CHEMWATCH

Bulletin Board

Contents

AUG. 23, 2024

(click on page numbers for links)

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CHEMWATCH

Bulletin Board

Contents

AUG. 23, 2024

CURIOSITIES

TECHNICAL NOTES

CHEMWATCH

Bulletin Board

Regulatory Update

AUG. 23, 2024

ASIA PACIFIC

Feedback on streamlining treated seed rules

2024-08-06

We are calling for submissions on a new group standard for treated seed to streamline rules around importing, manufacturing, supplying, storing, using, or disposing of treated seed.

We currently regulate chemicals that are used to treat seed in New Zealand, but we do not regulate treated seed that is imported into New Zealand.

Under the proposed rules, treated seed importers and manufacturers would have to ensure any seed is treated only with a substance containing active ingredients approved for use in New Zealand.

We have worked with industry and government agencies to develop the proposed new rules and make sure there is minimal disruption to seed importing and manufacturing.

Submissions close at 5.00 pm Wednesday 9 October 2024.

Read More

EPA NZ, 06-08-27

https://www.epa.govt.nz/news-and-alerts/latest-news/epa-receives-request-to-take-first-step-in-glyphosate-reassessment-process/

No grounds to reassess glyphosate

2024-07-06

A decision-making committee has found no grounds to reassess the use of glyphosate and glyphosate-containing substances, such as Roundup.

In February 2024, the Environmental Law Initiative (ELI) formally requested we determine whether there are grounds to reassess the substance, citing significant new information about the negative effects of the substance.

"We carefully weighed the information provided by the applicant alongside a large amount of other evidence and consider that products containing the substance are safe to use if the existing rules are followed," says Dr Chris Hill, General Manager Hazardous Substances and New Organisms.

What we received from the applicant does not meet the criteria for significant new information and does not justify a reassessment of this substance – particularly when considered alongside the findings of other international regulators.

We will review any new research on glyphosate that shows a change in the risks and is relevant to the New Zealand context.

Read More

EPA NZ, 06-07-24

https://www.epa.govt.nz/news-and-alerts/latest-news/views-wanted-on-three-internationally-restricted-chemicals/

Ministry for the Environment opens consultation on importing and exporting e-waste

2024-07-06

The Ministry for the Environment has released a consultation document proposing to introduce regulations around importing or exporting non-hazardous electronic waste under the Basel Convention.

The changes would require prior informed consent and a permit from the EPA to import or export all e-waste under the Imports and Exports (Restrictions) Prohibition Order (No 2) 2004.

Prior informed consent is currently required to import or export hazardous e-waste.

Submissions close on Wednesday 28 August.

Read More

EPA NZ, 06-07-24

https://environmentalprotectionauthority.cmail20.com/t/r-l-tdttzg-oituylkhri-h/

CHEMWATCH
Bulletin Board
Regulatory Update
AUG. 23, 2024

AMERICA

Biden-Harris Administration Announces Label Program to Bolster U.S. Manufacturing of Cleaner Construction Materials

2024-08-08

Program will support the Administration's initiative to "Buy Clean" construction materials from U.S. manufacturers as part of the Investing in America Agenda

Today, Aug. 7, the U.S. Environmental Protection Agency announced its plan for implementing a new label program to boost clean American manufacturing by helping federal purchasers and other buyers find and buy cleaner, more climate-friendly construction materials and products. The label program is made possible by a $100 million investment in the Biden-Harris Administration's Inflation Reduction Act and aims to cut climate pollution linked to the production of construction products and materials, which accounts for more than 15% of annual global greenhouse gas emissions. The Inflation Reduction Act invests billions of dollars to reduce industrial emissions while supporting good union jobs, greater equity, and a strong manufacturing base, including $350 million to support EPA's efforts to reduce greenhouse gas emissions from construction materials.

"Thanks to President Biden's Inflation Reduction Act, America has an opportunity to lead the world in developing cleaner construction materials to cut climate pollution and reap unprecedented economic opportunities," **said Assistant Administrator for the Office of Chemical Safety and Pollution Prevention Michal Freedhoff.** "By clearly labeling what 'buy clean' means for products like concrete, glass and steel, EPA will help accelerate demand for these materials and continue to build the clean energy economy."

"The Inflation Reduction Act is the most significant carbon-cutting piece of legislation in history," said Elliot Doomes, Commissioner of the Public Buildings Service at the U.S. General Services Administration. "GSA is proud to work with the EPA, other government agencies, and private industry to use our buying power to drive the development of more sustainable building materials, create good-paying jobs, and lower operating costs for the American taxpayer. This program will accelerate our efforts to achieve a net zero federal footprint and catalyze American innovation."

"The use of lower carbon materials, that have the durability of conventional materials while lowering greenhouse gas emissions, is one pathway that FHWA is pursuing to help us achieve President Biden's goal of net zero emissions by 2050," said Federal Highway Administration (FHWA) Associate Administrator for Infrastructure Hari Kalla. "EPA's announcement today supports transportation agencies throughout the country with tools to ensure we are appropriately implementing low carbon materials."

Today's announcement builds on EPA's selection of 38 organizations in Julyto collectively receive nearly $160 million to help businesses develop Environmental Product Declarations (EPDs), which report climate pollution linked to the production of construction materials and products. These efforts will bolster the competitiveness of U.S. manufacturers, which are among the cleanest in the world in key sectors.

Read More

US EPA, 08-08-24

https://www.epa.gov/greenerproducts/label-program-low-embodied-carbon-construction-materials

Lead-Safe Renovations for DIYers

2024-08-08

Any renovation, repair, or painting (RRP) project in a pre-1978 home that has lead-based paint can easily create dangerous lead dust. If you are planning an RRP project in a pre-1978 home, EPA recommends homeowners hire a lead-safe certified contractor who is certified and trained in lead-safe work practices, meaning a group of techniques to prevent lead exposure resulting from renovation and repair activities. And in fact, the RRP rule requires that contractors performing RRP projects in pre-1978 homes, child care facilities, and preschools be lead-safe certified.

Generally speaking, the RRP rule does not apply to homeowners doing RRP projects in their own home. However, it does apply if you rent all or part of your home, operate a childcare center in your home or if you buy, renovate and sell homes for profit (i.e., a house flipper). If you decide to do the work yourself, make sure to use lead-safe work practices for do-it-yourself (DIY) home renovation projects to protect you and your family.

CHEMWATCH
Bulletin Board
Regulatory Update
AUG. 23, 2024

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US EPA, 08-08-24

https://www.epa.gov/lead/lead-safe-renovations-diyers

EPA Strengthens the Safer Choice Standard for Commercial and Household Cleaning Products

2024-08-08

Updated label criteria for products will make it easier for consumers to identify safer, more sustainable options

Today, Aug. 8, the U.S. Environmental Protection Agency finalized updates to strengthen the Safer Choice and Design for the Environment (DfE) Standard, which identifies the requirements that products and their ingredients must meet to earn EPA's Safer Choice label or DfE logo. These updates strengthen the criteria products must meet to qualify for the voluntary Safer Choice label, supporting the use of safer chemicals in the marketplace.

The Safer Choice program makes it easier for consumers and purchasers for facilities like schools and office buildings to find cleaners, detergents and other products made with safer chemical ingredients. Similarly, the DfE program helps people find disinfectants that meet high standards for public health and the environment.

"When consumers see the Safer Choice label on products in stores or online, they can be confident that the products were made with the safest possible ingredients," **said EPA Office of Chemical Safety and Pollution Prevention Deputy Assistant Administrator for Pollution Prevention Jennie Romer.** "We've updated EPA's Safer Choice and DfE Standard for the first time in nearly a decade with feedback from our stakeholders to make it stronger, more transparent and to include updated packaging sustainability standards."

Read More

US EPA, 08-08-24

https://www.epa.gov/saferchoice/standard

EUROPE

SCCS Opinion on Triphenyl phosphate (CAS No. 204-112-2, EC No. 115-86-6)

2024-07-26

The SCCS concludes the following:

1. In light of the data provided and taking under consideration the concerns related to potential endocrine disrupting properties of Triphenyl Phosphate, does the SCCS consider Triphenyl Phosphate safe when used as a plasticiser in nail products up to a maximum concentration of 5%?

Based on the currently available information, it is not possible for the SCCS to conclude on the safety of Triphenyl phosphate because the genotoxicity potential cannot be excluded.
Alternatively, what is according to the SCCS the maximum concentration considered safe for use of Triphenyl Phosphate in nail products?
Does the SCCS have any further scientific concerns with regard to the use of Triphenyl Phosphate in nail products?

The SCCS mandates do not address environmental aspects. Therefore, this assessment did not cover the safety of Triphenyl phosphate for the environment.

Read More

European Commission, 26-07-24

https://health.ec.europa.eu/publications/sccs-opinion-triphenyl-phosphate-cas-no-204-112-2-ec-no-115-86-6

European Commission, 26-07-24

2024-07-30

Dunelm, a UK home furnishing retailer, is collaborating with The Salvation Army to launch an online textile takeback scheme to promote the circular economy and reduce emissions. The initiative allows customers to generate a free shipping label on Dunelm's website, choose a courier, and drop off used home textiles, including bedding, cushions, throws, blankets, and clothing for resale or recycling. The initiative reduces the need for new raw materials and minimizes waste by keeping materials in use through design, repair, reuse, remanufacturing, and recycling.

CHEMWATCH
Bulletin Board
Regulatory Update
AUG. 23, 2024

This effort complements Dunelm's existing store-based textile takeback program, which collects around 100 tons of textiles monthly.

Read More

RPRA, 30-07-24

https://rpra.ca/the-hub/uk-home-furnishing-retailer-and-salvation-army-partner-to-recycle-textiles/

Peer review of the pesticide risk assessment of the active substance Pythium oligandrum strain B301

2024-08-06

The conclusions of EFSA following the peer review of the initial risk assessments carried out by the competent authority of the rapporteur Member State Belgium for the pesticide active substance Pythium oligandrum strain B301 and the considerations as regards the inclusion of the substance in Annex IV of Regulation (EC) No 396/2005 are reported. The context of the peer review was that required by Regulation (EC) No 1107/2009 of the European Parliament and of the Council. The conclusions were reached on the basis of the evaluation of the representative uses of Pythium oligandrum strain B301 as a resistance inducer/elicitor to control trunk diseases on grapevines. The reliable endpoints, appropriate for use in regulatory risk assessment, are presented. Missing information identified as being required by the regulatory framework is listed. Concerns are reported where identified.

Read More

EFSA, 06-08-24

https://www.efsa.europa.eu/en/efsajournal/pub/8975

Call for a dedicated EU Nature Restoration Fund

2024-07-30

The EU urgently needs a dedicated funding instrument to address the escalating impacts of nature degradation and the climate crisis. Across Europe, we are witnessing an increase in droughts, floods, and wildfires, along with the decline of pollinators, soil erosion, and water eutrophication. These issues threaten livelihoods, food security, and place a significant burden on national disaster relief budgets. But there is a solution: nature itself. Every €1 invested in nature restoration can generate benefits from €8 to €38. Despite this, nature conservation and restoration

in the EU are critically underfunded. The value of biodiversity and why it is critical to invest in it are outlined in the Annex. The current approach, which relies on diverse funds to support nature conservation and deliver the objectives of the EU Biodiversity Strategy, has been insufficient. A study commissioned by the European Commission highlights a growing funding gap of approximately €19 billion annually until 2030. New funding needs exacerbate this shortfall, as the nature and climate crises intensify and the Nature Restoration Law enters into force.

Read More

EEB, 30-07-24

https://eeb.org/wp-content/uploads/2024/07/Call-for-a-dedicated-EU-Nature-Restoration-Fund-_July-2024.pdf

ECHA gets a role supporting the Industrial Emissions Directive

2024-08-05

The Agency's data and expert advice on chemicals will be used to support regulation of industrial emissions in the EU.

Helsinki, 5 August 2024 – The revised Industrial Emissions Directive (IED) regulates emissions from industrial installations and includes new tasks for the European Chemicals Agency. Using the information from its databases, ECHA provides lists of hazardous substances that are potentially used in the relevant industry sectors, extracts substance-related information, characterises uses of those substances by sector and provides expert support on chemicals management.

ECHA will join the exchange of information to draw up, review and update Best Available Techniques (BAT) reference documents, BREFs. This is known as the Sevilla process and is used for setting permit conditions for industry.

ECHA's formal participation in the Sevilla process is a result of several years of collaboration with the Commission's Joint Research Centre (JRC)'s European Bureau for Research on Industrial Transformation and Emissions (EU-BRITE) and the Commission's Directorate General for Environment. The information and advice provided by the Agency has been used for the BREF revision processes and has the potential to improve synergies between the IED and the REACH regulation.

Ofelia Bercaru, ECHA's Director of Prioritisation and integration, says: "ECHA's data and expertise on chemicals will contribute to reducing industrial emissions, protecting human health and the environment. We are looking forward to the strengthened co-operation with the European Commission and the involved stakeholders."

Read More

ECHA, 05-08-24

https://echa.europa.eu/-/echa-gets-a-role-supporting-the-industrial-emissions-directive

Janet's Corner

AUG. 23, 2024

Chemistree

2024-08-24

https://www.boredpanda.com/chemistry-memes/

CHEMWATCH
Bulletin Board

Hazard Alert

AUG. 23, 2024

Chloroform

2023-08-23

USES [2,3]

Chloroform is primarily used in the production of refrigerants (e.g. chlorofluorocarbon (CFC)-22, fluorocarbon-22), in the production of plastics (especially vinyl chloride) and in the manufacture of other chemicals. Chloroform is used as an extraction solvent for fats, oils, greases, rubber, waxes, gutta-percha, resins, lacquers, floor polishes, artificial silk manufacture, gums and adhesives. It is utilised as an industrial solvent in the extraction and purification of some antibiotics, alkaloids, vitamins and flavours. It is used as a solvent in organic chemistry, in photography and in making dyes, drugs and pesticides. Other uses are as a dry cleaning agent to remove spots, as a fumigant and in fire extinguishers to lower the freezing temperature of carbon tetrachloride. Chloroform formulated with other ingredients is used to control screwworm in animals. Chloroform is steadily being replaced by less toxic solvents and may no longer be used in some of these applications. Its use as an inhaled anaesthetic during surgery has already been largely discontinued.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

Chloroform may be released to the air from a large number of sources related to its manufacture and use, as well as its formation in the chlorination of drinking water, wastewater, and swimming pools. Pulp and paper mills, hazardous waste sites, and sanitary landfills are also sources of air emissions. Human exposure to chloroform may occur through drinking water, where chloroform is formed as a result of the chlorination of naturally occurring organic materials found in raw water supplies. Furthermore, chloroform may be found in some foods and beverages, largely from the use of tap water during production processes.

Routes of Exposure

Chloroform can be absorbed into the body by inhalation, through the skin and by ingestion. Exposure to chloroform can occur mainly in the workplace of industries that use chloroform. Inhalation and skin contact are the most likely exposure routes. Ingestion is unlikely. The general public may be exposed to trace amounts of chloroform by drinking chlorinated water, by eating food or drinking beverages where tap

Chloroform is an organic compound with the chemical formula $CHCl_3$. It is a clear, colourless, volatile, non-flammable liquid with a pleasant, sweet odour, which is detectable at ppm levels. Chloroform is slightly soluble in water. It is miscible with alcohol, benzene, petroleum ether, carbon tetrachloride, carbon disulfide and oils. Chloroform reacts vigorously with strong caustics, strong oxidants, chemically active metals such as aluminium, lithium, magnesium, sodium or potassium, and acetone, causing fire and explosion hazards. It can attack plastic, rubber and coatings. Chloroform decomposes slowly

water containing chloroform is used during production processes or by swimming in pools treated with chlorine.

HEALTH EFFECTS [4]

Acute Health Effects

The major effect from acute inhalation exposure to chloroform in humans is central nervous system depression. At very high levels (40,000 ppm), chloroform exposure may result in death, with concentrations in the range of 1,500 to 30,000 ppm producing anaesthesia, and lower concentrations (<1,500 ppm) resulting in dizziness, headache, tiredness, and other effects. Effects noted in humans exposed to chloroform via anaesthesia include changes in respiratory rate, cardiac effects, gastrointestinal effects, such as nausea and vomiting, and effects on the liver and kidney. In humans, a fatal oral dose of chloroform may be as low as 10 mL (14.8 g), with death due to respiratory or cardiac arrest. Tests involving acute exposure of animals have shown chloroform to have low acute toxicity from inhalation exposure and moderate acute toxicity from oral exposure.

Carcinogenicity

No information is available regarding cancer in humans or animals after inhalation exposure to chloroform. Epidemiologic studies suggest an association between cancer of the large intestine, rectum, and/or bladder and the constituents of chlorinated drinking water, including chloroform. However, there are no epidemiologic studies of water containing only chloroform. Chloroform has been shown to be carcinogenic in animals after oral exposure, resulting in an increase in kidney and liver tumours. EPA considers chloroform to be a probable human carcinogen and has ranked it in EPA's Group B2. EPA has determined that although chloroform is likely to be carcinogenic to humans by all routes of exposure under high-exposure conditions that lead to cell death and regrowth in susceptible tissues, chloroform is not likely to cause cancer in humans by any route of exposure under exposure conditions that do not cause cell death and regrowth. Therefore, EPA has not derived either an oral carcinogenic potency slope or an inhalation unit risk for chloroform.

Other Effects

Little information is available on the reproductive or developmental effects of chloroform in humans, via any route of exposure. A possible association between certain birth outcomes (e.g., low birth weight, cleft palate) and consumption of contaminated drinking water was reported. However,

CHEMWATCH
Bulletin Board
Hazard Alert
AUG. 23, 2024

because multiple contaminants were present, the role of chloroform is unclear. Animal studies have demonstrated developmental effects, such as decreased foetal body weight, foetal resorptions, and malformations in the offspring of animals exposed to chloroform via inhalation. Reproductive effects, such as decreased conception rates, decreased ability to maintain pregnancy, and an increase in the percentage of abnormal sperm were observed in animals exposed to chloroform through inhalation. Animal studies have noted decreased foetal weight, increased foetal resorptions, but no evidence of birth defects, in animals orally exposed to chloroform.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention.
- **Skin Contact:** In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.
- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
- **Serious Inhalation:** Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek medical attention.
- **Ingestion:** Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Workplace Controls & Practices [4]

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the workstation location.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling chloroform:

- Splash goggles;
- Lab coat;
- Vapour respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves

Personal Protection in Case of a Large Spill:

- Splash goggles;
- Full suit;
- Vapour respirator;
- Boots;
- Gloves;
- A self-contained breathing apparatus should be used to avoid inhalation of the product.
- Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION

United States

The following exposure limits are for Coal Tar Pitch Volatiles:
OSHA: The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for chloroform is 50 ppm (240 milligrams per cubic metre (mg/m3) as a ceiling limit. A worker's exposure to chloroform shall at no time exceed this ceiling level [29 CFR 1910.1000, Table Z-1].

- **NIOSH:** The National Institute for Occupational Safety and Health (NIOSH) has established a recommended exposure limit (REL) for chloroform of 2 ppm (9.78 mg/m3) as a 60-minute short-term exposure limit (STEL). NIOSH also considers chloroform a potential occupational carcinogen [NIOSH 1992].
- **ACGIH:** The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned chloroform a threshold limit value (TLV) of 10 ppm (49 mg/m3) as a TWA for a normal 8-hour workday and a 40-hour workweek. The ACGIH also considers chloroform a suspected human carcinogen (A2 substance) [ACGIH 1994, p. 16].

REFERENCES

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2. http://www.npi.gov.au/substances/chloroform/index.html
3. http://www.atsdr.cdc.gov/tfacts6.pdf
4. http://www.epa.gov/ttn/atw/hlthef/chlorofo.html
5. http://www.sciencelab.com/msds.php?msdsId=9927133
6. http://www.osha.gov/SLTC/healthguidelines/chloroform/recognition.html

Gluten reaction trigger identified, could lead to new celiac treatments

2024-08-12

Scientists have made a breakthrough that could lead to new treatment options for celiac patients. The team identified how and where the gluten response begins, with certain cells playing a bigger role than thought.

Like other autoimmune disorders, celiac disease occurs when the body mistakenly launches an immune response against a harmless molecule – in this case the trigger is gluten, a protein found in many cereal grains. Consuming these foods leads to a range of unpleasant symptoms, and the only treatment is a strict diet.

To help find a better option, the researchers on the new study investigated how and where the gluten response actually begins. In studies in mice and lab-grown mini-intestines (called organoids), they observed the responses of different cells to the presence of gluten.

"This allowed us to narrow down the specific cause and effect and prove exactly whether and how the reaction takes place," said Tohid Didar, corresponding author of the study.

It turns out that epithelial cells – those that make up the inner lining of the upper intestine – respond to gluten by actively stimulating the release of CD4+ T cells. In turn, these helper cells trigger an overactive immune response that's felt as the common celiac symptoms. It was widely thought that the response involves immune cells only, although epithelial cells were suspected to play a role. Now, the team says, that suspicion has been confirmed.

The team also uncovered another factor at play. The epithelial cells send stronger signals to the immune cells in the presence of Pseudomonas aeruginosa, a pathogenic bacteria species that's not normally a healthy part of the human microbiome.

The researchers say that the discovery could provide new targets for developing drugs that potentially treat or prevent celiac disease. Testing for P. aeruginosa could also help identify patients most at risk of developing the condition.

"The only way we can treat celiac disease today is by fully eliminating gluten from the diet," said Elena Verdu, corresponding author of the study. "This is difficult to do, and experts agree that a gluten-free diet is insufficient."

CHEMWATCH
Bulletin Board
Gossip
AUG. 23, 2024

The research was published in the journal Gastroenterology.

Source: McMaster University

New Atlas, 12 August 2024

https://newatlas.com

Quality control: Neatly arranging crystal growth to make fine thin films

2024-08-21

Table salt and refined sugar look white to our eyes, but that is only because their individual colorless crystals scatter visible light. This feature of crystals is not always desirable when it comes to materials for optical and electrical devices, however.

Metal-organic frameworks are one such material. Crystalline with micropores, thin films of these nanomaterials have been attracting attention as a next-generation material that could also have an impact on environmental issues such as hydrogen storage and carbon dioxide capture.

An Osaka Metropolitan University, Graduate School of Engineering team has found a way to control the growth of crystals on such thin films so that light scattering is reduced significantly.

Associate Professor Kenji Okada and Professor Masahide Takahashi led the team in developing a technique for forming thin films on substrates by having the crystals grow in an orderly manner through the use of a modulator.

A mixture of diluted acetic acid, the main acid of vinegar, and sodium acetate made up the modulator, which interacted with the copper-based medium to grow crystals in only one direction.

By arranging the crystals neatly without gaps, the team succeeded in fabricating a thin film of unprecedented high quality.

"The thin films fabricated in this research have numerous molecular-sized pores that allow light to pass through them well," Professor Okada explained. "They are expected to be used as optical sensors, optical

elements, and transparent gas adsorption sheets that utilize the change in optical properties during molecular adsorption."

Science Daily, 21 August 2024

https://sciencedaily.com

Hundreds of Patients in England To Benefit From the World's First Gene Editing Therapy

2024-08-08

NICE's final draft guidance recommends exagamglogene autotemcel ("exa-cel", also called Casgevy and made by Vertex) for people 12 years and over with severe beta-thalassaemia who need regular blood transfusions to manage their condition and when a blood and bone marrow transplant is suitable but no donor is available.

Exa-cel is the world's first CRISPR-based gene therapy and the first gene therapy available in Europe for treating severe beta-thalassaemia.

Beta-thalassaemia is an inherited blood disorder caused by a genetic mutation that reduces or prevents production of healthy red blood cells and haemoglobin (the protein found in red blood cells that carries oxygen around the body).

In the UK the condition mainly affects people of Pakistani, Indian and Bangladeshi ethnic origin.

People with the most severe type of beta thalassaemia need regular blood transfusions. Severe beta-thalassaemia can cause delayed growth, bone problems, problems with endocrine development and affect quality and length of life.

The independent committee heard from patient experts about the significant effect on work, family and friends that intense blood transfusions and their associated side effects and complications can have.

Costing £1,651,000 per course of treatment at its list price, exa-cel works by first removing and then modifying (editing) the faulty gene in a patient's bone marrow stem cells so the body produces functioning haemoglobin – the protein in red blood cells that carries oxygen around the body. The edited cells are then put back into the patient. As exa-cel involves people receiving their own edited cells, there is no risk of their body rejecting them.

CHEMWATCH
Bulletin Board
Gossip
AUG. 23, 2024

Exa-cel will be available through the Innovative Medicines Fund so that more data about its clinical and cost-effectiveness can be collected. This means it will be funded immediately to accelerate rollout for up to 460 people eligible for the treatment.

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Technology Networks, 8 August 2024

https://technologynetworks.com

Common drug restores youthful function to clean up aging brains

2024-08-15

A drug used to induce labor in pregnant women has been shown to reactivate tiny waste-clearing pumps in the brains of old mice. The finding could hold promise as a new way to fight Alzheimer's and Parkinson's diseases and overall cognitive decline.

When our brains are working properly, there is an excess of proteins that build up from the energy intensive processes that take place between our neurons. Those proteins need to be removed in order for the brain to continue to operate properly. When they aren't, they can gunk up the works, leading to the beta amyloid and tau protein tangles that are a hallmark of Alzheimer's disease or the build up of alpha-synuclein that accompanies Parkinson's.

In 2012 Danish neuroscientist, Maiken Nedergaard first described the system that uses cerebrospinal fluid (CSF) to remove waste from the brain and termed it the glymphatic system. Now, Nedergaard and her colleagues have looked deeper into the glymphatic system, focusing on lymph vessels called lymphangions. These are a series of tiny pumps in the neck that are responsible for moving dirty CSF out of the brain and into the lymph system where it ultimately reaches the kidneys to be processed.

Using advanced particle tracking in mice models, they found that as the rodents aged, the contractions in these pumps decreased. As a result, they found that older mice had 63% less dirty CSF flowing out of their brains compared to younger mice, setting the stage for the rodents to suffer cognitive decline.

Wondering if they could jump start the pumps and get them back into action, Nedergaard focused on the fact that lymphangions are lined with smooth muscle cells. So they looked to a drug called prostaglandin F2α, which works on these types of cells and is commonly used to induce labor in pregnant women. Sure enough, administering the drug to the elderly mice with a topical cream got the pumps working again to the point that the team saw the flow of dirty CSF out of the brain return to the same level of efficiency seen in younger mice.

Should the results hold in human trials, the finding could offer a brand-new way to combat the effects of cognitive impairment and brain-related diseases.

"These vessels are conveniently located near the surface of the skin, we know they are important, and we now know how to accelerate function," said study co-author Douglas Kelley, from the University of Rochester's Hajim School of Engineering and Applied Sciences. "One can see how this approach, perhaps combined with other interventions, could be the basis for future therapies for these diseases."

The research has been published in the journal Nature Aging.

New Atlas, 15 August 2024

https://newatlas.com

Catalyst for 'one-step' conversion of methane to methanol

2024-08-22

Scientists at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory and collaborating institutions have engineered a highly selective catalyst that can convert methane, a major component of natural gas, into methanol, an easily transportable liquid fuel, in a single, one-step reaction. As described in a paper just published in the Journal of the American Chemical Society, this direct process for methane-to-methanol conversion runs at a temperature lower than required to make tea and exclusively produces methanol without additional byproducts.

That's a big advance over more complex traditional conversions that typically require three separate reactions, each under different conditions, including vastly higher temperatures.

"We pretty much throw everything into a pressure cooker, and then the reaction happens spontaneously," said chemical engineer Juan Jimenez, a

CHEMWATCH
Bulletin Board
Gossip
AUG. 23, 2024

Goldhaber postdoctoral fellow in Brookhaven Lab's Chemistry Division and the lead author on the paper.

The simplicity of the system could make it particularly useful for tapping "stranded" natural gas reserves in isolated rural areas, far from the costly infrastructure of pipelines and chemical refineries, said Brookhaven chemist and study co-author Sanjaya Senanayake. Such local deployments would remove the need to transport high-pressure, flammable liquified natural gas.

"We could scale up this technology and deploy it locally to produce methanol than can be used for fuel, electricity, and chemical production," Senanayake said.

Brookhaven Science Associates, which manages Brookhaven Lab on behalf of DOE, and the University of Udine, collaborators in this work, have filed a patent cooperation treaty application on the use of the catalyst for one-step methane conversion. The team is exploring ways to work with entrepreneurial partners to bring the technology to market. They are motivated by the idea of "closing the carbon cycle" -- essentially, recycling carbon to prevent it from being released into the atmosphere -- to enable net-zero carbon clean-energy solutions.

"As scientists, we know the science and technology extremely well, but we're working with Brookhaven's Research Partnerships and Technology Transfer Office and entrepreneurial students who are doing the legwork on the economic side -- figuring out who are the best potential clients and markets for expanding this out," Jimenez said.

From basic science to industry-ready

The basic science behind the conversion builds on a decade of collaborative research. The Brookhaven chemists worked with experts at the Lab's National Synchrotron Light Source II (NSLS-II) and Center for Functional Nanomaterials (CFN) -- two DOE Office of Science user facilities that have a wide range of capabilities for tracking the intricacies of chemical reactions and the catalysts that enable them -- as well as researchers at DOE's Ames National Laboratory and international collaborators in Italy and Spain.

Earlier studies worked with simpler ideal versions of the catalyst, consisting of metals on top of oxide supports or inverted oxide on metal materials. The scientists used computational modeling and a range of techniques at NSLS-II and CFN to learn how these catalysts work to break

and remake chemical bonds to convert methane to methanol and to elucidate the role of water in the reaction.

"Those earlier studies were done on simplified model catalysts under very pristine conditions," Jimenez said. They gave the team valuable insights into what the catalysts should look like at the molecular scale and how the reaction would potentially proceed, "but they required translation to what a real-world catalytic material looks like," he said.

As Senanayake explained, "What Juan has done is take those concepts that we learned about the reaction and optimize them, working with our materials synthesis colleagues at the University of Udine in Italy, theorists at the Institute of Catalysis and Petrochemistry and Valencia Polytechnic University in Spain, and characterization colleagues here at Brookhaven and Ames Lab. This new work validates the ideas behind the earlier work and translates the lab-scale catalyst synthesis into a much more practical process for making kilogram-scale amounts of catalytic powder that are directly relevant to industrial applications."

New tools uncover the secret sauce

The new recipe for the catalyst contains an additional ingredient: a thin layer of "interfacial" carbon between the metal and oxide.

"Carbon is often overlooked as a catalyst," Jimenez said. "But in this study, we did a host of experiments and theoretical work that revealed that a fine layer of carbon between palladium and cerium oxide really drove the chemistry. It was pretty much the secret sauce. It helps the active metal, palladium, convert methane to methanol."

To explore and ultimately reveal this unique chemistry, the scientists built new research infrastructure both in the Catalysis Reactivity and Structure group's laboratory in the Chemistry Division and at NSLS-II.

"This is a three-phase reaction with gas, solid, and liquid ingredients -- namely methane gas, hydrogen peroxide and water as liquids, and the solid powder catalyst -- and these three ingredients react under pressure. So, we needed to build new pressurized three-phase reactors so we could monitor those ingredients in real time," Senanayake said.

The team built one reactor in the Chemistry Division and used infrared spectroscopy to measure the reaction rates and to identify the chemical species that arose on the catalyst surface as the reaction progressed. The chemists also relied on the expertise of NSLS-II scientists who built additional reactors to install at two NSLS-II beamlines -- Inner-Shell

CHEMWATCH
Bulletin Board
Gossip
AUG. 23, 2024

Spectroscopy (ISS) and In situ and Operando Soft X-ray Spectroscopy (IOS) -- so they could also study the reaction using X-ray techniques.

NSLS-II's Dominik Wierzbicki, a study co-author, worked to design the ISS reactor so the team could study the high-pressure, gas-solid-liquid reaction using X-ray spectroscopy. In this technique, "hard" X-rays, which have relatively high energies, enabled the scientists to follow the active metal, palladium, under realistic reaction conditions.

"Typically, this technique requires compromises because measuring the gas-liquid-solid interface is complex, and high pressure adds even more challenges," Wierzbicki said. "Adding unique capabilities to address these challenges at NSLS-II is advancing our mechanistic understanding of reactions carried out under high-pressure and opening new avenues for synchrotron research."

Study coauthors Iradwikanari Waluyo and Adrian Hunt, beamline scientists at IOS, also built an in-situ setup at their beamline and used it for lower energy "soft" X-ray spectroscopy to study cerium oxide in the gas-solid-liquid interface. These experiments revealed information about the nature of the active catalytic species during simulated reaction conditions.

"Correlating the information from the Chemistry Division to the two beamlines required synergy and is at the heart of the new capabilities," Senanayake said. "This collaborative effort has yielded unique insights into how the reaction can occur," he added, noting this study as a first demonstration of how such multimodal characterization tools can advance scientists' understanding of high-pressure catalytic reactions.

"The tools we developed for this study now provide additional in situ capabilities for other NSLS-II users interested in studying chemistry under pressurized conditions at our beamlines," Waluyo said.

In addition, colleagues Jie Zhang and Long Qi at Ames Lab performed in situ nuclear magnetic resonance studies, which gave the scientists key insights into the early stages of the reaction; and Sooyeon Hwang at CFN produced stunning transmission electron microscopy images to identify the carbon present in the material. The team's theory colleagues in Spain, led by Verónica Ganduglia-Pirovano and Pablo Lustemberg, provided the theoretical explanation for the catalytic mechanism by developing a state-of-the-art computational model for the three-phase reaction.

"We worked with a global team to gain a comprehensive understanding of the reaction and mechanism," Senanayake said.

In the end, the team discovered how the active state of their three-component catalyst -- made of palladium, cerium oxide, and carbon -- exploits the complex three-phase, liquid-solid-gas microenvironment to produce the final product.

Now, instead of needing three separate reactions in three different reactors operating under three different sets of conditions to produce methanol from methane with the potential of byproducts that require costly separation steps, the team has a three-part catalyst that drives a three-phase reaction all in one reactor with 100% selectivity for methanol production.

"This is a very valuable example of carbon neutral processing," Senanayake said. "We look forward to seeing this technology deployed at scale to make use of currently untapped sources of methane."

John Gordon, chair of the Chemistry Division, stated, "This research is a demonstration of how innovations in catalyst design and a foundational understanding of how reactions occur can help advance chemical processes of the future."

The research carried out at Brookhaven National Laboratory was supported by the DOE Office of Science and a Brookhaven National Laboratory Goldhaber Distinguished Fellowship. Collaborators and supercomputing resources used for this study were supported by additional funding, including from international organizations spelled out in the research paper. NSLS-II and CFN operations at Brookhaven are also funded by the Office of Science.

Science Daily, 22 August 2024

https://sciencedaily.com

Glassy gel is hard as plastic and stretches 7 times its length

2024-06-19

When you think of gel, you might imagine goo – but a new gel-like material has been engineered to be soft enough to stretch to almost seven times its original length while still being strong and clear, like glass.

Michael Dickey at North Carolina State University says his team discovered these "glassy gels" when his student, Meixiang Wang, was experimenting with ionic liquids and kept finding unexpected mechanical properties. The materials they devised are more than 50 per cent liquid, but as strong

CHEMWATCH
Bulletin Board
Gossip
AUG. 23, 2024

as the plastics used for water bottles, while also being very stretchy and sticky. "There are a bunch of cool things about them," he says.

Each glassy gel consists of long molecules called polymers mixed with an ionic liquid, a fluid that is essentially a salt in liquid form. The gel is a transparent solid that can withstand up to 400 times atmospheric pressure, but also stretch very easily up to 670 per cent. Dickey says that this could make it well-suited for building soft robotic grippers or 3D printing deformable materials.

He and his colleagues made glassy gels from several different mixtures of polymers and liquid salts and found that their strength and stretch depended on the precise ratio used.

"Just by changing the ratio of two ingredients, you can go from something very stretchy like a rubber band, to something almost as hard as glass," says Dickey.

This is because the materials get their stretchiness from the ionic liquid settling into spaces between the stiffer polymer molecules and pushing them apart, while their strength comes from the electrostatic attraction between the liquid's charged particles and the polymers, which prevents them from fully breaking away from each other.

The glassy gels can also self-heal – a cut or break can be repaired by applying heat, which makes molecules on the broken edges reconnect. Richard Hoogenboom at Ghent University in Belgium says this could make them useful in some instances when conventional plastics are used, but the formula may have to be tweaked so that it only softens at temperatures high enough so this doesn't happen accidentally.

New Scientist, 19 August 2024

https://newscientist.com

Living plastics: A new solution for plastic degradation through synthetic biology

2024-08-22

A study published in Nature Chemical Biology leverages the natural resilience of spores, which can endure extreme environmental conditions, by programming them to secrete plastic-degrading enzymes under specific circumstances. These spores are embedded into plastic matrices through standard plastic processing methods, such as high temperature, high pressure, or the use of organic solvents.

In normal conditions, the spores remain dormant, ensuring the plastic's stable performance. However, when exposed to specific triggers like surface erosion or composting, the spores activate and initiate the degradation process, leading to the plastic's complete breakdown.

The invention of plastics has improved our daily lives, but the massive production and improper disposal of plastic waste have made plastic pollution a major environmental issue. In 2016, Yoshida and team discovered a bacterium, Ideonella sakaiensis, in poly (ethylene terephthalate) (PET)-contaminated soil near a recycling facility in Japan. This bacterium can grow using PET as its main carbon source by producing two key enzymes: PETase and MHETase.

Since then, numerous synthetic biology research has been focusing on discovering, designing and evolving the relevant plastic-degrading enzymes. There has been little exploration of innovative methods for creating degradable plastics.

Dormant spores and living plastics

Microorganisms have developed intrinsic mechanisms to defend harsh conditions over billions of years. One classical example is the formation of spores that are resilient to dryness, high temperatures and high pressure (similar conditions in plastics processing).

Using synthetic biology, the research team engineered Bacillus subtilis with a genetic circuit to control the secretion of a plastic-degrading enzyme (lipase BC from Burkholderia cepacia). Under stress from heavy metal ions, Bacillus subtilis forms spores.

The team mixed these engineered spores with poly (caprolactone) (PCL) plastic granules and produced spore-containing plastics through high-temperature extrusion or solvent dissolution. Tests showed that these "living plastics" had similar physical properties to regular PCL plastics. During daily use, the spores remain dormant, ensuring the plastic's stable performance.

Spore release and degradation initiation

The first key step in plastic degradation is to release the spores embedded in the living plastic for cell reviving. Researchers have first demonstrated two methods of spore release. One method uses an enzyme (lipase CA) to erode the plastic surface.

CHEMWATCH
Bulletin Board
Gossip
AUG. 23, 2024

These released spores then germinated and expressed the lipase BC, which bound to the ends of PCL polymer chains and near-completely degraded the PCL molecules (final molecular weight <500 g/mol). The results showed that living plastic could degrade efficiently within 6–7 days, while ordinary PCL plastic subjected only to surface damage (lipase CA) still had a large amount of plastic debris after 21 days.

Another method for releasing spores is composting. In the absence of any additional exogenous agents, living plastics in soil could completely degrade within 25–30 days, while traditional PCL plastic took about 55 days to degrade to a level that was invisible to the naked eye.

Beyond PCL plastics

As mentioned earlier, PCL's processing conditions are relatively "mild" among plastics. To verify the system's general applicability, the team continued to test other commercial plastic systems. They mixed spores carrying GFP expression plasmids with PBS (polybutylene succinate), PBAT (polybutylene adipate-co-terephthalate), PLA (polylactic acid), PHA (polyhydroxyalkanoates), and even PET (poly [ethylene terephthalate]) and processed the mixture at temperatures as high as 300oC.

By releasing the spores through physical grinding, they surprisingly found that the spores could still revive and express the GFP. These results have laid a solid foundation for extending the method with other types of plastics.

To validate the potential for scaling up the system, the research team also conducted a small-scale industrial test on a PCL system using a single-screw extruder. The generated living PCL still exhibited rapid and efficient degradation property (degrading within 7 days). In the absence of external factors, the living PCL maintained a stable shape, demonstrating its robustness during the service (stable in Sprite for two months).

This study provides a novel method for fabricating green plastics that can function steadily when the spores are latent and decay when the spores are aroused and sheds light on the development of materials for sustainability.

The research, titled "Degradable Living Plastics Programmed by Engineered Spores," was performed by Dr. Dai Zhuojun's research group at

the Shenzhen Institute of Advanced Technology (SIAT), Chinese Academy of Sciences (CAS).

Phys Org, 22 August 2024

https://phys.org

Self-assembling RNA strands 'tamed the chemical chaos' in prebiotic mixtures

2024-08-19

New research shows how complex molecules that were key to kickstarting life on the early Earth could have survived, despite their inherent instability. The findings suggest that self-assembly processes could have boosted RNA sequences' resistance to hydrolysis, helping to 'tame the chemical chaos' in prebiotic mixtures.

'These [new] understandings are crucial for exploring the origins of life,' says Job Boekhoven, from the Technical University of Munich, Germany, who led the work.

Before modern cells existed, and DNA and proteins controlled life and metabolism, 'RNA molecules had to do it all, without any blueprints' says Kate Adamala, an expert in origins of life and semi-synthetic cells at the University of Minnesota, US. Back then, RNA sequences were responsible of storing information and coding for the instructions to make the first ever enzymes. But RNA is unstable. Without the protection provided by a biological cell, RNA strands should spontaneously decompose, as hydrolysis always favours the formation of monomers.

Now, Boekhoven's team's findings offer 'a plausible path for RNA molecules to quickly assemble into long sequences, and equally fast disassemble' says Adamala, who wasn't involved in the project. This would have allowed prebiotic cells to dynamically study the usefulness of assembled sequences. 'It's like an etch-a-sketch for early metabolism: assemble some sequences, try them out and erase the failed ones,' she adds.

Evolutionary advantages

Accepting the instability of RNA sequences was a significant step towards understanding the mechanisms of self-assembly, explains Boekhoven. 'We embraced the fact that hydrolysis exists, and also [existed] at the origin of life,' he says. Instead, Boekhoven's team focused on mechanisms that would slow hydrolysis down.

CHEMWATCH
Bulletin Board
Gossip
AUG. 23, 2024

The researchers created pools of nucleic acid monomers and molecules with different sequences, which are known as combinatorial libraries. To these, they added both chemical fuels – high energy molecules that favour oligomerisation – and DNA templates. The latter led to hybridisation, with complementary strands of nucleobases sticking together and forming stable double-stranded structures. 'This interaction is very important to stabilise labile molecules, such as RNA strands,' says Boekhoven.

Usually, synthetic sequences of RNA only survive hydrolysis for a few minutes. 'However, when hybridised with a complementary strand, they remained stable for hours,' he adds. 'It's a powerful model for understanding how the first RNA strands were formed, stabilised, selected, and replicated, [and] demonstrating how a pool of molecules can open-endedly evolve towards a minimal form of artificial life.'

According to Adamala, the self-assembly of the earliest biopolymers could have benefited protocells. The stable RNA sequences that arise from the libraries could encode information for important metabolic reactions and 'provide positive feedback to jumpstart natural selection and heredity', she adds.

Additionally, the RNA and DNA libraries interact with the scaffold that secures the structure of protocells, which could help individual cells to differentiate and develop an identity.

'Our findings [also] imply that nucleic acids affect the properties of protocells, which could result in an evolutionary advantage,' says Boekhoven. Nevertheless, the results still miss a key step – replication. 'It is the heart of living, self-sustaining systems,' he explains. 'But the mechanisms of selective stabilisation [could have] tamed the chemical chaos in prebiotic mixtures, [promoting the] copying and coding of sequences … and laying the foundation for the emergence of life.'

Chemistry World, 19 August 2024

https://chemistryworld.com

First visualization of valence electrons reveals fundamental nature of chemical bonding

2024-08-21

The distribution of outermost shell electrons, known as valence electrons, of organic molecules was experimentally observed for the first time by a team led by Nagoya University in Japan. As the interactions between

atoms are governed by the valence electrons, their findings shine light on the fundamental nature of chemical bonds, with implications for pharmacy and chemical engineering. The results were published in the Journal of the American Chemical Society.

The behavior of the electrons in atoms is complex, forming electron orbitals that have different functions depending on their closeness to the nucleus. The inner shell electrons, called core electrons, are used for self-stabilization and do not interact with other atoms. On the other hand, the outer electrons, or valence electrons, define most of the material's properties, especially during bonding with other atoms.

Understanding a material's properties requires extracting information about its valence electrons. However, it has been difficult to experimentally isolate only the valence electron information, leading to researchers having to rely on theoretical models and spectroscopy to estimate it.

By conducting world-class synchrotron X-ray diffraction experiments at SPring-8, the group discovered that it is possible to selectively extract only the valence electron density of atoms in a crystal.

"We named this method the CDFS method. Using this method, we observed the electron state of the glycine molecule, a type of amino acid," corresponding author Hiroshi Sawa said. "Although the method was relatively simple to perform, the result was impressive. The observed electron cloud did not exhibit the smooth, enveloping shape that many predicted, but rather a fragmented, discrete state."

To understand the nature of the results, the group made a color map of their observations. In chemistry, a color map uses colors to display variations in datasets across a specific range. Such maps are often used in conjunction with spectroscopic techniques, imaging, and chemical analysis to provide an intuitive way to interpret complex datasets.

The map of the cross-sectional view in the enlarged diagram clearly showed interruptions in the electron distribution surrounding the carbon atoms.

"When carbon forms bonds with surrounding atoms, it reconstructs its electron cloud to create hybridized orbitals. In this case, the outermost L-shell electrons have nodes based on their wave nature known as wave functions," Sawa explained. "This means that due to the wave nature of electrons, there are parts of the hybrid orbitals where electrons are absent,

CHEMWATCH
Bulletin Board
Gossip
AUG. 23, 2024

much different to the image that many people have of a continuous 'cloud' of electrons."

The fragmented electron cloud distribution observed in the experiment demonstrates the quantum mechanical wave nature of electrons, as predicted by physics. To confirm whether the observed electron cloud accurately captures the true state, they conducted advanced quantum chemical calculations in collaboration with Hokkaido University that confirmed that the experimental and theoretical results matched perfectly.

Sawa believes that the results show the benefits of interdisciplinary research. "I believe it has been helpful in providing a clear conclusion to the ambiguous understanding of bonding states that has puzzled researchers since the 19th century," Sawa said.

"Visualizing electron behavior is a challenging endeavor, yet the results can be elegantly understood as electrons acting in accordance with wave functions. I believe our findings have astonished many researchers and validated the model proposed by quantum chemistry."

With a precise understanding of the valence electron density distribution forming this molecule, the group conducted similar experiments and calculations on cytidine, a slightly more complex molecule. They successfully extracted the electrons within the carbon double bonds and clearly observed differences between the carbon-carbon and carbon-nitrogen bonds.

"This study has made it possible to directly visualize the essence of chemical bonds, potentially contributing to the design of functional materials and the understanding of reaction mechanisms. This is because it aids in discussing the electronic states of molecules, which are difficult to infer from just the chemical structural formula," Sawa said.

"It may, for example, explain why some medicines work and others don't. Fields where interactions influence functionality and structural stability, such as organic semiconductors and research on the structure of DNA double helixes, are likely to benefit most from our research."

Phys Org, 21 August 2024

https://phys.org

Weight Loss Drug Shows Potential Benefit for Type 2 Diabetes

2024-08-22

Researchers at the University of Liverpool have found that the weight loss drug, Tirzepatide is associated with significantly reduced risk of developing type 2 diabetes (T2D).

Obesity is a major worldwide health concern. Current global estimates of the number of adults living with obesity is at 650 million, with a further 340 million children and adolescents. Overweight and obesity represent the primary risk factors for the development of T2D, with T2D driving excess morbidity and mortality.

The study published in The Lancet's eClinicalMedicine used anonymised electronic medical records from a global federated database. Two cohorts of individuals were generated from this data; group one was those without pre-existing T2D, the second with T2D. Using real world data, Tirzepatide was tested in comparison to another weight loss drug, Semaglutide.

Compared to Semaglutide, Tirzepatide was found to be associated with significantly reduced risk of developing T2D in people living with obesity, and a reduction in major adverse cardiovascular events in people with T2D.

Dr Uazman Alam, Diabetes & Obesity Research, Institute of Life Course and Medical Sciences, University of Liverpool and Liverpool University Hospital NHS Foundation Trust said: "Around 1 in every 4 adults is living with obesity which is a major risk factor for diabetes. Around 4 million people have type 2 diabetes in the UK, with diabetes complications costing £6.2 billion a year for the UK healthcare system. These findings are incredibly positive in helping us address this significant health challenge."

Dr Matthew Anson, Clinical Research Fellow, University of Liverpool added: "In part, weight loss as a result of the drug may have played a role in the reduction of developing type 2 diabetes and also reducing cardiovascular complications. Now, definitive randomised control trials are needed to better understand how Tirzepatide could be used to prevent T2D in a population at higher risk of developing it."

Technology Networks, 22 August 2024

https://technologynetworks.com

CHEMWATCH
Bulletin Board

Novel Method Converts Microplastics into Valuable Graphene

2024-08-13

James Cook University researchers have achieved a significant breakthrough that allows them to convert microplastics to a highly valuable material.

JCU Professor Mohan Jacob said some plastic waste degrades into smaller fragments, often reaching micron sizes.

"These microplastics are notorious for their non-degradable and insoluble nature in water and are an evolving threat to fish and animals and humans," said Professor Jacob.

JCU's Dr Adeel Zafar said microplastics' characteristics enable them to absorb organic pollutants.

"Once they are in water they are ultimately integrated into both marine and human food chains. Disturbingly, microplastics disrupt marine life and coral reproduction," said Dr Zafar.

He said the recycling of microplastics faces significant challenges due to labour-intensive separation processes and high costs, resulting in very low resource recovery globally.

"Upcycling, which involves transforming plastic waste into higher-value materials rather than simply breaking it down, has a high demand," said Dr Zafar.

The team ground up plastic bottles into microplastics and then used the new Atmospheric Pressure Microwave Plasma synthesis technique to convert the debris to graphene – a one atom thick carbon material that is harder than diamond, 200 times stronger than steel and five times lighter than aluminum - the use of which is burgeoning in several industries.

"Approximately 30 mg of microplastics produced nearly 5 mg of graphene in 1 minute. This production rate is remarkably higher than achieved previously, and offers a simpler, more environmentally friendly alternative to current techniques," said Dr Zafar.

He said the research marks a significant milestone in the field. The graphene produced could be used for several applications including the manufacturing of various sensors and water purification, including the absorption of PFAS.

"The research not only pioneers a novel approach to graphene synthesis but also contributes to the broader goal of mitigating the adverse effects of microplastic pollution on our ecosystems," said Professor Jacob.

Technology Networks, 13 August 2024

https://technologynetworks.com

Autism in boys linked to common plastic exposure in the womb

2024-08-08

Prenatal exposure to higher levels of bisphenol A, a plastic commonly found in water bottles and packaging and known to leach into our foods and drinks, has been linked to autism spectrum disorder in boys, according to a new study that also identified the biological mechanism underlying this link.

The risks of exposure to bisphenol A (BPA), an industrial chemical used in plastic manufacturing and found in a wide variety of plastic products, are well-documented. Known to leach out of plastics and into the foods and beverages we consume, studies have linked BPA to health issues primarily because it mimics the structure and function of the hormone estrogen, disrupting body processes such as growth, cell repair, fetal development, energy levels, and reproduction.

It's also been linked to neurodevelopmental disorders like ADHD and autism, also referred to as autism spectrum disorder (ASD). In a new study, researchers from The Florey Institute of Neuroscience and Mental Health (The Florey) in Melbourne, Australia, have found a possible link between autism and exposure to BPA in the womb.

"Exposure to plastic chemicals during pregnancy has already been shown in some studies to be associated with subsequent autism in offspring," said Professor Anne-Louise Ponsonby, head of Florey's neuroepidemiology research group, who jointly led the study with research fellow Dr Wah Chin Boon. "Our work is important because it demonstrates one of the biological mechanisms potentially involved."

ASD is a clinically diagnosed neurodevelopmental condition that affects how people interact with others, communicate, learn, and behave. According to the World Health Organization (WHO), ASD affects about one in 100 children worldwide. Figures presented by the US Centers for Disease Control and Prevention (CDC) this year identified about one in 36

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

American children have the condition, which was nearly four times more common among boys than girls. Prevalence had increased from one in 54 recorded in 2016. In 2018, Autism Spectrum Australia (Aspect) revised its autism prevalence rates from one in 100 to an estimated one in 70 Australians on the autism spectrum, around a 40% increase.

While the increased prevalence of ASD is partly attributable to greater awareness and more advanced diagnosis, potential causative factors like genetics and environment during early life and the way the two things interact remain important.

In the present study, the researchers focused on the enzyme aromatase, which converts neuroandrogens, a class of male sex hormones found in the brain, into neuroestrogens, or female sex hormones. During fetal development, aromatase expression in the brain is high in males. Studies have shown that exposure to bisphenols, of which BPA is one, can disrupt brain aromatase function.

"BPA can disrupt hormone-controlled male fetal brain development in several ways, including silencing a key enzyme, aromatase, that controls neurohormones and is especially important in fetal male brain development," Ponsonby said. "This appears to be part of the autism puzzle."

To examine the interplay between prenatal BPA, aromatase function and sex in relation to ASD symptoms and diagnosis, the researchers obtained data from two large cohorts: the Barwon Infant Study (BIS) in Australia and the Columbia Center for Children's Environmental Health Study – Mothers and Newborns (CCCEH-MN) in the US.

They found a link between the presence of BPA and ASD was particularly evident in the top fifth of boys with vulnerability to the chemical's endocrine-disrupting properties. In other words, those with lower levels of aromatase. Boys in this group, born to mothers with higher BPA levels in their urine during late pregnancy, were 3.5 times more likely to have ASD symptoms by age two and six times more likely to have an ASD diagnosis verified by age 11 than those born to mothers with lower urinary BPA levels during pregnancy.

In both the BIS and CCCEH-MN cohorts, the evidence demonstrated that, overall, higher BPA levels were associated with epigenetic suppression of the aromatase enzyme. Epigenetic changes are DNA modifications that regulate whether genes are turned on or off. Here, the CYP19A1 gene, which provides instructions for producing aromatase.

The researchers went on to study the impact of prenatal BPA on mice.

"We found that BPA suppresses the aromatase enzyme and is associated with anatomical, neurological and behavioral changes in the male mice that may be consistent with autism spectrum disorder," said Boon. "This is the first time a biological pathway has been identified that might help explain the connection between autism and BPA."

The researchers' findings understandably drew comments from others in the scientific community. Some were impressed by the researchers' identification of the biological pathway thought to influence ASD.

"What's really new about their results is that they were able to pin the effect to a biological pathway that is important in brain development," said Professor Ian Rae, an expert on environmental chemicals from the School of Chemistry at the University of Melbourne. "In other words, BPA is acting as a 'rogue' hormone to out-compete the natural hormone that is usually involved in this pathway."

Whereas others viewed the results with varying degrees of skepticism.

"In mice studies where the mother was treated with 50 µg/kg/day of BPA for around four days mid-pregnancy, there were changes in the number of brain cells and their structure in the male offspring," said Dr Ian Musgrave, a senior lecturer from the School of Medicine Sciences at the University of Adelaide in Australia. "However, the majority of changes had huge overlaps between treated and untreated, and while statistically significant, it is not clear if this is biologically relevant. Furthermore, the doses were the maximum permissible, which most people are not going to be exposed to.

"What is more, the doses were given subcutaneously, which bypasses the metabolic systems BPA encounters when taken orally," Musgrave continued. "As most human exposures are oral, and human efficiently metabolize and excrete BPA taken orally, the exposure of the mice to BPA will be higher than humans."

Professor Elisa Hill-Yardin, Head of the Gut-Brain Axis Laboratory at RMIT University, said, "Future work to carefully measure bisphenol A levels over time during pregnancy to clarify these findings … The effects of diet may also be important in these findings.

"This is interesting research worthy of further investigation, but it's important to understand that there are many other genetic variations that are possible contributors to autism that have similar amounts of evidence,"

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

Hill-Yardin explained. "Ultimately, we still don't know for sure what causes autism for most people, and a normal healthy diet and lifestyle advice should be followed during pregnancy."

The study was published in the journal Nature Communications.

New Atlas, 8 August 2024

https://newatlas.com

Life from a drop of rain: New research suggests rainwater helped form the first protocell walls

2024-08-21

One of the major unanswered questions about the origin of life is how droplets of RNA floating around the primordial soup turned into the membrane-protected packets of life we call cells.

A new paper by engineers from the University of Chicago's Pritzker School of Molecular Engineering (UChicago PME), the University of Houston's Chemical Engineering Department, and biologists from the UChicago Chemistry Department, have proposed a solution.

In the paper, published in Science Advances, UChicago PME postdoctoral researcher Aman Agrawal and his co-authors—including UChicago PME Dean Emeritus Matthew Tirrell and Nobel Prize-winning biologist Jack Szostak—show how rainwater could have helped create a meshy wall around protocells 3.8 billion years ago, a critical step in the transition from tiny beads of RNA to every bacterium, plant, animal, and human that ever lived.

"This is a distinctive and novel observation," Tirrell said.

The research looks at "coacervate droplets"—naturally occurring compartments of complex molecules like proteins, lipids, and RNA. The droplets, which behave like drops of cooking oil in water, have long been eyed as a candidate for the first protocells. But there was a problem. It wasn't that these droplets couldn't exchange molecules between each other, a key step in evolution, the problem was that they did it too well, and too fast.

Any droplet containing a new, potentially useful pre-life mutation of RNA would exchange this RNA with the other RNA droplets within minutes, meaning they would quickly all be the same. There would be no differentiation and no competition—meaning no evolution.

And that means no life.

"If molecules continually exchange between droplets or between cells, then all the cells after a short while will look alike, and there will be no evolution because you are ending up with identical clones," Agrawal said.

Engineering a solution

Life is by nature interdisciplinary, so Szostak, the director of UChicago's Chicago Center for the Origins of Life, said it was natural to collaborate with both UChicago PME, UChicago's interdisciplinary school of molecular engineering, and the chemical engineering department at the University of Houston.

"Engineers have been studying the physical chemistry of these types of complexes—and polymer chemistry more generally—for a long time. It makes sense that there's expertise in the engineering school," Szostak said. "When we're looking at something like the origin of life, it's so complicated and there are so many parts that we need people to get involved who have any kind of relevant experience."

In the early 2000s, Szostak started looking at RNA as the first biological material to develop. It solved a problem that had long stymied researchers looking at DNA or proteins as the earliest molecules of life.

"It's like a chicken-egg problem. What came first?" Agrawal said. "DNA is the molecule which encodes information, but it cannot do any function. Proteins are the molecules which perform functions, but they don't encode any heritable information."

Researchers like Szostak theorized that RNA came first, "taking care of everything" in Agrawal's words, with proteins and DNA slowly evolving from it.

"RNA is a molecule which, like DNA, can encode information, but it also folds like proteins so that it can perform functions such as catalysis as well," Agrawal said.

RNA was a likely candidate for the first biological material. Coacervate droplets were likely candidates for the first protocells. Coacervate droplets containing early forms of RNA seemed a natural next step.

That is until Szostak poured cold water on this theory, publishing a paper in 2014 showing that RNA in coacervate droplets exchanged too rapidly.

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

"You can make all kinds of droplets of different types of coacervates, but they don't maintain their separate identity. They tend to exchange their RNA content too rapidly. That's been a long-standing problem," Szostak said.

"What we showed in this new paper is that you can overcome at least part of that problem by transferring these coacervate droplets into distilled water—for example, rainwater or freshwater of any type—and they get a sort of tough skin around the droplets that restricts them from exchanging RNA content."

'A spontaneous combustion of ideas'

Agrawal started transferring coacervate droplets into distilled water during his Ph.D. research at the University of Houston, studying their behavior under an electric field. At this point, the research had nothing to do with the origin of life, just studying the fascinating material from an engineering perspective.

"Engineers, particularly Chemical and Materials, have good knowledge of how to manipulate material properties such as interfacial tension, role of charged polymers, salt, pH control, etc.," said University of Houston Prof. Alamgir Karim, Agrawal's former thesis advisor and a senior co-author of the new paper. "These are all key aspects of the world popularly known as 'complex fluids'—think shampoo and liquid soap."

Agrawal wanted to study other fundamental properties of coacervates during his Ph.D. It wasn't Karim's area of study, but Karim had worked decades earlier at the University of Minnesota under one of the world's top experts—Tirrell, who later became founding dean of the UChicago Pritzker School of Molecular Engineering.

During a lunch with Agrawal and Karim, Tirrell brought up how the research into the effects of distilled water on coacervate droplets might relate to the origin of life on Earth. Tirrell asked where distilled water would have existed 3.8 billion years ago.

"I spontaneously said 'rainwater!' His eyes lit up and he was very excited at the suggestion," Karim said. "So, you can say it was a spontaneous combustion of ideas or ideation!"

Tirrell brought Agrawal's distilled water research to Szostak, who had recently joined the University of Chicago to lead what was then called the Origins of Life Initiative. He posed the same question he had asked Karim.

"I said to him, 'Where do you think distilled water could come from in a prebiotic world?'" Tirrell recalled. "And Jack said exactly what I hoped he would say, which was rain."

Working with RNA samples from Szostak, Agrawal found that transferring coacervate droplets into distilled water increased the time scale of RNA exchange—from mere minutes to several days. This was long enough for mutation, competition, and evolution.

"If you have protocell populations that are unstable, they will exchange their genetic material with each other and become clones. There is no possibility of Darwinian evolution," Agrawal said. "But if they stabilize against exchange so that they store their genetic information well enough, at least for several days, so that the mutations can happen in their genetic sequences, then a population can evolve."

Rain, checked

Initially, Agrawal experimented with deionized water, which is purified under lab conditions. "This prompted the reviewers of the journal who then asked what would happen if the prebiotic rainwater was very acidic," he said.

Commercial lab water is free from all contaminants, has no salt, and lives with a neutral pH perfectly balanced between base and acid. In short, it's about as far from real-world conditions as a material can get. They needed to work with a material more like actual rain.

What's more like rain than rain?

"We simply collected water from rain in Houston and tested the stability of our droplets in it, just to make sure what we are reporting is accurate," Agrawal said.

In tests with the actual rainwater and with lab water modified to mimic the acidity of rainwater, they found the same results. The meshy walls formed, creating the conditions that could have led to life.

The chemical composition of the rain falling over Houston in the 2020s is not the rain that would have fallen 750 million years after the Earth formed, and the same can be said for the model protocell system Agrawal tested.

The new paper proves that this approach of building a meshy wall around protocells is possible and can work together to compartmentalize the molecules of life, putting researchers closer than ever to finding the right

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

set of chemical and environmental conditions that allow protocells to evolve.

"The molecules we used to build these protocells are just models until more suitable molecules can be found as substitutes," Agrawal said. "While the chemistry would be a little bit different, the physics will remain the same."

Phys Org, 21 August 2024

https://phys.org

Feeding seaweed supplement to cattle halved methane emissions in Australian feedlot, study finds

2024-08-18

It takes a tasty treat to lure a cow's head into the narrow channel of a solar-powered contraption mounted to the back of a trailer.

Once inside, and munching away at the sweet pellet, sensors measure the potency of the animal's methane-laden burps. By the water trough, another device calculates the cow's weight, and over the fence tubs of feed on scales record how much it eats.

Like the other 19,000 cattle at Kerwee Feedlot, 150km west of Brisbane, the 80 cows in this pen are fed a twice-daily ration of freshly milled wheat and barley. But in the mix there's an added supplement derived from Asparagopsis, a species of red seaweed shown in some studies to reduce the methane output of cows. This is one of the longest commercial trials of the additive to date.

Globally, methane released by burping livestock, namely cattle, accounts for an estimated 5.5%-5.7% of all human-induced global heating. It is also responsible for the majority of emissions in Australia's livestock sector.

This feedlot, with the exception of the hi-tech monitoring equipment in one pen, is a standard set-up: cattle arrive from farms, spend a few hundred days fattening up for slaughter, and are then trucked to an abattoir. There are 57 feedlots just like it within a few hundred kilometres of Kerwee – almost half of Australia's feedlot capacity.

The trial at Kerwee involved feeding a commercial Asparagopsis supplement in the form of an infused canola oil over 200 days. The study involved 160 Angus steers in total, including a control group. The results, published in the journal of Translational Animal Science, found methane

emissions in the cattle fed the supplement reduced by more than half (a 51.7% reduction in production and 50.5% reduction in yield) when taken on average over the length of the trial, with a peak in methane reduction at 91% on day 29.

The taste and quality of the meat was not affected and cattle fed the supplement gained 20kg more than those without.

The results are a vast improvement on a net methane reduction of 19% in wagyu cattle observed in a 2023 study, and Associate prof Fran Cowley, who leads the University of New England's ruminant research group, says actual abatement may be higher than that recorded by the field instruments.

The only catch is that the cattle were in a feedlot, which account for less than 1% of the industry's methane emissions.

Cowley says reducing methane emitted from cattle grazing on farms will be far more difficult.

"Feedlots are the best case scenario for the efficacy of [methane] inhibition and ease of adoption for producers," Cowley says. "When we get out into grazing systems, things get much, much harder."

The vast majority of Australia's 27.8 million beef cattle spend most of their lives grazing in often-far flung paddocks, where it's not possible to hand-feed daily supplements.

Early results from a pen trial in March of a lick block infused with emissions inhibitors, which could be deployed in some paddocks, saw an on-average 12% abatement of methane.

Other strategies to reduce on-farm methane emissions include a raft of nascent technology including releasing additives into drinking water, selective breeding and improving the efficiency of farms.

Cowley estimates a mix of interventions could yield a 15%-20% methane reduction in Australia's beef cattle herd by 2030. That would still fall short of the federal government's commitment to cut methane emissions by a third in the same period, in line with global targets.

Climate scientists say methane emissions must be cut by 60% to limit the worst effects of global heating. The easiest way to do that, according to a global survey of 210 climate and food systems scientists, is to reduce rates of red meat consumption.

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

'Pretty serious costs'

Even in feedlots, the commercial viability of additives such as Asparagopsis remains unclear. Marcus Doumany, the chief operating officer of Stockyard Beef, the owner of Kerwee Feedlot, says it is not currently viable to roll out the supplement across all its hundred pens.

"We are looking at some pretty serious costs to industry to make this happen," Doumany says. "It's that classic early commercialisation phase, everyone is trying to work out when and what to do."

Cowley says the feed additives are at "research prices" but will fall as adoption and production ramps up. Alex Baker, the chief executive of FutureFeed, the licence distributors of the red seaweed supplement, "firmly believes" the productivity benefit – the slight weight gain, which Doumany described as "modest" – will drive a strong economic case for adoption.

Government incentives may also make adoption more enticing. The Department of Climate Change, Energy, the Environment and Water is assessing a proposal to that would allow producers to be issued Australian carbon credit units in exchange for methane emissions abatement with feed additives.

Baker says, if approved, the scheme would provide "additional confidence" to producers but predicts it would take at least 18 months until its up and running.

Global livestock methane emissions are projected to increase by 30% by 2050 under current policies.

The Guardian, 18 August 2024

https://theguardiam.com

Morphable materials: Researchers coax nanoparticles to reconfigure themselves

2024-08-19

A view into how nanoscale building blocks can rearrange into different organized structures on command is now possible with an approach that combines an electron microscope, a small sample holder with microscopic channels, and computer simulations, according to a new study by researchers at the University of Michigan and Indiana University.

The approach could eventually enable smart materials and coatings that can switch between different optical, mechanical and electronic properties.

"One of my favorite examples of this phenomenon in nature is in chameleons," said Tobias Dwyer, U-M doctoral student in chemical engineering and co-first author of the study published in Nature Chemical Engineering. "Chameleons change color by altering the spacing between nanocrystals in their skin. The dream is to design a dynamic and multifunctional system that can be as good as some of the examples that we see in biology."

The imaging technique lets researchers watch how nanoparticles react to changes in their environment in real time, offering an unprecedented window into their assembly behavior.

In the study, the Indiana team first suspended nanoparticles, a class of materials smaller than the average bacteria cell, in tiny channels of liquid on a microfluidic flow cell. This type of device allowed the researchers to flush different kinds of fluid into the cell on the fly while they viewed the mixture under their electron microscope. The researchers learned that the instrument gave the nanoparticles -- which normally are attracted to each other -- just enough electrostatic repulsion to push them apart and allow them to assemble into ordered arrangements.

The nanoparticles, which are cubes made of gold, either perfectly aligned their faces in a tidy cluster or formed a more messy arrangement. The final arrangement of the material depended on the properties of the liquid the blocks were suspended in, and flushing new liquids into the flow cell caused the nanoblocks to switch between the two arrangements.

The experiment was a proof of concept for how to steer nanoparticles into desired structures. Nanoparticles are too small to manually manipulate, but the approach could help engineers learn to reconfigure other nanoparticles by changing their environment.

"You might have been able to move the particles into new liquids before, but you wouldn't have been able to watch how they respond to their new environment in real-time," said Xingchen Ye, IU associate professor of chemistry who developed the experimental technique and is the study's lead corresponding author.

"We can use this tool to image many types of nanoscale objects, like chains of molecules, viruses, lipids and composite particles. Pharmaceutical

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

companies could use this technique to learn how viruses interact with cells in different conditions, which could impact drug development."

An electron microscope isn't necessary to activate the particles in practical morphable materials, the researchers said. Changes in light and pH could also serve that purpose.

But to extend the technique to different kinds of nanoparticles, the researchers will need to know how to change their liquids and microscope settings to arrange the particles. Computer simulations run by the U-M team open the door to that future work by identifying the forces that caused the particles to interact and assemble.

"We think we now have a good enough understanding of all the physics at play to predict what would happen if we use particles of a different shape or material," said Tim Moore, U-M assistant research scientist of chemical engineering and co-first author of the study. He designed the computer simulations together with Dwyer and Sharon Glotzer, the Anthony C. Lembke Department Chair of Chemical Engineering at U-M and a corresponding author of the study.

"The combination of experiments and simulations is exciting because we now have a platform to design, predict, make and observe in real time new, morphable materials together with our IU partners," said Glotzer, who is also the John Werner Cahn Distinguished University Professor and Stuart W. Churchill Collegiate Professor of Chemical Engineering.

The research is funded by the National Science Foundation.

Science Daily, 19 August 2024

https://sciencedaily.com

Scientists help turn whisky waste into valuable commodity

2024-08-21

A new method to extract valuable bio-based chemicals from whisky distillery waste streams could transform manufacturing and be worth up to £90 million in global chemical manufacturing markets.

Scientists from RIPCELL, a chemical manufacturing business, are working with researchers from the University of Aberdeen to demonstrate the feasibility of recovering high-value compounds, such as lactic acid, from

pot ale and spent lees—co-products of the first and second stages of the whisky distillation process.

These extracted chemicals have potential applications in sectors including pharmaceuticals, food and drink, and cosmetics, where manufacturing typically depends on unsustainable, petrochemical-derived ingredients.

The project used samples of waste streams provided by whisky group Chivas Brothers from 12 of its distilleries across Scotland.

The research team developed a process using a separation technique known as liquid chromatography to isolate and extract higher-value acids, initially from pot ale. It has now been adapted to retrieve additional solvents from spent lees.

While residue from pot ale is typically used in low value applications such as animal feeds, spent lees are currently discarded. Up to 10 liters of spent lees are generated for every liter of whisky made, and due to variations in distillery processes, water sources, and raw materials, co-products from different distilleries contain different chemical compounds.

A life cycle analysis of the process was also completed to quantify its environmental impact. The results showed that the bio-based chemicals produced through this method have a significantly lower carbon footprint compared to those produced through traditional petrochemical routes. Estimates suggest that on a global scale, the new manufacturing method for target chemicals could reduce industry emissions by 392 million kg of CO2 equivalent per year.

Following the success of the feasibility study, the next phase for the team will involve scaling up the separation process to prove its viability at an industrial scale.

Dr. Eve Wildman, founder of RIPCELL, said, "Around 2.6 billion liters of wastewater is produced from the Scottish whisky industry every year, so the potential of this process is huge. For decades, the majority of these co-products have been used as animal feed, but we have found a new, more valuable option to deal with spent lees that could change the ways in which distilleries manage and process their residues.

"At the same time, this could be transformational for the chemical industry. By taking a sustainable approach to manufacturing key compounds, rather than using fossil fuels, RIPCELL can help to reduce greenhouse gas emissions from the production process. For every kilo of bio-chemicals produced, we can remove 1.59 kg of harmful greenhouse gas emissions."

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

Dr. Liz Fletcher, director of business engagement at IBioIC, said, "This project is a brilliant example of how we can add economic value by taking a circular approach to co-products and applying biotechnology. For both whisky producers and the chemicals industry, this process marks a significant step forward in reducing the environmental impact of manufacturing. We look forward to supporting RIPCELL throughout its next steps to bring the process closer to commercial application."

Dr. Alan Mccue, senior lecturer at the University of Aberdeen, added, "The idea of utilizing wastewater from a traditional industry like whisky production for the recovery of bio-based chemicals is highly innovative. It's great to see Scottish heritage being linked to sustainable chemical production. The outcomes of this project are really exciting, and I look forward to supporting RIPCELL in the next stages of its development."

Phys Org, 21 August 2024

https://phys.org

Engineered Bacteria make thermally stable plastics similar to polystyrene and PET

2024-08-21

Bioengineers around the world have been working to create plastic-producing microbes that could replace the petroleum-based plastics industry. Now, researchers from Korea have overcome a major hurdle: getting bacteria to produce polymers that contain ring-like structures, which make the plastics more rigid and thermally stable. Because these molecules are usually toxic to microorganisms, the researchers had to construct a novel metabolic pathway that would enable the E. coli bacteria to both produce and tolerate the accumulation of the polymer and the building blocks it is composed of. The resulting polymer is biodegradable and has physical properties that could lend it to biomedical applications such as drug delivery, though more research is needed. The results are presented August 21 in the Cell Press journal Trends in Biotechnology.

"I think biomanufacturing will be a key to the success of mitigating climate change and the global plastic crisis," says senior author Sang Yup Lee, a chemical and biomolecular engineer at the Korea Advanced Institute of Science and Technology. "We need to collaborate internationally to promote bio-based manufacturing so that we can ensure a better environment for our future."

Most plastics that are used for packaging and industrial purposes contain ring-like "aromatic" structures -- for example, PET and polystyrene. Previous studies have managed to create microbes that can produce polymers made up of alternating aromatic and aliphatic (non-ring-like) monomers, but this is the first time that microbes have produced polymers made up entirely of monomers with aromatic sidechains.

To do this, the researchers first constructed a novel metabolic pathway by recombining enzymes from other microorganisms that enabled the bacteria to produce an aromatic monomer called phenyllactate. Then, they used computer-simulations to engineer a polymerase enzyme that could efficiently assemble these phenyllactate building blocks into a polymer.

"This enzyme can synthesize the polymer more efficiently than any of the enzymes available in nature," says Lee.

After optimizing the bacteria's metabolic pathway and the polymerase enzyme, the researchers grew the microbes in 6.6 L (1.7 gallon) fermentation vats. The final strain was capable of producing 12.3 g/L of the polymer (poly(D phenyllactate)). To commercialize the product, the researchers want to increase the yield to at least 100 g/L.

"Based on its properties, we think that this polymer should be suitable for drug delivery in particular," says Lee. "It's not quite as strong as a PET, mainly because of the lower molecular weight."

In future, the researchers plan to develop additional types of aromatic monomers and polymers with various chemical and physical properties -- for example, polymers with the higher molecular weights required for industrial applications. They're also working to further optimize their method so that it can be scaled up.

"If we put more effort into increasing the yield, then this method might be able to be commercialized at a larger scale," says Lee. "We're working to improve the efficiency of our production process as well as the recovery process, so that we can economically purify the polymers we produce."

This research was supported by the National Research Foundation, the Korean Ministry of Science, and ICT.

Science Daily, 21 August 2024

https://sciencedaily.com

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

Slashing Carbon Emissions: Stanford Engineers Unveil Game-Changing Electrified Reactor

2024-08-21

Researchers at Stanford have created an innovative reactor that uses electricity instead of fossil fuels, offering a cleaner alternative for industrial heating and potentially reducing carbon emissions significantly.

Industrial processes in the U.S. currently contribute about a third of the nation's carbon dioxide emissions, surpassing the combined annual emissions from passenger vehicles, trucks, and airplanes. Decarbonizing this sector is a challenging yet crucial step toward mitigating future climate impacts.

Researchers at Stanford Engineering have designed and demonstrated a new type of thermochemical reactor that is capable of generating the immense amounts of heat required for many industrial processes using electricity instead of burning fossil fuels. The design, published August 19 in Joule, is also smaller, cheaper, and more efficient than existing fossil fuel technology.

"We have an electrified and scalable reactor infrastructure for thermochemical processes that features ideal heating and heat-transfer properties," said Jonathan Fan, an associate professor of electrical engineering at Stanford and senior author on the paper. "Essentially, we're pushing reactor performance to its physical limits, and we're using green electricity to power it."

Heating with induction

Most standard thermochemical reactors work by burning fossil fuels to heat a fluid, which then flows into pipes in the reactor – like a boiler sending hot water to cast iron radiators in an old house, but with better insulation and at much higher temperatures. This requires a fairly large amount of infrastructure and there are many opportunities to lose heat along the way.

The new electrified reactor uses magnetic induction to generate heat – the same sort of process used in induction stoves. Instead of having to transport heat through pipes, induction heating creates heat internally within the reactor, by taking advantage of interactions between electric currents and magnetic fields. If you wanted to inductively heat up a steel rod, for example, you could wrap a wire around it and run an alternating current through the coil. These currents create an oscillating magnetic

field which, in turn, induces a current in the steel. And because steel is not a perfect conductor of electricity, some of that current turns into heat. This method effectively heats the whole piece of steel at the same time, rather than creating heat from the outside in.

Adapting induction heating for the chemicals industry is not as easy as just turning up the heat. Industrial reactors need to evenly create and distribute heat in a three-dimensional space and be much more efficient than the average stovetop. The researchers determined that they could maximize their efficiency by using particularly high-frequency currents, which alternate very quickly, in conjunction with reactor materials that are particularly bad conductors of electricity.

The researchers used new, high-efficiency electronics developed by Juan Rivas-Davila, an associate professor of electrical engineering and co-author on the paper, to produce the currents they required. They then used those currents to inductively heat a three-dimensional lattice made of a poorly conducting ceramic material in the core of their reactor. The lattice structure is just as important as the material itself, Fan said, because the lattice voids artificially lower the electrical conductivity even further. And those voids can be filled with catalysts – the materials that need to be heated to initiate chemical reactions. This makes for even more efficient heat transfer and means the electrified reactor can be much smaller than traditional fossil fuel reactors.

"You're heating a large surface area structure that is right next to the catalyst, so the heat you're generating gets to the catalyst very quickly to drive the chemical reactions," Fan said. "Plus, it's simplifying everything. You're not transferring heat from somewhere else and losing some along the way, you don't have any pipes going in and out of the reactor – you can fully insulate it. This is ideal from an energy management and cost point of view."

Electrified industry

The researchers used the reactor to power a chemical reaction, called the reverse water gas shift reaction, using a new sustainable catalyst developed by Matthew Kanan, a professor of chemistry at Stanford and co-author of the paper. The reaction, which requires high heat, can turn captured carbon dioxide into a valuable gas that can be used to create sustainable fuels. In the proof-of-concept demonstration, the reactor was over 85% efficient, indicating that it converted almost all electrical energy into usable heat. The reactor also demonstrated ideal conditions for facilitating the chemical reaction – carbon dioxide was converted to

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

usable gas at the theoretically predicted rate, which is often not the case with new reactor designs.

"As we make these reactors even larger or operate them at even higher temperatures, they just get more efficient," Fan said. "That's the story of electrification – we're not just trying to replace what we have, we're creating even better performance."

Fan, Rivas-Davila, Kanan, and their colleagues are already working to scale up their new reactor technology and expand its potential applications. They are adapting the same ideas to design reactors for capturing carbon dioxide and for manufacturing cement, and they are working with industrial partners in the oil and gas industries to understand what those companies would need to adopt this technology. They are also conducting economic analyses to understand what system-wide sustainable solutions would look like and how they could be made more affordable.

"Electrification affords us the opportunity to reinvent infrastructure, breaking through existing bottlenecks and shrinking and simplifying these types of reactors, in addition to decarbonizing them," Fan said. "Industrial decarbonization is going to require new, systems-level approaches, and I think we're just getting started."

Sci Tech Daily, 21August 2024

https://scitechdaily.com

Hydrogel can preserve medications for weeks outside of a fridge

2024-07-17

Mixing protein-based drugs with hydrogels can keep the atomic bonds in the medication safe from high temperatures or shaking

Many medications must be refrigerated, or they lose their effectiveness, but a new method of packing protein-based drugs into a stiff gel could make them last longer at room temperature.

Drugs can break down if they aren't stored properly, which can make them unsafe to use. Exposure to high temperatures, for example, can break the chemical bonds that maintain a drug molecule's shape, disrupting its function. For some drugs, shaking can make their molecules clump together, reducing their efficacy. Matthew Gibson at the University of Manchester in the UK has been working on addressing these challenges for almost 15 years.

He and his colleagues have now developed a method that could make handling protein-based drugs simpler and more practical. He says the new advance came from working with Dave Adams at the University of Glasgow in Scotland, who specialises in making hydrogels. They worked out how to mix proteins with gel ingredients and end up with a stiff white structure that can be loaded into a syringe. In this form, proteins that would usually have to be refrigerated at -20°C (-4°F) withstood temperatures as high as 50°C (122°F) and remained functioning under these conditions for up to four weeks.

The hydrogel gets its stiffness from small molecules combined into large chains, which are then broken by applying force. In syringes, pushing down on the plunger breaks the molecular bonds, turning the gel and protein mixture into a liquid. The hydrogel remnants were too big to enter the syringe's needle, so only the drug leaves the syringe.

The team tested this method with several compounds, including bovine insulin and β-Galactosidase, an enzyme commonly used for gene studies in biology. They also mailed a box filled with containers full of protein-packed hydrogels to themselves and found that the proteins withstood the temperatures and jostling of the journey through the postage system.

Though there are laboratory methods that can keep proteins stable for longer, this approach may be better suited to leave the lab and enter the clinic, says Alex Brogan at King's College London. He says that it would most benefit countries and regions where cold storage is rare and prohibitively expensive. If the new method works with protein-based vaccines, it could make disease prevention more equitable, he says.

Gibson says that he and his team are confident they could make their hydrogel at industrial scales, but they want to conduct more studies on its longevity and safety. While using it with vaccines is on their wish list, in the short term the method could also be used to store, transport and administer semaglutide, a drug used to treat diabetes and obesity.

New Scientist, 17 July 2024

https://newscientist.com

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

MDMA rejection poses questions for psychedelic drug trials

2024-08-20

Decision prompts reflection over how psychotherapy is involved, regulating combination treatments and safeguarding patients

The US Food and Drug Administration (FDA) has rejected MDMA as a psychiatric treatment for post-traumatic stress disorder (PTSD). US based Lykos Therapeutics had hoped to get the active ingredient in the club drug ecstasy approved for use in combination with psychotherapy.

Instead, on 9 August, the FDA asked for a further phase 3 clinical trial to collect more data on both safety and efficacy. The decision follows an overwhelming majority of the agency's advisory committee agreeing on 4 June that Lykos' application was lacking on both fronts. In a statement, Amy Emerson, Lykos' chief executive, said that 'conducting another phase 3 study would take several years'.

Then, on 10 August, editors at the journal Psychopharmacology retracted three papers from researchers affiliated to Lykos' predecessor, MAPS Public Benefit Corporation (MAPS-PBC). Two of the papers involved analysis of six clinical trials included in the FDA submission. The editors' notices cited 'protocol violations amounting to unethical conduct'. On 15 August, Lykos announced that it will cut about 75% of its staff and that Rick Doblin, who pioneered the therapy, is stepping down from the board to enable him to advocate more freely for psychedelic therapies.

Though some dispute MDMA's psychedelic status because it rarely causes hallucinations, it has played a significant role in recently resurging medical interest in such drugs. Therefore, other researchers exploring related treatments for conditions such as depression and addiction stand to learn much from Lykos' crisis.

Michael Abrams, a senior researcher at nonprofit consumer advocacy organisation Public Citizen, attended the June FDA committee. Public Citizen strongly asserted that the data was far from good enough for consideration. 'We're glad they rejected the therapy,' Abrams tells Chemistry World. 'But there's some question about why we got to this point, given how weak the trial was and then ethical concerns that emerged later.'

Vulnerable to abuse

The decision represents a striking change in MDMA's trajectory. Back in 2017, the FDA had granted the drug an expedited review process. That was spurred by promising early findings that suggested MDMA, in combination with psychotherapy, could offer relief for millions suffering from PTSD, including many military veterans.

Lykos applied for the right to market MDMA, which it refers to as midomafetamine, providing apparently strong data from two phase 3 trials showing reduced scores for PTSD symptoms. The company had hoped to only require one such trial. However, the FDA asked for a second, which included improved policies on misconduct after two therapists abused a patient.

The June panel had several concerns about the psychotherapy aspect of the trial, with the FDA stressing that it 'does not regulate the practice of psychotherapy'. The 11-member panel ruled 9-2 that the evidence does not demonstrate the drug's effectiveness, and 10-1 that its potential benefits do not outweigh the associated risks.

Abrams highlights the need for still stronger measures to protect patients from abuse during the multi-hour therapy sessions, which was discussed during 'riveting testimony' at the committee meeting. 'This is a very intensive treatment, a vulnerable position, and then you add on top of it that you're giving somebody a substance that is really very destabilising,' Abrams says.

Other concerns raised included that the trial participants' responses may have been biased by expecting a benefit when they received MDMA, whose effects were obvious. And if the participants experienced negative effects, some researchers conducting the trial may have discouraged them from reporting them. 'People came out as very critical of Lykos, very concerned about their experiences during the treatment,' says Abrams. 'You should have safeguards in place and make darn sure that these kinds of abuses do not occur.'

An unnecessary combination?

However, it should be possible to develop related psychiatric drugs avoiding such psychotherapy entirely during trials, according to David Olson from the University of California, Davis in the US. 'If a drug is safe and efficacious on its own, there is no reason that a doctor can't prescribe it with psychotherapy, as the FDA does not regulate the practice of medicine,' adds Olson. 'As an example, ketamine is approved as a stand-

CHEMWATCH
Bulletin Board
Curiosities
AUG. 23, 2024

alone treatment for depression, but many practitioners will combine its use with psychotherapy.'

Meanwhile, Holly Swartz from the University of Pittsburgh, US, points out that the FDA is actually taking its first steps into regulating some forms of psychotherapy. The agency's Center for Devices and Radiological Health approved a prescription-only, app-based cognitive behavioural therapy programme from Otsuka Pharmaceuticals in May. However, drugs such as MDMA are assessed by the Center for Drug Evaluation and Research, and Swartz notes the two FDA centres' approaches are very different. 'My impression is they don't really talk to each other,' she adds.

As such, the MDMA situation reveals structural issues with how regulators think about psychotherapy, Swartz underlines. 'These applications of psychedelics are really about opening people up to the therapy experience, so they go hand in hand. But there isn't a reasonable regulatory framework in place yet, I think, for vetting and approving these combination treatments,' she says. 'There have been dismantling studies where you look at psychotherapy and pharmacotherapy in combination or individually. In many instances there are additive effects, so considering them as separate entities, regulating them separately, doesn't make sense to me.'

She also adds that there are existing, effective, evidence-based psychotherapies for PTSD that sufferers can't get access to, owing to bottlenecks in training therapists and disseminating treatments.

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CHEMWATCH

Bulletin Board

Technical Notes

AUG. 23, 2024

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

CHEMICAL EFFECTS

Toxicity Reference Values for Force Health Protection: Provisional Occupational Exposure Guidelines

Emerging threat of marine microplastics: Cigarette butt contamination on Yellow Sea beaches and the potential toxicity risks to rotifer growth and reproduction

Hydrogen-bond organic-framework-based electrochemical sensor for highly sensitive determination of trace cadmium ions in environmental and e-cigarette samples

ENVIRONMENTAL RESEARCH

Machine learning based-model to predict catalytic performance on removal of hazardous nitrophenols and azo dyes pollutants from wastewater

Analysis of proper ink management impact on overall environmental equipment efficiency for sustainability

Cyclic methylsiloxanes in wastewater treatment plants: Occurrence, emissions, environmental distributions, and occupational exposure

PHARMACEUTICAL/TOXICOLOGY

Associations of prenatal exposure to individual and mixed organophosphate esters with ADHD symptom trajectories in preschool children: The modifying effects of maternal Vitamin D

'Humans think outside the pixels' - Radiologists' perceptions of using artificial intelligence for breast cancer detection in mammography screening in a clinical setting

OCCUPATIONAL

Meta-analysis Identifies Key Genes and Pathways Implicated in Benzo[a] pyrene Exposure Response

Occupational chronic psychological stress and transaminase, HSP70 gene family and its proteins association of the interaction with metabolic syndrome