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

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ASIA PACIFIC

Reconsideration of approval of label

2023-07-11

The APVMA gives notice that it has reconsidered the approval of the following labels under section 34AF of the Agricultural and Veterinary Chemicals Code scheduled to the Agricultural and Veterinary Chemicals Code Act 1994 (Agvet Code), with effect from the date shown.

Table 7: Variation of label approval – agricultural chemical products

Product name	Rygel Probuffer 700 Surfactant
Active constituent	350 g/L propionic acid, 350 g/L soyal phospholipids
Registrant name	Profeng Australia Pty Ltd
Registrant ACN	156 055 533
Date of variation	05/07/2023
Product registration no.	63606
Prior label approval no.	63606/0109
New label approval no.	63606/0109R
Description of the reconsideration and its purpose	Variation of label approval to amend first aid instructions and safety directions

Product name	Pacific Buffer 700 Surfactant
Active constituent	350 g/L propionic acid, 350 g/L soyal phospholipids
Registrant name	Pacific Agriscience Pty Ltd
Registrant ACN	096 082 316
Date of variation	05/07/2023
Product registration no.	65913
Prior label approval no.	65913/52283
New label approval no.	65913/52283R
Description of the reconsideration and its purpose	Variation of label approval to amend first aid instructions and safety directions

The APVMA has determined under section 81(3)(c) that section 81(3) of the Agvet Code apply to the earlier approved label, allowing supply of products bearing the earlier approved label for a period of 12 months from the date of variation.

Read More

APVMA, 11-07-23

https://apvma.gov.au/sites/default/files/2023-07/Gazette%20No%2014%2C%20Tuesday%2011%20July%202023.pdf

Agvet chemical voluntary recall: Semintra 10 mg/mL Oral Solution for Cats

2023-07-11

Product name: Semintra 10 mg/mL Oral Solution for Cats

APVMA registration number: 86454

APVMA approved label number: 115796

Batch numbers: E07522, E30545

Sold by: Boehringer Ingelheim Animal Health Australia nationwide between 1 June 2022 to 1 July 2023

On 10 July 2023, Boehringer-Ingelheim Animal Health Australia Pty Ltd (ACN 071 187 285) initiated a voluntary recall under section 106 of the Agricultural and Veterinary Chemicals Code scheduled to the Agricultural and Veterinary Chemicals Code Act 1994 (Cth) in relation to the chemical product described above.

Reason for voluntary recall

The voluntary recall for the product has been initiated due to an out-of-specification result during the shelf-life period. The recall is limited to the batches identified above.

Hazard

There is a low hazard associated with this recall. There is no anticipated impact on product safety or efficacy through the shelf-life period.

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What to do if in possession of this chemical product

Veterinary wholesalers will be contacted to return their inventory of the affected batches. There is no action required to be taken by veterinarians or pet owners. Product on hand at veterinary clinics is suitable for use.

More information

Visit the APVMA website to view the notice of voluntary recall for the chemical product described above.

The APVMA publishes a list of agvet chemical recall notices on its website and provides a subscription option to be notified by email when a new recall notice is published.

Contact

Questions about this voluntary recall should be directed to the Boehringer Ingelheim Animal Health Customer Service Team:

Email: customercare.australia@boehringer-ingelheim.com

Phone: 1800 808 691 (option 3 for recall questions, option 2 for animal welfare questions)

Read More

APVMA, 11-07-23

https://apvma.gov.au/sites/default/files/2023-07/Gazette%20No%2014%2C%20Tuesday%2011%20July%202023.pdf

Australia Chemicals that require annual import or export authorisation from AICIS

2023-07-21

decaBDE and PFOA-related compounds – authorisation required from 21 July 2023

From 21 July 2023, Australian importers and exporters of these chemicals must receive annual authorisation from AICIS:

- decabromodiphenyl ether (decaBDE)
- perfluorooctanoic acid (PFOA) and its salts
- PFOA-related compounds

This new rule does not apply if these chemicals are introduced only for research or analysis at volumes of 100 kg or less in an AICIS registration year.

See the chemicals that require authorisation and exceptions

This new requirement fulfils Australia's obligation as a party to the Rotterdam Convention, which is a multilateral treaty on the trade of hazardous chemicals. We previously gave notice about these changes on 20 June 2023.

How to apply for import or export authorisation?

You need to submit the relevant form and pay a fee. Affected introducers of these chemicals can submit an application now. This also applies to anyone who wishes to introduce these chemicals from 21 July 2023.

Apply for annual export authorisation - Rotterdam Convention

Apply for annual import authorisation - Rotterdam Convention

Chemicals that require annual import or export authorisation from AICIS

1. **Decabromodiphenyl ether (decaBDE)**

Common name	decaBDE
CAS number	1163-19-5
CAS name	Benzene, 1,1'-oxybis[2,3,4,5,6-pentabromo-]
IUPAC name	2,3,4,5,6-Pentabromo-1-(2,3,4,5,6-pentabromophenoxy)benzene
EC number	214-604-9; EC name: Bis(pentabromophenyl) ether
Molecular formula	C12Br10O
Synonyms	decabromodiphenyl ether decabromodiphenyl oxide bis(pentabromophenyl) oxide decabromo biphenyl oxide decabromo phenoxybenzene benzene 1,1' oxybis-, decabromo derivative, DBDPE2 DBBE DBBO DBDPO

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2. Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds

- perfluorooctanoic acid (PFOA, CAS number 335-67-1) and its salts
- any related substance (including its salts and polymers) having a linear or branched perfluoroheptyl group with the formula C7F15- directly attached to another carbon atom as one of the structural elements
- any related substance (including its salts and polymers) having a linear or branched perfluorooctyl group with the formula C8F17- as one of the structural elements

Exceptions - chemicals that don't require annual import or export authorisation from AICIS

2. Introductions of decabromodiphenyl ether (decaBDE), perfluorooctanoic acid (PFOA), its salts or PFOA-related compounds solely for the purpose of research or analysis at volumes of 100 kg or less in an AICIS registration year (30 August to 1 September).
3. The following fluorinated chemicals:

- C8F17-X, where X = F, Cl, Br
- C8F17-C(=O)OH,
- C8F17-C(=O)O-X' (where X' = any group, including salts) or
- C8F17-CF2-X' (where X' = any group, including salts)

Read More

Industrial Chemicals, 21-07-23

https://www.industrialchemicals.gov.au/news-and-notices/decabde-and-pfoa-related-compounds-authorisation-required-21-july-2023

AMERICA

US state actions concerning food packaging and chemicals in 2023

2023-07-20

The US Food and Drug Administration (FDA) recently announced a restructuring of the department to focus on chemicals used as food additives and in packaging. Meanwhile, US states are also making changes to chemical, packaging, and waste regulations. The following is a brief review of policies US states have adopted concerning food contact chemicals and materials in recent months.

Food contact chemicals – PFAS, bisphenols, and phthalates

Washington State Departments of Ecology and Health published a draft phthalates action plan that "provides a list of recommended actions that could be undertaken to reduce exposures to and sources of phthalates in Washington." The two departments plan to focus first on finding alternatives for phthalates in medical devices, building materials, and FCMs. The final version of the action plan is expected in December 2023.

The phthalates action plan is part of the second cycle of the Safer Products for Washington Program. The agencies went through a similar process with per and polyfluoroalkyl substances (PFAS) and bisphenols as part of the first work cycle (FPF reported). Results from the first cycle went into effect July 1, 2023, which included a first-in-the-nation prohibition on bisphenol-based epoxy liners in drink cans by January 2025. Only tetramethyl bisphenol F (TMBPF)-based liners are exempt.

Minnesota passed a bill to mandate disclosure of PFAS in products by 2026 and ban intentionally added PFAS in most products by 2028. Cookware must be PFAS-free by January 1, 2025. A state prohibition on PFAS in cannabis packaging, including edibles, went into effect on July 1, 2023.

Maine passed a law in 2019 to phase out PFAS from food packaging (FPF reported, also here) that was initially meant to start in January 2022 but was postponed (FPF reported). Now, the state's Department of Environmental Protection plans to start making rules in September 2023 to hopefully be implemented by early 2024, according to reporting from Chemical Watch.

Read More

FPF, 20-07-23

https://www.foodpackagingforum.org/news/us-state-actions-concerning-food-packaging-and-chemicals-in-2023

WASHINGTON STATE FINALIZES CYCLE ONE OF SAFER PRODUCTS RESTRICTIONS AND REPORTING

2023-07-12

Washington's Department of Ecology adopted a new rule, Chapter 173-337 WAC – Safer Products Restrictions and Reporting. This rule applies to any person that manufacturers, distributes, or sells a priority consumer product that contains a priority chemical in the state of Washington. This first cycle includes several restrictions and reporting requirements.

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Requirement Summary of Cycle 1:

PFAS in:

- Aftermarket stain and water resistance treatments for textile and leather consumer products

o Restricts intentionally added PFAS as of Jan. 1, 2025

- Carpets and rugs (including carpeted mats) for indoor and outdoor use

o Restricts intentionally added PFAS as of Jan. 1, 2025

- Leather and textiles furniture and furnishings intended for indoor use

o Restricts intentionally added PFAS as of Jan. 1, 2026

- Leather and textiles furniture and furnishings intended for outdoor use

o Reporting takes effect on Jan. 1, 2024

o Must submit notification by Jan. 31, 2025 and annually thereafter

- Ecology presumes the detection of total fluorine indicates the addition of PFAS, however manufacturers may contest the presence by providing credible evidence that demonstrates PFAS were not intentionally added.

Read More

US Consumer Products, 12-07-23

https://www.cps.bureauveritas.com/newsroom/washington-state-finalizes-cycle-one-safer-products-restrictions-and-reporting

EUROPE

DG Sante webinar on BPA restriction in food contact

2023-07-19

The EU Directorate General for Health and Food Safety (DG Sante) hosted a webinar and question period on July 18, 2023, following up on their recent announcement to ban the intentional use of bisphenol A (BPA, CAS 80-05-7), and potentially several other bisphenols targeted by other EU agencies including bisphenol S (CAS 80-09-1), bisphenol F, and 2,2-bis(4' -hydroxyphenyl)-4-methylpentane (CAS 6807-17-6), in food contact materials (FCMs) in the European Union (FPF reported). Jonathan Briggs of DG Sante reviewed the considerations that went into the decision to ban the substance and elaborated on what will take place next. The ban

will enter into force in early 2024 with an 18-month transition period. Consequently, the BPA-containing FCMs won't effectively be banned from the market until late 2025 or early 2026, and extensions for some material uses may yet be granted.

The ban will only apply to "intentionally added" BPA but what is "intentional use" has not yet been fully defined. Briggs noted that initially, recycled products will likely contain BPA, but the hope is that as the source materials phase out intentionally used BPA the recycled material contamination will also go down.

DG Sante does not predict major impacts on plastic FCMs but for "varnishes and coatings the story is somewhat different." The shift away from BPA is anticipated to affect the shelf life, cost, and energy consumption of coated products like some canned goods or lids. BPA is also sometimes found in inks, adhesives, and rubbers. Because "some applications will take longer than others" to transition (e.g., some acidic foods in coated metal packaging; heavy-duty coating on large vessels and containers), industry can apply by September 15, 2023, to extend the phase-out period.

Briggs stated that "efforts should be made to identify sources that contribute the greatest to human exposure and to address those over time." In the EU, bisphenol A has been banned in polycarbonate baby bottles since 2011, expanded to all products for infants and toddlers since 2018, and in thermal receipts since 2020.

Read More

FPF, 19-07-23

https://www.foodpackagingforum.org/news/dg-sante-webinar-on-bpa-restriction-in-food-contact

INTERNATIONAL

Enhancing cooperation with Japan on critical raw materials supply chains through a new Administrative Arrangement

2023-07-06

Enhancing cooperation with Japan on critical raw materials supply chains through a new Administrative Arrangement

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The European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs of the European Commission and the Japan Organization for Metals and Energy Security (JOGMEC) signed an 'Administrative Arrangement on Cooperation in Critical Raw Materials Supply Chains' in Brussels, ahead of the EU-Japan Summit, at the occasion of the visit of the President of JOGMEC to Brussels.

The agreement is part of the EU's objective to strengthen its global engagement with reliable partners at the multilateral level and through mutually beneficial partnerships, as outlined in the recent Critical Raw Materials Act proposed by the European Commission.

Today's agreement presents an opportunity to deepen our cooperation with a forward-looking and ambitious partner like Japan on issues that are essential for the green and digital transition of our industries. It will allow us to share information and deepen our respective understandings in key areas, particularly in supply chain risk management, innovation, and recycling and circularity frameworks and exchanging information on projects and relevant support instruments.

More information

Critical Raw Materials Act webpageEN

Details

Publication date: 6 July 2023

Author: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

Read More

European Commission,06-07-23

https://single-market-economy.ec.europa.eu/news/enhancing-cooperation-japan-critical-raw-materials-supply-chains-through-new-administrative-2023-07-06_en

Per- and polyfluoroalkyl substances (PFAS)

2023-06-28

Per- and polyfluoroalkyl substances (PFAS) are a large class of thousands of synthetic chemicals that are used throughout society. However, they are increasingly detected as environmental pollutants, and some are linked to negative effects on human health.

They all contain carbon-fluorine bonds, which are one of the strongest chemical bonds in organic chemistry. This means that they resist degradation when used and also in the environment. Most PFAS are also easily transported in the environment covering long distances away from the source of their release.

PFAS have been frequently observed to contaminate groundwater, surface water and soil. Cleaning up polluted sites is technically difficult and costly. If releases continue, they will continue to accumulate in the environment, drinking water and food.

Latest updates

Universal PFAS restriction proposal:

- Second batch of Q&As from the info session online, 28 June 2023
- First Q&As published from the info session, 3 May 2023
- Watch the info session on the proposed PFAS restriction
- Have your say on the proposal to restrict PFAS by 25 September 2023
- Direct link to consultation
- ECHA publishes PFAS restriction proposal, 7 February 2023
- Recording of media briefing held by the five national authorities

Restriction proposal on PFAS in firefighting foams:

- ECHA's committees: EU-wide PFAS ban in firefighting foams warranted, 22 June 2023
- ECHA's Risk Assessment Committee backs PFAS ban in firefighting foams, 24 March 2023
- Proposal to ban 'forever chemicals' in firefighting foams throughout the EU, 23 Feb 2022

Other:

- Perfluoroheptanoic acid (PFHpA) and its salts added to Candidate List of substances of very high concern, 17 January 2023

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Read More

ECHA, 28-06-23

https://echa.europa.eu/hot-topics/perfluoroalkyl-chemicals-pfas

Time

2023-07-28

(link)

Sodium bicarbonate

2023-07-28

USES [2,3]

Sodium bicarbonate is used across a range of applications in various industries. It is an alkaline solution, meaning it neutralises acids. In this capacity it is used as an antacid—for conditions such as heartburn and indigestion. It can also be used to help contrast-induced nephropathy, stomach ulcers, dental plaque, and tooth discolouration. Besides its use as an antacid, bicarbonate of soda is used in baking as a leavening agent.

ROUTES OF EXPOSURE [3]

Routes of Exposure

Sodium bicarbonate can be taken intravenously and orally.

HEALTH EFFECTS [4]

Sodium bicarbonate poisoning affects a range of systems, including the integumentary and respiratory systems.

Acute Health Effects

Severity of symptoms depend on the level and type of exposure.

If a high concentration of chemical dust is inhaled, it can result in coughing, sneezing, or a sore throat. If large amounts of the chemical compound are ingested, it can cause gastrointestinal problems or abdominal pain. Eye contact with the chemical can result in mild irritation, including temporary redness and temporary impairment of vision.

Chronic Effects

Chronic exposure to sodium bicarbonate is toxic to multiple body systems. Long term skin exposure to the chemical may cause dermatitis, characterised by skin redness and swelling, which may cause blistering and scaling and thickening of the epidermis. Although this chemical is not thought to cause other long-term effects, exposure should be minimised as a matter of course.

Sodium bicarbonate, aka baking soda or bicarbonate of soda, is a soluble odourless white crystalline powder. It is a salt that breaks down to form bicarbonate and sodium in water. [1,2]

SAFETY

First Aid Measures [5]

Ingestion: If swallowed, immediately give the victim water to drink. First aid is usually not required; if in doubt, contact the poisons hotline.

Skin contact: Remove all contaminated clothing, footwear and accessories. Do not re-wear clothing until it has been thoroughly decontaminated. Immediately rinse affected areas with plenty of soap and water. Contact a doctor in the event of continued irritation.

Eye contact: Flush eyes (including under the eyelids), with water for at least 15 minutes. Removal of contact lenses should only be done by skilled personnel. Contact a medical professional immediately.

Inhalation: If the person inhales fumes, combustion products or aerosols, remove them from the contaminated site. Other measures are usually unnecessary. If in doubt, contact the poisons information centre.

General: Never administer anything by mouth to an unconscious, exposed person.

Exposure Controls/ Personal Protection

Engineering controls: Emergency eyewash fountains and quick-drench areas should be accessible in the immediate area of the potential exposure. Ensure there is adequate ventilation. Use a local exhaust ventilation or process enclosure, to limit the amount of chemical dust in the air.

Personal protection: Safety glasses, protective and dustproof clothing, gloves, a P.V.C apron and an appropriate mask or dusk respirator. Wear impervious shoes. Other protection could include barrier cream and skin cleansing cream. For specifications regarding other PPE, follow the guidelines set in your jurisdiction.

REGULATION

United States

The Time Weighted Average (TWA) for sodium bicarbonate has been set at 10mg/m3.

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Australia

No TWA has been set specifically for this chemical. Instead, there is a blanket limit of 10mg/m3 for dusts when no other limits have been specified.

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Molecular highway for electrons in organic light-emitting diodes: Researchers develop new material concept

2023-07-25

From televisions to smartphones: organic light-emitting diodes (OLEDs) are nowadays finding their way into many devices that we use every day. To display an image, they are needed in the three primary colors red, green and blue. In particular, light-emitting diodes for blue light are still difficult to manufacture because blue light—physically spoken—has a high energy, which makes the development of materials difficult.

Especially the presence of minute quantities of impurities in the material that cannot be removed plays a decisive role in the performance of these materials. These impurities—oxygen molecules, for example—form obstacles for electrons to move inside the diode and participate in the light-generation process. When an electron is captured by such an obstacle, its energy is not converted into light but into heat. This problem, known as "charge trapping", occurs primarily in blue OLEDs and significantly reduces their efficiency.

A team led by Paul Blom, director at the Max Planck Institute for Polymer Research, has now tackled the problem of charge trapping. They have used a new class of molecules for this purpose. These consist of two chemical parts; one is responsible for the electron conduction, whereas the other part is not sensitive to impurities.

By manipulating the chemical structure of the molecule, a special spatial arrangement is achieved: When several molecules are joined, they form a kind of "spiral"—that means the electron-conducting part of the molecules forms the inner part, which is shielded on the outside by the other part of the molecules. This resembles, in a molecular way, a coaxial cable with an electron conducting inner core and an outer part shielding the core.

The cladding thus forms a kind of "protective layer" for the electron-conducting core, shielding it from the intrusion of oxygen molecules. Thus, the electrons can move fast and freely along the central axis of the spiral without being trapped by obstacles, similar to cars on a highway without crossings, traffic lights or other obstacles. .

"One of the special things about our new material is that the absence of losses due to impurities and resulting efficient electron transport can greatly simplify the design of blue OLEDs, while maintaining a high efficiency," says Paul Blom.

Organic light-emitting diodes (OLEDs) are now widely used. For use in displays, blue OLEDs are additionally required to supplement the primary colors red and green. Especially in blue OLEDs, impurities give rise to strong electrical losses, which could be partly circumvented by using highly complex and expensive device layouts. A team from the Max Planck Institute for Polymer Research has now developed a new material concept that potentially allows efficient blue OLEDs with a strongly simplified structure.

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With their work, the researchers hope to have taken an important step toward simpler production of blue light-emitting diodes. They have now published their results in the journal Nature Materials.

Phys Org, 25 July 2023

https://phys.org

Scientists develop automated analysis method for identification and quantification of microplastic particles

2023-07-26

Microplastics are everywhere in the environment. The tiny particles, with diameters of less than 5 millimeters, can also absorb and transport contaminants and toxins. "We urgently need analytical techniques to learn about the size, concentration and composition of these particles," says Dr. Natalia Ivleva at the Chair of Analytical Chemistry and Water Chemistry at TUM. Together with her team, the scientist has developed a new process.

To be able to detect microplastic particles, the researchers had several hurdles to overcome: The first was the problem of low concentrations. River water, for example, contains massive amounts of suspended solids and fine sand, with plastic accounting for less than 1% of the particles. These particles must first be isolated before their concentrations and ultimately their chemical composition are determined.

Previous methods have relied on the analysis of the residues that are released when the samples are heated. With that approach, however, it is not possible to determine the number, size and shape of the plastic particles.

Plastics can be identified through light scattering

"Our approach is fundamentally different," says Dr. Ivleva. "It is particle-based. That means that instead of destroying the particles, we analyze them directly." To do this, the researchers use a method known as Raman microspectroscopy. It works by shining a monochromatic laser source onto a sample and detecting the light scattered by the molecules.

Comparing the scattered light against the laser source provides information on the substance under investigation. To analyze plastic particles with a diameter greater than 1 µm (micrometer), they must first be filtered out of the aqueous solution, detected under the

How high are concentrations of microplastics in the environment, in our drinking water or in foods? Researchers at the Technical University of Munich (TUM) have developed an automated analysis method for the identification and quantification of particles.

microscope and then illuminated with laser light. Because plastics such as polyethylene, polystyrene and polyvinyl chloride scatter the photons in characteristic ways, they each generate signals as unique as a fingerprint.

Automation instead of manual measurements

It took years to develop the tracing process. "When we started, we still had to make manual measurements," recalls the chemist. "It took us months to investigate a few thousand particles." In the meantime the team has succeeded in automating the detection of microplastics. A single analysis no longer takes weeks, but only a matter of hours.

Although the tiny particles still have to be filtered out of the aqueous solution, followed by placement of the filter under the Raman microspectroscope, all remaining steps are carried out by the software developed by the team. The plastic particles are first localized with a light microscope, photographed and measured, and the particles are distinguished from fibers. The software uses these data to compute the number of particles and fibers and to select the image sections needed for a statistically significant result in the subsequent Raman spectroscopy.

In the next step, the laser is directed onto the sample and the scattering is detected and analyzed. This allows quick and reliable analysis of the number, size, shape and composition of the microplastics. The open-source TUM-Particle Typer 2 software is now available to researchers around the world, and Ivleva's team has published two articles on the process in the journal Analytical and Bioanalytical Chemistry.

Nanoplastics require special detection processes

To investigate nanoparticles with diameters of less than 1 µm, however, Dr. Ivleva's team is already working on a modified process. "Nanoparticles like these are difficult or even impossible to discern under a light microscope. To detect them, we first have to carry out size fractionation and then identify them," explains the researcher.

For this purpose, a field flow fractionation (FFF) system is used. This creates a water flow that captures the particles—depending on their size—and separates them by transporting them at varying speeds. A specially developed device, combined with Raman spectroscopy, permits the chemical characterization of different types of nanoplastics.

"The new analytical processes permit rapid and precise investigation of concentration, size and composition of micro- and nanoplastics," sums up

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Dr. Ivleva. "This will now make it possible to study the influence of these particles on the environment and human health."

Phys Org, 26 July 2023

https://phys.org

Study unveils new RNA dysregulation process that contributes to neurodegeneration

2023-07-23

Researchers at Johns Hopkins University School of Medicine, University of Chicago, the Howard Hughes Medical Institute and other institutes in the United States recently carried out a study aimed at better understanding the processes through which C9ORF72 gene mutation might ultimately contribute to the development of ALS and FTD. Their findings, published in Nature Neuroscience, highlight a promising avenue that could improve therapeutic interventions for these complex neurodegenerative disorders.

"My research group has been interested in identifying modifiers of the C9ORF72 repeat RNA metabolism," Dr. Shuying Sun, one of the researchers who carried out the study, told Medical Xpress. "A hexanucleotide repeat expansion in the C9ORF72 gene is the most prevalent genetic cause of both ALS and FTD. As the expansion is located in the noncoding region, the repeat-containing RNA is believed to be one major factor that drives the disease pathogenesis."

Sun and her colleagues have been trying to identify genetic modifiers of the unconventional production of toxic poly-dipeptide proteins from the repeat RNA. This could in turn allow them to identify viable strategies to prevent the accumulation of these toxic proteins and thus reduce their toxic effects. In one of their previous studies, they thus performed a genome-wide CRISPR-Cas9 screen to search for genetic modifiers of dipeptide production.

"We found that the two m6A methyltransferases are candidate genes that can modulate the poly-dipeptide level," Sun explained. "We also analyzed public proteomic data and found the two methyltransferases are downregulated in C9ORF72-ALS/FTD patient iPS-neurons. Altogether, this initiated our further study on the m6A dysregulation and how this contributes to neurodegeneration in C9ORF72-ALS/FTD."

Sun and her colleagues performed a series of analyses on patient-derived induced pluripotent stem cell (iPSC)-differentiated neurons (iPSNs) and

Recent neuroscience studies have consistently outlined the role of the C9ORF72 gene in the development of some neurodegenerative diseases. These studies found that mutations of this gene increase the risk of developing amyotrophic lateral sclerosis (ALS) and frontotemporal dementia (FTD), two neurodegenerative disorders characterized by motor impairments, issues with communicating and other distinct symptoms.

postmortem tissues extracted from deceased patients with ALS/FTD and with C9ORF72 gene mutations. Using various high-throughput genetic sequencing techniques, they specifically assessed an RNA modification known as M6A (methyladenosine), and its impact on the regulation of genes across the full range of expressed messenger RNA (mRNA), known as transcriptome.

"We also examined the molecular mechanism of m6A regulation on C9 repeat RNA," Sun said. "Finally, we measured neuron survival to examine the rescue efficacy by modulating the m6A pathway. Our findings reveal a novel layer of RNA regulation that plays a critical role in the pathogenic mechanism underlying neurodegeneration."

Overall, the findings gathered by this research team showed that the m6A modification in the C9ORF72 genetic sequence of expanded repeats facilitated the decay of RNA via the nuclear reader YTHDC1, thus regulating the repeats. Moreover, reduction in m6A appeared to facilitate the accumulation of repeat RNAs and the encoding of toxic proteins known to be associated with neurodegeneration.

By elevating m6A methylation, Sun and her colleagues were able to significantly reduce the level of repeat RNAs, safeguarding the neurons they were experimenting on and reducing their risk of decaying. In the future, these results could pave the way towards the development of more effective treatments for ALS and FTD, for instance prompting trials assessing the value of epitranscriptomic therapy as a potential intervention.

"We would like to further test the rescue efficacy in vivo using appropriate mouse models," Sun added. "We are also interested in developing pharmaceutical approaches targeting this pathway. Additionally, we hope to investigate the underlying disease mechanisms involving RNA metabolism and m6A dysregulation in sporadic ALS and other neurological disorders."

Medical Xpress, 23 July 2023

https://medicalxpress.com

Some sharks get a new set of teeth every few weeks, while crocodiles can go through thousands of chompers in their long lifetimes. Yet the ability to endlessly replace our pearly whites is something that's eluded us and nearly all other mammals. By the time our 32 'adult' teeth grow in, that's as good as it gets.

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Humans may soon grow new teeth, with promising drug trial set

2023-07-17

Now, a Japanese team of scientists is set to trial an experimental drug that would allow humans to grow completely new teeth.

A clinical trial scheduled for July 2024 will initially be for participants with tooth agenesis, a genetic condition that results in the absence of teeth, but the scientists have a view to making the treatment available for general use by as soon as 2030.

"The idea of growing new teeth is every dentist's dream." said Katsu Takahashi, lead researcher and head of the dentistry and oral surgery department at the Medical Research Institute Kitano Hospital in Osaka. "I've been working on this since I was a graduate student. I was confident I'd be able to make it happen."

In an earlier study, the researchers landed on an antibody for uterine sensitization-associated gene-1 (USAG-1), which could stimulate new tooth growth in mice with tooth agenesis.

Essentially, the scientists found that USAG-1 interacts with other proteins to suppress tooth growth. Blocking the interaction can lead to bone morphogenetic protein (BMP) signaling, which triggers new tooth growth.

Following on from those 2018 mice trials, experiments with ferrets had similar success in growing new teeth. The animals grew a seventh front tooth that was the same shape and makeup as its neighbors.

"We hope to pave the way for the medicine's clinical use," Takahashi said.

For years, scientists have been trying to crack the code on the genetic expression that enables animals such as sharks to continuously grow teeth, among other experimental research, but translating it to human application has been elusive.

The original 2021 study was published in the journal Science Advances.

New Atlas, 17 July 2023

https://newatlas.com

One of the central challenges for synthetic chemists is to impose control over free radicals. Highly reactive molecules with an unpaired electron, free radicals, may be familiar to you; these are the type of molecules we take antioxidant supplements for, in an effort to tame oxidative stress.

A 'toolbox of biocatalysts' improves control over free radicals

2023-07-21

In the world of synthetic chemistry, however, free radicals hold a lot of promise.

"Free radical chemistry is very useful for the synthesis of both bioactive small molecules and everyday polymers," said UC Santa Barbara chemistry professor Yang Yang, an author of a paper on the matter that appears in Nature Catalysis. "However, imposing stereocontrol over free-radical mediated reactions has eluded the asymmetric catalysis community for decades. We're trying to develop biocatalytic strategies to further push the boundaries of free radical chemistry."

To fully unlock the synthetic potential of free radicals, Yang and colleagues focus on stereochemistry—also known as 3D chemistry, which focuses on the three-dimensional orientation of atoms and molecules.

The stereochemistry of organic molecules has a significant impact on their properties. For example, (S)-carvone or "left-handed" carvone is the primary ingredient that accounts for the distinctive odor of mint. In contrast, (R)-carvone or "right-handed" carvone is found in caraway seeds and has a completely different smell. Thus, to precisely control the stereochemistry is a major goal of synthetic chemistry. To achieve it, chemists turned to catalysts, substances that enable chemical reactions without themselves being consumed or transformed in the process, making them reusable.

Achieving this type of stereocontrol is no small feat. "In general, steering free radicals towards desired stereochemistry is very difficult," Yang said. Free radicals, once formed, do not interact tightly with the catalyst. Additionally, these radicals are essentially free in another sense—they can quickly wander away from potential reactive sites.

But Yang and collaborators have a few tricks up their sleeves: metalloenzymes—naturally occurring proteins with a reactive metal center, able to generate and rein in those free radicals for selective transformations.

"Specifically in this paper we solve a problem in this field, which is how to control the stereoselective addition of a radical species to an aromatic compound," Yang said. "The radical in this case is derived from racemic starting material."

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This is where the three-dimensional chemistry comes in. "Racemic" means that the material is composed of equal proportions of "left-handed" and "right-handed" (also known as "chiral") molecules—asymmetric molecules that are composed of the same atoms, so are chemically identical, but are mirror images of each other. Like your hands, you can match them up reflection-wise, but you can't superimpose them facing the same way. Which, under normal circumstances, would pose a problem for enzymes.

"Enzymes are widely perceived as very specific catalysts," Yang said. "If the enzymes are so specific, which happens oftentimes in nature, then the enzyme can only recognize and convert one enantiomeric form of a chiral compound," Yang said. "And oftentimes the enzyme doesn't accept its mirror image.

"But in our work," Yang continued, "we've engineered an enzyme that can accept both the left-handed and right-handed form of the starting material, and then convert these starting materials into the same major enantiomeric product with excellent selectivity."

In their paper, the researchers used an iron-dependent enzyme to produce highly reactive radical species. Through directed evolution, they engineered a set of selective iron enzymes to produce either the left-handed or the right-handed product with excellent selectivity. Furthermore, with a third, "kinetic resolution" enzyme, the researchers can selectively convert the left-handed starting material, leaving the right-handed starting material untouched.

"So we have a toolbox of enzymes to allow for various types of stereocontrol for the radical functionalization of aromatic compounds," Yang said. "And yet these enzymes only differ from each other by a few mutations." Yang hopes this growing toolbox of biocatalysts will help others gain better control over their 3D chemistry, a classic problem that continues to face organic chemists.

"Our metalloenzymes provide a potentially general solution to control the selectivities of free radicals," Yang said. "So these biocatalytic solutions we created will hopefully facilitate the synthesis and study of chiral compounds in academia and industry."

Phys Org, 21 July 2023

https://phys.org

Researchers have recently discovered two naturally occurring bacteria capable of breaking down chlorinated "forever chemicals," also known as PFAS.

Scientists Discover Bacteria That Can Break Down Certain "Forever Chemicals"

2023-07-23

Scientists specializing in chemical and environmental engineering at the University of California, Riverside have discovered two types of bacteria in the soil capable of breaking down a class of stubborn "forever chemicals," giving hope for low-cost biological cleanup of industrial pollutants.

Assistant Professor Yujie Men and her team at the Bourns College of Engineering have found that these bacteria are able to eradicate a specific subgroup of per- and poly-fluoroalkyl substances, known as PFAS, particularly those that contain one or more chlorine atoms within their chemical structure. Their findings were published in the scientific journal, Nature Water.

Unhealthful forever chemicals persist in the environment for decades or much longer because of their unusually strong carbon-to-fluorine bonds. Remarkably, the UCR team found that the bacteria cleave the pollutant's chlorine-carbon bonds, which starts a chain of reactions that destroy the forever chemical structures, rendering them harmless.

"What we discovered is that bacteria can do carbon-chlorine bond cleavage first, generating unstable intermediates," Men said. "And then those unstable intermediates undergo spontaneous defluorination, which is the cleavage of the carbon-fluorine bond."

Chlorinated PFAS are a large group in the forever chemical family of thousands of compounds. They include a variety of non-flammable hydraulic fluids used in industry and compounds used to make chemically stable films that serve as moisture barriers in various industrial, packaging, and electronic applications.

The two bacteria species – Desulfovibrio aminophilus and Sporomusa sphaeroides – identified by Men's group are naturally occurring and are known to live in the subterranean microbiomes where groundwater may be contaminated with PFAS. For expedited cleanups, an inexpensive nutrient, such as methanol, could be injected into groundwater to promote bacterial growth. This would greatly increase the bacteria's presence to destroy the pollutants more effectively, Men said. If the bacteria are not already present, the contaminated water could be inoculated with one of the bacterium species.

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Men is the corresponding author of the paper and Bosen Jin, a UCR chemical and environmental engineering graduate student, is the lead author. Other UCR co-authors are postdoc Jinyu Gao; former postdoc Huaqing Liu; former graduate students Shun Che and Yaochun Yu; and Associate Professor Jinyong Liu.

The study expands on earlier work by Men, in which she demonstrated that microbes can break down a stubborn class of PFAS called fluorinated carboxylic acids.

Microbes have long been used for the biological cleanup of oil spills and other industrial pollutants, including the industrial solvent trichloroethylene or TCE, which Men has studied.

But what's known about using microorganisms to clean up PFAS is still in its infancy, Men said. Her discovery shows great promise because biological treatments, if effective pollutant-eating microbes are available, are generally less costly and more environmentally friendly than chemical treatments. Pollutant-eating microbes can also be injected into difficult-to-reach locations underground.

Men's latest PFAS study comes as the U.S. Environmental Protection Agency is promulgating new regulations to spur cleanups of PFAS-contaminated groundwater sites throughout the nation because these chemicals have been linked to a host of ill health effects, including cancer, kidney disease, and hormone disruptions.

~ sSciTechDaily, 23 July 2023

https://scitechdaily.com

New method for polyurethane synthesis using fluorine compound developed

2023-07-21

Most polyurethane is currently synthesized by means of reacting diisocyanate with diol. However, isocyanate compounds are highly toxic, and the tightening of regulations on the use of diisocyanate are progressing recently, particularly in the EU, because of health and environmental concerns. In recent years, active research is proceeding into the synthesis of polyurethane without using isocyanate compounds with a view to implementing a sustainable society.

However, most current methods are not practicable because of the variety of problems associated with them: They have low utility as well as high

Polyurethane is highly elastic, wear resistant and durable, and is used, for example, in cushions, fibers, thermal insulation materials, dyes, adhesives and automobile parts. Polyurethane is an industrially-important polymer material, with an estimated worldwide market value of 75 billion dollars.

environmental costs, and the quality of the derived polyurethane is low as well as being expensive.

Against this backdrop, Kobe University Associate Professor Tsuda and AGC, combined their efforts to jointly develop a novel polyurethane synthesis method. University-industry cooperation between the research group of Associate Professor Tsuda, pioneers of the Photo-on-demand organic synthesis method and AGC, a manufacturer of fluorinated compounds and polyurethane raw materials, created a new academic field and industrial activity based on the development of a new polyurethane synthesis method and functional materials.

Content of the research

A variety of fluorinated biscarbonates (BFBC) were synthesized by a condensation reaction of fluorinated carbonates, synthesized in the photo-on-demand synthesis method from fluorinated alcohols and chloroform, with diols. The BFBC generated could be purified by merely drying the derived sample solution at reduced pressure, enabling the quantitative derivation of the target substance by a simple operation.

The synthesis of a non-isocyanate polyurethane (NIPU) with an average molecular weight in excess of 10,000 was achieved by polycondensation of the derived BFBC with diamine. The NIPU synthesized without solvent was only slightly discolored at over 120°C, and that discoloration was not observed up to 100°C. On the other hand, if a solvent is used, it can be polymerized at a lower temperature, and a high molecular weight colorless NIPU is derived at a high-yield.

They were able to form a highly-elastic colorless and transparent polyurethane by an appropriate combination of BFBC and diamines in hard and soft segments. They also succeeded in synthesizing a novel fluorinated polyurethane which is a colorless transparent oil.

The variety and types of polyurethane synthesized, with a range from general purpose to specific applications, have the following benefits when compared to the previously reported synthesis methods of NIPU:

1. Any NIPU can be synthesized which employs commercially available diols or diamines employed in the industrial manufacture of polyurethane by the isocyanate method, or which was originally used in the synthesis of NIPU.

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2. This is a synthesis method which does not use organic bases, metallic catalysts or solvents in the synthesis, such that a high quality NIPU can be derived which does not contain any of them.
3. The average molecular weight and terminal functional groups can be controlled by the admixture ratio of BFBC and the diamines. An NIPU prepared by this method with the molecular weight of the order of 10,000 can be employed as a prepolymer in order to synthesize even larger polymers or networked polymers.
4. The reagents, solvents and eliminated fluoroalkyl alcohols can basically be recovered, and be re-utilized in the synthesis of these NIPU.

Future perspectives

The conventional polyurethane synthesis method using isocyanate has advantages from a cost perspective. However, the novel and useful non-isocyanate polyurethane (NIPU) synthesis method using these newly developed fluorinated carbonates and fluorinated biscarbonates can replace several conventional methods with a view to implementing a sustainable society, in addition to enabling the creation of functional polyurethanes which conventional methods cannot synthesize.

Research is proceeding at present, both from an academic and industrial perspective, with a view to bringing this process to market.

The study is published in the journal Bulletin of the Chemical Society of Japan.

Phys Org, 21 July 2023

https://phys.org

Animal testing under REACH: Bringing numbers into the debate

2023-07-21

The "Center for Alternatives to Animal Testing" (CAAT) based in Baltimore and at the University of Konstanz now wants to bring numbers into the REACH debate. In two current studies, based on data from the European Chemicals Agency (ECHA), the researchers show that so far around 4.2 million animals have been used for hazard assessment under REACH (of which 1.3 million animals are in ongoing studies). An additional 3.5 to 6.9 million animal tests are expected due to the revision of REACH in 2022. Their studies have been published in the journal ALTEX.

Sixteen years ago, the REACH chemical regulation came into force across Europe. REACH obliges the chemical industry to identify the health risks of all chemicals used in their products. The downside of REACH is that this hazard assessment requires a large number of animal tests. Just how many was not clear until now.

Animal-free, alternative test methods were relatively rarely used. What is known as read-across methods (prediction of toxicity from comparison with structurally similar, already tested chemicals) were rejected in 75% of cases.

Animal-free alternative methods

The researchers from Konstanz and Baltimore advocate the use of animal-free alternative methods (New Approach Methodologies, NAMs). "Some of these new methods are not only suitable for large-scale chemical screenings, but also provide more meaningful results than animal testing, as the chemicals are tested on human cells—naturally in a petri dish," explains Thomas Hartung, Director of the Center for Alternatives to Animal Testing (CAAT) and professor at the University of Konstanz.

"Animal-free alternative methods are available for an increasing range of test purposes. The goal must be to adapt the legislation to the current state of scientific knowledge," demands Marcel Leist, professor of in-vitro-toxicology at the University of Konstanz and co-director of the Center for Alternatives to Animal Testing Europe. The CAAT researchers emphasize the importance of bringing scientists, authorities and industry to the same table to advance the introduction of alternative methods.

Phys Org, 21 July 2023

https://phys.org

Age Reversal Breakthrough: Harvard/MIT Discovery Could Enable Whole-Body Rejuvenation

2023-07-26

Groundbreaking Discovery in Aging Reversal

In a monumental study, a team of researchers has revealed a novel approach to combating aging and age-related diseases. This work, undertaken by scientists at Harvard Medical School, introduces the first chemical method to rejuvenate cells, bringing them to a more youthful state. Prior to this, only powerful gene therapy could achieve this feat.

On July 12, 2023, researchers from Harvard Medical School, the University of Maine, and the Massachusetts Institute of Technology (MIT) published a fresh research paper in Aging. The paper, titled, "Chemically induced reprogramming to reverse cellular aging," extends upon a previously groundbreaking discovery. The researchers are Jae-Hyun Yang, Christopher A. Petty, Thomas Dixon-McDougall, Maria Vina Lopez, Alexander

In a pioneering study, researchers from Harvard Medical School, University of Maine, and MIT have introduced a chemical method for reversing cellular aging. This revolutionary approach offers a potential alternative to gene therapy for age reversal. The findings could transform treatments for age-related diseases, enhance regenerative medicine, and potentially lead to whole-body rejuvenation.

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Tyshkovskiy, Sun Maybury-Lewis, Xiao Tian, Nabilah Ibrahim, Zhili Chen, Patrick T. Griffin, Matthew Arnold, Jien Li, Oswaldo A. Martinez, Alexander Behn, Ryan Rogers-Hammond, Suzanne Angeli, Vadim N. Gladyshev, and David A. Sinclair.

Exploring the Methodology

This discovery builds on the finding that the expression of specific genes, known as Yamanaka factors, can transform adult cells into induced pluripotent stem cells (iPSCs). This breakthrough, which earned a Nobel Prize, prompted scientists to question if cellular aging could be reversed without pushing cells to become too young and potentially cancerous.

In this recent study, the scientists probed for molecules that could, in tandem, revert cellular aging and refresh human cells. They designed advanced cell-based assays to differentiate between young and old, as well as senescent cells. The team employed transcription-based aging clocks and a real-time nucleocytoplasmic protein compartmentalization (NCC) assay. In a significant development, they identified six chemical combinations that could return NCC and genome-wide transcript profiles to youthful states, reversing transcriptomic age in less than a week.

Relevance and Potential Applications

The Harvard team has previously shown the possibility of reversing cellular aging without causing unregulated cell growth. This was done by inserting specific Yamanaka genes into cells using a viral vector. Studies on various tissues and organs like the optic nerve, brain, kidney, and muscle have yielded encouraging results, including improved vision and extended lifespan in mice. Additionally, recent reports have documented improved vision in monkeys.

These findings have profound implications, paving the way for regenerative medicine and potentially full-body rejuvenation. By establishing a chemical alternative to gene therapy for age reversal, this research could potentially transform the treatment of aging, injuries, and age-related diseases. The approach also suggests the possibility of lower development costs and shorter timelines. Following successful results in reversing blindness in monkeys in April 2023, plans for human clinical trials using the lab's age reversal gene therapy are currently underway.

Views from the Research Team

"Until recently, the best we could do was slow aging. New discoveries suggest we can now reverse it," said David A. Sinclair, A.O., Ph.D., Professor

in the Department of Genetics and co-Director of the Paul F. Glenn Center for Biology of Aging Research at Harvard Medical School and lead scientist on the project. "This process has previously required gene therapy, limiting its widespread use."

The team at Harvard envisions a future where age-related diseases can be effectively treated, injuries can be repaired more efficiently, and the dream of whole-body rejuvenation becomes a reality. "This new discovery offers the potential to reverse aging with a single pill, with applications ranging from improving eyesight to effectively treating numerous age-related diseases," Sinclair said.

SciTechDaily, 26 July 2023

https://scitechdaily.com

Breakthrough in solid-state storage innovates how biological materials are stored and handled

2023-07-26

Biological materials that are frequently used in developing new medicines and diagnostic testing tools such as mRNA, enzymes, and antibodies are highly sensitive to changing ambient conditions during storage, transportation, and handling. When they are not stored and handled properly, they can degrade or become inactive. The result is a fundamental limitation to access in resource-limited and underserved communities.

For example, the Pfizer COVID vaccine rollout was limited in speed and breadth due the need for deep freezers for storage and transport. More broadly, even when refrigeration infrastructure is present, failures occurred in over 10% of cases, resulting in over $35 billion in losses annually according to IQVIA Institute for Human Data Science.

To overcome some of the key limitations, researchers at California Polytechnic State University (Cal Poly) in San Luis Obispo, CA, have developed the new method for storing biological materials with vast potential for use by the scientific and medical communities.

When most of us open our medicine cabinets, we find pharmaceutical drugs stored in forms such as liquids, powders packaged in capsules, pills and tablets. Pharmaceuticals have proven that each form plays an important role in how the medication is stored and used.

Apart from a few exceptions, biological materials such as medications, are currently limited to being stored as frozen or refrigerated liquids and

Scientists have developed a novel method for storing biological materials such as RNA and proteins in a solid-state. The storage in solid-state resembles the form of a pill or a tablet, which dissolves in water for on-demand use. The innovation provides a new way to overcome current limitations in the storage and handling of products derived from living cells used for a variety of health care and scientific research purposes.

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freeze-dried powders. The absence of a tablet-like form has limited the field, often making it challenging to reach the locations and users where they are needed.

"Just as tablets have changed the way we take medications, the solid-state storage platform opens new possibilities for how we handle and use biological materials, unlocking the potential for existing therapies and emerging biotechnologies," said Dr. Javin Oza, associate professor in chemistry and biochemistry, who led the research on the new storage platform.

Most biological materials require storage as liquids which are frozen in deep freezers for the duration of their shelf life. As a society, we accomplish this through a complex and integrated system of refrigerators and freezers, known as the cold-chain. In recent years, many research teams, including the group at Cal Poly have made progress in freeze-drying biological materials, which has improved the way they are stored and handled, but the use of freeze-drying remains limited.

The solid-state storage of biologics represents the next big step because tablets provide unique advantages to better preserve the material they encapsulate. For example, the innovation allows researchers to be able to package biological materials into tablets that can be stored on a shelf at room temperature, and added to water to be dissolved for on-demand use. In addition to ensuring the stability and activity of the biological materials, solid-state storage has been developed to ensure that tablets quickly disintegrate and dissolve into water.

"Our innovation makes storing and using biologics as easy as an Alka-Seltzer tablet, just drop it into water, mix, and it's ready to go," Oza added.

As a test case for the solid-state storage platform's ability to support a complex mixture of biologics, the team demonstrated that the cell's machinery capable of decoding genetic information into making RNA and proteins can be stored in a solid-state. When added to water, the machinery reactivates to decode genetic information as if it were still within the cell. The team also went a step further to demonstrate that emerging biotechnology tools such as CRISPR can be activated after storage in a solid-state.

The team's results demonstrate potential for a wide range of applications. The ability to store biologics at room temperature and activate them on demand could be useful for delivering therapeutics to remote locations where the cold-chain is unavailable. For instance, one could envision

portable, on-demand production of vaccines to remote locations. The platform could also be used for diagnostic testing of anything from COVID-19 screening to testing wastewater contaminants, simply by changing the composition of the tablets. For utilization in the field, the solid-state storage has the added benefit of being simple to use, reducing the need for specialty training of technicians, further improving access at the point of need.

Further improvements to the platform will be needed to suit specific use cases. The researchers anticipate that additional modifications such as coatings could help the solid-state storage be more suitable for withstanding extreme environments such as heat, humidity, and chemicals. Additionally, continued improvements in treatments and coatings to the solid-state biologics could lead to biological medication tablets that can be taken orally rather than through injections. If successful, medications such as insulin and Humira (immunosuppressive treatment for arthritis) could someday be taken orally rather than through injections, improving the quality of life for millions of people.

Since the field of biotechnology is growing rapidly, the potential impacts extend beyond health care, and into biomanufacturing, education, and research. The innovation is also likely to impact the way biologics are transported around the globe and into space for the on-demand production of life-saving therapies.

Phys Org, 26 July 2023

https://phys.org

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New method of recycling-colored plastics offers possible solution to 'huge environmental challenge'

2023-07-25

A new method for recycling-colored plastics has been developed by scientists at Cardiff University.

The process, which breaks down colored polymers, the principal component of plastics, into their original components, could lead to a circular plastic recycling economy reducing pollution on land and in our oceans, the researchers claim.

Widely used in drinks bottles, food packaging, clothing and electronics, colored plastics can be melted down and remolded into new products, but additives or colorants cannot be removed in current recycling processes.

To avoid this method of downcycling, where recycled plastic is of lower quality than the original material, the Cardiff team used a chemical process called depolymerization.

Dr. Ben Ward, Senior Lecturer in Inorganic Chemistry at Cardiff University, said, "Our current recycling economy only allows plastics and polymers to be recycled a finite number of times, after which they go to landfill or are incinerated. This is a huge environmental challenge."

"It is also a problem for industry who want to reuse and recycle colored polymers but are limited by additives which affect the quality and color of recycled products."

"We've addressed this in our study by taking colored polymers, unmaking them, isolating the monomers, and re-making them into pure, white polymers. This is the first time that has ever been achieved and it goes right to the heart of tackling the problem of plastic recycling."

Using a reactor based in the labs at Cardiff University's School of Chemistry, the team chose specific molecules known as monomers to make plastics that are strong and stable, while adding in recyclability as part of the molecular design process.

Further monomers were added to the reactor to give the plastics color while maintaining the same properties as the base materials.

Through a chemical process called depolymerization, the team were able to unmake their products returning them to the original monomers.

A new method for recycling-colored plastics has been developed by scientists at Cardiff University.

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They found that the colors could be removed during the depolymerization process, making the plastics recyclable and more sustainable.

Dr. Ward added, "What we're showing is that this is a mechanism by which you can recycle plastics infinitely and that technology just doesn't exist for traditional plastics."

"While industry doesn't currently have the infrastructure to use our approach to plastics recycling, we're showing chemical viability, laying the baseline from which this can be done in the future."

The team is currently working to refine the process further and make it more cost-effective, as well as ensuring that these new polymers can be processed for use in real-world products.

Phys Org, 25v July 2023

https://phys.org

Researchers achieve water-assisted strong underwater adhesion

2023-07-25

As the interfacial water layer hinders the formation of interfacial contacts and intermolecular interactions between the adhesive and the substrate, in almost all cases of underwater adhesion, water molecules typically act as a destroyer, resulting in poor adhesion. Thus, removing interfacial water from the substrate surfaces is essential for the formation of super-strong underwater adhesion.

Despite various single physical attempts such as absorption, hydrophobic repulsion and extrusion, the complete removal of interfacial water contradiction is hard to achieve because of the unavoidable presence of bound water at the interface. Hence, an unconventional dehydration mechanism with a conceptually new material design at the physical-chemical coupling and a multiscale method are required for deep removal of water at the contact interface and self-adaptive cohesion enhancement to create powerful underwater adhesives.

In a study published in PNAS, Zhou Feng's group from the Lanzhou Institute of Chemical Physics (LICP) of the Chinese Academy of Sciences developed a self-strengthening liquid underwater adhesive (SLU-adhesive) and achieved fast and robust underwater adhesion through deep-water removal at the contact interface and self-adaptive cohesion enhancement.

As the interfacial water layer hinders the formation of interfacial contacts and intermolecular interactions between the adhesive and the substrate, in almost all cases of underwater adhesion, water molecules typically act as a destroyer, resulting in poor adhesion.

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The researchers utilized a multiscale dehydration mechanism based on a physical–chemical coupling to develop the SLU-adhesive. The adhesion mechanism of the removal of interfacial water involves multiscale dehydration in three steps, namely, physical replacement of the surface water on the substrate with SLU-adhesive at mm scale because of its excellent wettability, physical removal of water at μm scale by generating carbon dioxide bubbles from the chemical reaction between isocyanate groups and water at the interface, and simultaneous chemical consumption of the surface-bound water at molecular level.

This series of adhesion behaviors is instantaneous, spontaneous, and tacitly coordinated throughout the entire process of liquid adhesive contact, spreading, wetting, and gelation on the substrate surface. Strong adhesion over 1,600 kPa can be achieved on various materials, including inorganic metals and organic plastic materials, without preloading in different environments such as pure water, a wide range of pH solutions (pH = 3 to 11), and seawater.

Due to their excellent adhesion property and self-adaptive adhesion procedure, SLU-adhesive materials demonstrate great potential for a wide range of applications in underwater sand stabilization, underwater repair, and even as a self-reporting adhesive for the detection of adhesion failure.

Phys Org, 25 July 2023

https://phys.org

Mechanochemical process makes fluorochemicals without HF

2023-07-21

A new technique for making fluorochemicals bypasses the production of hydrogen fluoride (HF) gas. This could make fluorochemical production safer, and the researchers who developed the method say it also has the potential to streamline supply chains and decrease energy requirements, helping to lower the industry's carbon footprint.

All of the fluorine atoms in fluorochemicals that are currently manufactured originate from the naturally occurring mineral calcium fluoride, which is also known as fluorspar. To produce fluorochemicals, fluorspar must be converted into HF through an energy-intensive process involving the reaction of acid-grade fluorspar with sulfuric acid at high temperatures.

A new technique for making fluorochemicals bypasses the production of hydrogen fluoride (HF) gas.

However, HF is highly toxic and, despite strict safety protocols, several spill incidents have occurred, with damaging effects on the environment and, in some cases, fatal outcomes.

Because of this a team led by researchers from the University of Oxford, UK, set out to develop a safer and more sustainable fluorination method to enable academic researchers and industry to access fluorochemicals directly from fluorspar while avoiding the production of HF.

'Fluorochemicals are prominent in all of our daily lives and have an enormous impact on society from medicines to materials,' says Oxford-based PhD student Calum Patel. 'But hydrogen fluoride has gained notoriety in the press more recently in the context of spillages and industrial accidents.'

Chemistry World, 21 July 2023

https://chemistryworld.com

Green chemistry pioneers aim to change world

2023-07-25

The earth is currently plagued by a number of very vexing molecules: carbon dioxide and methane in the atmosphere, plastic polymers in the oceans, and hydrocarbons in our energy systems, to name a few.

Is there a unifying solution to all of this? Well, no, but for Dr John Warner and Professor Paul Anastas, pioneers of "green chemistry", there is a way to make the right molecules in the first place.

So profound has this simple proposition been that it's taken them from US universities to the White House, and from start-up companies to not-for-profits that are changing entire curricula. They were popular guests at the First Australian Conference on Green and Sustainable Chemistry and Engineering, held in Cairns.

Warner and Anastas have spent much of the past three decades encouraging chemists to design products that avoid negative effects on the environment.

"Sometimes people think of green chemistry as some hazy path – you know, we're going to put on slippers and robes, get clay pipes and smoke pot," Warner told Cosmos in Cairns. "In fact, it's quite the opposite. You drop nothing. You add green chemistry to what normal, 'traditional' chemists do."

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In 1998, Anastas and Warner published a book outlining 12 principles for making chemistry greener.

These principles range from choosing appropriate ingredients, all the way to waste prevention and degradation at the end of a material's job.

One is energy efficiency – which for chemists, means things like choosing reactions that can be done at room temperature rather than under high heat.

Another is catalysis: using a small material that provokes a reaction, without getting consumed itself, is much less wasteful than using large amounts of another substance to react with the material you're working with.

Green chemists, by Anastas and Warner's definition, consider the 12 principles, before beginning to make their molecules.

This doesn't mean that every principle is adhered to perfectly in every single molecule a chemist makes.

"In all the work that I have done, I have never simultaneously addressed all 12 principles," says Warner.

But they must be considered first.

"That means that you are consciously building them into a deliberative process, because you value those things, and you want to ensure that you make the best efforts to achieve them," says Anastas.

"The process of considering them is not weak – it is very, very powerful."

Chemists are used to making products that do one job as well as possible – like making the most efficient drug to treat a medical condition, for instance. It's a big mental shift to get them considering 12 other factors, like biodegradability and hazardous solvents, as well.

"What happens now in industry is something really cool gets invented, and everyone gets excited. Next thing, you've got business people, you've got sales, and they start spending hundreds of thousands, maybe millions, of dollars," explains Warner.

"About a year, or a year and a half in, someone says 'Okay, let's go to manufacturing – wait, we can't use that solvent. We can't use that reagent.'"

Because the chemists designing these products in the first place aren't thinking about the hazards or the effects of their designs, they fail to

anticipate when those hazards might be too high to make their work viable commercially.

"Not only is there a loss of productivity, there's this psychological nastiness going on in that company," says Warner.

"Had that first chemist understood green chemistry – not always, things are still going to slip through the cracks – but there is a much better chance that by understanding toxicity, and environmental impact, they will avoid those profound mistakes that become very costly to industry."

Warner, who has been granted over 300 patents, has the evidence to show that green chemistry can be the smartest industrial bet. His inventions include hair colour that restores grey hair back to its original black or brown, an asphalt rejuvenator that allows old bitumen to be re-used, and pharmaceutical therapies for the nervous system disease, ALS.

One of Anastas' many projects, meanwhile, is the Molecular Design Research Network, which is finding the qualities that make a molecule toxic – in the same way that chemists can predict what could make a molecule dissolve in water, or melt at a low temperature.

"We've been able to design molecules that have all kinds of functionality, but we're not so good at designing things to be nontoxic," he says.

"So how do we go about reducing toxicity by design? A huge advantage that we have is there's a better part of a century devoted to pharmaceutical manufacturing, and pharmaceutical discovery.

"All of these lessons that we've learned about how to make a molecule that can get into the body, that can cross the right membranes, that can find the right receptor in order to cause a biological effect – you now turn those lessons on their head, and say you want a molecule that doesn't get into your body, that doesn't bind to another receptor, that doesn't cause a biological effect."

After a quarter of a century in the mainstream, what's next for green chemistry? Warner is focused on education, particularly through the organisation Beyond Benign, which he founded with his wife Dr Amy Cannon.

"If we change education, we get all the problems, because there's enough diversity of people that can go out there and start solving problems," he says.

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Anastas has a few more specific pointers – using waste, and particularly CO2, as chemical feedstocks, and using photons and electrons to provoke reactions rather than dangerous substances like chlorine and cyanide.

But he is also still looking for widespread change, as is evident from his latest book, First Do No Harm.

"When I say 'what's next for green chemistry', it's really what's next for chemistry, because all chemistry needs to be green."

Ellen Phiddian's airfare to Cairns was paid by the Royal Australian Chemical Institute, which managed the First Australian Conference on Green and Sustainable Chemistry and Engineering.

Cosmos Magazine, 25 July 2023

https://cosmosmagazine.com

Researchers capture atomic view of synthetic DNA, revealing 'molecular scissors' that could treat disease

2023-07-24

West Virginia University researchers are now able to view synthetic DNA at the atomic level, giving them the ability to understand how to change its structure in hopes of enhancing its scissor-like function. Learning more about these synthetic DNA reactions could be the key to unlocking new technology for medical diagnoses and treatments.

In the chemistry world, the findings help answer a 30-year-old question about this specific DNA structure and how scientists can get it to produce a reaction without changing the DNA itself, a process called catalysis.

The researchers' findings are published in Communications Chemistry.

"This is only, maybe, the third example lending insights, at the very detailed atomic level, into how chemically active DNA promote their unique functions that give all these applications their power," said Aaron Robart, associate professor in the WVU School of Medicine Department of Biochemistry and Molecular Medicine, and principal investigator of the project. "Atomic detail gives us a long-sought road map to start building and improving a technology that can be broadly applicable to health and diagnostics."

West Virginia University researchers are now able to view synthetic DNA at the atomic level, giving them the ability to understand how to change its structure in hopes of enhancing its scissor-like function.

Robart said once scientists understand how to make the technology function more efficiently, it could theoretically be applied as treatment for diseases such as retinal degeneration or cancer.

Robart points out synthetic DNA used in the study, known as DNAzymes, is different from human DNA. Created in a lab, DNAzymes are inexpensive to produce and capable of catalyzing chemical reactions. They've been artificially evolved to perform such functions as monitor air quality and measure heavy metals that have leached into soil.

"Typically, we think of DNA as inert, serving as a storage unit for our genetic information," Robart said. "However, there are certain types of DNA evolved in the laboratory that defy the conventional rules. These DNAs can fold into complex shapes, enabling them to perform a remarkable range of reactions.

"The only problem is, after 30 years of research, we really didn't have a clue on how any of the chemistry was happening. One of the big things we were missing is what our lab does with crystals, resulting in high resolution structures of what nucleic acids look like down to the atom detail and how they can do all this chemistry."

To be able to see DNA at the atomic level, Robart and his lab students, Evan Cramer, of Lake Ann, Michigan; Sarah Starcovic, of Cameron; and Beka Avey of Martinsburg, collaborated with Advanced Photon Source at the U.S. Department of Energy's Argonne National Laboratory in Chicago. The process—X-ray crystallography—involves crystallizing synthetic DNA and then zapping it with super powered X-rays to reveal its structure. Working with APS, the team was able to control the X-ray and collect data via the internet.

"Using this information, we can better understand how other DNAzymes may behave in their cleavage reactions," said Starcovic, who is pursuing a doctoral degree in biochemistry and molecular medicine.

Robart said what they saw was a structure with little arms that can reach out to find another section of a complementary sequence and clamp themselves together, similar to the way Velcro attaches.

"These DNAs can act as molecular scissors with precise specificity to cut RNA or DNA, or they can function as glue," Robart explained. "Say you have a mutated gene that's causing disease, we could get this DNA into the cells and it would be able to get rid of all that kind of message that's causing the proteins that lead to the disease."

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Cramer, lead author of the published paper and a biochemistry and molecular medicine doctoral student, said he hopes future studies fill knowledge gaps for clinical implementation.

"It is difficult to improve something when how it works is not entirely known," he said.

Robart said the next step is to focus on alternative techniques for capturing DNAzymes at different points along their function.

"It will be like we're making an old school animation molecular flipbook," Robart said. "This level of detail is used to understand how to improve, target and regulate their activity. This is only one of hundreds of different varieties of DNAzymes, all with their own unique properties begging to be applied to topics in human health."

He said he also hopes to gain insight from School of Medicine colleagues on how the model systems could be used for therapeutics.

"We're in a unique spot," Robart said. "We have a potential cure in search of a disease. I feel fortunate to be in an environment surrounded by so many talented collaborators in the School of Medicine to help this exciting technology reach its full potential."

Phys Org, 24 July 2023

https://phys.org

A new TikTok trend has people drinking toxic borax. An expert explains the risks – and how to read product labels

2023-07-26

A potentially dangerous trend has gained prominence on TikTok, with a number of people mixing borax into water and drinking it for supposed health benefits.

This isn't new. Social media platforms have been host to many dangerous "challenges" – and users have been dosing themselves with questionable substances for years.

There's no evidence to support the latest claims about borax. So how dangerous is it? And how can we assess the safety of the many other substances we use in daily life?

What is borax?

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Borax, or sodium borate decahydrate, is a salt made of a combination of boron, sodium, oxygen and hydrogen. It comes in the form of a colourless crystalline solid that can easily be dissolved in water.

Borax and the related boric acid are commonly used in household products including laundry cleaning products, wood preservers, fertilisers, contact lens solution and ant killers.

Borax crystals are also widely available in supermarkets, hardware stores and garden centres. These products are typically pure borax, but other additives may be present.

Don't confuse borax with boron

TikTok users posting videos of themselves ingesting borax and water solution have falsely claimed it can help treat inflammation, joint pain, arthritis, lupus and a range of other conditions.

This is yet another hoax "remedy" in a long list of false hope products. Alternative therapies are often touted as being "natural" and therefore supposedly non-toxic.

But while borax is naturally occurring, this isn't a guarantee of safety. Arsenic, ricin and the toxin responsible for botulism are also 100% natural, but can be highly toxic to humans.

And although the element boron specifically is considered essential for plants and some animals, its role in the functioning of the human body is less clear. Boron can be found in some of the foods we eat, such as grapes and potatoes, but isn't classified as an essential nutrient. The very small amount of boron your body may need can be safely obtained by eating a diet rich in fruits and vegetables.

How dangerous is borax?

Borax is not considered safe to ingest.

In toxicology, the median lethal dose, or LD50, is the approximate dose required to kill half the animals in a population being studied.

The LD50 for borax in rats is about 5g per kilogram of body weight. This is a relatively large dose, which means acute toxicity causing death is unlikely in humans. But just because a dose won't kill, that doesn't mean it isn't harmful – and it definitely doesn't mean it's good for you.

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Borax was used extensively as a food preservative in the early 1900s. That was before the work of Harvey Washington Wiley and his poison squad uncovered a range of side effects to consumption, including headaches, nausea, vomiting, gastric discomfort and more.

Borax is also classified as a reproductive toxin, which means it "may impair fertility" and "may cause harm to the unborn child". It is banned as a food additive in Australia, the United States and several other countries.

Safety first, last and always

A number of dangerous social media challenges have gone viral over the past decade. One notable example was the "Tide pod challenge", in which users recorded themselves biting or eating laundry pods.

The consumption of laundry pods has caused a number of deaths (although these can't necessarily be linked to the Tide pod challenge). From 2013 to 2022, poison centres in the US have managed around 10,000 cases each year related to children age five and under being exposed to laundry detergent packets.

Clearly, we shouldn't be drinking borax or eating laundry pods. Yet such substances can't always be avoided – so the best protection is to understand the dangers associated with them.

Apart from reading the generic safety warnings on a product, such as "CAUTION" or "KEEP OUT OF REACH OF CHILDREN", consumers can dig a little deeper through the use of resources known as safety data sheets (or SDS).

Every product containing hazardous substances must legally have an SDS. So whether you're using a shampoo, hand sanitiser, vinegar or borax, there will almost certainly be an SDS available. Here's the SDS for Johnson's Baby Shampoo, as an example.

You can find the SDS of a product online by searching the product's name and "SDS" in Google. These documents follow a standardised format and provide details of hazards associated with a product.

They also include standardised hazard pictograms that represent the associated physical, health and environmental risks. You've probably seen these before, such as a "flammable" sign on a deodorant, or a "corrosive" sign on a household cleaner.

As far as borax is concerned, the main product shown in the TikTok videos has an SDS that lists the human silhouette and exclamation mark

pictograms. These correspond to the listed hazards of skin irritation, serious eye irritation and potential damage to fertility or an unborn child.

A number of precautionary statements follows – with advice on appropriate personal protective equipment, and how to store and dispose of the product.

Further details go beyond the typical consumer information and include composition, first aid information, toxicological information and firefighting methods. These are helpful for medical professionals treating patients and fire fighters dealing with chemical spills and fires.

Safety data sheets aren't perfect, but they are a useful resource. So the next time you see an unusual "miracle cure" on social media, or there's a chemical in your home you aren't sure about, consider reading the SDS.

The Conversation, 26 July 2023

https://theconversation.com

Potent anti-cancer therapy created using 'click chemistry'

2023-07-24

A potent anti-cancer therapy has been created using Nobel prize-winning "click chemistry," where molecules click together like LEGO bricks, in a new study by UCL and Stanford University researchers.

The study, published in Nature Chemistry, opens up new possibilities for how cutting-edge cancer immunotherapies might be built in future.

The research team created an anti-cancer therapy with three components: one targeting the cancer cell, another recruiting a white blood cell called a T cell to attack the cancer cell, and a third knocking out part of the cancer cell's defenses.

Previously, this type of three-component therapy has only been built using a complex process called protein engineering, in which DNA sequences for multiple proteins are combined and inserted into a single cell.

One of the three-component therapies the researchers built, which used an enzyme called sialidase to strip away sugars that the cancer cell uses to hide itself, was especially effective at killing breast cancer cells in a dish. The researchers said this showed that the enzyme—which only recently

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started being explored in cancer research—has the potential to be the basis of next-generation anti-cancer agents.

First author Dr. Peter Szijj (UCL Chemistry) said, "Click chemistry is a quicker and more adaptable way to build these multifunctional anti-cancer agents than protein engineering. It's relatively easy to attach click 'handles' to proteins so you can try lots of combinations quickly to test what might work best. Using protein engineering, you need a separate mechanism for each component."

Senior corresponding author Professor Vijay Chudasama (UCL Chemistry) said, "As proteins are large and complex molecules, you require a combination of precise protein modification and reliable click chemistry to attach them together in a controlled manner. We have achieved this and shown our strategy to be an interesting alternative to using the classical protein engineering approach."

"We hope that by using chemistry to create novel and highly sophisticated multi-protein anti-cancer agents we can inspire chemists to cross the typical boundaries of the discipline to engage in novel applications in areas such as medical imaging, diagnostics and disease therapies."

Click chemistry relies on two reaction partners (click handles) that can attach to each other very rapidly and selectively, without the production of any toxic by-products. These click handles can be added to proteins, in this case using functionalized pyridazinediones (PDs), allowing the proteins to click neatly together like LEGO.

The pioneers of click chemistry were awarded the 2022 Nobel Prize in Chemistry. Professor Carolyn R. Bertozzi, of the University of Stanford, who is a co-author on this latest paper, was one of three winners of the prize for her work on biorthogonal chemistry—click chemistry in living cells.

For the new paper, researchers at UCL first clicked two antibody fragments together—one fragment binding to a cancer cell, another fragment binding to a T cell so that it would destroy the cancer cell. Similar T cell engagers, created via protein engineering, have already been approved for use in humans and are used to treat cancers such as multiple myeloma, a rare blood cancer, in the United States and Europe.

The team then added a third component, a checkpoint inhibitor, which removes an aspect of a cancer cell's defenses. This component was either a PD-1-blocking antibody fragment, which is already used to treat specific advanced forms of skin or lung cancer and re-awakens immune cells to

target cancer cells; or the more experimental sialidase enzyme, which strips away specific sugars (sialic acids) on the surface of the cancer cell as well as on the T cell.

These sugars, present on all our cells, are produced in large amounts by cancer cells and help them to hide from our immune system by switching off approaching immune cells.

The research team found that adding either of these components improved the cancer-killing efficiency of the therapy, and that adding sialidase was especially potent.

The researchers also added a fourth molecule, biotin, allowing them to visualize how well the components bound to their respective targets. They said that this could be substituted for another small molecule with a different function—for instance, to minimize side-effects by masking the protein construct until it reaches its intended target: the cancer.

In the paper, the researchers said that using chemistry in this way to create cancer therapies showed "much untapped potential that is still waiting to be uncovered."

This sialidase enzyme-containing therapeutic now needs to be tested in animals before any trials involving humans could begin.

Phys Org, 24 July 2023

https://phys.org

'Stunning' discovery: Metals can heal themselves

2023-07-19

Scientists for the first time have witnessed pieces of metal crack, then fuse back together without any human intervention, overturning fundamental scientific theories in the process. If the newly discovered phenomenon can be harnessed, it could usher in an engineering revolution—one in which self-healing engines, bridges and airplanes could reverse damage caused by wear and tear, making them safer and longer-lasting.

The research team from Sandia National Laboratories and Texas A&M University described their findings today in the journal Nature.

"This was absolutely stunning to watch first-hand," said Sandia materials scientist Brad Boyce.

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"What we have confirmed is that metals have their own intrinsic, natural ability to heal themselves, at least in the case of fatigue damage at the nanoscale," Boyce said.

Fatigue damage is one-way machines wear out and eventually break. Repeated stress or motion causes microscopic cracks to form. Over time, these cracks grow and spread until—snap! The whole device breaks, or in the scientific lingo, it fails.

The fissure Boyce and his team saw disappear was one of these tiny but consequential fractures—measured in nanometers.

"From solder joints in our electronic devices to our vehicle's engines to the bridges that we drive over, these structures often fail unpredictably due to cyclic loading that leads to crack initiation and eventual fracture," Boyce said. "When they do fail, we have to contend with replacement costs, lost time and, in some cases, even injuries or loss of life. The economic impact of these failures is measured in hundreds of billions of dollars every year for the U.S."

Although scientists have created some self-healing materials, mostly plastics, the notion of a self-healing metal has largely been the domain of science fiction.

"Cracks in metals were only ever expected to get bigger, not smaller. Even some of the basic equations we use to describe crack growth preclude the possibility of such healing processes," Boyce said.

Unexpected discovery confirmed by theory's originator

In 2013, Michael Demkowicz—then an assistant professor at the Massachusetts Institute of Technology's department of materials science and engineering, now a full professor at Texas A&M—began chipping away at conventional materials theory. He published a new theory, based on findings in computer simulations, that under certain conditions metal should be able to weld shut cracks formed by wear and tear.

The discovery that his theory was true came inadvertently at the Center for Integrated Nanotechnologies, a Department of Energy user facility jointly operated by Sandia and Los Alamos national laboratories.

"We certainly weren't looking for it," Boyce said.

Khalid Hattar, now an associate professor at the University of Tennessee, Knoxville, and Chris Barr, who now works for the Department of Energy's Office of Nuclear Energy, were running the experiment at Sandia when the

discovery was made. They only meant to evaluate how cracks formed and spread through a nanoscale piece of platinum using a specialized electron microscope technique they had developed to repeatedly pull on the ends of the metal 200 times per second.

Surprisingly, about 40 minutes into the experiment, the damage reversed course. One end of the crack fused back together as if it was retracing its steps, leaving no trace of the former injury. Over time, the crack regrew along a different direction.

Hattar called it an "unprecedented insight."

Boyce, who was aware of the theory, shared his findings with Demkowicz.

"I was very glad to hear it, of course," Demkowicz said. The professor then recreated the experiment on a computer model, substantiating that the phenomenon witnessed at Sandia was the same one he had theorized years earlier.

Their work was supported by the Department of Energy's Office of Science, Basic Energy Sciences; the National Nuclear Security Administration and the National Science Foundation.

A lot remains unknown about the self-healing process, including whether it will become a practical tool in a manufacturing setting.

"The extent to which these findings are generalizable will likely become a subject of extensive research," Boyce said. "We show this happening in nanocrystalline metals in vacuum. But we don't know if this can also be induced in conventional metals in air."

Yet for all the unknowns, the discovery remains a leap forward at the frontier of materials science.

"My hope is that this finding will encourage materials researchers to consider that, under the right circumstances, materials can do things we never expected," Demkowicz said.

Phys Org, 19 July 2023

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Scientists observe driver of chemical reaction in plastics industry for first time

2023-07-26

Now, here is a strange thing. One of the most important drivers of perhaps the largest industrial chemical reaction has never been observed in over 100 years of study.

Reactions of three related molecules—ethane, ethyl, and ethylene—are the key factors in producing hundreds of millions of tons of plastic and other industrially important chemicals annually. These chemical reactions are central to both producing plastics and the combustion of natural gas, yet researchers have only been able to theorize about how they work by analyzing final products, because most experiments are unable to observe short-lived chemical intermediates, despite their importance in driving such reactions.

Now, Ben-Gurion University of the Negev scientists have detected the last unobserved intermediate in the ethane pyrolysis reaction for the first time. With these findings, those reactions could become more efficient—producing more products with less material, byproducts, pollution, and energy.

Their findings, with their US and Swiss colleagues, were published recently in Angewandte Chemie.

"Observing this intermediate is the beginning of the path to making associated processes cleaner and more efficient, an important factor in industries such as plastics and natural gas," says corresponding author Dr. Josh Baraban. His Ph.D. student Nadav Genossar-Dan led the theoretical and practical aspects of the experiment, originally designed to target ethylidene, an elusive radical closely related to ethane and ethyl.

"At first, I didn't know what we had done," admits Genossar-Dan, "it was only when I was looking at the data we collected that I realized we had managed to observe this important chemical."

"Going back through the literature since the 1930s, I couldn't find a single researcher who had managed to observe it," he added.

Genossar-Dan designed a flash pyrolysis experiment—heating the molecule until it cracks apart, for very short times (a tenth of a millisecond). But he needed a synchrotron (an unusual tool based on an electron accelerator of which there are only a few dozen in the entire world), which can be used to produce vacuum ultraviolet light.

He managed to book a one-week experiment in the Swiss Light Source synchrotron, and then worked around the clock with three of his group members and the hosting scientist to run the experiments. Because they are so rare, synchrotrons run 24/7 and researchers must apply for permission to use them.

Genossar-Dan's modeling explained the experiments and the findings completely. Now it is up to others to follow them.

In the end, the demanding work, both designing and running the experiment, paid off as they made chemistry history.

Phys Org, 26 July 2023

https://phys.org

Molecular highway for electrons in organic light-emitting diodes: Researchers develop new material concept

2023-07-25

Organic light-emitting diodes (OLEDs) are now widely used. For use in displays, blue OLEDs are additionally required to supplement the primary colors red and green. Especially in blue OLEDs, impurities give rise to strong electrical losses, which could be partly circumvented by using highly complex and expensive device layouts. A team from the Max Planck Institute for Polymer Research has now developed a new material concept that potentially allows efficient blue OLEDs with a strongly simplified structure.

From televisions to smartphones: organic light-emitting diodes (OLEDs) are nowadays finding their way into many devices that we use every day. To display an image, they are needed in the three primary colors red, green and blue. In particular, light-emitting diodes for blue light are still difficult to manufacture because blue light—physically spoken—has a high energy, which makes the development of materials difficult.

Especially the presence of minute quantities of impurities in the material that cannot be removed plays a decisive role in the performance of these materials. These impurities—oxygen molecules, for example—form obstacles for electrons to move inside the diode and participate in the light-generation process. When an electron is captured by such an obstacle, its energy is not converted into light but into heat. This

Organic light-emitting diodes (OLEDs) are now widely used.

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problem, known as "charge trapping", occurs primarily in blue OLEDs and significantly reduces their efficiency.

A team led by Paul Blom, director at the Max Planck Institute for Polymer Research, has now tackled the problem of charge trapping. They have used a new class of molecules for this purpose. These consist of two chemical parts; one is responsible for the electron conduction, whereas the other part is not sensitive to impurities.

By manipulating the chemical structure of the molecule, a special spatial arrangement is achieved: When several molecules are joined, they form a kind of "spiral"—that means the electron-conducting part of the molecules forms the inner part, which is shielded on the outside by the other part of the molecules. This resembles, in a molecular way, a coaxial cable with an electron conducting the inner core and an outer part shielding the core.

The cladding thus forms a kind of "protective layer" for the electron-conducting core, shielding it from the intrusion of oxygen molecules. Thus, the electrons can move fast and freely along the central axis of the spiral without being trapped by obstacles, similar to cars on a highway without crossings, traffic lights or other obstacles.

"One of the special things about our new material is that the absence of losses due to impurities and resulting efficient electron transport can greatly simplify the design of blue OLEDs, while maintaining a high efficiency," says Paul Blom.

With their work, the researchers hope to have taken an important step toward simpler production of blue light-emitting diodes. They have now published their results in the journal Nature Materials.

Phys Org, 26 July 2023

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