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

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ASIA PACIFIC

Our new agricultural inhibitors webpage is live

2024-04-04

Inhibitors are substances that decrease the harmful effects agricultural activity can have on the environment. Agricultural inhibitors include methane, nitrification, and urease inhibitors.

They may be (or contain) hazardous substances and require our approval before they can be used in Aotearoa New Zealand.

We've launched a new webpage with information and a step-by-step guide, so you can find out whether your inhibitor substance needs approval under the HSNO Act, and if it does, how to find the right approval.

We will continue to update the page with new information as specific examples and scenarios become available.

Read More

EPA New Zealand, 04-04-24

<https://www.epa.govt.nz/hazardous-substances/rules-notice-and-how-to-comply/specific-substance-guidance/agricultural-inhibitors/>

Proposed regulatory decision for fenitrothion reconsideration

2024-04-09

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has published its proposed decision on the reconsideration of fenitrothion, an insecticide used for the control of pests in agricultural situations. This includes the control of locusts and grasshoppers in pasture and cereal crops, and as a grain protectant for stored cereal grains.

The APVMA is proposing to:

- vary and affirm the active constituent approval
- vary and affirm chemical product registrations and associated labels where at least one use pattern is proposed to be supported
- cancel one chemical product registration and associated label approvals.

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The proposed decision includes consideration of all current active constituents, chemical products and associated labels.

A summary of fenitrothion uses, which are proposed to be supported or not supported, are available on the APVMA website. A summary of the underlying risk assessments has also been published in the Review Technical report.

Public consultation on the proposed decision is open for 3 months and will close on 8 July 2024. The APVMA Special Gazette, 9 April 2024 includes more information about the proposed decision and how to make a submission.

Enquiries about the proposed decision or public consultation can be directed to enquiries@apvma.gov.au.

Read More

APVMA, 09-04-24

<https://www.apvma.gov.au/news-and-publications/publications/gazette/special-gazette-9-apr-24>

'Forever chemicals' of the modern world that will not go away

2024-04-9

Scientists are warning that the environmental impact of a group of more than 14,000 human-made chemicals known as Per- and poly-fluoroalkyl substances (PFAS) has been seriously underestimated and likely surpass the limits for safe human consumption.

PFAS are known as 'forever chemicals' because they do not degrade. They have been widely used since the 1950s for common applications where heat resistance or water, grease and stain resistance is required.

For the first time, an international study led by researchers from UNSW Sydney has assessed worldwide contamination levels of surface and groundwater.

The findings show that PFAS materials in products such as non-stick frypans, clothing, cosmetics, insecticides and food packaging exist at levels that exceed safe drinking water standards.

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According to UNSW's Professor Denis O'Carroll, after collating and peer-reviewing more than 45,000 data points spanning about 20 years, PFAS contamination of water was 5-50% higher than drinking standards.

"Many of our source waters are above PFAS regulatory limits. We already knew that PFAS is pervasive in the environment, but I was surprised to find out the large fraction of source waters that are above drinking water advisory recommendations," O'Carroll said.

The senior author of the paper and head of the university's water research laboratory noted this was the first study to attempt to quantify PFAS environmental impact on a global scale.

Read More

The mandarin, 09-04-24

<https://www.themandarin.com.au/243637-forever-chemicals-of-the-modern-world-that-will-not-go-away/>

Bureau of Indian Standards Issues Draft Specification for Use of Polystyrene with Food Pharmaceuticals and Drinking Water

2024-04-09

The Bureau of Indian Standards (BIS) has issued a draft Indian Standard for Polystyrene (Crystal and High Impact) to ensure its safe use with food, pharmaceuticals, and drinking water. The standard, a revision of IS 10142, focuses on preventing toxic hazards from polymer additives and impurities. Comments are invited until 13 April 2024.

Addressing Safety Concerns in the Use of Polystyrene

The standard emphasizes the inert nature of polystyrene but recognizes the potential for additives and impurities to migrate into packaged materials, posing risks to consumers over time. It is based on the original standard of 1982 and the first revision of 1999 and is in line with international regulations such as the FDA regulations in the USA and EU directives. This second revision introduces modifications to Clause 4.1 on basic resins and updates cross-referenced standards.

In addition, the standard is designed to complement existing Indian Standards on plastics for food contact applications and to improve quality monitoring of polystyrene materials. It emphasises the importance of using these standards together to ensure consumer safety and health.

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Read More

Indian Chemical Regulation Helpdesk, 09-04-24

<https://indianchemicalregulation.com/bureau-of-indian-standards-issues-draft-specification-for-use-of-polystyrene-with-food-pharmaceuticals-and-drinking-water/>

AMERICA

Risk Evaluation for Formaldehyde

2024-03-15

On March 15, 2024, EPA released the draft risk evaluation under the Toxic Substances Control Act (TSCA) for formaldehyde for public comment and peer review.

Formaldehyde's use as a pesticide is also undergoing a separate review under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The FIFRA risk assessment, which addresses the pesticidal uses of formaldehyde, will be released in 2024 on docket EPA-HQ-OPP-2015-0739.

Risk Evaluation Findings

EPA preliminarily finds that formaldehyde poses unreasonable risk to human health. However, EPA notes that these risks may not apply to everyone, everywhere and describes some of the sources of uncertainties in EPA's findings.

Due to its varied sources, people are routinely exposed to formaldehyde in indoor and outdoor environments, often from more than one source at a time. High levels of exposures to formaldehyde can cause health problems when inhaled and if it is absorbed into the skin. Inhaling high levels of formaldehyde for a short period of time can cause sensory irritation such as eye irritation. Inhaling formaldehyde for longer periods of time can damage the lungs and increase asthma and allergy-related conditions, sensory irritation, reproductive toxicity, and cancer. Skin contact with products containing formaldehyde can also cause allergic reactions.

In the draft risk evaluation, EPA evaluated the risks that arise from ways in which people may be exposed to formaldehyde from the production and use of products that are subject to TSCA - as opposed to exposures from those products that are excluded from TSCA (such as pesticides) and exposures from sources of formaldehyde that are biogenic such as

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APR. 19, 2024

breathing and the decomposition of leaves) and exposures from other sources of formaldehyde.

[Read More](#)

US EPA, 15-03-24

<https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-evaluation-formaldehyde>

New Virginia law to increase monitoring for 'forever chemicals' in drinking water

2024-04-09

Gov. Glenn Youngkin has signed into law measures that will increase monitoring statewide for hazardous chemicals such as the one detected in Spring Hollow reservoir.

Introduced by Del. Sam Rasoul, D-Roanoke, the legislation establishes a framework for the regulation of forever chemicals, also known as PFAS for per- and polyfluoroalkyl substances. Rasoul's bill and one from Sen. Jeremy McPike, D-Prince William, received strong support this year in the General Assembly.

"In a bipartisan way, people are very concerned about dangerous chemicals being released into our drinking water," Rasoul said Tuesday.

Currently, some public water systems either test for PFAS themselves or agree to monitoring by the Virginia Department of Health. The legislation, to take effect July 1, requires VDH to share with the Virginia Department of Environmental Quality all test results that show levels above a maximum contaminant level, which varies depending on the chemical.

[Read More](#)

The Roanoke Times, 09-04-24

https://roanoke.com/news/local/new-virginia-law-to-increase-monitoring-for-forever-chemicals-in-drinking-water/article_43a17a0a-f6a5-11ee-b389-8b09a3cdbc6d.html

Per- and Polyfluoroalkyl Substances (PFAS)

2024-04-10

Final PFAS National Primary Drinking Water Regulation

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On April 10, 2024, EPA announced the final National Primary Drinking Water Regulation (NPDWR) for six PFAS. To inform the final rule, EPA evaluated over 120,000 comments submitted by the public on the rule proposal, as well as considered input received during multiple consultations and stakeholder engagement activities held both prior to and following the proposed rule. EPA expects that over many years the final rule will prevent PFAS exposure in drinking water for approximately 100 million people, prevent thousands of deaths, and reduce tens of thousands of serious PFAS-attributable illnesses.

EPA is also making unprecedented funding available to help ensure that all people have clean and safe water. In addition to today's final rule, \$1 billion in newly available through the Bipartisan Infrastructure Law to help states and territories implement PFAS testing and treatment at public water systems and to help owners of private wells address PFAS contamination.

EPA finalized a National Primary Drinking Water Regulation (NPDWR) establishing legally enforceable levels, called Maximum Contaminant Levels (MCLs), for six PFAS in drinking water. PFOA, PFOS, PFHxS, PFNA, and HFPO-DA as contaminants with individual MCLs, and PFAS mixtures containing at least two or more of PFHxS, PFNA, HFPO-DA, and PFBS using a Hazard Index MCL to account for the combined and co-occurring levels of these PFAS in drinking water.

EPA also finalized health-based, non-enforceable Maximum Contaminant Level Goals (MCLGs) for these PFAS.

[Read More](#)

US EPA, 10-04-24

<https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas#Regs>

What they're saying about the EPA's regulation of 'forever chemicals' in drinking water

2024-04-10

On April 10 the Environmental Protection Agency unveiled a new regulation to tackle drinking water contamination from the "forever chemicals" known as PFAS. To get these toxic chemicals out of our drinking water, the rule establishes maximum contaminant levels, or MCLs, that set limits on six notorious PFAS: PFOA, PFOS, GenX, PFBS, PFNA and PFHxS.

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Here are excerpts from the statements of environmental, health and community advocacy leaders and organizations about the EPA announcement, which marks historic progress addressing PFAS.

Tony Spaniola, co-chair, Great Lakes PFAS Action Network: "This is a monumental victory for the American people. Simply put, these PFAS drinking water standards will save the lives of countless Americans for generations to come. Thank you to President Biden for putting public health and science above the demands of powerful special interests. Thank you to the EPA for its diligent work. And thank you to our friends and allies in communities across the country for never giving up. Together, we have shown that the government can work for all of us."

Linda Birnbaum, Ph.D., former director of the National Institute of Environmental Health Sciences: "We've been waiting for federal regulation of these chemicals for a long time. We know that drinking water is a very significant source of the contamination."

Ken Cook, president, Environmental Working Group: "More than 200 million Americans could have PFAS in their tap water, and for decades Americans have been exposed to toxic 'forever chemicals' with no oversight from their government. Today's announcement of robust, health-protective legal limits on PFAS in tap water will finally give tens of millions of Americans the protection they should have had decades ago. It is the most consequential decision to regulate drinking water in 30 years." Statement

Emily Donovan, co-founder, Clean Cape Fear: "We learned about GenX and other PFAS in our tap water six years ago. I raised my children on this water and watched loved ones suffer from rare or recurrent cancers. No one should ever worry if their tap water will make them sick or give them cancer. I'm grateful the Biden EPA heard our pleas and kept its promise to the American people. We will keep fighting until all exposures to PFAS end and the chemical companies responsible for business-related human rights abuses are held fully accountable."

Read More

PBS, 09-04-24

<https://www.ewg.org/news-insights/news/2024/04/what-theyre-saying-about-epas-regulation-forever-chemicals-drinking>

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More than 200 chemical plants must reduce toxic emissions under new EPA rule

2024-04-09

More than 200 chemical plants nationwide will be required to reduce toxic emissions that are likely to cause cancer under a new rule issued Tuesday by the Environmental Protection Agency. The rule advances President Joe Biden's commitment to environmental justice by delivering critical health protections for communities burdened by industrial pollution from ethylene oxide, chloroprene and other dangerous chemicals, officials said.

Areas that will benefit from the new rule include majority-Black neighborhoods outside New Orleans that EPA Administrator Michael Regan visited as part of his 2021 Journey to Justice tour. The rule will significantly reduce emissions of chloroprene and other harmful pollutants at the Denka Performance Elastomer facility in LaPlace, Louisiana, the largest source of chloroprene emissions in the country, Regan said.

Read More

PBS, 09-04-24

<https://www.pbs.org/newshour/science/more-than-200-chemical-plants-must-reduce-toxic-emissions-under-new-epa-rule>

Notice of Proposed Rulemaking Title 27, California Code of Regulations Safe Harbor Warnings for Acrylamide Exposure from Food

2024-04-05

Public Comments Date:

Friday, April 5, 2024 to Monday, May 20, 2024

The Office of Environmental Health Hazard Assessment (OEHHA) proposes to amend Article 6 of Title 27 of the California Code of Regulations, section 25607.2. This proposed rulemaking would amend subsection (b) to provide an additional safe harbor warning option, for businesses that cause significant exposures to acrylamide in food products.

- Notice
- Initial Statement of Reasons
- Proposed Regulatory Text

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Public Comments

To be considered, OEHHA must receive comments by May 20, 2024, the designated close of the written comment period. All written comments will be posted on the OEHHA website at the close of the public comment period.

OEHHA strongly recommends that the public submit written information electronically, rather than in paper form. Comments may be submitted electronically through our website at <https://oehha.ca.gov/comments>.

Link to Public Comments

Comment Submissions - Notice of Proposed Rulemaking Title 27, California Code of Regulations Safe Harbor Warnings for Acrylamide Exposure from Food

Downloads

Notice of Proposed Rulemaking Title 27, California Code of Regulations Safe Harbor Warnings for Acrylamide Exposure from Food

Apr 5, 2024

Initial Statement of Reasons Safe Harbor Warning for Acrylamide Exposure from Food

Apr 5, 2023

Proposed Amendments to the Proposition 65 Clear and Reasonable Warning Regulation: Safe Harbor Methods and Content

Apr 5, 2024

<https://oehha.ca.gov/proposition-65/crn/notice-proposed-rulemaking-title-27-california-code-regulations-safe-harbor>

Read More

CA.gov, 05-04-24

<https://oehha.ca.gov/proposition-65/crn/notice-proposed-rulemaking-title-27-california-code-regulations-safe-harbor>

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EUROPE

EU VOTES TO UPDATE RULES ON THE TREATMENT OF URBAN WASTEWATER

2024-04-11

Since regulations on urban wastewater treatment were introduced in the 1990s, water quality across the European Union has improved substantially.

Presently, 98% of wastewater is collected and treated according to EU standards. But, despite this progress, instances of insufficient wastewater treatment persist, and the situation is being made worse by challenging-to-treat chemicals like PFAS, known as 'forever chemicals', which continue to impact both the environment and the health of Europeans.

In a recent development, the European Parliament voted this week to update regulations concerning the collection, treatment, and discharge of urban wastewater.

These updated rules aim to improve environmental protection and human health standards. However, local authorities across Europe have expressed concerns about the costs involved.

According to the updated rules, by 2035, all settlements with a minimum of 1,000 inhabitants will need to ensure the removal of biodegradable organic matter, such as food waste or faeces.

In addition to this, towns exceeding 150,000 inhabitants must have systems in place to eliminate nitrogen and phosphorus by 2039, with towns of 10,000 people or more to follow suit by 2045. Municipalities with populations over 150,000 will also need to subject micropollutants to advanced treatment by 2045.

Read More

Euractiv, 11-04-24

<http://eu-policies.com/competences/health/eu-votes-update-rules-treatment-urban-wastewater/>

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EU REPORT HIGHLIGHTS THE NEED TO REDUCE TRANSPORT EMISSIONS

2024-04-05

Although emissions from sectors like energy, industry, buildings, and agriculture have decreased since 1990, greenhouse gas emissions from transportation have surged by 26%, reaching 1,046 megatonnes of CO₂ in 2023.

According to a report by the NGO Transport & Environment (T&E), while there may be a slight reduction in transport emissions by 2030, they are expected to remain significantly above the EU's emissions reduction target of -55% compared to 1990 levels. This would place a heavier burden on other sectors to meet the target.

The report suggests that if emissions reductions in other sectors align with the EU's target, the transport sector could contribute to 44% of total emissions, up from the current 29%.

The increase in transport emissions is attributed mostly to higher levels of mobility, with car travel rising by 15% since 2000 and aviation emissions more than doubling since 1990. Freight transport emissions have also risen, with lorries and buses seeing a 25% increase and shipping emissions up by 20% compared to 1990 levels.

While technological solutions like electric cars exist, their widespread deployment will take time. In 2023, only one in six new cars sold were fully electric, and considering the average lifespan of cars, it will take years for electric vehicles to replace the current fleet.

T&E proposes regulating company cars, which constitute 58% of new car sales, as a means to drive demand for electric vehicles. The European Commission is exploring this idea through a public consultation.

Read More

Euractiv, 05-04-24

<http://eu-policies.com/competences/climate/eu-report-highlights-need-reduce-transport-emissions/>

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INTERNATIONAL

Study maps "forever chemical" water contamination hotspots worldwide, including many in U.S.

2024-04-10

Dangerous concentrations of long-lingering "forever chemicals" have been found in surface and groundwater worldwide, according to a study released Tuesday that showed Australia, the United States and Europe as hotspots.

A paper published in the journal Nature Geoscience analysed data from 45,000 water samples globally and found a "substantial fraction" had levels of PFAS — per- and polyfluoroalkyl substances — above recommended levels.

Found in everyday products such as non-stick frying pans, food packaging and waterproof clothing, the substances have been linked to serious health conditions including cancer and birth defects.

They have been found everywhere from turtle eggs to Antarctic snow, but the latest study showed they were prevalent in surface water and groundwater used by humans for drinking.

"Many of our source waters are above PFAS regulatory limits," said Denis O'Carroll, one of the study's authors and a professor at the University of New South Wales in Australia.

Read More

CBS News, 10-04-24

<https://www.cbsnews.com/news/pfas-forever-chemicals-maps-show-water-contamination-hotspots-worldwide/>

Deciphering the differences in plastic particles reported in foods

2024-04-11

Microplastics (MPs) can get into foods through two main pathways, (1) from an organism collecting the particles from the environment while alive, e.g., filter feeding shrimp; or (2) from packaging or processing equipment.

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To get a better understanding of human exposure to microplastics from foods, Emine Merve Canga and co-authors from University College Dublin reviewed research on microplastics in foods via both pathways. By analyzing the factors contributing to the wide range in numbers of reported particles, they hoped to elucidate inconsistencies in research methodology and provide recommendations to improve MP assessment.

Canga et al. found 67 studies fitting their search criteria which they broadly categorized by either food type: salt, seafood, honey, beer, produce, bottled waters; or by packaging type: takeaway containers, disposable cups, teabags, infant feeding bottles.

Of the four packaging types investigated, tea bags had by far the greatest discrepancy in reported particles. They explain, “[o]ne study reported that approximately 15 billion MPs were released into a cup of tea from a single teabag, whereas another research paper found only approximately 106.3 ± 14.6 MP/teabag after brewing.” The authors propose that the difference in the tea bag studies could come from the polymers of the tea bags. The four studies all counted MPs in the same size range but some used nylon while others had PET or did not report what their teabags were made from. Additionally, “properties of teabag brands, and the features of the production processes might lead to inconsistent outcomes.”

Read More

FPF, 11-04-24

<https://www.foodpackagingforum.org/news/deciphering-the-differences-in-plastic-particles-reported-in-foods>

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REACH Update

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New CLP hazard classes will be included in IUCLID

2024-04-09

Companies can soon start including information on new hazard classes in their IUCLID dossiers, following the amendment of the Classification, Labelling and Packaging (CLP) Regulation.

Helsinki, 9 April 2024 - The new hazard classes for classifying, labelling and packaging substances and mixtures will be included in the IUCLID software from 29 April 2024.

These are:

- endocrine disruptors (ED) for human health or the environment;
- persistent, bioaccumulative and toxic (PBT); very persistent and very bioaccumulative (vPvB); and
- persistent, mobile and toxic (PMT); very persistent and very mobile (vPvM).

Companies can start including information concerning these hazards when submitting dossiers under the CLP, REACH and Biocidal Products regulations to ECHA.

Different transition periods apply for substances and mixtures. Once they have expired, companies must indicate how their substance or mixture is classified following the new hazard classes when submitting information to ECHA.

There are currently no changes to the completeness check of REACH registrations in relation to the new hazard classes, but the IUCLID Validation assistant will remind companies to start entering this data whenever available. ECHA is also updating the manuals on dossier preparation with advice regarding the new IUCLID fields.

ECHA's newly launched chemicals database, ECHA CHEM, will be expanded in autumn 2024 to include the re-designed classification and labelling inventory, which will also cover the new hazard classes.

Guidance on the new hazard classes will be available later this year.

Read More

ECHA, 09-04-24

<https://echa.europa.eu/es/-/new-clp-hazard-classes-will-be-included-in-iuclid>

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Janet's Corner

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How the first molecule in the universe was formed?

2024-04-19



https://twitter.com/por_nerdism/status/1211681364048658433/photo/1

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Hazard Alert

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1,3-Dichloropropene

2024-04-19

USES [2,3]

1,3-Dichloropropene is used mainly in farming as a pesticide, specifically as a preplant fumigant and nematicide. It is widely used in the United States and other countries, but is in the process of being phased out in the European Union. It is also used in making other chemicals.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

The primary source of exposure to 1,3-dichloropropene is by breathing air containing it. This can occur either via contaminated workplace air or air around hazardous waste sites that contain it. Exposure may also occur through drinking contaminated water or touching contaminated soil where it is produced or used, or near hazardous waste sites that contain it.

Routes of Exposure

The main routes of exposure to 1,3-dichloropropene are:

- inhalation,
- skin absorption,
- ingestion,
- skin and/or eye contact

HEALTH EFFECTS [4]

Acute Health Effects

Acute inhalation exposure of humans after a tank truck spill resulted in mucous membrane irritation, cough, chest pain, and breathing difficulties. Effects on the lung, including emphysema and oedema, have been observed in rats acutely exposed to 1,3-dichloropropene by inhalation. Lung congestion and haemorrhage, ulcerations of the glandular stomach, haemorrhage of the small intestine, dark and patchy liver, and haemorrhage of the liver have been observed in rats acutely exposed to 1,3-dichloropropene in their diet or via gavage (experimentally placing the chemical in the stomach). Neurotoxic effects, including hunched posture, lethargy, ptosis, ataxia, and decreased respiratory rate, have also

1,3-Dichloropropene, chemical formula C₃H₄Cl₂, is a clear to straw-coloured liquid with a sharp, sweet, irritating odour. [1] 1,3-Dichloropropene dissolves in water and evaporates easily. It is a by-product in the chlorination of propene to make allyl chloride [1,2]

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been observed in orally exposed rats. Acute animal tests in rats, mice, and rabbits have demonstrated 1,3-dichloropropene to have moderate acute toxicity from inhalation, moderate to high acute toxicity from oral exposure, and high acute toxicity from dermal exposure.

Carcinogenicity

Information on the carcinogenic effects of 1,3-dichloropropene in humans is limited. Two cases of histiocytic lymphomas and one case of leukaemia have been reported in emergency response personnel exposed to concentrated 1,3-dichloropropene vapours during cleanup of a tank truck spill. An increased incidence of bronchioalveolar adenomas has been reported in male mice exposed by inhalation but not in rats or female mice. Forestomach and liver tumours in rats and forestomach, urinary bladder, and lung tumours in mice have been observed in rodents exposed to 1,3-dichloropropene via gavage. Liver tumours were noted in rats exposed to 1,3-dichloropropene in the diet. EPA has classified 1,3-dichloropropene as a Group B2, probable human carcinogen.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Immediately flush with large amounts of water for at least 15 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while flushing. Seek medical attention immediately.
- **Skin Contact:** Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of soap and water.
- **Inhalation:** Remove the person from exposure. Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped. Transfer promptly to a medical facility.

Workplace Controls & Practices [4]

Control measures include:

- enclosing chemical processes for severely irritating and corrosive chemicals,
- using local exhaust ventilation for chemicals that may be harmful with a single exposure, and
- using general ventilation to control exposures to skin and eye irritants.

The following work practices are also recommended:

- Label process containers.

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- Provide employees with hazard information and training.
- Monitor airborne chemical concentrations.
- Use engineering controls if concentrations exceed recommended exposure levels.
- Provide eye wash fountains and emergency showers.
- Wash or shower if skin comes in contact with a hazardous material.
- Always wash at the end of the workshift.
- Change into clean clothing if clothing becomes contaminated.
- Do not take contaminated clothing home.
- Get special training to wash contaminated clothing.
- Do not eat, smoke, or drink in areas where chemicals are being handled, processed or stored.
- Wash hands carefully before eating, smoking, drinking, applying cosmetics or using the toilet.

Personal Protective Equipment [5]

Gloves and Clothing

- Avoid skin contact with 1,3-Dichloropropene.
- Wear personal protective equipment made from material that cannot be permeated or degraded by this substance.
- Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove and clothing material for your operation.
- All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection

- Wear indirect-vent, impact and splash resistant goggles when working with liquids.
- Wear a face shield along with goggles when working with corrosive, highly irritating or toxic substances.
- Do not wear contact lenses when working with this substance.

Respiratory Protection

- Improper use of respirators is dangerous.
- Respirators should only be used if the employer has implemented a written program that takes into account workplace conditions,

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requirements for worker training, respirator fit testing, and medical exams.

- Where the potential exists for exposure over 1 ppm, use an approved supplied-air respirator with a full face-piece operated in a pressure-demand or other positive-pressure mode.
- For increased protection use in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.

REGULATION

United States

- NIOSH: The National Institute for Occupational Safety & Health has set a recommended airborne exposure limit (REL) of 1 ppm averaged over a 10-hour workshift for 1,3-dichloropropene.
- ACGIH: The American Conference of Governmental Industrial Hygienists has set a threshold limit value (TLV) is 1 ppm averaged over an 8-hour workshift.

Australia

- Safe Work Australia: The recommended time weighted exposure limit is 1ppm over an 8-hour period.

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Microplastics Make Their Way from the Gut to Other Organs

2024-04-15

It's happening every day. From our water, our food and even the air we breathe, tiny plastic particles are finding their way into many parts of our body.

But what happens once those particles are inside? What do they do to our digestive system?

In a recent paper published in the journal *Environmental Health Perspectives*, University of New Mexico researchers found that those tiny particles – microplastics – are having a significant impact on our digestive pathways, making their way from the gut and into the tissues of the kidney, liver and brain.

Eliseo Castillo, PhD, an associate professor in the Division of Gastroenterology & Hepatology in the UNM School of Medicine's Department of Internal Medicine and an expert in mucosal immunology, is leading the charge at UNM on microplastic research.

"Over the past few decades, microplastics have been found in the ocean, in animals and plants, in tap water and bottled water," Castillo says. "They appear to be everywhere."

Scientists estimate that people ingest 5 grams of microplastic particles each week on average – equivalent to the weight of a credit card.

While other researchers are helping to identify and quantify ingested microplastics, Castillo and his team focus on what the microplastics are doing inside the body, specifically to the gastrointestinal (GI) tract and to the gut immune system.

Over a four-week period, Castillo, postdoctoral fellow Marcus Garcia, PharmD, and other UNM researchers exposed mice to microplastics in their drinking water. The amount was equivalent to the quantity of microplastics humans are believed to ingest each week.

Microplastics had migrated out of the gut into the tissues of the liver, kidney and even the brain, the team found. The study also showed the microplastics changed metabolic pathways in the affected tissues.

"We could detect microplastics in certain tissues after the exposure," Castillo says. "That tells us it can cross the intestinal barrier and infiltrate into other tissues."

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Castillo says he's also concerned about the accumulation of the plastic particles in the human body. "These mice were exposed for four weeks," he says. "Now, think about how that equates to humans, if we're exposed from birth to old age."

The healthy laboratory animals used in this study showed changes after brief microplastic exposure, Castillo says. "Now imagine if someone has an underlying condition, and these changes occur, could microplastic exposure exacerbate an underlying condition?"

He has previously found that microplastics are also impacting macrophages – the immune cells that work to protect the body from foreign particles.

In a paper published in the journal *Cell Biology & Toxicology* in 2021, Castillo and other UNM researchers found that when macrophages encountered and ingested microplastics, their function was altered and they released inflammatory molecules.

"It is changing the metabolism of the cells, which can alter inflammatory responses," Castillo says. "During intestinal inflammation – states of chronic illness such as ulcerative colitis and Crohn's disease, which are both forms of inflammatory bowel disease – these macrophages become more inflammatory and they're more abundant in the gut."

The next phase of Castillo's research, which is being led by postdoctoral fellow Sumira Phatak, PhD, will explore how diet is involved in microplastic uptake.

"Everyone's diet is different," he says. "So, what we're going to do is give these laboratory animals a high-cholesterol/high-fat diet, or high-fiber diet, and they will be either exposed or not exposed to microplastics. The goal is to try to understand if diet affects the uptake of microplastics into our body."

Castillo says one of his PhD students, Aaron Romero, is also working to understand why there is a change in the gut microbiota. "Multiple groups have shown microplastics change the microbiota, but how it changes the microbiota hasn't been addressed."

Castillo hopes that his research will help uncover the potential impacts microplastics are having to human health and that it will help spur changes to how society produces and filtrates plastics.

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"At the end of the day, the research we are trying to do aims to find out how this is impacting gut health," he says. "Research continues to show the importance of gut health. If you don't have a healthy gut, it affects the brain, it affects the liver and so many other tissues. So even imagining that the microplastics are doing something in the in the gut, that chronic exposure could lead to systemic effects."

Technology Networks, 15 April 2024

<https://technologynetworks.com>

Microscopy structures reveal mechanism behind bitter taste

2024-04-15

Cryo-electron microscopy (cryo-EM) structures of a human taste receptor have revealed new information about the mechanisms that enable us to perceive bitter flavours.

Our ability to taste bitter flavours is the result of complex interactions between over 1000 compounds and a suite of 26 receptors, called type-2 taste receptors (TAS2Rs). However, understanding of these interactions has been hindered by a lack of structural data.

Now, researchers in the US and China have reported two cryo-EM structures of the human bitter taste receptor, TAS2R14. TAS2R14 spans across the membranes of cells on the tongue as well as numerous other human tissues and can recognise, and bind to, more than 100 structurally diverse tastant compounds that are associated with bitter flavours.

The new structures reveal the presence of two binding sites on the receptor: an allosteric site located inside the cell and an orthosteric site located on the extracellular part of the receptor. A tunnel, surrounded by hydrophobic amino-acid residues, appears to run between the two sites.

The researchers observed that the orthosteric site was occupied by cholesterol – a compound found in all animal cell membranes. The team believe that this puts the receptor in a semi-active state allowing it to be easily activated by the bitter tastant. It is thought that bile acids, which have a similar chemical structure to cholesterol, could also bind to, and activate, TAS2R14.

The only other TAS2R structure to have previously been determined is that of TAS2R46 and comparison with TAS2R14 reveals distinct structural

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differences, suggesting that each TASR2 receptor could bind to particular types of molecule.

During the project, the researchers discovered that the TAS2R14 protein is expressed in many other tissue types and is found in concentrations 100 times higher in the cerebellum than on the tongue. Further work is planned to uncover the role that the receptor plays in cellular signalling outside of the mouth.

Chemistry World, 15 April 2024

<https://chemistryworld.com>

Advanced nuclear magnetic resonance technique reveals precise structural, dynamical details in zeolites

2024-04-17

Zeolites are widely used in many industries, yet their intrinsic catalytic nature is not completely understood, due to the complexity of the hydroxyl-aluminum moieties.

Atomic-scale analysis of local environments for the hydroxyl species is essential for revealing the intrinsic catalytic activity of zeolites and guiding the design of high-performance catalysts. However, many unfavorable factors prohibit the elucidation of their fine structures such as low quantity, meta-stable property, structural similarity, hydrogen-bonding environment, and long-range disordered nature.

Recently, a research team led by Prof. Hou Guangjin and Prof. Chen Kuizhi from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) unraveled the precise structure of complex hydroxyl groups in zeolites with a comprehensive set of self-developed coupling-edited ^1H - ^{17}O solid-state nuclear magnetic resonance (NMR) methods. The study was published in the *Journal of the American Chemical Society*.

The ^{17}O solid-state NMR would be a candidate to improve the analytical precision of zeolites if it could overcome the technical difficulties related to the extremely low natural abundance, low gyromagnetic ratio, and quadrupolar nature of the ^{17}O isotope. Therefore, researchers employed a novel ^{17}O -enrichment method and developed a series of ^{17}O -NMR-based spectral editing pulse sequences, allowing them to improve the spectral resolution and address the subtle protonic structures within zeolites.

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The precise and high-resolution species identification was attributed to comprehensively addressing an often-neglected and undesired NMR interaction, namely, the 2nd-order quadrupolar-dipolar cross-term interaction (2nd-QD interaction), which was indeed helpful in gaining invaluable information on zeolite structures.

In addition, researchers quantitatively probed $\text{Al}\cdots\text{H}$, $\text{O}\cdots\text{H}$ proximities within both one-bond and multi-bond ranges, and semi-quantitatively realized the dissociation rates of hydroxyl protons such as Brønsted acid site. They revealed the atomic-scale local environment of the catalytically important Al-OH and Si-OH moieties.

The NMR techniques developed in this study might be further applied in providing high-resolution analysis of subtle protonic structures in other circumstances such as metal-oxide surfaces, metal-organic frameworks, and biomaterials. "Our study may provide a generic strategy for high-resolution analysis of the subtle protonic structures in zeolites with ^{17}O solid-state NMR," said Prof. Hou.

website, 17 April 2024

<https://phys.org>

Golden Graphene: Researchers Successfully Synthesize "Goldene"

2024-04-17

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

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

In search of "goldene"

The discovery and synthesis of graphene – an allotrope of carbon forming a single layer of carbon atoms – prompted significant interest in the development of alternative 2D materials. Gold became one of the elements at the forefront of these efforts, due to the already apparent usefulness of gold nanoparticles in electronics and biomedicine. But

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synthesizing a 2D material comprised solely of metals turned out to be a very difficult task, due to the metal's tendency to lump together.

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

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

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

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

Japanese smithing technique releases goldene

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

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

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

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the released goldene sheets to prevent them from curling up or lumping together.

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

Goldene is interesting because it exhibits some very special properties. Gold has two free bonds when two-dimensional, which the researchers say could lead to the application of goldene in carbon dioxide conversion, hydrogen-generating catalysis, selective production of value-added chemicals, hydrogen production, water purification, communications and much more.

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

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

Technology Networks, 17 April 2024

<https://technologynetworks.com>

Chemists invent a more efficient way to extract lithium from mining sites, oil fields, used batteries

2024-04-16

Chemists at the Department of Energy's Oak Ridge National Laboratory have invented a more efficient way to extract lithium from waste liquids leached from mining sites, oil fields, and used batteries. They demonstrated that a common mineral can adsorb at least five times more lithium than can be collected using previously developed adsorbent materials.

"It's a low-cost, high-lithium-uptake process," said Parans Paranthaman, an ORNL Corporate Fellow and National Academy of Inventors Fellow with 58 issued patents. He led the proof-of-concept experiment with Jayanthi Kumar, an ORNL materials chemist with expertise in the design, synthesis, and characterization of layered materials.

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“The key advantage is that it works in a wider pH range of 5 to 11 compared to other direct lithium extraction methods,” Paranthaman said. The acid-free extraction process takes place at 140 degrees Celsius, compared to traditional methods that roast mined minerals at 250 degrees Celsius with acid or 800 to 1000 degrees Celsius without acid.

The team has applied for a patent for the invention.

Lithium is a lightweight metal commonly used in energy-dense and rechargeable batteries. Electric vehicles, which are needed to achieve net-zero emissions by 2050, rely on lithium-ion batteries. Industrially, lithium is extracted from brines, rocks and clays. The ORNL innovation may help meet rising demand for lithium by making domestic sources commercially viable.

The research reveals a route away from the status quo: a linear economy in which materials from mining, refining or recycling are made into products that, at the end of their lives, are discarded as waste. The work moves toward a circular economy in which materials are kept in circulation as long as possible to reduce the consumption of virgin resources and the generation of waste.

Phys Org, 16 April 2024

<https://phys.org>

Coffee grinder, old tires spur creation of sulfur-free oil

2024-04-17

Using a coffee grinder, a freezer and a furnace, researchers have discovered a chemical synergy between scrap tires and polystyrene can be harnessed to create sulfur-free, light oil.

Believed to be the first study of its kind, chemical engineers at Monash found strong synergies between tire scrap and plastics including low-density polyethylene (LDPE) and polystyrene when they were treated together in a system using the process known as rapid pyrolysis that involves subjecting them to high temperatures over a short time.

Blending either polystyrene or LDPE with tire scrap for pyrolysis effectively eliminated the production of hazardous sulfur-containing compounds that are normally found in the liquid oil produced from the breakdown of tires.

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Professor Lian Zhang, of the Department of Chemical and Biological Engineering, who led the research team, said LDPE and polystyrene are both very commonly used across a range of consumer goods including packaging, plastic bags and films, bottles and containers and even medical disposables.

“Adding these plastics and using this process to break down tires can substantially reduce the risk of releasing hazardous materials into the environment,” said Professor Zhang.

“We believe our findings provide a very solid foundation and justification for using co-pyrolysis as an effective and value-added technology for upcycling potentially troublesome waste products.”

Further analysis allowed the mechanisms underpinning the interactions between the chemical components in the system to be identified in detail, explained Ph.D. student Wahyu Narulita Dewi, first author of the study just published in the journal *Waste Management*.

The Monash team is already undertaking further work to develop and optimize the technology with the aim of enhancing the yield and the quality of the sulfur-free light oil produced by the process.

Further related research will also be a focus of a new Australian Research Council (ARC) Industrial Transformation Research Hub for Value-Added Processing of Underutilized Carbon Waste, led by Professor Zhang, to be launched later in 2024.

Phys Org, 17 April 2024

<https://phys.org>

Early western European coins' Byzantine origins

2024-04-16

About 200 years after the fall of the Roman Empire, western Europe started making thousands of silver coins, signaling a transformation in the early medieval economy. A new chemical analysis of currency from seventh and eighth centuries England, France, and the Netherlands suggests that this boom in coin production may have started with silver from the Byzantine Empire in the eastern Mediterranean (Antiquity 2024, DOI: 10.15184/aqy.2024.33).

“It’s really interesting when you have the sudden appearance of silver when there has been no silver [coinage] beforehand, to ask where that

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comes from,” says Jane Kershaw, an archaeologist at the University of Oxford who led the study.

Kershaw and collaborators at the University of Cambridge and the Free University of Amsterdam used a technique called portable laser ablation to remove tiny samples of metal from 49 early medieval coins from the Fitzwilliam Museum in Cambridge, England. The researchers carried out the minimally destructive sample collection process at the museum in Cambridge, and then sent the samples to Amsterdam to be analyzed by inductively coupled plasma mass spectrometry.

The researchers looked at the coins’ trace metal content as well as the ratio of lead isotopes in the metal. Kershaw says she had expected all the coins to have been made from silver mined in what is now France, in Melle. The coins made after 750 CE were made from Melle silver, but the 29 oldest coins were clearly from elsewhere, she says. They all had a higher fraction of trace gold and larger amounts of heavier lead isotopes, which suggested that those older coins came from the same silver stock.

The older coins’ composition was distinct from that of silver mined elsewhere in western Europe, recycled Roman silver, and silver from the Middle East. Kershaw says it was surprising to find that the composition matched that of Byzantine silver, because there isn’t much other evidence of trade between the Byzantine Empire and western Europe at the time.

“Researchers often want an easy answer” to provenance questions, says Nicole Little, an analytical scientist at the Smithsonian Institution’s Museum Conservation Institute. Scientists often hope that a single technique or elemental signature revealed all the answers—but artifacts can have complicated histories. Little says Kershaw and her colleagues “did a good job capturing the nuances of analytical chemistry” by collecting both trace element and isotope data to understand the coins’ origins.

Old coinage and other silver artifacts can reveal a lot about history, Kershaw says. “It’s in museum collections. There’s a lot of it. Come on, people, analyze it!”

and, 16 April 2024

<https://cen.acs.org>

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The HPV Vaccine Protects Male Fertility

2024-04-09

If you’re sexually active, you will (almost certainly) contract a sexually transmitted infection (STI). This fate is largely predetermined thanks to the most common STI: human papillomavirus (HPV). It’s so ubiquitous that 90% of sexually active men and 80% of sexually active women become infected during their lifetime.

Though HPV is infamously known for causing unsightly warts around the genitals, most cases are actually asymptomatic and resolve quickly without notice. Some infections, however, ultimately lead to cancers of the cervix, penis, anus, mouth, or throat. Of these, cervical cancer is by far the most dangerous. It kills more than 340,000 women every year.

Thankfully, there are three safe and highly effective vaccines available. If given as recommended during adolescence, they can provide decades of protection against the most dangerous types of HPV that cause genital warts and cancer. Since the vaccines’ arrival over fifteen years ago, rates of genital warts and HPV-linked cancers have fallen precipitously, raising hopes that cervical cancer could actually be eliminated.

Though the HPV vaccine faced some early backlash, particularly from conservative groups who thought it encouraged promiscuity, uptake in the United States has been solid. Nearly 60% of youths aged 13 to 15 were fully vaccinated as of 2021, and this rate is trending strongly towards the goal of 80% coverage by 2030.

HPV vaccine uptake amongst boys has trailed girls’, however. The disparity is undoubtedly due to the intense focus on getting young women and girls vaccinated to prevent cervical cancer. But make no mistake, males have much to gain from vaccination, as well. Not only will they suffer from fewer cases of genital warts and various cancers, they’ll also be far less likely to pass an HPV infection to their partners.

Recent research is shining light on another reason for males to get vaccinated: their fertility.

About 15% of men experience infertility, and in 60% to 75% of instances, the cause is idiopathic, meaning that there’s an unexplained reduction of semen quality. Lifestyle factors such as smoking, drinking, poor diet, and obesity likely play a large role, but so, too might HPV.

“HPV can affect every cellular component of the seminal fluid and could impair sperm parameters, including sperm count, motility, genomic

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integrity, morphology, and concentration, leading to male infertility," a team of researchers based out of the University of Palermo wrote in a paper published December 16th.

Scientists have found the virus in sperm. During insemination, these sperm can transfer viral DNA to the female egg.

"Women inseminated with infected sperm seem to have a higher risk of miscarriage, probably because the virus is transmitted to the trophoblast cells, reducing the blastocyst's potential for implantation," the researchers commented.

Studies suggest vaccination can both prevent and help the immune system clear HPV infections, tangibly boosting male fertility in the process. Vaccinated males show improved sperm motility. Moreover, men infected with HPV who get vaccinated enjoy a higher pregnancy rate with their partners. These couples also experience greater delivery rates of healthy newborns and a decrease in the rate of miscarriage.

Globally, males are already grappling with a potential fertility crisis. Studies consistently show sperm counts in decline. To preserve the integrity of their remaining 'swimmers' and protect their female partners, young men and boys should absolutely get vaccinated against HPV.

Real Clear Science, 09 April 2024

<https://realclearscience.com>

Trash To Treasure: Researchers Turn Metal Waste Into Catalyst for Green Hydrogenphys

2024-04-17

Scientists have found a way to transform metal waste into a highly efficient catalyst to make hydrogen from water, a discovery that could make hydrogen production more sustainable.

A team of researchers from the University of Nottingham's School of Chemistry and Faculty of Engineering have found that the surface of swarf, a byproduct of the metal machining industry, is textured with tiny steps and grooves on a nanoscale level. These textures can anchor atoms of platinum or cobalt, leading to an efficient electrocatalyst that can split water into hydrogen and oxygen. The research has been published in the Journal of Material Chemistry A of the Royal Society of Chemistry.

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Hydrogen is a clean fuel that can be used to generate heat or power vehicles, and the only byproduct of its combustion is water vapor. However, most hydrogen production methods rely on fossil fuel feedstock. Electrolysis of water is one of the most promising green pathways for hydrogen production, as it only requires water and electricity.

The industry is facing a challenge with water electrolysis, as this process requires rare and expensive elements like platinum to catalyse the water splitting. With the limited global supply and increasing prices of precious metals, there is an urgent need for alternative electrocatalyst materials to produce hydrogen from water.

Dr Jesum Alves Fernandes, School of Chemistry, University of Nottingham, who led the research team, said: "Industries in the UK alone generate millions of tons of metal waste annually. By using a scanning electron microscope, we were able to inspect the seemingly smooth surfaces of the stainless steel, titanium, or nickel alloy swarf. To our astonishment, we discovered that the surfaces had grooves and ridges that were only tens of nanometres wide. We realized that this nanotextured surface could present a unique opportunity for the fabrication of electrocatalysts."

The researchers used magnetron sputtering to create a platinum atom "rain" on the swarf's surface. These platinum atoms then come together into nanoparticles that fit snugly into the nanoscale grooves.

Technology Networks, 17 April 2024

<https://technologynetworks.com>

How a sugar acid crucial for life could have formed in interstellar clouds

2024-04-11

Researchers may have figured out how a crucial ingredient that cells need to produce energy could form in deep space.

Calculations and lab experiments suggest that glyceric acid can arise from radiation blasting carbon dioxide and ethylene glycol in interstellar clouds, researchers report in the March 15 Science Advances.

The study is "a great start to understand how these molecules are formed in space," says Anthony Remijan, an astrochemist at the National Radio Astronomy Observatory in Charlottesville, Va., who was not involved in the research. The finding suggests that "if you put the right mixture together,

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in the right conditions, maybe you can even afford more complex molecules in space," he says.

Glyceric acid plays an important role in cell metabolism, energy balance and photosynthesis, and it can go on to help form other complex molecules important for life. The acidic sugar has previously been found in meteorites, suggesting that it can form in outer space. Astronomers have yet to directly observe glyceric acid in space, but they suspect it may form in interstellar clouds such as the Orion Nebula, which roils with gas, plasma and dust.

Telescope observations alone can't decipher how an organic compound forms in space. But astronomers can identify what gases are present in interstellar clouds. And chemists can predict what happens to those gases when blasted with radiation. That approach has led scientists to demonstrate how, for example, the simple sugar ribose could be made in simulated interstellar conditions (SN: 4/7/16).

So the new study began with a principal question: "Can we synthesize [glyceric acid] at low temperature and low pressure, like we get in space?" says Ryan Fortenberry, a theoretical astrochemist at the University of Mississippi near Oxford. "We think we can."

Fortenberry and colleagues started by looking into the properties of two compounds that are abundant in interstellar clouds — carbon dioxide and ethylene glycol, commonly known as the active ingredient in antifreeze.

Computer calculations of how CO₂ and ethylene glycol respond to radiation suggest that they could team up to form glyceric acid in space. To verify the theoretical results, physical chemist Ralf Ingo Kaiser of the University of Hawaii at Manoa and colleagues deposited ices of carbon dioxide and ethylene glycol in a vacuum chamber at extremely low pressure and temperature. The team then blasted the compounds with radiation.

"We cannot generate galactic cosmic rays in our lab," Kaiser says, so they opted for the next best thing: spraying the compounds with electrons to simulate the shower of charged particles that's triggered when cosmic rays hit ice. As the ices transitioned to vapors, the team further blasted the chamber with ultraviolet radiation, which resulted in the formation of glyceric acid molecules.

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"It's not magic," Fortenberry says. "But it feels like magic, because you get these biologically significant species from really mind-blowingly simple molecules."

While simple organic molecules are easy to observe in many cosmic environments, complex organics are harder to find. The study provides an understanding into "how much that very simple chemistry that we can observe can evolve into something more complex," says Stefanie Milam, an astrochemist at NASA's Goddard Space Flight Center in Greenbelt, Md.

A next step, Fortenberry's team says, is to search interstellar clouds for glyceric acid. Astronomers could use the Atacama Large Millimeter/submillimeter Array in Chile, which has helped find phosphorus-bearing molecules and others important for life in the cosmos (SN: 1/21/20).

Science News, 11 April 2024

<https://sciencenews.org>

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Alzheimer's Starts Earlier and Progresses Faster in People With Down Syndrome

2024-04-17

Nearly all adults with Down syndrome will develop evidence of Alzheimer's disease by late middle age. A new study by researchers at Washington University School of Medicine in St. Louis shows that the disease both starts earlier and moves faster in people with Down syndrome, a finding that may have important implications for the treatment and care of this vulnerable group of patients.

The findings were part of a study, available online in *Lancet Neurology*, comparing how Alzheimer's develops and progresses in two genetic forms of the disease: a familial form known as autosomal-dominant Alzheimer's disease, and Down syndrome-linked Alzheimer's.

"Currently, no Alzheimer's therapies are available for people with Down syndrome," said co-senior author Beau Ances, MD, PhD, the Daniel J. Brennan Professor of Neurology. Ances, who cares for patients with Down syndrome, explained that people with the developmental disability historically have been excluded from Alzheimer's clinical trials.

"This is a tragedy because people with Down syndrome need these therapies as much as anyone," Ances continued.

Down syndrome is caused by the presence of an extra chromosome 21. That extra chromosome carries a copy of the APP (amyloid precursor protein) gene, meaning that people with Down syndrome produce far more amyloid deposits in their brains than is typical. Amyloid accumulation is the first step in Alzheimer's disease. For people with Down syndrome, cognitive decline often occurs by the time they reach their 50s.

People with autosomal dominant Alzheimer's disease also have a predictable timeline to cognitive decline. These patients inherit mutations in one of three specific genes: PSEN1, PSEN2 or APP. They tend to develop cognitive symptoms at the same age as did their parents: in their 50s, 40s or even 30s.

"Since these two populations develop disease at relatively young ages, they don't have the age-associated changes seen in most Alzheimer's patients, who are typically over age 65," said corresponding author Julie Wisch, PhD, a senior neuroimaging engineer in Ances' lab. "This, combined with the well-defined age of onset in both conditions, gives us a rare

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opportunity to separate out the effects of Alzheimer's disease from normal aging and expand our understanding of disease pathology."

As part of this study, the researchers mapped the development of tau tangles, the second step in the development of Alzheimer's disease. Using positron-emission tomography (PET) brain scans from 137 participants with Down syndrome and 49 with autosomal dominant Alzheimer's, the researchers examined when tau tangles appeared relative to amyloid plaques and which parts of the brain were affected.

The study revealed that amyloid plaques and tau tangles — protein abnormalities that precede cognitive decline in Alzheimer's — accumulate in the same areas of the brain and in the same sequence in both groups, broadly speaking. However, the process happens earlier and more quickly in people with Down syndrome, and the levels of tau are greater for a given level of amyloid.

"Normal progression with Alzheimer's is that you see amyloid, and then you get tau — and this happens five to seven years apart — and then neurodegeneration," Wisch explained. "With Down syndrome, the amyloid and tau buildup happen at nearly the same time."

There is currently only one treatment for Alzheimer's disease approved by the Food and Drug Administration (FDA) and proven to change the course of the disease: lecanemab, which targets amyloid. Since amyloid accumulation is the first step in the disease, lecanemab is recommended for people in early stages of Alzheimer's, with very mild or mild symptoms. Therapies targeting tau are also under development, aimed at people in later stages of the disease, when tau pathology plays a more prominent role.

"Since there is a compression of the amyloid and the tau phases of the disease for people with Down syndrome-associated Alzheimer's, we will need to target both amyloid and tau," Ances said. "We may need to come up with different approaches for this population."

This paper is part of a collaboration between two major research consortia: the Dominantly Inherited Alzheimer Network (DIAN), an international network led by Washington University to study autosomal dominant Alzheimer's; and the national Alzheimer's Biomarker Consortium-Down Syndrome (ABC-DS), of which Washington University is a part. Ances leads a project within the ABC-DS to map the molecular changes that occur in the brain as Alzheimer's develops in people with Down syndrome.

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“This is the third paper that has come out of this longstanding collaboration between these two giant consortiums,” said co-senior author Brian A. Gordon, PhD, an assistant professor of radiology at Washington University’s Mallinckrodt Institute of Radiology and an assistant professor of psychological & brain sciences. “By studying how Alzheimer’s develops in these two unique populations, we are building a more detailed and nuanced understanding of Alzheimer’s pathology that could lead to better diagnostics and therapies for people with any form of the disease.”

Technology Networks, 17 April 2024

<https://technologynetworks.com>

Carbon-capturing concrete walls conceal a quirky Japanese house

2024-04-17

The Block-Wall House is located in Japan’s Nagano Prefecture, next to a rural road. It has a lot of glazing, so in an attempt to offer privacy from passing vehicles and pedestrians, Nendo installed an angled screen that allows the owners to see out, but makes it harder for the casual passerby to see inside. The screen is made up of approximately 2,000 blocks arranged in parallel rows to create five walls with a combined length of 110 m (360 ft). It’s this screen that’s actually made from the sustainable concrete.

The concrete is made by the Kajima Corporation, in collaboration with the Chugoku Electric Power Co, Denka, and Landes Co, and is named CO2-SUICOM. During its manufacturing process, a special cement mixture is placed in a curing chamber and CO2 is then pumped into the chamber to be absorbed. The absorbed CO2 is then stuck inside the concrete, and will not be released. Crucially, it’s also just as strong as regular concrete, unlike Washington State University’s somewhat similar effort.

“Generally, concrete hardens through a chemical reaction between cement and water,” explains Kajima Corporation. “But with CO2-SUICOM, over half the cement is replaced with a material we call γ -C2S. Instead of reacting with water, γ -C2S reacts with the CO2 in the air to harden. After mixing the materials need to create CO2-SUICOM, the concrete can be placed in a location with high CO2 levels so it can capture the CO2 and harden, trapping the gas inside. For example, a thermal power plant or other facility that produces carbon-heavy exhaust gases can redirect the

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gases into a carbon sequestration chamber, where concrete products made with CO2-SUICOM can be placed to capture the CO2 in the gases.”

As is usually the case, the devil is in the details, however. Obviously greener concrete is a good thing in itself and under the right conditions this could be used to create net-zero infrastructure, but if it’s not affordable and practical to produce, it’s not going to be widely adopted.

On that note, signs are actually quite hopeful. A Kajima Corporation representative told us that the cost of producing CO2-SUICOM concrete is currently about three times higher than standard concrete used in Japan. Work is currently being undertaken on further reducing this cost and the firm believes it will become a lot more affordable in the near future.

Alongside this new concrete there have also been some other interesting efforts to make our buildings greener, including projects by Provencher Roy, the University of Tokyo and VTT Finland.

New Atlas, 17 April 2024

<https://newatlas.com>

Could not getting enough sleep increase your risk of type 2 diabetes?

2024-04-17

So what can we make of these findings? It turns out the relationship between sleep and diabetes is complex.

The study

Researchers analysed data from the UK Biobank, a large biomedical database which serves as a global resource for health and medical research. They looked at information from 247,867 adults, following their health outcomes for more than a decade.

The researchers wanted to understand the associations between sleep duration and type 2 diabetes, and whether a healthy diet reduced the effects of short sleep on diabetes risk.

As part of their involvement in the UK Biobank, participants had been asked roughly how much sleep they get in 24 hours. Seven to eight hours was the average and considered normal sleep. Short sleep duration was broken up into three categories: mild (six hours), moderate (five hours)

Not getting enough sleep is a common affliction in the modern age. If you don’t always get as many hours of shut-eye as you’d like, perhaps you were concerned by news of a recent study that found people who sleep less than six hours a night are at higher risk of type 2 diabetes.

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and extreme (three to four hours). The researchers analysed sleep data alongside information about people's diets.

Some 3.2% of participants were diagnosed with type 2 diabetes during the follow-up period. Although healthy eating habits were associated with a lower overall risk of diabetes, when people ate healthily but slept less than six hours a day, their risk of type 2 diabetes increased compared to people in the normal sleep category.

The researchers found sleep duration of five hours was linked with a 16% higher risk of developing type 2 diabetes, while the risk for people who slept three to four hours was 41% higher, compared to people who slept seven to eight hours.

One limitation is the study defined a healthy diet based on the number of servings of fruit, vegetables, red meat and fish a person consumed over a day or a week. In doing so, it didn't consider how dietary patterns such as time-restricted eating or the Mediterranean diet may modify the risk of diabetes among those who slept less.

Also, information on participants' sleep quantity and diet was only captured at recruitment and may have changed over the course of the study. The authors acknowledge these limitations.

Why might short sleep increase diabetes risk?

In people with type 2 diabetes, the body becomes resistant to the effects of a hormone called insulin, and slowly loses the capacity to produce enough of it in the pancreas. Insulin is important because it regulates glucose (sugar) in our blood that comes from the food we eat by helping move it to cells throughout the body.

We don't know the precise reasons why people who sleep less may be at higher risk of type 2 diabetes. But previous research has shown sleep-deprived people often have increased inflammatory markers and free fatty acids in their blood, which impair insulin sensitivity, leading to insulin resistance. This means the body struggles to use insulin properly to regulate blood glucose levels, and therefore increases the risk of type 2 diabetes.

Further, people who don't sleep enough, as well as people who sleep in irregular patterns (such as shift workers), experience disruptions to their body's natural rhythm, known as the circadian rhythm.

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This can interfere with the release of hormones like cortisol, glucagon and growth hormones. These hormones are released through the day to meet the body's changing energy needs, and normally keep blood glucose levels nicely balanced. If they're compromised, this may reduce the body's ability to handle glucose as the day progresses.

These factors, and others, may contribute to the increased risk of type 2 diabetes seen among people sleeping less than six hours.

While this study primarily focused on people who sleep eight hours or less, it's possible longer sleepers may also face an increased risk of type 2 diabetes.

Research has previously shown a U-shaped correlation between sleep duration and type 2 diabetes risk. A review of multiple studies found getting between seven to eight hours of sleep daily was associated with the lowest risk. When people got less than seven hours sleep, or more than eight hours, the risk began to increase.

The reason sleeping longer is associated with increased risk of type 2 diabetes may be linked to weight gain, which is also correlated with longer sleep. Likewise, people who don't sleep enough are more likely to be overweight or obese.

Good sleep, healthy diet

Getting enough sleep is an important part of a healthy lifestyle and may reduce the risk of type 2 diabetes.

Based on this study and other evidence, it seems that when it comes to diabetes risk, seven to eight hours of sleep may be the sweet spot. However, other factors could influence the relationship between sleep duration and diabetes risk, such as individual differences in sleep quality and lifestyle.

While this study's findings question whether a healthy diet can mitigate the effects of a lack of sleep on diabetes risk, a wide range of evidence points to the benefits of healthy eating for overall health.

The authors of the study acknowledge it's not always possible to get enough sleep, and suggest doing high-intensity interval exercise during the day may offset some of the potential effects of short sleep on diabetes risk.

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In fact, exercise at any intensity can improve blood glucose levels.

The Conversation, 17 April 2024

<https://theconversation.com>

Queensland researchers create device that consumes carbon dioxide and generates electricity

2024-04-18

Researchers at the University of Queensland (UQ) have built an electrical generator that consumes carbon dioxide, potentially opening the door to a new industrial-scale carbon capture method.

The carbon-negative “nano-generator” is the work of Zhuyuan Wang and Xiwang Zhang from UQ’s Dow Centre for Sustainable Engineering Innovation.

It pairs a poly amine gel already used to absorb CO₂ with a thin “skeleton” of boron nitrate that’s only a few atoms thick.

The prototype device generates electricity as it absorbs CO₂.

It’s the latter of those two results that have the researchers most excited.

The nano-generators have the potential to be a key component in a new form of industrial carbon capture.

Dr Wang believes, with further development, the technology can be scaled up to significantly reduce global CO₂ emissions.

“We imagine two uses – one is we use the technology to directly integrate it to a commercial CO₂ absorption plant so this can generate some electricity when absorbing CO₂ to offset the cost,” he said.

“We are very confident it can because nowadays CO₂ absorption is not a lucrative business.

“Our technology can be used in these plants, we can largely reduce the energy consumption and of course the capital costs, so make this business more sustainable and lucrative.”

A second application could be as a small, portable domestic unit consuming CO₂ from the immediate environment while creating enough electricity to power small devices or light bulbs.

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Dr Wang said they have been working on the nano-generator for the past two years, but more research was needed to make the chemical process more efficient.

“At present, we can harvest around 1 per cent of the total energy carried intrinsically by gas CO₂ but, like other technologies, we will now work on improving efficiency and reducing cost,” Dr Wang said.

Professor Zhang, who is the director of the Dow Centre, said they would continue to develop the nano-generator through GETCO₂, a research scheme run by one of the Australian Research Council’s centres of excellence.

Dr Wang said they are also seeking industrial partners.

Existing carbon capture methods costly and inefficient

Carbon capture and storage (CCS) is employed by the oil and gas industry as one way to help offset greenhouse gas emissions.

It currently involves capturing CO₂ at the site of production and then burying it deep underground where it becomes trapped in a porous rock layer.

The Institute for Energy Economics and Financial Analysis said the majority of carbon capture and storage projects around the world were not performing as well as expected.

The institute said that while CCS had been around for decades, it was costly, there were only about 30 active projects in the world and “numerous projects” had been cancelled or failed.

It found that for Australian projects from 2016-17 to 2022-23, CCS injected 33 per cent of emissions, which was collectively only 42 per cent of their carbon capture targets.

ABC News, 18 April 2024

<https://abc.net.au>

Do You Need to Use Toothpaste?

2024-04-15

Billions of people around the world dutifully brush their teeth with toothpaste every day, but some are starting to question this status quo. These contrarians see sense in brushing but aren’t sure whether the paste is really necessary. And it’s not just laypersons wondering out loud

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about this apparent blasphemy — critiques are coming from dentists themselves.

“While toothpaste manufacturers claim that you need toothpaste to brush your teeth, it’s not true. Toothpaste is not necessary to make your teeth clean or healthy,” writes Dr. Todd Bertman of New York’s Advanced Dental Arts.

“Brushing our teeth with a paste makes our mouth feel fresh and clean, but toothpaste is, in fact, an avoidable step,” claims the blog of Huffman Smiles from Huffman, Texas.

“The real act of cleaning your teeth is achieved with the toothbrush, not the toothpaste,” reads a post from Grand Street Dental’s website.

These views likely originate from a minority of dentists, but they appear prominently on Google searches. To the layperson, such statements can seem equally authoritative to those of the American Dental Association (ADA). The ADA, by the way, recommends “brushing teeth twice a day for two minutes using a fluoride toothpaste.”

The importance of fluoride

Fluoride is the simplest negatively charged ion of the element fluorine. It’s the primary ingredient of any effective toothpaste. It makes teeth more resistant to acid, puts minerals back into teeth, and interferes with oral bacteria’s ability to make acid.

Rather than take the ADA’s word for it, we can search the scientific literature for studies addressing toothpaste’s effectiveness. There are plenty to be found, involving tens of thousands of participants, dating back to the 1950s! The broad, clear takeaway is that brushing with fluoride-containing toothpaste greatly reduces the risk of cavities compared to brushing with one lacking fluoride.

But this seems to leave the door open to ditching toothpaste... If fluoride provides much of the benefit from brushing with toothpaste, could one simply brush without paste and swig and swish a fluoride mouth-rinse afterward?

“Conceivably yes,” Grant Ritchey, a dentist in Tonganoxie, Kansas, told Big Think. Ritchey practices with a skeptical, evidence-based mindset and shares that worldview on numerous platforms. “The main variables would be if the fluoride rinse had the same concentration and duration of contact

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with the teeth as the toothpaste, if the teeth were clean when the mouth rinse was used, etc. If those are kept constant, it would be the same.”

Such a strategy could save a pretty penny as well. Between the third quarters of 2022 and 2023, the price of toothpaste leapt 45%, a rise that the Council for Community and Economic Research called “extreme” and “perplexing,” even in these inflationary times.

While there are no studies specifically addressing the hypothetical of forgoing toothpaste in favor of a fluoride rinse, it’s reasonable to assume that such a strategy would benefit one’s dental health compared to doing nothing, just perhaps not as much as brushing with toothpaste as well.

Toothpaste, after all, is more than just fluoride. Formulations have been honed over more than a century. Today, they commonly include hydrated silica, an abrasive substance that boosts plaque removal, sodium lauryl sulfate, an antibacterial that helps disperse toothpaste’s other active ingredients around the mouth, calcium phosphates, which help remineralize teeth, and xylitol, a sugar-free sweetener. All of these compounds have been shown to be safe and effective, and likely contributed to the global decrease in cavities, according to a recent scientific review.

When they were first sold commercially in the latter half of the 19th century, toothpastes generally contained chalk, soap, essential oils from flowers or wintergreen, and sugar. Adding to the antiquated feel, they were marketed in jars, not tubes. They also didn’t work very well.

Today, a preponderance of evidence suggests that modern varieties do.

Are toothpastes 100% essential to maintain a cavity-free, pearly-white smile? Perhaps not. But there’s no denying that they help. If you’re concerned about their recently sky-high costs, but don’t want to ditch toothpaste entirely, you can likely get away with using less on your brush. You don’t need to coat the bristles, just a pea-sized amount is plenty.

Real Clear Science, 15 April 2024

<https://realclearscience.com>

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Microscopy structures reveal mechanism behind bitter taste

2024-04-15

Cryo-electron microscopy (cryo-EM) structures of a human taste receptor have revealed new information about the mechanisms that enable us to perceive bitter flavours.

Our ability to taste bitter flavours is the result of complex interactions between over 1000 compounds and a suite of 26 receptors, called type-2 taste receptors (TAS2Rs). However, understanding of these interactions has been hindered by a lack of structural data.

Now, researchers in the US and China have reported two cryo-EM structures of the human bitter taste receptor, TAS2R14. TAS2R14 spans across the membranes of cells on the tongue as well as numerous other human tissues and can recognise, and bind to, more than 100 structurally diverse tastant compounds that are associated with bitter flavours.

The new structures reveal the presence of two binding sites on the receptor: an allosteric site located inside the cell and an orthosteric site located on the extracellular part of the receptor. A tunnel, surrounded by hydrophobic amino-acid residues, appears to run between the two sites.

The researchers observed that the orthosteric site was occupied by cholesterol – a compound found in all animal cell membranes. The team believe that this puts the receptor in a semi-active state allowing it to be easily activated by the bitter tastant. It is thought that bile acids, which have a similar chemical structure to cholesterol, could also bind to, and activate, TAS2R14.

The only other TAS2R structure to have previously been determined is that of TAS2R46 and comparison with TAS2R14 reveals distinct structural differences, suggesting that each TAS2R receptor could bind to particular types of molecule.

During the project, the researchers discovered that the TAS2R14 protein is expressed in many other tissue types and is found in concentrations 100 times higher in the cerebellum than on the tongue. Further work is planned to uncover the role that the receptor plays in cellular signalling outside of the mouth.

Chemistry World, 15 April 2024

<https://chemistryworld.com>

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What are 'Ozempic babies'? Can the drug really increase your chance of pregnancy?

2024-04-18

We've heard a lot about the impacts of Ozempic recently, from rapid weight loss and lowered blood pressure, to persistent vomiting and "Ozempic face".

Now we're seeing a rise in stories about "Ozempic babies", where women who use drugs like Ozempic (semaglutide) report unexpected pregnancies.

But does semaglutide (also sold as Wegovy) improve fertility? And if so, how? Here's what we know so far.

Remind me, what is Ozempic?

Ozempic and related drugs (glucagon-like peptide-1 receptor agonists or GLP-1-RAs) were developed to help control blood glucose levels in people with type 2 diabetes.

But the reason for Ozempic's huge popularity worldwide is that it promotes weight loss by slowing stomach emptying and reducing appetite.

Ozempic is prescribed in Australia as a diabetes treatment. It's not currently approved to treat obesity but some doctors prescribe it "off label" to help people lose weight. Wegovy (a higher dose of semaglutide) is approved for use in Australia to treat obesity but it's not yet available.

How does obesity affect fertility?

Obesity affects the fine-tuned hormonal balance that regulates the menstrual cycle.

Women with a body mass index (BMI) above 27 are three times more likely than women in the normal weight range to be unable to conceive because they are less likely to ovulate.

The metabolic conditions of type 2 diabetes and polycystic ovary syndrome (PCOS) are both linked to obesity and fertility difficulties.

Women with type 2 diabetes are more likely than other women to have obesity and to experience fertility difficulties and miscarriage.

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Similarly, women with PCOS are more likely to have obesity and trouble conceiving than other women because of hormonal imbalances that cause irregular menstrual cycles.

In men, obesity, diabetes and metabolic syndrome (a cluster of conditions that increase the risk of heart disease and stroke) have negative effects on fertility.

Low testosterone levels caused by obesity or type 2 diabetes can affect the quality of sperm.

So how might Ozempic affect fertility?

Weight loss is recommended for people with obesity to reduce the risk of health problems. As weight loss can improve menstrual irregularities, it may also increase the chance of pregnancy in women with obesity.

This is why weight loss and metabolic improvement are the most likely reasons why women who use Ozempic report unexpected pregnancies.

But unexpected pregnancies have also been reported by women who use Ozempic and the contraceptive pill. This has led some experts to suggest that some GLP-1-RAs might affect the absorption of the pill and make it less effective. However, it's uncertain whether there is a connection between Ozempic and contraceptive failure.

In men with type 2 diabetes, obesity and low testosterone, drugs like Ozempic have shown promising results for weight loss and increasing testosterone levels.

Avoid Ozempic if you're trying to conceive

It's unclear if semaglutide can be harmful in pregnancy. But data from animal studies suggest it should not be used in pregnancy due to potential risks of fetal abnormalities.

That's why the Therapeutic Goods Administration recommends women of childbearing potential use contraception when taking semaglutide.

Similarly, PCOS guidelines state health professionals should ensure women with PCOS who use Ozempic have effective contraception.

Guidelines recommended stopping semaglutide at least two months before planning pregnancy.

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For women who use Ozempic to manage diabetes, it's important to seek advice on other options to control blood glucose levels when trying for pregnancy.

What if you get pregnant while taking Ozempic?

For those who conceive while using Ozempic, deciding what to do can be difficult. This decision may be even more complicated considering the unknown potential effects of the drug on the fetus.

While there is little scientific data available, the findings of an observational study of pregnant women with type 2 diabetes who were on diabetes medication, including GLP-1-RAs, are reassuring. This study did not indicate a large increased risk of major congenital malformations in the babies born.

Women considering or currently using semaglutide before, during, or after pregnancy should consult with a health provider about how to best manage their condition.

When pregnancies are planned, women can take steps to improve their baby's health, such as taking folic acid before conception to reduce the risk of neural tube defects, and stopping smoking and consuming alcohol.

While unexpected pregnancies and "Ozempic babies" may be welcomed, their mothers have not had the opportunity to take these steps and give them the best start in life.

The Conversation, 18 April 2024

<https://theconversation.com>

Low-VOC' paints may still release harmful volatiles

2024-04-11

Water-based paints labelled as having 'zero' or 'low' levels of volatile organic compounds (VOCs), could still contain such chemicals, according to a new analysis. The researchers behind the findings are calling for further research into the risks associated with emissions of these chemicals in indoor environments.

In water-based paints, water is used as the main solvent for resin and pigment particles, instead of the organic solvents used in traditional paint products. As a result, they generally contain low levels of VOCs. However, to ensure comparable performance and quality to traditional products, other additives are used – such as coalescing agents and preservatives –

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many of which are semi-volatile organic compounds (SVOCs) that have been linked to potential health risks.

To find out more about the chemicals in water-based paint products, a team of researchers in China and the US, analysed 40 of the best-selling water-based paints of different brands from across the global market, most of which were labelled as 'zero-VOC' or 'low-VOC'.

After extraction, filtration, and concentration, the samples were analysed using gas chromatography–mass spectrometry (GC–MS). Dry paint films were also prepared by applying paints on aluminium foil and drying them in a ventilated fume hood for up to two days.

'We used organic solvents to extract the various compounds in the water-based paints and after filtration and concentration we analysed the samples with GC–MS,' explains Yujie Fan, a researcher at Tsinghua University in China, who worked on the project. 'We then confirmed the identified compounds using chemical [reference] standards and quantified the concentrations of these chemicals in the water-based paint.'

Overall, they detected 20 SVOCs with concentrations ranging from 10 to 6200 parts per million (ppm) in the wet films and from 10 to 35,000ppm in the dry films. The team notes that these compounds can persist indoors for years, often in dust.

Several coalescing agents – which help the paint form a strong, continuous film as it dries – were identified in many of the samples, while isothiazolinone preservatives, which have been linked to severe allergies and asthma, were identified in almost half of the paint products.

Finally, in 24 of the wet paint samples advertised as either zero- or low-VOC, 11 different VOCs were detected including ethylene glycol, which was detected in 15 samples at concentrations ranging from 800 to 20,000ppm.

The researchers said that the health risks of these products were not just related to toxicity but also to overall exposure levels. 'We should be aware ... these chemicals may persist in indoor environment – they emit slowly but once they are released they may [adhere] to different surfaces and may result in potential risks for humans,' says Tsinghua University's Ying Xu, who led the project.

Responding to the study findings, a spokesperson for the British Coatings Federation (BCF) said that all paint sold in the UK and the EU had 'strict' VOC limits that manufacturers had to comply with and that the VOC

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content was required, by law, to be communicated on the product label. They added that the BCF takes the position that the use of the terms 'zero-VOC' and 'VOC-free' were 'false claims'.

'There will always be a trace element of VOCs in paint, even if no raw materials containing VOCs have been added,' they said. 'It is impossible to ensure that every batch of paint is completely free of VOCs.'

Referring to the researchers' detection of ethylene glycol in liquid paints at up to 20,000ppm, they highlighted that under EU regulations, the maximum allowed VOC content for an indoor matte paint was 30,000ppm.

'The VOC content of the tested water-based paints is much lower than that found in solvent-based paints, which typically contain more than 60% VOCs. As such claiming "low VOC" on a product containing only 2% VOCs [or 20,000ppm] is not green washing as this is within allowed limits.'

They also explained that although preservatives were potentially hazardous, without them the paint would spoil quickly, making it unusable and that mixtures containing isothiazolinones above a specific concentration limit must be labelled properly given their potential to cause an allergic skin reaction. 'Decorative paints are not toxic and not harmful when used appropriately,' they added.

Chemistry World, 11 April 2024

<https://chemistryworld.com>

Two-dimensional nanomaterial sets record for expert-defying, counter-intuitive expansion

2024-04-17

Working at Interface Science Western, home of the Tandetron Accelerator Facility, Stoczek and Fanchini formulated two-dimensional nanosheets of tungsten semi-carbide (or W₂C, a chemical compound containing equal parts of tungsten and carbon atoms) which when stretched in one direction, expand perpendicular to the applied force. This structural design is known as auxetics.

The trick is that the structure of the nanosheet itself isn't flat. The atoms in the sheet are made of repeating units consisting of two tungsten atoms to every carbon atom, which are arranged metaphorically like the dimpled surface of an egg carton. As tension is applied across the elastic nanosheet in one direction, it expands out in the other dimension as the dimples flatten.

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Prior to this innovation, there has been only one reported material that could expand by 10 per cent per unit length in this counter-intuitive way. The Western-engineered tungsten semi-carbide nanosheet can expand to 40 percent, a new world record.

“We were specifically looking to create a two-dimensional nanomaterial from tungsten semi-carbide,” said Stoczek. “In 2018, theorists predicted that it might exhibit this behaviour to an excellent level, but nobody had been able to develop it, despite extensive attempts by research groups all over the world.”

It wasn't possible to construct the new tungsten semi-carbide nanomaterial using chemical means, so Stoczek and Fanchini relied on plasma physics to form the single atom layers. Made of charged particles of atoms, plasma is the fourth state of matter (with solid, liquid and gas). Plasma can be observed in the natural world in the northern lights, or Aurora Borealis, and the Sun's corona during the recent solar eclipse. It is also used in neon lighting, fluorescent tubes and flat-screen TVs.

Typically, the instrumentation used to make two-dimensional nanomaterials are special furnaces where gases are heated at a high enough temperature to chemically react and form the desired substance. This approach simply did not work because any chemical reaction, the most common process, would lead to a product different from the desired nanomaterial.

“That's where most researchers who tried to get this material before us got stuck, so we had to pivot,” said Fanchini.

Instead of heating a gas made of tungsten and carbon atoms in furnaces, which would produce neutral particles as you would get for solids, liquids or gases, Stoczek and Fanchini designed a new customized instrumentation that produces a plasma, which is made up of electrically charged particles.

Stretch goals

There are countless possible applications for these W2C nanosheets, beginning with a new type of strain gauge. These commercially available gauges are a standard way to measure expansion and stretch in everything from airplane wings to household plumbing.

“Imagine if you want to know if a pipe in your house is deforming and risks bursting at some point. You can stick a sensor on the pipe made from this two-dimensional nanomaterial, and then use a computer to monitor

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the current passing through it. If the current rises, it means the pipe is expanding and risks bursting,” said Stoczek.

The new nanomaterial, in fact, becomes more electrically conductive and that opens the door for endless possibilities to use in things like sensors, or any device that detects events or changes in the environment and sends the information to other electronics. Another application is embedding the material right in stretchable electronics, like wearable technology, so that they have more conductivity.

“Normally, strain gauges would rely on the fact that when you stretch a material, it gets thinner and you change the conductivity of a material to carry a current,” said Fanchini. “With this new nanomaterial, this would no longer be the case.”

Science Daily, 17 April 2024

<https://sciencedaily.com>

New plastic coating discovery gives greater functionality to 3D printing

2024-04-17

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

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

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

One of the most common commercial 3D printing techniques is powder bed fusion or laser sintering. In this process a layer of free-flowing polymer powder is laid down and a laser is guided by a computer generated design and melts the powder layer-by-layer.

A new layer of powder is applied to the previous layer and once again the laser melts the powder together while simultaneously anchoring it to the layer below. This process continues until the designed part is complete, often consisting of thousands of layers.

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

“The real benefit of 3D printing or additive manufacturing is in the design and production of bespoke and unique objects, but its limitations are in the materials and palette of available properties that limit the overall application space.

“This new process provides an easy route to the development of a wide range of material capabilities without compromising processability,” says Professor Christopher Tuck, professor of materials engineering in the Center for Additive Manufacturing in the Faculty of Engineering.

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

“There are a few challenges facing the 3D printing industry due to limitations on the functionality of the polymers used. To tackle some of these challenges we have created a simple but effective approach to adding functionality by coating the particles. We’ve designed the colored shell polymer so that it matches the mechanical and thermal properties of the printing polymer.

“Most importantly we’ve demonstrated this with the key polymer (PA-12) that is ubiquitous to the industry. Our new colored polymeric powders work perfectly in the existing commercially deployed machines,” says Professor Steve Howdle, head of the School of Chemistry.

Currently objects made using PA-12 can’t be used in moist environments due to the growth of mold and fungi. The new shell coating can also be used to develop coatings that prevent this from happening, opening up new possibilities for the use of 3D printed objects in new areas.

Professor Howdle adds, “A key benefit of this process is that it can easily be incorporated into current commercial 3D printing processes and this could be potentially transformative for the industry in widening scope

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Curiosities

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by introducing new functionality, simplifying processes and importantly achieving all of this sustainably.”

Phys Org, 17 April 2024

<https://phys.org>

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Technical Notes

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