquid crystal polymers, polyester, polyethylene naphthalate and ceramics, according to recent analysis by the non-profit environmental organisation ChemSec. However, the non-profit points out that polytetrafluoroethylene (PTFE), also known as Teflon, cannot be easily substituted in printed circuit/wiring boards without a complete redesign of the equipment.

When it comes to PFAS-free options for insulating wires and cables to resist fire, corrosion, moisture and cracking, ChemSec highlights polyvinylchoride, polypropylene, polyethylene, neoprene and silicone, among other options.

Cookware

Cookware is one of the earliest uses of Teflon or PTFE, which was first synthesised over 80 years ago. It is extremely hydrophobic and lipophobic, giving pots and pans a non-stick finish.

A couple of years ago, Consumer Reports tested three recommended nonstick frying pans and found that the PTFE-coated pan had measurable amounts of perfluorooctanoic acid (PFOA) and several other PFAS. Bakeware, however, tends to have a mix of PFAS polymer coatings and is more complex in its composition, which complicates analysis of it.

Alternatives to PFAS-coated cookware are simpler to develop

Chemicals like PFOA – exposure to which human epidemiological studies have linked to a range of health problems including cancer – are often used as a processing agent in the manufacture of PTFE coated cookware, while other PFAS may also be produced by PTFE degradation over time.

Alternatives to PFAS-coated cookware are simpler to develop as a replacement coating doesn't necessarily need to be developed. Cast iron, ceramic and stainless-steel pans can be adequate stand-ins, although potentially with some loss of performance. Beyond stovetop cookware, there is also glass for baking.

Chemistry World, 10 October 2024

https://chemistryworld.com

Radiative Cooling Clothes Could Help Combat Rising Urban Temperatures

2024-10-10

Researchers have developed a natural fabric that could be worn to counter rising temperatures in cities worldwide.

A team of international researchers has developed a natural fabric that urban residents could wear to counter rising temperatures in cities worldwide, caused by buildings, asphalt, and concrete.

As heatwaves become more prominent, cooling textiles that can be incorporated into clothes, hats, shoes and even building surfaces provide a glimpse into a future where greenhouse gas-emitting air conditioners may no longer be needed in our cities.

Engineers from Zhengzhou University and the University of South Australia say the wearable fabric is designed to reflect sunlight and allow heat to escape, while blocking the sun's rays and lowering the temperature. They have described the textiles in the latest issue of Science Bulletin.

The fabric promises to bring relief to millions of city dwellers experiencing warmer and more uncomfortable temperatures caused by global climate change and fewer green spaces.

UniSA visiting researcher Yangzhe Hou says the fabric leverages the principle of radiative cooling, a natural process where materials emit heat into the atmosphere, and ultimately into space.

"Unlike conventional fabrics that retain heat, these textiles are made of three layers that are engineered to optimise cooling," Hou says.

The upper layer, made of polymethyl pentene fibres, allows heat to radiate effectively. The middle layer, composed of silver nanowires, enhances the

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fabric's reflectivity, preventing additional heat from reaching the body. The bottom layer, made of wool, directs heat away from the skin, ensuring that wearers remain cool, even in the hottest urban environments.

"In our experiment, when placed vertically, the fabric was found to be 2.3°C cooler than traditional textiles, and up to 6.2°C cooler than the surrounding environment when used as a horizontal surface covering.

"The fabric's ability to passively reduce temperatures offers a sustainable alternative to conventional air conditioning, providing energy savings and reducing the strain on power grids during heatwaves."

Zhengzhou University researchers Jingna Zhang and Professor Xianhu Liu say the technology not only addresses the immediate problem of urban heat islands, but also contributes to broader efforts to mitigate climate change and move towards more sustainable urban living.

It is hoped the technology could be adapted for even broader applications, including construction material, outdoor furniture and urban planning.

While the fabric holds significant promise, researchers say the current production process is costly, and the long-term durability of the textiles needs further investigation and government support before it can be commercialised.

"Whether consumers are willing to pay more for wearable fabrics depend on the cooling effect, durability, comfort and their environmental awareness," the researchers say.

Technology Networks, 10 October 2024

https://technologynetworks.com

This Food Packaging "Significantly" Produces Microplastics in Urine, Says New Research

2024-09-05

Toxicology researchers evaluated three categories of groceries to find that a "widely used" type is disrupting major body systems.

Maybe you've heard about the increasing research that's suggesting too much exposure to polyfluoroalkyl substances, or PFAS, could increase cancer risk and disrupt hormonal harmony. Meanwhile, another substance used in plastic packaging, bisphenol A or BPA, has been linked to high

blood pressure, type 2 diabetes and heart disease, according to the Mayo Clinic.

BPA is used in items like reusable water bottles, as well as food containers in the freezer aisle and heat-and-eat kiosks around the market. Without following a few important steps, those quick, convenient options may come with a price, says a team of researchers in Turkey who compared the BPA exposure and health effects between fresh, canned and ready-to-eat meals.

The randomized, controlled, single-blinded July 2024 study published in Nutrients followed 48 healthy university students between the ages of 18 and 30. The study was led by researchers in Turkey who specialize in the study of toxicology, pharmacology, and public health.

Study participants were randomly assigned to eat either fresh, canned or plastic-packaged ready-to-eat meals over a four-day period. On the first and second days, they were given a series of rules to follow to limit their plastic exposure:

- Avoid "meals prepared outside the home, canned food and beverages, frozen meals, plastic-packaged food, water from polycarbonate bottles, food stored in plastic containers or use plastic containers in microwave ovens."
- Not to eat any food or beverage other than water after 10 p.m.
- Fast for at least eight hours.
- Avoid any physical activity beyond their typical routine.
- Only consume processed products packaged in glass containers or in "low-density polyethylene plastic containers" like those you might buy milk or orange juice in.
- Avoid coffee, or only use a French press or ceramic dripper instead of a plastic coffee machine.
- The researchers took urine samples and a 24-hour "food consumption record" to ensure participants complied with these requirements.

On the third and fourth days of the study, participants' heart rate and blood pressure readings were taken before they received their meal assignment for the day. Urine samples, heart rate and blood pressure readings were taken two, four and six hours after eating the meal.

The researchers found that the study participants who ate ready-to-eat meals had "significantly increased urine BPA concentrations" compared to the other two groups. The authors cited past research which suggested

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this can have implications for the liver, in addition to the hormone-disrupting effects on the thyroid and issues with other important health functions.

Another observation was that those who ate the fresh meals appeared to clear out evidence of plastics from their system via urine two hours faster than the ready-to-eat group.

Eating ready-to-eat meals was also associated with higher blood pressure and pulse pressure, or the difference between the upper and lower numbers of your blood pressure, according to the Cleveland Clinic, as well as decreased diastolic blood pressure and heart rate.

The participants who ate canned food saw higher blood pressure values, which may speak to the constricting effect of sodium on the blood vessels.

These findings may be one more reason to slow down and take a few moments to prepare something fresh, or at least be sure to remove your food from its plastic packaging before you warm it—and minimize those prepared, processed foods.

For the convenience of frozen foods, look for microwavable meals that come in compostable containers. Increasingly, manufacturers of prepared foods with higher-quality ingredients are utilizing these eco- and human-friendly methods.

The Healthy, 5 August 2024

https://thehealthy.com

A look into 'mirror molecules' may lead to new medicines

2024-10-10

A University of Texas at Dallas chemist and his colleagues have developed a new chemical reaction that will allow researchers to synthesize selectively the left-handed or right-handed versions of "mirror molecules" found in nature and assess them for potential use against cancer, infection, depression, inflammation and a host of other conditions.

The results are important, because while the left- and right-handed versions (enantiomers) of chemical compounds have identical chemical properties, they differ in how they react in the human body. Developing cost-effective ways to synthesize only the version with a desired biological effect is critical to medicinal chemistry.

In a study published in Science, the researchers describe how their chemical synthesis method can quickly, efficiently and in a scalable manner produce a sample that is purely one enantiomer of a mirror-image pair of molecules, as opposed to a mixture of the two. The new method involves adding prenyl groups—molecules made of five carbon atoms—to enones by means of a newly developed catalyst in one step in the synthesis process.

"Adding a prenyl group is the way nature assembles these molecules, but it has been challenging for scientists to replicate this successfully," said Dr. Filippo Romiti, assistant professor of chemistry and biochemistry in the School of Natural Sciences and Mathematics at UT Dallas and a corresponding author of the study.

"Nature is the best synthetic chemist of all; she's way ahead of us. This research represents a paradigm shift in the way we can now synthesize large quantities of biologically active molecules and test them for therapeutic activity," said Romiti, who is also a Cancer Prevention & Research Institute of Texas (CPRIT) Scholar.

Naturally occurring compounds are a significant source of potential new medicines, but because they often occur only in minute quantities, scientists and pharmaceutical companies must develop methods to synthesize larger amounts to test in the lab or to manufacture into drugs.

In their study, the researchers demonstrated how incorporating their new chemical reaction resulted in a synthesis process that reached completion in about 15 minutes at room temperature, which is more energy-efficient than having to heat or cool substances significantly during a reaction.

Romiti collaborated with researchers at Boston College, the University of Pittsburgh and the University of Strasbourg in France to develop the new chemical reaction. Romiti's role involved creating the synthesis process.

The researchers developed their method as part of an effort to synthesize polycyclic polyprenylated acylphloroglucinols (PPAPs), which are a class of more than 400 natural products with a broad spectrum of bioactivity, including combating cancer, HIV, Alzheimer's disease, depression, epilepsy and obesity.

Romiti and his colleagues demonstrated a proof of concept by synthesizing enantiomers of eight PPAPs, including nemorosonol, a chemical derived from a Brazilian tree that has been shown by other researchers to have antibiotic activity.

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"For 20 years, we've known that nemorosonol is antimicrobial, but which enantiomer is responsible? Is it one or both?" Romiti said. "It could be that one version has this property, but the other does not."

Romiti and his colleagues tested their nemorosonol enantiomer against lung and breast cancer cell lines provided by Dr. John Minna, director of the Hamon Center for Therapeutic Oncology Research at UT Southwestern Medical Center.

"Our entantiomer of nemorosonol had pretty decent effects against cancer cell lines," Romiti said. "This was very interesting and could only have been discovered if we had access to large quantities of a pure entantiomeric sample to test."

Romiti said that more research will be needed to confirm whether one nemorosonol enantiomer is specifically antimicrobial and the other anticancer.

The study results could impact drug discovery and translational medicine in several ways. In addition to informing scalable and more efficient drug-manufacturing processes, the findings will enable researchers to make more efficiently natural product analogs, which are optimized versions of the natural product that are more potent or selective in how they work in the body.

"We developed this process to be as pharma-friendly as possible," Romiti said. "This is a new tool for chemists and biologists to study 400 new drug leads that we can make, plus their analogs, and test their biological activity. We now have access to potent natural products that we previously could not synthesize in the lab."

Romiti said the next step will be to apply the new reaction to the synthesis of other classes of natural products, in addition to PPAPs.

Phys Org, 10 October 2024

https://phys.org

Protein Discovery Offers New Approach for Treating Jet Lag

2024-10-07

Scientists from Duke-NUS Medical School and the University of California, Santa Cruz, have discovered the secret to regulating our internal clock. They identified that this regulator sits right at the tail end of Casein

Kinase 1 delta (CK1δ), a protein which acts as a pace setter for our internal biological clock or the natural 24-hour cycles that control sleep-wake patterns and other daily functions, known as circadian rhythm.

Published in the journal PNAS, their findings could pave the way for new approaches to treating disorders related to our body clock.

CK1δ regulates circadian rhythms by tagging other proteins involved in our biological clock to fine-tune the timing of these rhythms. In addition to modifying other proteins, CK1δ itself can be tagged, thereby altering its own ability to regulate the proteins involved in running the body's internal clock.

Previous research identified two distinct versions of CK1δ, known as isoforms δ1 and δ2, which vary by just 16 building blocks or amino acids right at the end of the protein in a part called the C-terminal tail. Yet these small differences significantly impact CK1δ's function. While it was known that when these proteins are tagged, their ability to regulate the body clock decreases, no one knew exactly how this happened.

Using advanced spectroscopy and spectrometry techniques to zoom in on the tails, the researchers found that how the proteins are tagged is determined by their distinct tail sequences.

Howard Hughes Medical Institute Investigator Professor Carrie Partch from the Department of Chemistry & Biochemistry at the University of California, Santa Cruz and corresponding author of the study explained:

"Our findings pinpoint to three specific sites on CK1δ's tail where phosphate groups can attach, and these sites are crucial for controlling the protein's activity. When these spots get tagged with a phosphate group, CK1δ becomes less active, which means it doesn't influence our circadian rhythms as effectively. Using high-resolution analysis, we were able to pinpoint the exact sites involved—and that's really exciting."

Having first studied this protein more than 30 years ago while investigating its role in cell division, Professor David Virshup, the director of the Cancer and Stem Cell Biology Programme at Duke-NUS and co-corresponding author of the study, elaborated:

"With the technology we have available now, we were finally able to get to the bottom of a question that has gone unanswered for more than 25 years. We found that the δ1 tail interacts more extensively with the main part of the protein, leading to greater self-inhibition compared to δ2. This

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means that δ1 is more tightly regulated by its tail than δ2. When these sites are mutated or removed, δ1 becomes more active, which leads to changes in circadian rhythms. In contrast, δ2 does not have the same regulatory effect from its tail region."

This discovery highlights how a small part of CK1δ can greatly influence its overall activity. This self-regulation is vital for keeping CK1δ activity balanced, which, in turn, helps regulate our circadian rhythms.

The study also addressed the wider implications of these findings. CK1δ plays a role in several important processes beyond circadian rhythms, including cell division, cancer development, and certain neurodegenerative diseases. By better understanding how CK1δ's activity is regulated, scientists could open new avenues for treating not just circadian rhythm disorders but also a range of conditions.

Professor Patrick Tan, Senior Vice-Dean for Research at Duke-NUS, commented:

"Regulating our internal clock goes beyond curing jet lag—it's about improving sleep-quality, metabolism and overall health. This important discovery could potentially open new doors for treatments that could transform how we manage these essential aspects of our daily lives."

The researchers plan to further investigate how real-world factors, such as diet and environmental changes, affect the tagging sites on CK1δ. This could provide insights into how these factors affect circadian rhythms and might lead to practical solutions for managing disruptions.

Duke-NUS is a global leader in medical education and biomedical research, driving breakthroughs that transcend scientific exploration for the benefit of our communities. By merging scientific research with translational methods, the School deepens our understanding of prevalent diseases and develops innovative new treatment approaches.

Technology Networks, 7 October 2024

https://technologynetworks.com

Spectroscopy study determines how catalysts remove dangerous nitrogen oxides

2024-10-10

Catalysts belonging to the zeolite family help to remove toxic nitrogen oxides from industrial emissions. Researchers at the Paul Scherrer Institute

PSI have now discovered that their complex nano porous structure is crucial. Specifically, individual iron atoms sitting in certain neighboring pores communicate with each other, thereby driving the desired reaction.

Industry produces gases that are harmful to both humans and the environment and therefore must be prevented from escaping. These include nitric oxide and nitrous oxide, the latter also known as laughing gas. Both can be produced simultaneously when manufacturing fertilizers, for example.

To remove them from the waste gases, companies use zeolite-based catalysts. Researchers at the Paul Scherrer Institute PSI, in collaboration with the Swiss chemical company CASALE SA, have now worked out the details of how these catalysts render the combination of these two nitrogen oxides harmless.

The results of their research have been published in the journal Nature Catalysis and provide clues as to how the catalysts could be improved in the future.

An entire zoo of iron species

"The Lugano-based company CASALE contacted us because they wanted to develop a better understanding of how their catalysts used for the abatement of nitrogen oxide actually work," says Davide Ferri, head of the Applied Catalysis and Spectroscopy research group at the PSI Center for Energy and Environmental Sciences.

The zeolites used for this are composed of aluminum, oxygen and silicon atoms forming a kind of framework. Zeolites occur naturally—as minerals in rock formations, for example—or they can be manufactured synthetically. Many catalysts used in the chemical industry are based on these compounds, with additional elements added to the basic structure depending on the specific application.

When the zeolite framework also contains iron as an active substance, it enables the conversion of the two nitrogen oxides, nitric oxide (NO) and nitrous oxide(N2O), into harmless molecules. "However, these iron atoms can be located in many different positions of the zeolite framework and can possess various forms," says Filippo Buttignol, a member of Ferri's group. He is the principal author of the new study, which he conducted as part of his doctoral thesis.

"The iron can lodge in the small spaces of the zeolite in the form of single atoms, or else several iron atoms can be bound together and with

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oxygen atoms in slightly larger spaces in the regular lattice as diatomic, multiatomic or polyatomic clusters." In short, the catalyst contains an entire zoo of different iron species. "We wanted to know which of these iron species is actually responsible for the catalysis of nitrogen oxides."

The researchers, who specialize in spectroscopic analyses, knew exactly which three types of experiment they needed to carry out to answer this question. They performed these while the catalytic reaction was taking place in their zeolite sample.

First they used the Swiss Light Source SLS at PSI to analyze the process using X-ray absorption spectroscopy. "This allowed us to look at all the iron species simultaneously," explains Buttignol.

Next, in collaboration with ETH Zurich, they used electron paramagnetic resonance spectroscopy to identify the contribution of each species. And finally—again at PSI—the scientists used infrared spectroscopy to determine the molecular aspect of the different iron species.

Catalysis happens at individual but communicating atoms

Each of these three methods contributed a piece of the puzzle, eventually leading to the following overall picture: Catalysis takes place at single iron atoms which are located in two very specific, neighboring sites of the zeolite lattice. During the process, these two iron atoms act in concert with each other.

One of them, sitting at the center of four oxygen atoms in the zeolite arranged in the form of a square and responsible specifically to convert nitrous oxide, communicates with a different iron atom, which is surrounded by oxygen atoms arranged in the form of a tetrahedron and at which the nitric oxide reacts.

"Only where this precise arrangement is found do we see iron contributing to the catalysis of the simultaneous abatement of the two gases," says Buttignol. Each of these iron atoms gave up an electron and took it back again, in other words, the typical redox reaction of catalysis took place there over and over again.

Removing hazardous nitrogen oxides more efficiently

Ferri concludes, "If you know exactly where the chemical reaction takes place, you can start adjusting the manufacture of catalysts accordingly."

The catalysis of nitric oxide and nitrous oxide and thus their removal from industrial waste gases is important because both are toxic to humans.

Beyond this, both gases are also harmful to the environment: nitric oxide is one of the causes of acid rain, while nitrous oxide has such a strong impact on the climate that one molecule of it contributes almost 300 times more to the greenhouse effect than a molecule of carbon dioxide.

Phys Org, 10 October 2024

https://phys.org

New insights into ammonia decomposition

2024-10-08

Using ammonia is regarded as a promising method of transporting hydrogen. However, an efficient process is also needed to convert it back into hydrogen and nitrogen.

An international research team has gained new insights into the mode of operation of an iron catalyst that can be used to split ammonia into nitrogen and hydrogen.

Hydrogen is converted into ammonia to make the energy carrier easier to transport.

This means that catalysts are also needed that can subsequently break ammonia down into its starting materials again.

A team from the German Ruhr University Bochum, the Max Planck Institute for Chemical Energy Conversion (MPI CEC) in Mülheim an der Ruhr, Technische Universität Berlin and the Italian Institute of Technology in Genoa describes how the iron catalyst enables this reaction in detail in the journal ACS Catalysis from September 6, 2024.

How to make hydrogen transportable

Green hydrogen is regarded as a promising energy carrier. It can be produced by splitting water using wind or solar energy.

However, in many cases the locations where hydrogen is needed don't provide the right conditions for water electrolysis.

Hydrogen must be liquefied for transportation, which is only possible at extremely low temperatures.

Converting hydrogen into ammonia, which can be liquefied at much higher temperatures, is therefore considered an attractive alternative.

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"What's more, the chemical industry already has an established infrastructure for ammonia handling," says Professor Martin Muhler, Head of the Laboratory of Industrial Chemistry in Bochum and Max Planck Fellow at the MPI CEC.

Efficient catalysts are needed to break down ammonia (NH3) back into its starting compounds nitrogen (N2) and hydrogen (H2). The problem is that conventional iron catalysts generally facilitate an undesirable reaction to form iron nitride instead of nitrogen.

In the current study, the researchers have shown exactly how this side reaction occurs.

They tested ammonia decomposition using a catalyst of the latest generation provided by Clariant.

The team consisting of Dr. Maximilian Purcel, Astrid Müller and Professor Martin Muhler from Ruhr University Bochum and MPI CEC carried out the relevant experiments.

The findings were refined using complex molecular dynamics simulations, supported by machine learning, which were conducted by the Italian partner institute.

The team from Technische Universität Berlin successfully identified the iron nitrides formed under reaction conditions using X-ray diffraction and tracked their transformations.

More efficient future catalysts

"Our findings can be used to develop more efficient catalysts for splitting ammonia in the future," concludes Martin Muhler. "Ammonia synthesis and decomposition has a long track record," he adds. "We cite scientific publications from the past 100 years." These include the work of Martin Muhler's doctoral supervisor Gerhard Ertl, who was awarded the Nobel Prize for his research in 2007.

Science Daily, 8 October 2024

https://sciencedaily.com

Japanese Scientists Develop a Greener Way To Produce Chemical Building Block

2024-10-07

A new study introduces an eco-friendly method using an AEM electrolyzer to hydrogenate cyclic amines, reducing the chemical industry's carbon emissions. This process replaces fossil fuels with water and renewable electricity, maintaining high efficiency.

To reduce the environmental impact of the chemical manufacturing industry, it is crucial to develop greener methods for producing the chemical building blocks of widely used compounds.

It's no secret manufacturing processes have some of the most impactful and intense effects on the environment, with the chemical manufacturing industry topping the charts for both energy consumption and emissions output. While this makes sense thanks to the grand scale in which manufactured chemicals are involved in daily life, it still leaves a lot to be desired for sustainability's sake. By focusing on renewable energy sources and alternative methods for creating the chemical building blocks of some of the most commonly used compounds, researchers hope to reduce the chemical manufacturing industry's footprint with some green innovation.

Researchers published their results in the Journal of the American Chemical Society on October 7.

The main focus of this study is cyclic amines, as these are the most important building blocks for fine chemicals. These compounds are arranged in a ring and, in this case, have a nitrogen atom. One of the stars of the show is pyridine, which gives way to piperidine, a cyclic amine that is of key importance in the fine chemical industry. Piperidine, for example, provides the framework for many materials such as FDA-approved drugs, pesticides and everyday materials used in many people's lives.

Traditional Methods and Their Limitations

Typical methods of adding hydrogen to a nitrogen-containing cyclic amine involve using hydrogen gas as a proton and electron source. The hydrogenation process relies on hydrogen obtained through the steam reforming of methane, a major greenhouse gas. Not only is this method energy-intensive, but it also is responsible for around 3% of the global carbon dioxide emissions. This process is also highly dependent on fossil fuels and takes a great amount of energy. Fortunately, researchers have

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found a way around this by developing an anion-exchange membrane (AEM) electrolyzer.

An AEM electrolyzer allows for the hydrogenation of different kinds of pyridines at ambient temperature and pressure, without having to use acidic additives like in traditional methods. The electrolyzer works to split water into its components, atomic hydrogen and oxygen. The atomic hydrogen obtained is then added to the cyclic compound. The AEM electrolyzer also demonstrates great versatility with other nitrogen-containing aromatics, making it a promising path for a wide set of applications. Additionally, by developing a method that can be used at ambient temperatures and pressures, the electrical energy needed for the process is dramatically decreased.

"The method offers significant potential for industrial-scale applications in pharmaceuticals and fine chemicals, contributing to the reduction of carbon emissions and advancing sustainable chemistry," said Naoki Shida, first author of the study and researcher at Yokohama National University.

Benefits of the AEM Electrolyzer Method

This process uses water and renewable electricity as an energy source, contrasting with the reliance on fossil fuels for the conventional method. Efficiency has not been compromised with this method and the percent yield on a large scale is 78%, further affirming this technology can be reasonably scalable. One issue that might be encountered is an increase in cell voltage during the electrolysis process, but this can be mitigated through either improved AEM or, preferably, designing an AEM with organic electrosynthesis specifically in mind.

For the electrocatalytic hydrogenation technology to catch on and make a difference, it needs to be scalable to an industrial scale for pharmaceutical and fine chemical companies to use it. The more this technology is used, the easier it is to transition it to be used for other nitrogen-containing aromatic compounds, further expressing the practicality of the electrocatalytic hydrogenation process. Ideally, this method would establish itself as the alternative to traditional methods used in the chemical industry and down the line would reduce the overall carbon footprint chemical manufacturing leaves behind.

Sci Tech Daily, 7 October 2024

https://scitechdaily.com

A sprinkle of boron makes for a better fusion reactor recipe

2024-10-08

Seeking to improve the tokamak fusion reactor known as ITER, researchers have found a way to stop rogue tungsten atoms from shearing off the walls and messing with the plasma. The finding is another important milestone on fusion's road to success.

As the science of nuclear fusion continues to advance, tackling some of the smaller issues that arise through advancing research can have a big impact. One of the concerns scientists have about fusion reactors has to do with tungsten. The element is increasingly being explored as a way to line the inside of plasma fusion reactors known as tokamaks and stellarators because of its ability to withstand the scorching temperatures created inside of them.

But when the super hot plasma that's held inside these reactors bumps into walls lined in tungsten, some of the metal's atoms pop off and join the plasma. This has the unwanted effect of cooling the plasma and making a fusion reaction less likely.

Now, after conducting tests at three tungsten-lined tokamaks and using computer modeling, researchers at the U.S. Department of Energy's Princeton Plasma Physics Laboratory have come up with a novel solution. They found that injecting boron powder into the reactor shields the tungsten walls from the ravages of the plasma and allows it to hold on to all of its atoms.

"The boron is sprinkled into the tokamak plasma as a powder, like from a saltshaker, which is ionized at the plasma's edge and then deposited on the tokamak's inner walls and the exhaust region," said Joseph Snipes, Princeton's deputy head for Tokamak Experimental Science. "Once coated with a thin layer of boron, it will stop the tungsten from getting into the plasma and radiating away the plasma energy."

Snipes and his team found that the boron could be sprinkled from one location only to successfully coat all the walls. They are now working to develop a boron injection system that could potentially be used at the ITER reactor-scale tokamak.

ITER, which stands for the International Thermonuclear Experimental Reactor, is located in southern France and will be the world's largest nuclear fusion plant when it comes online. The system was originally

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scheduled to begin operations in 2025, but that timeline has been extended by about 10 years.

The researchers are presenting their findings this week at the 66th Annual Meeting of the American Physical Society Division of Plasma Physics in Atlanta, Georgia.

Source: Princeton Plasma Physical Laboratory

New Atlas, 8 October 2024

https://newatlas.com

Liquefied natural gas carbon footprint is worse than coal

2024-10-03

Liquefied natural gas leaves a greenhouse gas footprint that is 33% worse than coal, when processing and shipping are taken into account, according to a new Cornell University study.

"Natural gas and shale gas are all bad for the climate. Liquefied natural gas (LNG) is worse," said Robert Howarth, author of the study and a professor of ecology and environmental biology. "LNG is made from shale gas, and to make it you must supercool it to liquid form and then transport it to market in large tankers. That takes energy."

The research, "The Greenhouse Gas Footprint of Liquefied Natural Gas (LNG) Exported from the United States," published Oct. 3 in Energy Science & Engineering.

The emissions of methane and carbon dioxide released during LNG's extraction, processing, transportation and storage account for approximately half of its total greenhouse gas footprint, Howarth said.

Over 20 years, the carbon footprint for LNG is one-third larger than coal, when analyzed using the measurement of global warming potential, which compares the atmospheric impact for different greenhouse gases. Even on a 100-year time scale -- a more-forgiving scale than 20 years -- the liquefied natural gas carbon footprint equals or still exceeds coal, Howarth said.

The findings have implications for LNG production in the U.S., which is the world's largest exporter after it lifted an export ban in 2016, according to the paper. Almost all of the increase in natural gas production since 2005

has been from shale gas. Howarth said the exported LNG is produced from shale in Texas and Louisiana.

The liquefication process -- where the extracted natural gas is cooled to minus 260 degrees Fahrenheit -- makes LNG easier to transport on tanker ships.

But that mode of transportation comes at an environmental cost. The ships with two- or four-stroke engines that transport LNG have lower carbon dioxide emissions than steam-powered ships. But as those stroke-engine vessels burn LNG during storage and transportation, methane slips through as emitted exhaust gas, putting more into the atmosphere.

Methane is more than 80 times more harmful to the atmosphere than carbon dioxide, so even small emissions can have a large climate impact, Howarth said.

That's why, he said, the modern LNG tankers with two- and four-stroke engines have more greenhouse gas emissions than those tankers powered by steam. Regardless of better fuel efficiency and lower carbon dioxide emissions, methane still escapes in the tanker's exhaust.

Significant methane emissions occur in the natural gas liquefication process, a figure close to 8.8% of total when using the global warming potential. Methane emissions from tankers vary from 3.9% to 8.1%, depending on the ship.

"Almost all the methane emissions occur upstream when you're extracting the shale gas and liquefying it," Howarth said. "This is all magnified just to get the liquefied natural gas to market.

"So liquefied natural gas will always have a bigger climate footprint than the natural gas, no matter what the assumptions of being a bridge fuel are," Howarth said. "It still ends up substantially worse than coal."

The research was supported by a grant from the Park Foundation.

Science Daily, 3 October 2024

https://sciencedaily.com

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