CHEMWATCH

Bulletin Board

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ASIA PACIFIC

Stronger regulation of crystalline silica substances from 1 September 2024

2024-09-02

Safe Work Australia has published amendments to the model Work Health and Safety (WHS) regulationswhich will strengthen protections for workers at risk of exposure to silica dust across all industries, including building and construction.

The amendments provide stronger regulation of work with all materials containing at least 1% crystalline silica and require:

- controlled processing of all crystalline silica substances
- assessing the risk of work involving processing of a crystalline silica substance, and
- additional duties for any processing of engineered stone that is assessed as high risk, including preparing a silica risk control plan.

Changes to the WHS regulations will only take effect in a jurisdiction once implemented in the WHS laws of the jurisdiction. Check with your state or territory WHS regulatorto find out how the changes will be implemented in your jurisdiction.

Safe Work Australia has resources available to assist persons conducting a business or undertaking (PCBUs) understand and comply with their obligations under the amended regulations, including:
Working with crystalline silica substances: Guidance for PCBUs, and

- Supporting resources that summarise key concepts including what is silica dust, completing a silica risk control plan and how to control the risks of silica dust.

Read More

Safe Work Australia, 02-09-24

https://www.safeworkaustralia.gov.au/doc/working-crystalline-silica-substances-guidance-pcbus

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Consultation to update the New Zealand clinical trial regulatory guidelines

2024-08-23

A plan aiming to streamline clinical trial reporting procedures in some circumstances is now out for consultation.

Medsafe is seeking public feedback on a series of proposed updates to the regulatory guidelines for people conducting clinical trials for medicines and medical devices.

Clinical trials are a core part of a high-performing health system and are a key step in the process of bringing new medicines to market or changing the way medicines are used. However, trials do, by their nature, expose patients to potential benefits, as well as risks, and for this reason are tightly controlled. In some instances, the evidence gathered from these trials will make up part of the data considered by Medsafe and other regulatory authorities when assessing a medicine for approval.

A key change will be the provision of guidance for conducting first-in-human trials. These trials, where a medicine is administered to humans for the first time, are an important part of medicines development, but they are also the phase of trials associated with the greatest risk for participants.

Medsafe has also been working with the New Zealand Association of Clinical Research (NZACRes) to produce a simple guide to safety reporting requirements for those conducting clinical trials. This guide is also being consulted on.

Other updates aim to keep our guidance in line with current best practice. For example, involving consumers and patient advocacy groups in the design and conduct of trials, encouraging the implementation of pharmacovigilance systems and clarifying the responsibilities of those involved in clinical trials.

Read More

NZ Ministry of Health, 23-08-24

https://www.health.govt.nz/news/consultation-to-update-the-new-zealand-clinical-trial-regulatory-guidelines

AMERICA

Child safety bill heads to Governor Newsom

2024-08-30

SACRAMENTO, Calif. – Today the California Legislature took the bold step to protect children's health by passing a bill that bans six harmful chemicals in school food. The bipartisan bill prohibits these chemicals from food provided in the state's public schools during regular school hours.

Assembly Bill 2316, the California School Food Safety Act, championed by Assemblymember Jesse Gabriel (D-Encino), would ban Red Dye No. 40, Yellow Dye No. 5, Yellow Dye No. 6, Blue Dye No. 1, Blue Dye No. 2 and Green Dye No. 3 from such food.

The dyes have been found to cause neurobehavioral problems in some children.

"California has a responsibility to protect our students from chemicals that harm children and that can interfere with their ability to learn," said Gabriel.

"As a lawmaker, a parent and someone who struggled with ADHD, I find it unacceptable that we allow schools to serve foods with additives that are linked to neurobehavioral harms," he continued. "This bill will empower schools to better protect the health and well-being of our kids and encourage manufacturers to stop using these harmful additives.

Read More

Consumer Reports, 30-08-24

https://advocacy.consumerreports.org/press_release/california-lawmakers-pass-landmark-ban-on-toxic-dyes-in-school-food/

EPA Will Postpone Submission Period for TSCA Section 8(a)(7) Reporting on PFAS

2024-09-04

The U.S. Environmental Protection Agency is scheduled to publish a direct final rule on September 5, 2024, that will amend the Toxic Substances Control Act (TSCA) regulation with reporting and recordkeeping requirements for perfluoroalkyl and polyfluoroalkyl substances (PFAS) to make a "one-time modification" to change the data submission period

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from November 12, 2024, through May 8, 2025, to July 11, 2025, through January 11, 2026. For any reporter who is reporting exclusively as an article importer and is also considered a small manufacturer, the submission period will begin on July 11, 2025, and last for 12 months: July 11, 2025, through July 11, 2026. EPA is also taking action to correct an inadvertent error in the rulemaking by revising the text "published study reports" under the requirement to submit Organisation for Economic Co-operation and Development's (OECD) Harmonised Templates (OHT) to the correct requirement of submitting OHTs for "unpublished study reports." EPA states that there are no other changes to the reporting and recordkeeping requirements in the existing rule. The direct final rule will be effective 60 days after publication in the Federal Register. If EPA receives adverse comment 30 days after the date of publication, it will publish a timely withdrawal in the Federal Register informing the public that this direct final rule will not take effect.

Read More

B&C, 04-09-24

https://www.lawbc.com/epa-will-postpone-submission-period-for-tsca-section-8a7-reporting-on-pfas/

EUROPE

Background report to the guide for the use of the EU Ecolabel criteria in the green public procurement of absorbent hygiene products

2024-08-29

Green public procurement (GPP) is a powerful tool to achieve environmental objectives by means of the incorporation of green requirements into public sector purchasing contracts. Public authorities, by promoting "green" purchases, incentivise environmentally beneficial outcomes and foster market innovation as well as the transformation towards a sustainable economy model.

In order to "green" the market, it is essential for producers to be able to make certifiable and credible green claims about their products and for customers to know what to ask for. While the EU Ecolabel policy can provide environmental references or standards for the former, the EU GPP policy can provide for the latter.

The EU GPP recommendations placed in this document are based on the EU Ecolabel criteria and intend to provide authorities with guidance on how to use ecolabels, and in particular the EU Ecolabel, in the procurement process. This report aims to bring these two policies together in order to find synergies between the supply-side EU Ecolabel policy and the demand-side EU GPP policy – specifically for the procurement of absorbent hygiene products such as baby diapers, sanitary towels, panty liners, tampons, nursing pads, or incontinence products.

In addition to a brief introduction to the EU Ecolabel policy, to the EU GPP policy and to procurement procedures as a whole, research is presented to support JRC recommendations to public procurers about exactly what green criteria to set when trying to procure environmentally friendly absorbent hygiene products.

The recommended environmental criteria are categorised into the five most appropriate areas (addressed in detail in 9 technical specifications and 10 award criteria) based on their link to the subject matter of the procurement, ease of verification (in cases where there is no EU Ecolabel) and relevance to the environmental impact., as follows:

1. Fluff pulp sourcing and manufacturing (referring to the impacts associated with upstream processes for cellulose fibre sourcing and processing, i.e., emissions and energy consumption);
2. Man-made cellulose fibre sourcing and manufacturing (referring to impacts associated with upstream processes for cellulose fibre sourcing and processing i.e., emissions and viscose process efficiency);
3. Cotton and other cellulose seed fibre sourcing and manufacturing (referring to the impacts associated with upstream processes for cotton fibre sourcing and processing i.e., bleaching);
4. Material efficiency in the production of the final product (in terms of the impact associated with material recovery in the core process);

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European Commission, 29-08-24

https://publications.jrc.ec.europa.eu/repository/handle/JRC138563

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EU emissions trading system – countries considered to apply CORSIA in 2024

2024-08-31

EU rules on an emissions trading system (The ETS Directive) implement appropriately the carbon offsetting scheme (CORSIA) set up by the International Civil Aviation Organization for airlines based in EU and EEA countries.

The Commission must adopt acts every year listing countries other than EU/EEA countries, Switzerland and the UK, which are considered to be applying CORSIA.

This list for 2024 will be used to calculate the CORSIA offsetting required from airlines under the Directive.

Read More

31-08-24

https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14363-EU-emissions-trading-system-countries-considered-to-apply-CORSIA-in-2024_en

Sweden to raise fossil fuel reduction targets to level with EU climate goals

2024-08-28

Sweden will increase the proportion of biofuels blended with fossil fuels to meet the EU's 2030 climate targets, the government announced on Tuesday (27 August), reversing its previous policy.

Sweden's centre-right governing parties and their far-right ally, the Sweden Democrats (SD, ECR), confirmed at a press conference on Tuesday that the so-called reduction obligation for fossil fuels will be increased.

It is a "golden solution", said Climate and Environment Minister Romina Pourmokhtari (Liberals, Renew), adding that "the blending of biofuels can increase without raising the price at the pump."

The reduction obligation requires companies that sell petrol and diesel to reduce greenhouse gas emissions, mainly by blending more renewable fuels – a mechanism that leads to higher prices at the pump, comparable to a hidden fuel tax and therefore unpopular.

"The reason why the price does not need to be affected is mainly that the availability of biofuels is greater today", Pourmokhtari said.

Read More

Euractiv, 28-08-24

https://www.euractiv.com/section/politics/news/sweden-to-raise-fossil-fuel-reduction-targets-to-level-with-eu-climate-goals/

Engaging the private sector in climate change mitigation

2024-08-21

Comparison of different approaches in the Nordic region

This report presents the findings of a study of the various approaches taken by the Nordic countries to involve the private sector in national strategies to achieve climate targets. As part of their climate mitigation strategies, each Nordic country has engaged the private sector in climate action through specific government-led public-private collaboration initiatives. The report's primary objective was to analyze and compare the diverse strategies adopted by Nordic governments to seek input from the business and industry sectors in the form of roadmaps developed in coordination with public authorities. In all the Nordic countries such sector roadmaps are viewed as important components of public policies to achieve national climate targets.

Read More

Nordic Co-operation, 21-08-24

https://www.norden.org/en/publication/engaging-private-sector-climate-change-mitigation

EU closer to rules saving children's toys from toxic chemicals

2024-09-04

New EU-wide rules protect children have been backed by the Parliament and must now go to inter-institutional negotiations.

The European Parliament today (5 September) backed a proposal aiming to improve the safety of toys available on the EU market – with a particular

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focus on substances harmful and toxic for children and the growing risks posed by digital products.

Marion Walsmann (Germany/EPP), steering the file through the Parliament, told Euronews that the current Toy Safety Directive from 2009 is outdated and needs revision, especially with the increasing importance of online marketplaces.

"But also, in view of the latest scientific findings regarding harmful chemicals, the corresponding limit values would have to be adapted or introduced in the first place," she added.

With that aim, the European Commission tabled a proposal for a new Regulation in 2023. "This proposal will ensure that children are even more protected when playing with toys, including from harmful chemicals," Commissioner Thierry Breton said at the time.

Read More

Euronews, 04-09-24

https://www.euronews.com/health/2024/09/05/eu-closer-to-rules-saving-childrens-toys-from-toxic-chemicals

Water bosses could be jailed if they cover up sewage dumping under new law

2024-09-05

CEOs in England and Wales could face two years in prison under proposals to force firms to supply data quickly

Water bosses in England and Wales could be jailed for up to two years if they cover up sewage dumping, under legislation proposed by the Labour government.

At the moment, CEOs of water companies face fines for failing to comply with investigations by the Environment Agency (EA) and the Drinking Water Inspectorate (DWI), but there have been just three such fines since privatisation three decades ago.

Civil servants at the Department for Environment, Food and Rural Affairs (Defra) told journalists on Wednesday that they planned to tighten compliance rules to force companies to hand over sewage data quickly,

and that the maximum sentence for covering up this information or failing to release it would be two years.

Read More

The Guardian, 05-09-24

https://www.theguardian.com/environment/article/2024/sep/04/water-bosses-could-be-jailed-cover-up-sewage-dumping-law

INTERNATIONAL

A Landscape of Sustainability Attributes Considered by Companies During Chemical and Material Selection

2024-08-22

Building on the OECD Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives, this report describes the results of a landscape study of sustainability attributes used by companies to guide chemical and material selection decisions. Results outline the range of sustainability attributes being considered, factors guiding the choice of standards and metrics used, as well as lessons learned in terms of challenges, needs and opportunities in the use and interpretation of a range of sustainability impacts to support chemical/material selection decisions. Companies are at various stages, given their value chain position and individual circumstances, in considering sustainability attributes in their chemical and material selection decisions, whether for the design of new chemistries, industrial processes or industrial/consumer products. Companies noted that sustainability attributes were not often considered in chemical substitution efforts given that regulatory and market-based chemical restrictions are primary risk-driven. Future guidance development to establish a minimum and recommended set of sustainable attributes should be flexible to the company/sector/product context as well as specific standards or metrics that could be used to evaluate them. Guidance should also be supportive of chemical-level innovation and selection decisions and aligned with forthcoming mandatory sustainability reporting requirements.

Commission admits REACH deadlines 'unrealistic' in probe by EU watchdog

2024-09-04

Internal discussions continue on more practical timeframes for the circumstances, say officials.

Deadlines set out under REACH for presenting draft decisions are "unrealistic" because dossiers have become increasingly complex and political, the European Commission has said in response to an Ombudsman inquiry.

Although the EU executive said it understands that the time it needs to process proposals "may appear slow", the three-month deadline for the preparation of a draft restriction has proven impractical in light of the complicated procedures and the increasing number with wide scope.

Read More

Chemical Watch, 04-09-24

https://product.enhesa.com/1224030/commission-admits-reach-deadlines-unrealistic-in-probe-by-eu-watchdog

Janet's Corner

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Appendix

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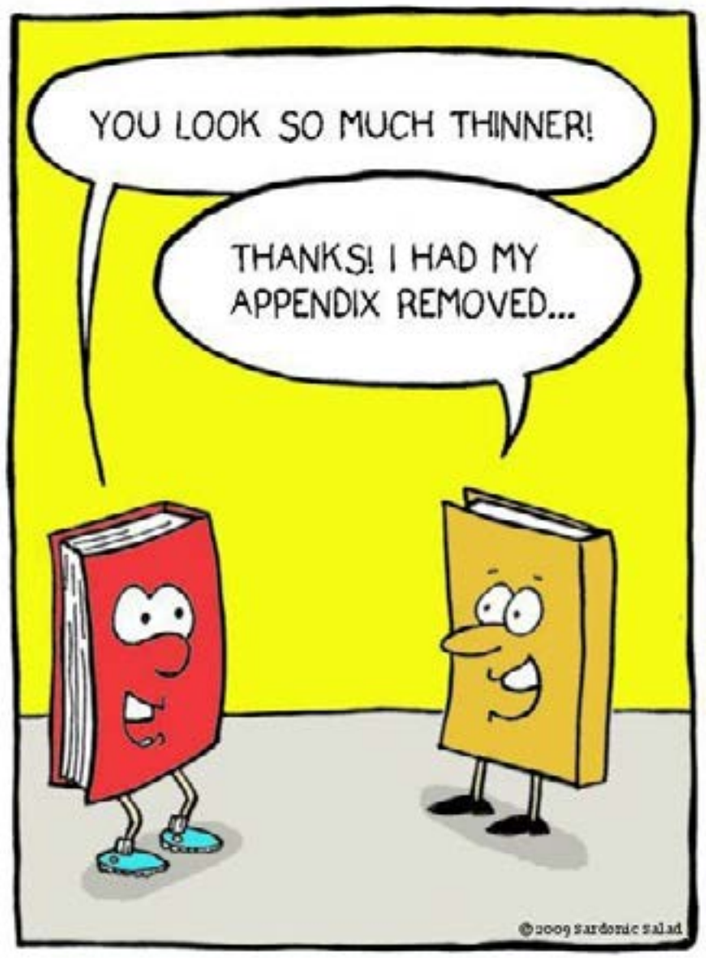

https://www.toonpool.com/cartoons/appendix_92503

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Hazard Alert

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Nickel

2024-09-13

Nickel is a chemical element with the chemical symbol Ni and atomic number 28. It is a silvery-white lustrous metal with a slight golden tinge. Nickel belongs to the transition metals and is hard and ductile. [1] Nickel is a fairly good conductor of heat and electricity. In its familiar compounds nickel is bivalent, although it assumes other valences. It also forms a number of complex compounds. Most nickel compounds are blue or green. Nickel dissolves slowly in dilute acids but, like iron, becomes passive when treated with nitric acid. Finely divided nickel adsorbs hydrogen. [1,2]

USES [2,3]

The major use of nickel is in the preparation of alloys. Nickel alloys are characterised by strength, ductility, and resistance to corrosion and heat. About 65 % of the nickel consumed in the Western World is used to make stainless steel, whose composition can vary but is typically iron with around 18% chromium and 8% nickel. 12% of all the nickel consumed goes into super alloys. The remaining 23% of consumption is divided between alloy steels, rechargeable batteries, catalysts and other chemicals, coinage, foundry products, and plating. Nickel is easy to work and can be drawn into wire. It resists corrosion even at high temperatures and for this reason it is used in gas turbines and rocket engines. Monel is an alloy of nickel and copper (e.g. 70% nickel, 30% copper with traces of iron, manganese and silicon), which is not only hard but can resist corrosion by seawater, so that it is ideal for propeller shaft in boats and desalination plants.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

Nickel is a natural element of the earth's crust; therefore, small amounts are found in food, water, soil, and air. Food is the major source of nickel exposure, with an average intake for adults estimated to be approximately 100 to 300 micrograms per day (µg/d). In addition, individuals may be exposed to nickel in occupations involved in its production, processing, and use, or through contact with everyday items such as nickel-containing jewellery and stainless steel cooking and eating utensils, and by smoking tobacco. Nickel is found in ambient air at very low levels as a result of releases from oil and coal combustion, nickel metal refining, sewage sludge incineration, manufacturing facilities, and other sources. Given its high instability, nickel carbonyl exposure is extremely rare.

Routes of Exposure

The major route of exposure to nickel is via the consumption of food or water containing the metal. In addition, exposure can occur through skin contact with soil, bath or shower water, or metals containing nickel, as well as by handling coins or touching jewellery-containing nickel. Exposure may also occur by inhaling air or smoking tobacco containing nickel.

Higher exposure may occur if you work in industries that process or use nickel.

HEALTH EFFECTS [4]

Acute Health Effects

Exposure to extremely high level of nickel by inhalation resulted in severe damage to the lungs and kidneys. Gastrointestinal distress (e.g., nausea, vomiting, diarrhoea) and neurological effects were reported in workers who drank water on one shift that was contaminated with nickel as nickel sulphate and nickel chloride. Pulmonary fibrosis and renal oedema were reported in humans and animals following acute (short-term) exposure to nickel carbonyl. Acute animal tests in rats have shown nickel compounds to exhibit acute toxicity values ranging from low to high. The soluble compounds, such as nickel acetate, were the most toxic, and the insoluble forms, such as nickel powder, were the least toxic.

Carcinogenicity

Nickel Salts: Nickel sulphate via inhalation and nickel acetate in drinking water were not carcinogenic in either rats or mice. EPA has not evaluated soluble salts of nickel as a class of compounds for potential human carcinogenicity.

Nickel Refinery Dust and Nickel Subsulphide: Human studies have reported an increased risk of lung and nasal cancers among nickel refinery workers exposed to nickel refinery dust. Nickel refinery dust is a mixture of many nickel compounds, with nickel subsulphide being the major constituent. Animal studies have also reported lung tumours from inhalation exposure to nickel refinery dusts and to nickel subsulphide. EPA has classified nickel refinery dust and nickel subsulphide as Group A, human carcinogens.

Nickel Carbonyl: Nickel carbonyl has been reported to produce lung tumours in rats exposed via inhalation. EPA has classified nickel carbonyl as a Group B2, probable human carcinogen.

Other Effects

No information is available regarding the reproductive or developmental effects of nickel in humans. Animal studies have reported reproductive and developmental effects, such as a decreased number of live pups per litter, increased pup mortality, and reduction in foetal body weight, and effects to the dam from oral exposure to soluble salts of nickel. Sperm

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abnormalities and decreased sperm count have been reported in animals exposed to nickel nitrate orally and nickel oxide by inhalation, respectively.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.
- **Skin Contact:** In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.
- **Inhalation:** If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
- **Ingestion:** Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Workplace Controls & Practices [4]

Control measures include:

Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protective Equipment [5]

- Safety glasses
- Lab coat
- Dust respirator (be sure to use an approved/certified respirator or equivalent)
- Gloves

Personal Protection in Case of a Large Spill

- Splash goggles

- Full suit
- Dust respirator
- Boots
- Gloves
- A self-contained breathing apparatus should be used to avoid inhalation of the product

Note: Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION

United States

Exposure Limit	Limit Values*	HE Codes	Health factors and Target Organs
*These values do not apply to nickel carbonyl.			
OSHA Permissible Exposure Limit (PEL) - General Industry See29 CFR 1910.1000 Table Z-1	1 mg/m³ TWA	HE2	Nasal, sinus, and lung cancers
		HE15	Dermatitis
OSHA PEL - Construction Industry See29 CFR 1926.55 Appendix A	1 mg/m³ TWA	HE2	Nasal, sinus, and lung cancers
		HE15	Dermatitis
OSHA PEL - Shipyard Employment See 29 CFR 1915.1000 Table Z-Shipyards	1 mg/m³ TWA	HE2	Nasal, sinus, and lung cancers
		HE15	Dermatitis
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)	0.015 mg/m³ TWA Ca	HE2	Lung and sinus cancers
		HE15	Sensitization dermatitis, allergic skin rash

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Exposure Limit	Limit Values*	HE Codes	Health factors and Target Organs
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2001)	Elemental: 1.5 mg/m³ TWA A5	HE10	Pneumoconiosis
		HE15	Dermatitis
	Insoluble compounds: 0.2 mg/m³ A1	HE2	Nasal and lung cancers
	Nickel subsulfide:0.1 mg/m³ TWA A1	HE2	Nasal and lung cancers
CAL/OSHA PELs	Metal: 0.5 mg/m³TWA Insoluble compounds: 0.1 mg/m³ TWA	HE2	Nasal, sinus, and lung cancer

References

1. http://en.wikipedia.org/wiki/Nickel
2. http://www.lenntech.com/periodic/elements/ni.htm
3. http://www.epa.gov/ttn/atw/hlthef/nickel.html
4. http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=244&tid=44
5. http://www.sciencelab.com/msds.php?msdsId=9927372
6. https://www.osha.gov/dts/chemicalsampling/data/CH_256200.html
7. http://www.npi.gov.au/substances/nickel/health.html

New Process for Transforming Byproducts Makes Biodiesel More Profitable

2024-09-04

An electrochemical process developed by researchers at Tokyo Institute of Technology (Tokyo Tech), using sodium borate and a nickel-oxide catalyst, offers a promising solution for the valorization of glycerol, a low-value byproduct of biodiesel production. By manipulating borate-glycerol complex formation, this process enhances the selectivity and efficiency of glycerol electrooxidation, converting it into valuable three-carbon compounds such as dihydroxyacetone and glyceraldehyde, thereby enhancing the economic viability and environmental benefits of biodiesel production.

Biodiesel, a green alternative to conventional diesel, has been shown to reduce carbon dioxide emissions by up to 74%. Biodiesel is produced through transesterification, converting triglycerides into biodiesel and producing glycerol as a low-value byproduct. Since glycerol makes up about 10% of the output, efforts have focused on boosting its value. One method involves electrochemical oxidation, turning glycerol into high-value three-carbon compounds like dihydroxyacetone (DHA) and glyceraldehyde (GLYD), though past approaches often yielded unstable or low-value products under strong alkaline conditions.

In a study published in the Journal of Catalysis(External site) on 15 August 2024 researchers led by Associate Professor Tomohiro Hayashi from Tokyo Institute of Technology (Tokyo Tech) and Professor Chia-Ying Chiang from National Taiwan University of Science and Technology, Taiwan, have developed a highly selective and efficient glycerol electrooxidation (GEOR) process that can lead to the production of valuable 3-carbon (3C) products.

"Establishing an electrochemical route for a highly selective and efficient glycerol electrooxidation process to desirable 3C products is essential for biodiesel production," says Hayashi and Chiang.

Selective oxidation of glycerol is challenging due to its structure. Glycerol has three –OH groups: two primary carbon atoms and one on a secondary carbon atom. This arrangement creates steric hindrance, making it hard for reactants to target specific –OH groups for oxidation. In alkaline conditions, the –OH groups also cause unwanted side reactions that break carbon-carbon bonds, resulting in two-carbon or one-carbon compounds instead of the desired three-carbon products.

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To address this, the researchers conducted GEOR using sodium borate and bicarbonate buffer as a mild alkaline electrolyte and a nickel-oxide (NiOx) catalyst. The sodium borate helps protect certain –OH group, improving the selectivity of the reaction, while the NiOx catalyst enhances the efficiency of the electrooxidation process. Sodium borate forms coordination complexes with glycerol's primary and secondary alcohol groups to form GLYD and DHA respectively. However, the final product depends on the ratio of borate to glycerol. To understand how different concentrations of glycerol and borate affect the electrooxidation process, a fixed concentration of 0.1 M borate buffer was reacted with varying concentrations of glycerol (0.01, 1, 2.0 M) and a fixed concentration of 0.1 M glycerol with varying concentrations of borate buffer (0.01, 0.05, 0.10, and 0.15 M). while maintaining a pH of 9.2.

Higher borate concentrations were found to increase the selectivity for 3C products, particularly DHA, with the highest selectivity of up to 80% observed at a borate concentration of 0.15 M. This improvement is attributed to the increased buffer capacity provided by the borate solution, which helps maintain a stable pH during the reaction and stabilizes the borate-glycerol complex for further oxidation into 3C compounds. Conversely, increasing the glycerol concentration reduced both the yield and selectivity of 3C products. At a glycerol concentration of 1 M, GLYD was the main product, with a selectivity of 51%.

The difference in the type of 3C product was found to be related to the formation of different glycerol-borate complexes. Using Raman spectroscopy, the researchers found higher borate concentrations favor six-membered ring complexes, promoting secondary –OH oxidation and DHA production. Conversely, higher glycerol concentrations favor five-membered ring complexes, leading to primary –OH oxidation and GLYD formation.

"Five-membered ring complexes were more likely to form in the electrolyte with a borate-to-glycerol ratio of 0.1, whereas six-membered ring complexes became more prominent in the electrolyte with a borate-to-glycerol ratio of 1.5," says Hayashi and Chiang.

These findings present a promising strategy for transforming glycerol into valuable products, boosting the sustainability and profitability of biodiesel production.

Technology Networks, 4 September 2024

https://technologynetworks.com

Chemical imaging method holds promise for separate overlapping fingerprints

2024-09-13

A new study from the Department of Forensic Medicine at Aarhus University is the first in the world to analyze fingerprints on gelatin lifters using chemical imaging. This could be crucial in criminal cases where current methods fall short.

Danish police frequently collect fingerprints at crime scenes using so-called gelatin lifters. Unlike tape, these lifters are easy to use and are suitable for lifting fingerprints from delicate surfaces, such as peeling wall paint, and irregular objects like door handles.

Once collected, the fingerprints are photographed digitally so they can be processed through fingerprint databases. However, traditional photography cannot separate overlapping fingerprints, which are often found at crime scenes. Very faint prints are also problematic. As a result, many fingerprints that could otherwise contribute to investigations unfortunately have to be discarded.

A fine spray of solvent

A solution is presented in the new study from the Department of Forensic Medicine at Aarhus University, recently published in the journal Analytical Chemistry.

"We are presenting a method that has the potential to be integrated into the police's traditional workflow. If this happens, more fingerprints from crime scenes could be used and evaluated both visually and chemically," says postdoc Kim Frisch, who is behind the study.

The method is based on a technique called Desorption Electrospray Ionization Mass Spectrometry (DESI-MS), which works by measuring the chemical compounds in fingerprints based on their mass.

"We send a very fine spray of solvent, consisting of electrically charged droplets of methanol. This releases and ionizes substances on the surface of the fingerprint on the gelatin lifter. The substances are then drawn into the instrument, where their masses are measured individually," explains Frisch.

DESI-MS was invented about 20 years ago and was developed for general surface analysis. In 2008, it was shown that the technique could be used for chemical imaging of fingerprints on glass surfaces and tape.

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"But now we show that the technique can also be used to analyze fingerprints collected on gelatin lifter, which are used by police in many countries, including Denmark. This is analytical chemistry used in a forensic context, and it has great potential," says the researcher.

Revealing fingerprints where traditional optical imaging fails

Overlapping fingerprints pose a significant challenge for investigators because they are difficult to separate. The study shows that the new method can be used to separate overlapping fingerprints and to enhance faint fingerprints in situations where optical imaging fails.

So far, the method has been tested on fingerprints lifted in the laboratory, but the researchers are now testing the method on fingerprints from crime scenes. For this purpose, they have received fingerprints collected by the National Special Crime Unit of the Danish Police, and there are high hopes for the results at the Department of Forensic Medicine.

Can we analyze gender, age, and dietary habits?

The method is still under development, and the researchers are now focusing more on analyzing the chemical composition of fingerprints.

A fingerprint is much more than a unique pattern—it also contains a variety of chemical compounds from the person who left the print. These compounds include natural lipids, amino acids, and peptides secreted from the skin. However, the fingerprint can also contain nicotine, caffeine, drugs, cosmetic ingredients, and potentially incriminating substances such as lubricant from condoms and explosives that have been secreted through the skin or contaminated the skin upon contact.

Chemical imaging could potentially be used for profiling the person who left the fingerprint.

Many researchers around the world are working to develop methods for this purpose—not only using the technique employed at the Department of Forensic Medicine in Aarhus. There are examples in the literature that fingerprints can reveal whether people have ingested or touched substances of abuse such as cocaine, cannabis, and ayahuasca.

Studies have also been conducted with the aim of determining individuals' gender, age, and lifestyle factors such as diet, medication, and smoking from their fingerprints. The Department of Forensic Medicine continues to work on the study in an effort to maximize the information that can be obtained from fingerprints.

Research focused on practical application

The research is conducted in close collaboration with the National Special Crime Unit of the Danish Police because it is important that the work is aimed at practical application.

So far, the results suggest that the method could be used in practice.

"When the police collect fingerprints at a crime scene, the gelatin lifters can, in principle, be sent to the Department of Forensic Medicine, where we scan the samples. However, the scanning process is time consuming, which means that we would not be able to analyze samples in the hundreds, as we do with, for example, blood samples. We expect that the method will be used in the future as a special analysis in more serious cases such as murder and rape," says Frisch.

Phys Org, 13 September 2024

https://phys.org

Revolutionary Process Turns Plastic Waste Into Valuable Chemicals

2024-09-06

The catalytic process efficiently breaks down polymers into chemical precursors, advancing the development of a circular economy for plastics.

A new chemical process can essentially vaporize plastics that dominate the waste stream today and turn them into hydrocarbon building blocks for new plastics.

The catalytic process, developed at the University of California, Berkeley, works equally well with the two dominant types of post-consumer plastic waste: polyethylene, the component of most single-use plastic bags; and polypropylene, the stuff of hard plastics, from microwavable dishes to luggage. It also efficiently degrades a mix of these types of plastics.

The process, if scaled up, could help bring about a circular economy for many throwaway plastics, with the plastic waste converted back into the monomers used to make polymers, thereby reducing the fossil fuels used to make new plastics. Clear plastic water bottles made of polyethylene tetraphthalate (PET), a polyester, were designed in the 1980s to be recycled this way. But the volume of polyester plastics is minuscule compared to that of polyethylene and polypropylene plastics, referred to as polyolefins.

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"We have an enormous amount of polyethylene and polypropylene in everyday objects, from lunch bags to laundry soap bottles to milk jugs — so much of what's around us is made of these polyolefins," said John Hartwig, a UC Berkeley professor of chemistry who led the research. "What we can now do, in principle, is take those objects and bring them back to the starting monomer by chemical reactions we've devised that cleave the typically stable carbon-carbon bonds. By doing so, we've come closer than anyone to give the same kind of circularity to polyethylene and polypropylene that you have for polyesters in water bottles."

Hartwig, graduate student Richard J. "RJ" Conk, chemical engineer Alexis Bell, who is a UC Berkeley Professor of the Graduate School, and their colleagues published the details of the catalytic process on August 29 in the journal Science.

A Circular Economy for Plastics

Polyethylene and polypropylene plastics constitute about two-thirds of post-consumer plastic waste worldwide. About 80% ends up in landfills, is incinerated, or simply tossed into the streets, often ending up as microplastics in streams and the ocean. The rest is recycled as low-value plastic, becoming decking materials, flowerpots, and sporks.

To reduce this waste, researchers have been looking for ways to turn the plastics into something more valuable, such as the monomers that are polymerized to produce new plastics. This would create a circular polymer economy for plastics, reducing the need to make new plastics from petroleum, which generates greenhouse gases.

Two years ago, Hartwig and his UC Berkeley team came up with a process for breaking down polyethylene plastic bags into the monomer propylene — also called propene — that could then be reused to make polypropylene plastics. This chemical process employed three different bespoke heavy metal catalysts: one to add a carbon-carbon double bond to the polyethylene polymer and the other two to break the chain at this double bond and repeatedly snip off a carbon atom and, with ethylene, make propylene (C_3H_6) molecules until the polymer disappeared. But the catalysts were dissolved in the liquid reaction and short-lived, making it hard to recover them in an active form.

In the new process, the expensive, soluble metal catalysts have been replaced by cheaper solid ones commonly used in the chemical industry for continuous flow processes that reuse the catalyst. Continuous flow processes can be scaled up to handle large volumes of material.

Conk first experimented with these catalysts after consulting with Bell, an expert on heterogeneous catalysts, in the Department of Chemical and Biomolecular Engineering.

Synthesizing a catalyst of sodium on alumina, Conk found that it efficiently broke or cracked various kinds of polyolefin polymer chains, leaving one of the two pieces with a reactive carbon-carbon double bond at the end. A second catalyst, tungsten oxide on silica, added the carbon atom at the end of the chain to ethylene gas, which is constantly streamed through the reaction chamber to form a propylene molecule. The latter process, called olefin metathesis, leaves behind a double bond that the catalyst can access again and again until the entire chain has been converted to propylene.

The same reaction occurs with polypropylene to form a combination of propene and a hydrocarbon called isobutylene. Isobutylene is used in the chemical industry to make polymers for products ranging from footballs to cosmetics and to make high-octane gasoline additives.

Surprisingly, the tungsten catalyst was even more effective than the sodium catalyst in breaking polypropylene chains.

"You can't get much cheaper than sodium," Hartwig said. "And tungsten is an earth-abundant metal used in the chemical industry in large scale, as opposed to our ruthenium metal catalysts that were more sensitive and more expensive. This combination of tungsten oxide on silica and sodium on alumina is like taking two different types of dirt and having them together disassemble the whole polymer chain into even higher yields of propene from ethylene and a combination of propene and isobutylene from polypropylene than we did with those more complex, expensive catalysts."

Like a String of Pearls

One key advantage of the new catalysts is that they avoid the need to remove hydrogen to form a breakable carbon-carbon double bond in the polymer, which was a feature of the researchers' earlier process to deconstruct polyethylene. Such double bonds are an Achilles heel of a polymer, in the same way that the reactive carbon-oxygen bonds in polyester or PET make the plastic easier to recycle. Polyethylene and polypropylene don't have this Achilles heel — their long chains of single-carbon bonds are very strong.

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"Think of the polyolefin polymer like a string of pearls," Hartwig said. "The locks at the end prevent them from falling out. But if you clip the string in the middle, now you can remove one pearl at a time."

The two catalysts together turned a nearly equal mixture of polyethylene and polypropylene into propylene and isobutylene — both gases at room temperature — with an efficiency of nearly 90%. For polyethylene or polypropylene alone, the yield was even higher.

Conk added plastic additives and different types of plastics to the reaction chamber to see how the catalytic reactions were affected by contaminants. Small amounts of these impurities barely affected the conversion efficiency, but small amounts of PET and polyvinyl chloride — PVC — significantly reduced the efficiency. This may not be a problem, however, because recycling methods already separate plastics by type.

Hartwig noted that while many researchers are hoping to redesign plastics from the ground up to be easily reused, today's hard-to-recycle plastics will be a problem for decades.

"One can argue that we should do away with all polyethylene and polypropylene and use only new circular materials. But the world's not going to do that for decades and decades. Polyolefins are cheap, and they have good properties, so everybody uses them," Hartwig said. "People say if we could figure out a way to make them circular, it would be a big deal, and that's what we've done. One can begin to imagine a commercial plant that would do this."

Sci Tech Daily, 6 September 2024

https://scitechdaily.com

Folded or cut, this lithium-sulfur battery keeps going

2024-09-13

Sulfur has been suggested as a material for lithium-ion batteries because of its low cost and potential to hold more energy than lithium-metal oxides and other materials used in traditional ion-based versions.

To make Li-S batteries stable at high temperatures, researchers have previously proposed using a carbonate-based electrolyte to separate the two electrodes (an iron sulfide cathode and a lithium metal-containing anode). However, as the sulfide in the cathode dissolves into the electrolyte, it forms an impenetrable precipitate, causing the cell to quickly lose capacity.

Liping Wang and colleagues wondered if they could add a layer between the cathode and electrolyte to reduce this corrosion without reducing functionality and rechargeability.

The team coated iron sulfide cathodes in different polymers and found in initial electrochemical performance tests that polyacrylic acid (PAA) performed best, retaining the electrode's discharge capacity after 300 charge-discharge cycles.

Next, the researchers incorporated a PAA-coated iron sulfide cathode into a prototype battery design, which also included a carbonate-based electrolyte, a lithium metal foil as an ion source, and a graphite-based anode.

They produced and then tested both pouch cell and coin cell battery prototypes.

After more than 100 charge-discharge cycles, Wang and colleagues observed no substantial capacity decay in the pouch cell.

Additional experiments showed that the pouch cell still worked after being folded and cut in half.

The coin cell retained 72% of its capacity after 300 charge-discharge cycles.

They next applied the polymer coating to cathodes made from other metals, creating lithium-molybdenum and lithium-vanadium batteries.

These cells also had stable capacity over 300 charge-discharge cycles.

Overall, the results indicate that coated cathodes could produce not only safer Li-S batteries with long lifespans, but also efficient batteries with other metal sulfides, according to Wang's team.

The authors acknowledge funding from the National Natural Science Foundation of China; the Natural Science Foundation of Sichuan, China; and the Beijing National Laboratory for Condensed Matter Physics.

Science Daily, 13 September 2024

https://sciencedaily.com

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Blood Biomarker May Help Early Detection of Alzheimer's Disease

2024-09-05

New research has discovered a unique and promising avenue for diagnosing Alzheimer's disease (AD) earlier – by analysing AD biomarkers in blood – so that the impacts of dementia can be reduced.

AD is the most common form of dementia, estimated to contribute to 60-70 per cent of cases, or more than 33 million cases worldwide, according to the World Health Organisation. Currently incurable, AD is usually diagnosed when a person is having significant difficulties with memory and thinking that impact their daily life.

University of Melbourne researcher Dr Brandon Mahan leads a group of analytical geochemists from the Faculty of Science who are collaborating with neuroscientists in the Faculty of Medicine, Dentistry and Health Sciences (based at The Florey) to develop a blood test for earlier diagnosis of AD, as described in a paper published in Metallomics.

In a world first, the researchers applied inorganic analytical geochemistry techniques, originally developed for cosmochemistry – for example, to study the formation and evolution of the Earth, the Moon, other planets and asteroid samples – and adapted these highly sensitive techniques to search for early biomarkers of AD in human blood serum.

They compared the levels of potassium isotopes in blood serum in 20 samples – 10 healthy and 10 AD patients from the Australian Imaging, Biomarker and Lifestyle study and biobank.

"Our minimally invasive test assesses the relative levels of potassium isotopes in human blood serum and shows potential to diagnose AD before cognitive decline or other disease symptoms become apparent, so action can be taken to reduce the impacts," Dr Mahan said.

"Our test is scalable and – unlike protein-based diagnostics that can break down during storage – it avoids sample stability issues because it assesses an inorganic biomarker."

Currently, clinical diagnosis of AD is based on medical history, neurological exams, cognitive, functional and behavioural assessments, brain imaging, and protein analysis of cerebrospinal fluid or blood samples.

"Earlier diagnosis would enable earlier lifestyle changes and medication that can help slow disease progression and would allow more time

for affected families to take action to reduce the social, emotional and financial impacts of dementia," Dr Mahan said. "It could also make patients eligible for a wider variety of clinical trials, which advance research and may provide further medical benefits.

"My research team – the Melbourne Analytical Geochemistry group – seeks partners and support to continue this important research and development."

Co-author Professor Ashley Bush from The Florey sees promise in the results from the small pilot study.

"Our blood test successfully identified AD and shows diagnostic power that could rival leading blood tests currently used in clinical diagnosis," Professor Bush said. "Significant further work is required to determine the ultimate utility of this promising technique."

With the world's population aging, incidence of AD is rising. The number of dementia sufferers is anticipated to double every 20 years and the global cost of dementia is forecast to rise to US$2.8 trillion by 2030. In 2024, more than 421,000 Australians live with dementia. It is the second leading cause of death in Australia and the leading cause for Australian women.

Technology Networks, 5 September 2024

https://technologynetworks.com

New photocatalyst achieves superior oxidative methane coupling

2024-09-13

Researchers have developed a novel catalyst Au/BiOx-TiO2 for efficient, selective and stable photocatalytic light-driven oxidative coupling of methane (OCM).

Producing value-added chemicals through OCM is a promising approach to alleviate energy issues. However, OCM requires strict reaction conditions due to its high reaction energy barrier. Compared with the anaerobic coupling of methane, the aerobic coupling of methane has a lower reaction barrier, yet it still faces challenges such as poor product selectivity and slow reaction rate. Therefore, it is necessary to design efficient catalysts and optimize reaction pathways to address issues of stability, selectivity and reactivity in OCM.

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The group designed and synthesized a dual-site photocatalyst, Au/BiOx-TiO2, which is a composite system of BiOx clusters and Au nanoparticles. The BiOx clusters are uniformly distributed around the Au nanoparticles, tightly bound together. The synergistic effect of Au nanoparticles and BiOx clusters enables the activation of C-H bonds in CH4 and the coupling of CH3 at separate sites, preventing overoxidation of CH4 at a single site. This significantly improves the selectivity for C2+ products.

Using a self-designed flow reactor, the photocatalytic OCM achieved a CH4 conversion rate of 20.8 mmol g−1 h−1 and a C2H6 production rate of 9.6 mmol g−1 h−1. The selectivity for C2+ products exceeded 97%, with stability lasting up to 50 hours, outperforming many previously reported catalysts.

The group also verified the mechanism of lattice oxygen participation in OCM based on in-situ spectroscopy and theoretical calculations. The lattice oxygen can effectively enhance the C-H activation, and introducing an appropriate amount of oxygen can replenish lattice oxygen via the Mars-Van Krevelen mechanism, achieving high selectivity and stability simultaneously.

This work highlights the importance of employing catalytic site engineering in chemical reactions and sheds light on sustainable and energy-efficient CH4 conversion.

The study is published in Science Advances. The groups were led by Prof. Xiong Yujie, Prof. Liu Dong and Prof. Zhang Ning from the University of Science and Technology of China (USTC).

Phys Org, 13 September 2024

https://phsy.org

Newly Developed "Chameleon" Chemical Could Revolutionize Rare-Earth Metal Purification

2024-09-13

Researchers at the Department of Energy's Oak Ridge National Laboratory have discovered a chemical "chameleon" that could enhance the purification process for rare-earth metals used in clean energy, medical, and national security applications.

The study, performed in collaboration with Vanderbilt University, is the latest of many efforts by ORNL's Chemical Sciences Division to lower the barriers to accessing metals called lanthanides, which are used widely in

diverse products and applications, from biomedical imaging to industrial chemical production to electronics. There are 15 lanthanides, and they, along with two other elements, are collectively known as the rare-earth metals.

Contrary to what their name implies, most rare-earth metals are not in fact rare; lanthanides are naturally occurring in mineral ore deposits, and many are as common in the environment as copper and lead. However, the powerful properties of the metals that cause them to be so widely used are only functional if an individual lanthanide is separated from the mixture of other metals in which it is present when mined. The metal of choice must be purified to a high level before it becomes useful in its intended application. The rarity lies in the difficulty of this process.

Challenges in Separating Lanthanides

"It's a big challenge, because the lanthanide ions are very similar in their sizes and chemical properties," said Subhamay Pramanik, former ORNL postdoc and now radiochemist with ORNL's Nanomaterials Chemistry group. "They differ by only the slightest amount, so isolating pure individual lanthanides requires very precise separations science."

To isolate a select metal from rare-earth mineral solutions, scientists and industry use ligands — chemical compounds that selectively bind to a particular metal within the solution. These compounds are mixed into an organic solvent, then mixed with a water-based solution of the lanthanide mixture. Like oil, organic solvents do not mix with water, so the layers separate. If the compound successfully grabs the target metal from the solution during mixing, it pulls the metal into the organic layer when the solvent and aqueous solution separate. Then the metal can be processed and further purified.

The best current industrial separations processes occur in stages, with lanthanides separated in a particular order — heavy to light or light to heavy. The process is time-consuming and costly, and it produces a lot of waste that is not always environmentally friendly.

Discovery of the Chameleon Ligand

Enter the chameleon. When studying an existing ligand similar to the compounds used in the aforementioned process, scientists discovered something unique: a ligand that behaves differently depending on the experimental conditions. Like a chameleon changes its color to adapt to its environment, the compound changes its behavior when the environment

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around it changes, binding to different lanthanides depending on the acid concentration of the solution and the amount of time the ligand is allowed to interact with it. For example, if the environment is more acidic, the ligand preferentially binds to a heavier lanthanide.

"In typical separation systems, a ligand usually shows preference for either lighter or heavier lanthanides," said ORNL's Santa Jansone-Popova, who co-led the study. "We found you can use the same compound to perform multiple different separations, which is exciting and unique. And we identified the mechanisms by which it does it."

Potential Benefits of the Chameleon Ligand

Using the same compound to separate multiple different lanthanides in the series could lower the number of steps needed in this common and costly process. Moreover, depending on the conditions, the ligand in this study could separate the heaviest, the lightest and mid-weight lanthanides — in any order.

Other ligands do not show this same behavior. However, until now, scientists did not know this one would either. The chameleon ligand looks similar to other well-established ligands, but it has completely different behavior. Now that it is known that such capabilities and systems exist for lanthanide-binding compounds, the ligand can be studied in more depth, and more compounds with similar behavior could be discovered.

"Just because the structure of a ligand looks very similar to another, it doesn't have to behave the same, and that understanding moves the needle and pushes the boundaries of what's known," said ORNL's Ilja Popovs, who co-led the study. "It has the potential to make the separations processes faster, cleaner and better — reducing the number of stages, providing better selectivity and purity, and leading to more environmentally friendly processes."

Sci Tech Daily, 13 September 2024

https://scitechdaily.com

Ig Nobel prize goes to team who found mammals can breathe through anuses

2024-09-13

In a stark demonstration of how award-winning breakthroughs can come from the most unlikely directions, researchers have won an Ig Nobel prize for discovering that mammals can breathe through their anuses.

After a series of tests on mice, rats and pigs, Japanese scientists found the animals absorb oxygen delivered through the rectum, work that underpins a clinical trial to see whether the procedure can treat respiratory failure.

The team is among 10 recognised in this year's Ig Nobel awards (see below for more), the irreverent accolades given for achievements that "first make people laugh, and then make them think". They are not to be confused with the more lucrative and career-changing Nobel prizes to be handed out in Scandinavia next month.

The latest crop of Ig Nobel winners received their awards at a ceremony at Massachusetts Institute of Technology on Thursday. The event featured real Nobel laureates to distribute the prizes, "24/7" lectures in which experts first explained their subject in 24 seconds, then in seven words, and copious paper-plane throwing.

Other work honoured on the night included US research to house pigeons in missiles to help guide them to their targets; UK investigations which found that claims of extreme old age tend to come from areas that have short average lifespans and and a historical lack of birth certificates, and a French study which found that scalp hair tends to whorl in a clockwise direction, though less so in the southern hemisphere.

The Japanese researchers became interested in whether humans with breathing difficulties might benefit from having oxygen pumped up their backsides after noting that some animals, such as loaches, can use their intestines to breathe. They began the work in the Covid crisis when many hospitals were desperately short of mechanical ventilators to support breathing in people with severe infections.

The team's experiments, which earned the Ig Nobel prize in physiology, showed that mice, rats and pigs could absorb oxygen into the bloodstream when it was delivered via the rectum, thus supporting normal breathing. Writing in the journal Med in 2021, Ryo Okabe at Tokyo Medical and Dental University and colleagues described how "enteral ventilation" offered "a new paradigm" to help patients in respiratory failure.

Dr Takanori Takebe, an author of the study at Cincinnati children's hospital medical centre, confessed to "mixed feelings" on hearing of the award, but warmed to it on finding out it was recognised for making people laugh and then think. If it fuelled interest in enteral ventilation, he said, "I'd be so happy." The team is running a phase 1 trial in human volunteers.

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Dr Saul Newman at the University of Oxford bagged the demography prize for showing that many claims of people living extraordinarily long lives come from places with short life spans, no birth certificates, and where clerical errors and pension fraud abound. "Extreme old age records are a statistical basket case," he said. "From the level of individual cases, up to broad population patterns, virtually none of our old-age data makes sense."

Prof Roman Khonsari, a craniofacial surgeon at the Necker-Enfants Malades university hospital in Paris, and colleagues won the anatomy prize for their global study of hair whorls. While scalp hair spirals in a clockwise direction on most people, their research found, there is more counter-clockwise spiralling in the southern hemisphere.

"I was operating when I got the call," Khonsari said. "I was extremely glad because, despite the undeniable irrelevance of this study, I am convinced that deciphering patterns in nature can lead to important discoveries on fundamental developmental mechanisms. Shapes carry interesting amounts of information."

The discovery led to comparisons with tornadoes, which typically rotate in different directions in the northern and southern hemispheres. Writing in the Journal of Stomatology, Oral and Maxillofacial Surgery, the researchers theorised that the Coriolis effect, by which the Earth's spin deflects winds to the right in the northern hemisphere and to the left in the southern hemisphere, could be at work. Not that Khonsari believes it. "Frankly, I don't think it is a plausible hypothesis," he said.

The other winners of the 2024 Ig Nobel prizes

Peace

Awarded to the late BF Skinner, a US psychologist, for exploring the feasibility of housing live pigeons inside missiles to guide them to their targets. The project, which Skinner himself described as "crackpot", was dropped despite a perfect demonstration involving a pigeon trained to target features on the New Jersey coastline. "The spectacle of a living pigeon carrying out its assignment, no matter how beautifully, simply reminded the committee of how utterly fantastic our proposal was," Skinner wrote.

Botany

Given to Jacob White in the US and Felipe Yamashita in Germany for reporting evidence that the South American plant Boquila trifoliolata can

mimic the leaves of plastic plants it is placed alongside, leading them to conclude that "plant vision" is a plausible hypothesis.

Medicine

Won by a Swiss, German and Belgian group for demonstrating that fake medicine that causes painful side-effects can be more effective in patients than fake medicine that does not cause painful side-effects.

Physics

Awarded to James Liao at the University of Florida for a comprehensive, multi-publication investigation into the swimming abilities of a dead trout.

Probability

Shared by a team of 50 researchers, mostly Dutch, who flipped 350,757 coins to test a hypothesis put forward by Persi Diaconis, a former magician and professor of statistics at Stanford University. Their work supported Diaconis's prediction that tossed coins are (slightly) more likely to land the same way up as they started.

Chemistry

Another win for the Netherlands, with a team in Amsterdam using chromatography to separate drunk and sober worms, all the in the name of polymer science.

Biology

Another posthumous award, the Ig Nobel in biology honoured the late Fordyce Ely and William Petersen for their 1940 investigation into factors affecting the production of milk in dairy herds. Writing in the Journal of Animal Science, the pair recounted placing a cat on the back of a cow and repeatedly exploding paper bags to see if milk-flow changed. The terrified cows appeared to release less milk. "Frightening at first consisted in placing a cat on the cow's back and exploding paper bags every 10 seconds for two minutes," the researchers wrote. "Later the cat was dispensed with as unnecessary."

The Guardian, 13 September 2024

https://theguardian.com

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Carbohydrate polymers could be a sweet solution for water purification

2024-09-11

Water polluted with heavy metals can pose a threat when consumed by humans and aquatic life. Sugar-derived polymers from plants remove these metals but often require other substances to adjust their stability or solubility in water.

Now, researchers report a sugar-like polymer that traps heavy metals within insoluble clumps for easy removal. In proof-of-concept tests, the polymer removed ionic cadmium and lead from river water spiked with these persistent contaminants. The work has been published in ACS Central Science.

Some heavy metal ions can be toxic at high levels in drinking water. Methods for removing these contaminants, such as filtration, can be energy intensive and rely on metal-capturing membranes that clog quickly and must be replaced. To improve water purification, researchers have turned to plants.

Plants defend their cells with a barrier of polysaccharides, made of macromolecules with repeating sugar units, that trap metal ions. For example, in a recent study, researchers used sticky polysaccharide extracts from okra and aloe to remove microplastics from wastewater.

However, some polysaccharides dissolve in water, requiring additives to form insoluble gels for metal capture and removal. So, Cassandra Callmann and her research team at the University of Texas at Austin set out to design a single material with sugar-like structures and controllable water solubility to remove heavy metals from water.

The team constructed several polymers, each having a water-insoluble backbone with different water-soluble carbohydrates dangling from the repeating units like charms on a bracelet. In initial tests, the carbohydrate "charm" that attracted and bound ionic cadmium most efficiently contained a carboxylic acid group.

Next, in tests of water spiked with ionic cadmium, the polymer with carboxylic acid formed visible clumps after three minutes, and the clumps could be filtered out. The clumps also redissolved, releasing the cadmium, by adjusting the acidity of the water. After three cycles of binding, clumping and redissolving, the polymer maintained the same metal-trapping efficiency, demonstrating its potential as a recyclable material.

As a proof-of-concept, the team next tested the carbohydrate-containing polymer on Colorado River water spiked with ionic cadmium and lead. The river sample contained substantially more ionic calcium, sodium and magnesium than the added metals.

Over a 24-hour period, the polymer captured up to 20% and 45% of the added cadmium and lead, respectively, and minimal amounts of the other metal ions. The researchers say their new material is a promising step towards more efficient, reusable and selective materials for water purification.

Phys Org, 11 September 2024

https://phys.org

Promising Lassa Fever Vaccine Prevents Disease and Death in Preclinical Animal Models

2024-09-13

Researchers from Thomas Jefferson University and the University of Maryland Baltimore, in collaboration with the United States Army Medical Research Institute of Infectious Diseases (USAMRIID) and the Geneva Foundation, have developed a promising new vaccine candidate that protects against Lassa fever. The study, published in npj Vaccines on August 9, 2024, demonstrated that the vaccine effectively prevents severe cases of the disease and death in preclinical animal models and paves the way for research in people.

To date, several Lassa candidate vaccines are currently in development. However, out of these, Matthias Schnell, PhD, director of the Jefferson Center for Vaccines and Pandemic Preparedness at Thomas Jefferson University, who co-led the study, pointed out that his team's LASSARAB vaccine has an advantage. He noted that the two other platforms in development for Lassa fever are both based on live viral vectors, "which come with their own safety issues," he says. "Our vaccine is a deactivated or killed vaccine which is considered safer in general."

The vaccine, named LASSARAB, uses a deactivated rabies virus platform to deliver antigens to protect against the Lassa fever virus. Lassa fever is a severe hemorrhagic disease that is endemic to parts of West Africa, causing an estimated 300,000 to 500,000 infections and over 5,000 deaths each year. The disease can lead to severe complications including organ failure, deafness, and long-term neurological disorders. Currently, there are no licensed vaccines to prevent Lassa fever.

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"The damage to a patient is devastating," says Kathleen Cashman, PhD, a virologist and principal investigator at The Geneva Foundation supporting USAMRIID who also co-led the study. She adds that the virus infects and compromises cells, causing multiple organ failures which can be fatal. "It is a very severe disease that's difficult to protect against, so when you find something that can keep you from dying, that's pretty astounding."

The researchers used 12 young non-human primates to test the vaccine, half receiving two doses of the LASSARAB vaccine, and the other half receiving CORAVAX, a COVID-19 vaccine, as a negative control. While both used rabies as a vector, the antigens used to activate an immune response were different. Over 28 days, the control group exhibited more severe disease symptoms, greater damage to their internal organs, and did not survive, while the LASSARAB-vaccinated group had less damage and survived until the end of the study. The researchers also noted that much remains unknown about the persistence of the disease in young animals in general, highlighting the need for further research.

While the vaccine protected against severe disease and death and reduced fever, it did not prevent infection. The researchers believe the 28-day study period was not long enough to fully assess the vaccine's ability to provide long-term immunity. They are optimistic that longer-term studies with more mature animal models will provide further insights into the vaccine's ability to prevent long-term side effects.

The rabies platform used in the LASSARAB vaccine was developed by Dr. Schnell's lab and offers several key advantages. In addition to protecting against Lassa fever, the vaccine also protects against rabies which is an important consideration for many Lassa-endemic regions. Previous studies have shown that a similar rabies-based vaccine against the Ebola virus can also remain stable at a variety of temperatures including 50 degrees Celsius for up to two weeks. Dr. Schnell, also chair of the Department of Microbiology and Immunology at Sidney Kimmel Medical College, highlighted that rabies vaccines have a proven safety profile, allowing for their use in children and immunosuppressed populations. This dual protection could be particularly beneficial in regions where both diseases are prevalent.

"If you get vaccinated and boosted against rabies, most people have lifelong protection," Dr. Schnell says. "So, we hope that the protection against Lassa will be also long-lived, which is important."

Funding for this study was provided by a $30 million grant from the National Institute of Allergy and Infectious Diseases (NIAID), which has

been crucial in advancing the vaccine candidate to this critical stage. "This kind of work needs government and nonprofit funding," says Dr. Schnell, who added that the team is very grateful to receive this funding since there are limited commercial incentives from pharmaceutical companies for this type of vaccine. "This is not a SARS-CoV-2 vaccine. This vaccine is for neglected infectious diseases in a region of poor financial standing, so these people need our help."

To that end, Dr. Schnell's Lassa virus vaccine is now headed to a phase 1 clinical trial in November after successfully completing an Investigational New Drug (IND) application with the Food and Drug Administration.

Technology Networks, 13 September 2024

https://technologynetworks.com

AI Finds a Cheaper Way To Make Green Hydrogen

2024-09-29

AI developed a new catalyst for green hydrogen production, improving efficiency and reducing costs.

Researchers at the University of Toronto are using artificial intelligence to accelerate scientific breakthroughs in the search for sustainable energy. They used the Canadian Light Source (CLS) at the University of Saskatchewan (USask) to confirm that an AI-generated "recipe" for a new catalyst offered a more efficient way to make hydrogen fuel.

To create green hydrogen, you pass electricity that's been generated from renewable resources between two pieces of metal in water. This causes oxygen and hydrogen gases to be released. The problem with this process is that it currently requires a lot of electricity and the metals used are rare and expensive.

Researchers are searching for the right alloy, or combination of metals, that would act as a catalyst to make this reaction more efficient and affordable. Traditionally, this search would involve trial and error in the lab, but when you are trying to find the proverbial needle in a haystack, this approach takes too much time.

"We're talking about hundreds of millions or billions of alloy candidates, and one of them could be the right answer," said Jehad Abed. He was part of a team that developed a computer program to significantly speed up this search. Their findings were published in the Journal of the American Chemical Society. At the time of this project, Abed was a PhD student under the supervision of Edward Sargent at the University of Toronto working alongside scientists at Carnegie Mellon University.

The AI program the team developed took over 36,000 different metal oxide combinations and ran virtual simulations to assess which combination of ingredients might work the best. Abed then tested the program's top candidate in the lab to see if its predictions were accurate.

The team used the CLS's ultra-bright X-rays to analyze the catalyst's performance during a reaction. "What we needed to do is use that very bright light at the Canadian Light Source to shine it on our material and see how the atomic arrangements would change and respond to the amount of electricity that we put in," said Abed. The researchers also used the Advanced Photon Source at the Argonne National Laboratory in Chicago.

The alloy, a combination of the metals ruthenium, chromium, and titanium in specific proportions, was a clear winner, according to Abed. "The computer's recommended alloy performed 20 times better than our benchmark metal in terms of stability and durability," said Abed. "It lasted a long time and worked efficiently."

While the AI program Jehad and colleagues developed shows great promise, the material itself still needs to undergo lots of testing to ensure it will last under "real world" conditions.

"The computer was right about this alloy being more effective and stable. That was a breakthrough because it shows that this method for finding better catalysts is working," said Abed. "What would take a person years to test, the computer can simulate in a matter of days."

The researchers are hopeful that AI will offer a faster route to finding the answers we need to make green energy practical for widespread use.

Technology Networks, 29 August 2024

https://technologynetworks.com

Cheaper, highly effective oral 'Ozempic' drugs are on the way

2024-09-09

The race is on to develop the first daily weight-loss pill that would be both cheaper and less invasive than the current injectable drugs on the market, with the latest strong trial results from US company Terns following similarly positive outcomes from competitors including Eli Lilly, Roche and Structure Therapeutics.

The one-a-day glucagon-like peptide-1 receptor (GLP-1R) agonist tablet would work much like the current suite of medications including Wegovy and Ozempic, (semaglutide) and Zepbound (tirzepatide), but would take away the need to self-inject the drug in order to achieve the same weight-loss results. These small-molecule drugs effectively target the gastrointestinal tract, doing away with the need to administer the medication by injection.

The latest results come from California's Terns Pharmaceuticals, which has reported its findings following a 28-day Phase I clinical trial of its TERN-601 oral medication, testing for tolerability and safety.

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"These compelling results underscore TERN-601's potential to be a class-leading GLP-1R agonist based on its composite profile of initial indications of efficacy, tolerability and manufacturing scalability," said Amy Burroughs, chief executive officer of Terns. "With operational preparations well underway, we look forward to swiftly advancing this promising product candidate into Phase 2 clinical development in 2025."

In the study, TERN-601 was tested at different doses on 37 healthy but overweight or obese individuals. The randomized trial, split the participants into three cohorts (high, medium and low dose, in addition to a placebo control group). The high-dose (740 mg) participants had the best results, with 67% achieving an average weight loss of 5.5% after the four-week trial. In the other groups, 33% of the medium-dose participants lost 5% of their body weight, while just 11% of the low-dose individuals reached the 5% weight-loss benchmark. Among the placebo group, the average weight loss was 0.6%.

Side effects were reported as mild or medium – much like the gastrointestinal issues that come with existing GLP-1 receptor agonist drugs.

"We are delighted to demonstrate potent GLP-1R agonism with TERN-601 as its distinct drug properties allowed for sustained target coverage with once-daily dosing and the evaluation of doses up to 740 mg, while being tolerable," noted Emil Kuriakose, chief medical officer of Terns. "Importantly, we believe we have successfully identified an optimal range of clinically active, well tolerated doses to take forward in Phase 2 clinical trials, with no new dose range exploration anticipated."

However, the company has some catching up to do, with pharmaceutical competitors already at advanced trial stages for oral GLP-1 medications.

In February 2025, Eli Lilly is pushing forward with Phase III trials for its drug known as orforglipron, which showed promising results from its 2023 Phase II testing. While the assessment time frame was much longer at 26 weeks, it achieved between 8.6% and 12.6% weight-loss results among the 272 participants recruited for the trial. A placebo cohort, in comparison, had an average of 2% weight loss. Once again, higher doses resulted in more weight lost.

At 36 weeks, orforglipron saw participants lose between 9.4% and 14.7% of their body weight, compared to 2.3% in the placebo group.

"These study results support the continued development of orforglipron in Phase III," said Jeff Emmick, Lilly's senior vice president for product development, in a statement in 2023.

Pfizer is also in the race, working on the oral weight-loss medication danuglipron, but has pivoted from a twice-daily pill to a once-a-day format.

"We believe an improved once-daily formulation of danuglipron could play an important role in the obesity treatment paradigm, and we will focus our efforts on gathering the data to understand its potential profile," said Mikael Dolsten, chief scientific officer and president of Pfizer research and development, in a 2023 statement. "Results from ongoing and future studies of the once-daily danuglipron modified release formulation will inform a potential path forward with an aim to improve the tolerability profile and optimize both study design and execution."

Meanwhile, Viking Therapeutics is working on both a subcutaneous and oral medication, and Structure Therapeutics has been buoyed by promising Phase II trial results of its oral small molecule medication. After eight weeks, the average weight loss of participants was 5.5%, and a Phase IIb study is set to begin in the fourth quarter of 2024.

"Safe and effective oral small molecule GLP-1 receptor agonists would be a significant advance in that they could expand access for many patients for whom this is not now possible," said Structure CEO Raymond Stevens in a statement.

In July, Roche also reported strong results from its small molecule oral drug known as CT-996, with participants experiencing an average of 7.3% weight loss, compared to 1.2% for the placebo group.

"We are pleased to see the clinically meaningful weight loss in people treated with our oral GLP-1 therapy CT-996, which could eventually help patients address both chronic weight management and glycaemic control indications," said Levi Garraway, Roche's chief medical officer in a statement.

While drug developers believe oral obesity drugs will essentially dominate the weight-loss drug market, they're also expected to still be several years away from being commercially available.

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The Terns results were published in an investor presentation paper.

New Atlas, 09 September 2024

https://newatlas.com

Researchers solve long-standing mystery of alumina surface structure

2024-9-12

Aluminum oxide (Al2O3), also known as alumina, corundum, sapphire, or ruby, is one of the best insulators used in a wide range of applications: in electronic components, as a support material for catalysts, or as a chemically resistant ceramic, to name a few.

Knowledge of the precise arrangement of the surface atoms is key to understanding how chemical reactions occur in this material, such as those in catalytic processes. Atoms inside the material follow a fixed arrangement, giving rise to the characteristic shapes of crystals.

On the surface, however, the structure deviates from that inside the crystal. The strongly insulating nature of alumina has hindered experimental studies, and the surface structure evaded precise determination for more than half a century. Researchers at TU Wien and the University of Vienna have now solved the complex structure of the Al2O3 surface, a puzzle listed in 1997 as one of the "three mysteries of surface science."

The research group led by Jan Balajka and Ulrike Diebold has published its findings in Science.

High-resolution microscopy identifies surface atoms

The research team used noncontact atomic force microscopy (ncAFM) to analyze the surface structure. This method generates images of the surface structure by scanning a sharp tip mounted on a quartz tuning fork at a close distance from the surface. The frequency of the tuning fork changes as the tip interacts with the atoms on the surface without touching the material.

Johanna Hütner, who performed the experiments, explains, "In an ncAFM image, one can see the location of atoms, but not their chemical identity. We overcame the lack of chemical sensitivity by precisely controlling the tip. Attaching a single oxygen atom to the tip apex allowed us to distinguish between oxygen and aluminum atoms on the surface.

"The oxygen atom on the tip is repelled by other oxygen atoms on the surface and attracted to aluminum atoms of the Al2O3 surface. Mapping the local repulsion or attraction enabled us to visualize the chemical identity of each surface atom directly."

Restructuring stabilizes the surface without changing its composition

The researchers found that the surface rearranges to allow the aluminum atoms at the surface to penetrate into the material and form chemical bonds with the oxygen atoms in the deeper layers. This rearrangement of the first two atomic layers significantly reduces the energy, effectively stabilizing the structure. In contrast to previous beliefs, the numerical ratio of aluminum to oxygen atoms remains unchanged.

The three-dimensional model of the aluminum oxide surface was optimized with machine learning methods. The main challenge was to match the restructured surface with the underlying crystal.

"The structure is very complex, resulting in a vast number of possibilities for how the experimentally inaccessible atoms below the surface could be arranged. The state-of-the-art machine learning algorithms combined with conventional computational methods allowed us to examine numerous possibilities and create a stable three-dimensional model of the aluminum oxide surface," states Andrea Conti, who carried out the computational modeling.

"Through the collaborative effort of experimental and computational research, we not only tackled a long-standing mystery by determining the detailed structure of this enigmatic insulator, but also discovered structure design principles applicable to an entire class of materials. Our results pave the way for advancements in catalysis, material science, and other fields," says Jan Balajka, who led the research.

Phys Org, 12 September 2024

https://phys.org

Enzyme-inspired catalyst puts chemicals in right position to make ethers

2024-09-12

Taking inspiration from enzymes, chemists at the University of Illinois Urbana-Champaign developed a catalyst to simplify the synthesis of ethers, key functional components of many drugs, foods, personal care items and other consumer goods. The catalyst puts the two chemical

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ingredients in just the right proximity and position to come together, bypassing the need for the steps and quantities required under standard synthesis protocols.

Led by U. of I. chemistry professor M. Christina White, the researchers published their findings in the journal Science.

"Ethers are very important molecules -- they're in everything -- and our approach really streamlines the process for making them, as well as lets us make ethers we couldn't before," said White. "We always are inspired by nature. Enzymes showed us the way we could do these reactions better, simpler and more efficiently."

The ideal ingredient pairing for making an ether is an alcohol and a hydrocarbon called an alkene, but they won't react on their own if mixed together, said graduate student Sven Kaster, the first author of the study. The textbook protocol involves ripping a proton from the alcohol, which makes it reactive, but results in a mixed cocktail of products from which the desired ether must be extracted. It also requires large amounts of the ingredients to yield enough ether to be useful, which is not practical for complex, valuable components.

"We took a different approach to solving the problem," Kaster said. "We did not want to activate the alcohol, and we didn't want to have to use large quantities of the reaction partners."

The researchers developed self-assembling small-molecule catalysts containing the metal palladium that can cleave a bond between carbon and hydrogen in an alkene to make it react with alcohol. They dubbed the catalysts SOX. However, just making alkenes reactive wasn't enough to yield the ethers the researchers wanted.

They turned to biology for inspiration, looking at how enzymes catalyze complex reactions in nature: by placing the reaction partners close together and in the right orientation to react, White said. They produced a version of the SOX catalyst, Sven-SOX, with specific geometry and electronic properties so that the activated alkene and the alcohol would align just right to produce the desired ethers.

"It's like, if two people want to hold hands, they have to be close together. But to do it comfortably, they also have to be facing the right way," White said. "We brought together those two functions, proximity and position, and kind of built our own self-assembling 'enzyme,' but with simple components."

The Sven-SOX catalyst worked over a broad spectrum of ether-generating reactions. The researchers produced more than 130 ethers, including complex, bulky ones that have thus far been challenging to produce under other means.

"This really highlights the importance of basic science and the power of small molecules to perform like an enzyme," White said. "This work showed us how to think about designing such catalysts in the future and making use of the tools that enzymes use in nature. We want to incorporate that into future catalyst design to solve important problems in chemistry, medicine and industry."

The National Institute of General Medical Sciences of the National Institutes of Health supported this work.

Science Daily, 12 September 2024

https://sciencedaily.com

Insulin-free life for diabetics closer after successful cell pouch trial

2024-09-12

Implanting a pouch of stem-cell-derived pancreas cells under the skin of type 1 diabetics has enabled them to live without insulin injections for years and maintain non-diabetic blood sugar levels, according to the results of a clinical trial. It's a big step towards a functional cure for the disease.

Type 1 diabetes (T1D) is an autoimmune condition where the body's immune system attacks and destroys the insulin-producing beta cells in the islets of the pancreas, requiring type 1 diabetics to inject insulin daily to replace what's not being produced. T1D is commonly diagnosed during childhood or early adolescence and requires constant monitoring to reduce the risk of episodes of low blood sugar (hypoglycemia) and long-term complications.

Developing a 'functional cure' for T1D has been at the forefront of medical research, especially as science and technology have advanced. Many of these functional cures have involved the transplantation of pancreatic cells to replace the damaged and dead ones. In a similar vein, Canada-based regenerative medicine therapeutics company Sernova Corp has reported very promising results from early clinical trials using its novel Cell Pouch System technology in type 1 diabetics.

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"This first-in-world data is potentially game-changing for Sernova and, more specifically, provides tangible hope for T1D patients that we are a significant step further in our mission of providing a functional cure for this terrible disease; as a type 1 diabetic myself, I could not be more determined to drive our program forward and ultimately onto the market," said Jonathan Rigby, president and CEO of Sernova.

Sernova's Cell Pouch System is a small, implantable medical device that's inserted under the skin against the abdominal muscle and contains stem-cell-derived 'therapeutic cells' – in the case of type 1 diabetics, cells that produce insulin. Because the device is porous, after implantation blood vessels infiltrate it and form a biocompatible tissue environment that ensures the long-term survival and function of the cells it houses.

About six weeks after implantation of the Cell Pouch, which allows time for patients to be stabilized on immune-suppressing therapy, islet cells are transplanted into the vascularized tissue chambers formed by the pouch. (Immunosuppressants reduce the risk that the patients' bodies will reject the transplanted cells.) Patients can receive 'top-up' islet transplants if they are still dependent on insulin six months after the last transplant. Those trial participants who retained their implants were followed up for at least three years.

New Atlas, 12 September 2024

https://newatlas.com

Light-Based Technique Detects Early Prostate Cancer With 90% Accuracy

2024-09-03

Researchers have developed a light-based blood analysis method with 90% accuracy for early cancer detection.

An Aston University researcher has used light to develop the first step towards a quicker, cheaper and less painful technique to detect cancer.

Professor Igor Meglinski from the University's Aston Institute of Photonic Technologies led the team that has developed a new method of analysing the crystals in dehydrated blood. Their paper "Insights into polycrystalline microstructure of blood films with 3D Mueller matrix imaging approach" has been published in the Nature journal Scientific Reports.

Professor Meglinski used a new polarisation-based image reconstruction technique to analyse polycrystalline structures in dried blood samples. The

proteins in blood change their shape and how they fit together during the early stages of diseases like cancer. Professor Meglinski and his team used changes in the proteins' tertiary structure or unique 3D shape together with its quaternary structure - which is how multiple proteins join together - to detect and classify cells.

This technique enabled the researchers to conduct a detailed layer-by-layer analysis of dry blood smears, which is crucial for identifying significant differences between healthy and cancerous samples.

The researchers analysed 108 blood film samples from three equal size groups: healthy volunteers, those who had prostate cancer and a third group who had the illness and had cells that were more likely to aggressively spread.

Professor Meglinski said: "Our study introduces a pioneering technique to the liquid biopsy domain, aligning with the ongoing quest for non-invasive, reliable and efficient diagnostic methods.

"A key advancement in our study is the characterisation of the mean, variance, skewness, and kurtosis of distributions with the cells which is crucial for identifying significant differences between healthy and cancerous samples.

"This breakthrough opens new avenues for cancer diagnosis and monitoring, representing a substantial leap forward in personalised medicine and oncology."

The study's findings had a 90% accuracy rate of both early diagnosis and classification of cancer which is much higher than existing screening methods. Also, as the technique relies on blood samples instead of tissue biopsies, it is less traumatic and risky for patients.

Professor Meglinski added: "This high level of precision, combined with the non-invasive nature of the technique, marks a significant advancement in liquid biopsy technology.

"It holds immense potential for revolutionising cancer diagnosis, early detection, patient stratification and monitoring, thereby greatly enhancing patient care and treatment outcomes.

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"This study also presents a testament to the resilience and support of our Ukrainian colleagues involved in the research, especially in light of the ongoing conflict in Ukraine."

Technology Networks, 3 September 2024

https://technologynetworks.com/a>

Discovery could lead to longer-lasting EV batteries, hasten energy transition

2024-09-12

Batteries lose capacity over time, which is why older cellphones run out of power more quickly. This common phenomenon, however, is not completely understood.

Now, an international team of researchers, led by an engineer at the University of Colorado Boulder, has revealed the underlying mechanism behind such battery degradation. Their discovery could help scientists to develop better batteries, which would allow electric vehicles to run farther and last longer, while also advancing energy storage technologies that would accelerate the transition to clean energy.

The findings were published September 12 in the journal Science.

"We are helping to advance lithium-ion batteries by figuring out the molecular level processes involved in their degradation," said Michael Toney, the paper's corresponding author and a professor in the Department of Chemical and Biological Engineering. "Having a better battery is very important in shifting our energy infrastructure away from fossil fuels to more renewable energy sources."

Engineers have been working for years on designing lithium-ion batteries -- the most common type of rechargeable batteries -- without cobalt. Cobalt is an expensive rare mineral, and its mining process has been linked to grave environmental and human rights concerns. In the Democratic Republic of Congo, which supplies more than half of the world's cobalt, many miners are children.

So far, scientists have tried to use other elements such as nickel and magnesium to replace cobalt in lithium-ion batteries. But these batteries have even higher rates of self-discharge, which is when the battery's internal chemical reactions reduce stored energy and degrade its capacity over time. Because of self-discharge, most EV batteries have a lifespan of seven to 10 years before they need to be replaced.

Toney, who is also a fellow of the Renewable and Sustainable Energy Institute, and his team set out to investigate the cause of self-discharge. In a typical lithium-ion battery, lithium ions, which carry charges, move from one side of the battery, called the anode, to the other side, called the cathode, through a medium called an electrolyte. During this process, the flow of these charged ions forms an electric current that powers electronic devices. Charging the battery reverses the flow of the charged ions and returns them to the anode.

Previously, scientists thought batteries self-discharge because not all lithium ions return to the anode when charging, reducing the number of charged ions available to form the current and provide power.

Using the Advanced Photon Source, a powerful X-ray machine, at the U.S. Department of Energy's Argonne National Laboratory in Illinois, the research team discovered that hydrogen molecules from the battery's electrolyte would move to cathode and take the spots that lithium ions normally bind to. As a result, lithium ions have fewer places to bind to on the cathode, weakening the electric current and decreasing the battery's capacity.

Transportation is the single largest source of greenhouse gases generated in the U.S, accounting for 28% of the country's emissions in 2021. In an effort to reduce emissions, many automakers have committed to moving away from developing gasoline cars to produce more EVs instead. But EV manufacturers face a host of challenges, including limited driving range, higher production costs and shorter battery lifespan than conventional vehicles. In the U.S. market, a typical all-electric car can run about 250 miles in a single charge, about 60% that of a gasoline car. The new study has the potential to address all of these issues, Toney said.

"All consumers want cars with a large driving range. Some of these low cobalt-containing batteries can potentially provide a higher driving range, but we also need to make sure they don't fall apart in a short period of time," he said, noting that reducing cobalt can also reduce costs and address human rights and energy justice concerns.

With a better understanding of the self-discharge mechanism, engineers can explore a few ways to prevent the process, such as coating the cathode with a special material to block hydrogen molecules or using a different electrolyte.

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"Now that we understand what is causing batteries to degrade, we can inform the battery chemistry community on what needs to be improved when designing in batteries," Toney said.

Science Daily, 12 September 2024

https://sciencedaily.com

Explainer: Why drug shortages happen and how can we reduce them?

2024-08-08

Drug shortages are a decades-old problem, but over the past few years they have hit record levels. A consistent stream of supply issues has disrupted supplies of vital medicines – from hormone replacement therapy (HRT), antibiotics and cancer chemotherapies, to medicines used to treat attention deficit hyperactivity disorder (ADHD), as well as the newest class of diabetes and weight-loss treatments.

Some of those shortages are now subsiding, as new supply routes come online, or quality issues are resolved. But some are more persistent. Some of the drugs on the US current shortages list have been there for almost a decade.

But what are the reasons behind these shortages and what is being done to ensure patients have continuous access to the medicines they need?

What is a drug shortage?

A drug shortage defines a period when the demand or projected demand for a drug exceeds the supply. Drug shortages can occur for many reasons, including manufacturing and quality problems, delays and discontinuation.

How much of a problem are drug shortages?

Medicines shortages can compromise patient care by delaying treatment or diverting patients to different, less suitable, drugs. They also put strain on pharmacy teams trying to source the products they need, and place economic burden on the healthcare system by spiking prices.

During the first quarter of 2024, the American Society of Health-System Pharmacists (ASHP) – which actively monitors drug shortages in the US – alongside the University of Utah Drug Information Service, tracked an 'all-

time high' of 323 active shortages, surpassing the previous record of 320 shortages in 2014.

The ASHP said most shortages involve low-cost generic drugs, particularly sterile injectables used in hospital treatments and procedures, such as baseline cancer therapies and intravenous antibiotics. Some of these medications have no alternatives, forcing hospitals and doctors to ration medication or even delay care.

The situation is no better in the UK. In November 2023, the British Generic Manufacturers Association (BGMA) trade body reported that medicines supply problems had reached record highs with a reported 100% increase in shortages of medicines between January 2022 and January 2024.

What's more, the global nature of pharmaceutical supply chains means shortages are often interconnected, meaning that shortages in one country frequently impact on others.

Why do drug shortages happen?

Reasons are multifactorial – geopolitical factors such as Brexit, the Ukraine-Russia war and the Covid-19 pandemic have had a significant impact on supplies, as have soaring energy costs and inflation, logistical issues and the availability of raw ingredients.

One key reason for acute shortages is a sudden and unprecedented increase in demand, for example, due to a rapid increase in disease prevalence. In December 2022, an increase in cases of Strep A among children in the UK caused a surge in demand for penicillin, amoxicillin and azithromycin, particularly in solution, which resulted in shortages across the country and a significant increase in wholesale prices.

Emerging trends, such as the 'Davina effect' whereby an awareness campaign led by TV personality Davina McCall led to a sudden increase in demand for hormone replacement therapy (HRT) in the UK can add further pressure to supply chains. Since 2022, Novo Nordisk has struggled to scale up manufacturing of Ozempic (semaglutide), to match public demand. Originally developed as a diabetes treatment, demand for the glucagon-like peptide-1 (GLP-1) receptor agonist soared after clinical trials showed the drug could be used off-label as a weight-loss aid and it was promoted heavily by celebrities on social media.

Another reason for shortages is a sudden drop in supply. This might be because of recalls or quality problems – such as when Indian manufacturer Intas, the main supplier of cisplatin and carboplatin cancer

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chemotherapies to the US, failed a US Food and Drug Administration inspection last year, prompting a nationwide shortage. Or because a company takes a commercial decision to discontinue an unprofitable product, and there are insufficient alternative suppliers. However, drops in supply can also be the result of natural disasters – for example, in 2023, a tornado hit a Pfizer plant in Rocky Mount, US, destroying part of a large facility that manufacturers a quarter of the company's sterile injectables for US hospitals.

Manufacturing problems, including shortages of raw materials or delivery mechanisms, issues with industrial capacity and flexibility and distribution or logistical problems, such as disruptions in international trade due to geopolitical conflict, can all contribute to shortages. Sterile injectables are particularly vulnerable to shortages compared to solid oral dose medications because of their expensive and more complex manufacturing processes.

The risk of drug shortages also increases because there is a geographic concentration of active pharmaceutical ingredient (API) manufacturing in China and India; two of the world's largest producers of pharmaceuticals. In 2018, investigations identified traces of potentially carcinogenic nitrosamines in batches of the blood pressure medicine valsartan originating from a manufacturing plant in China, which was responsible for supplying API to multiple drugmakers around the world. The finding prompted a global recall from several manufacturers and sparked concerns for ongoing drug supplies.

However, the ASHP has said that the most severe and persistent shortages are driven by extreme price competition among generic manufacturers, which undermines investment in manufacturing capacity, quality assurance, and supply chain reliability and leads to a lack of incentives to produce less profitable drugs. As a result, lower-priced drugs are more likely to experience shortages.

What is the protocol when shortages happen?

Several countries have set up national reporting systems so that shortages can be communicated more easily. For, example, in the US, manufacturers can notify the FDA Drug Shortage Staff via a direct web portal, and the list is updated daily with new and resolved shortages, as well as additional information received from product suppliers regarding manufacturing capacity.

When a shortage occurs, the FDA works directly with the manufacturer of the drug to address the shortage and with other manufacturers to help ramp up production if they are willing to do so. In the case where a shortage cannot be resolved immediately and the shortage involves a critical drug needed for US patients, the FDA may look for a firm that is willing and able to redirect product into the US market to address a shortage.

In the UK, the Department of Health and Social Care (DHSC) will liaise with medicines manufacturers, alternative suppliers and wholesalers to secure additional supplies; commission clinical advice from the NHS Specialist Pharmacy Service and national clinical experts regarding management options and alternative medicines; and contact medicines important to identify potential sources of medicines.

In October 2019, serious shortage protocols (SSPs) were introduced as part of preparations for a 'no-deal' Brexit to allow pharmacists to offer an alternative product specified in the protocol for items in short supply. Since then, the DHSC has issued 61 SSPs, with the number of active protocols peaking at nine in July and September 2022.

The UK government has also restricted the export and hoarding of some medicines where there is evidence, or risk, of a critical shortage which could adversely impact UK patients. This list is reviewed and updated regularly.

And, in 2020, the DHSC established the National Supply Disruption Response service to address supply problems affecting medicines and other products.

Regulators, such as the Medicines and Healthcare products Regulatory Agency, can also take a variety of regulatory actions such as speeding up the assessment process for new marketing authorisations; granting temporary exemptions from medicines labelling requirements so that medicines packaged for use in another country can be used; importing and testing batches of licensed medicines; and considering manufacturers' requests to import unlicensed medicines for the treatment of individual patients. Other countries' regulators have similar powers, but details vary.

What is being done to limit shortages?

In December 2023, the European Medicines Agency published a list of more than 200 critical medicines to avoid potential shortages – it deems a medicine critical according to two main criteria: the seriousness of the

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disease it targets and the availability of alternative medicines. The list is set to be expanded in 2024 and then updated every year.

At the end of April 2024, the EMA published recommendations to address vulnerabilities in the production and delivery of medicines included in the EU critical medicines list and strengthen their supply chains.

As part of these recommendations, suppliers in Europe may be asked to take on new measures such as stockpiling medicines; reviewing past shortages or back orders to help identify demand patterns; and increasing manufacturing capacity to avoid potential shortages of critical medicines in the supply chain.

There is currently limited transparency as to the actions of the DHSC in the UK regarding decisions affecting supply chains and it is unclear if the UK is following a similar system to the EU. In 2023, organisations representing UK pharmacists called for reforms to the systems used to manage shortages – for example to enable pharmacists to amend prescriptions to provide alternatives to patients when medicines are out of stock. But, in January 2024, the government indicated that it had no plans to introduce legislative proposals of this kind and would instead continue to rely on serious shortage protocols to enable pharmacists to amend prescriptions on a case-by-case basis.

In the US, many policy solutions have been offered, including stockpiles, and support for domestic and advanced manufacturing. The Biden administration has pushed to fund an increase in domestic manufacturing as a way to combat supply chain issues in pharmaceuticals, with measures taken in 2021 as well as this year to encourage more production capacity.

In April 2024, the US Department of Health and Human Services appointed a supply chain resilience and shortage coordinator to spearhead strengthening critical medical supply chains and related shortages.

And, in May, the US Senate Finance Committee drafted a bipartisan bill to mitigate shortages by having state healthcare provider Medicare pay bonuses to hospitals and physicians for contracting practices that ensure adequate supplies of drugs – starting with generic sterile injectables and infused medications, such as chemotherapies.

Chemistry World, 8 August 2024

https://chemistryworld.com

Spectroscopic study unveils key steps for turning CO_2 into valuable chemicals

2024-09-12

A new study takes advantage of advanced spectroscopic methods and theory to shed light on the intricate processes involved in converting carbon dioxide (CO2) into valuable chemicals like ethylene and ethanol. This research holds significant promise for advancing sustainable practices in the chemical industry.

The paper, titled "Key intermediates and Cu active sites for CO2 electroreduction to ethylene and ethanol," is published in the journal Nature Energy.

The electrochemical reduction of CO2 (CO2RR) is a promising technology that uses renewable electricity to convert CO2 into high-value chemicals, effectively closing the carbon cycle. Ethylene and ethanol, the focus of this study, are crucial for producing environmentally-friendly plastics and fuels, respectively.

However, the exact mechanisms and intermediate steps involved in this conversion have remained elusive until now. The former mechanistic understanding is crucial in order to rationally design the active sites, which we show here are not only present in the synthesized pre-catalyst, but can also be formed and evolve in the course of the reaction through the interaction with reactants and reaction intermediates.

The research team led by group leader Dr. Arno Bergmann, Prof. Dr. Beatriz Roldán Cuenya and Prof. Dr. Núria López employed in-situ surface-enhanced Raman spectroscopy (SERS) and density functional theory (DFT) to investigate the molecular species on copper (Cu) electrocatalysts and thereby, gain insights into the reaction mechanism.

Their findings reveal that the formation of ethylene occurs when specific intermediates, known as *OC-CO(H) dimers, form on undercoordinated Cu sites. Conversely, the production of ethanol requires highly compressed and distorted coordination environment of the Cu sites, with the key intermediate *OCHCH2.

One of the critical discoveries is the role of surface morphology in the reaction process. The team found that the undercoordinated Cu sites strengthen the binding of CO, a crucial step in the reduction process. These Cu sites, characterized by atomic-level irregularities, likely form

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under reaction conditions and make the catalytic surface more effective, leading to better performance in producing ethylene and ethanol.

These findings have significant implications for the chemical industry, particularly in the production of plastics and fuels. By understanding the specific conditions and intermediates required for the selective production of ethylene and ethanol, researchers can design more efficient and sustainable catalysts. This could lead to more effective ways to utilize CO2, reducing the carbon footprint of chemical manufacturing processes.

The study was a collaborative effort, with theoretical support from a research group in Spain. This partnership allowed for a comprehensive investigation, combining experimental and theoretical approaches to provide a detailed understanding of the CO2 reduction process.

The research conducted by the Interface Science Department at the Fritz Haber Institute and Institute of Chemical Research of Catalonia represents a significant step forward in the field of CO2 reduction. By unveiling the key intermediates and active sites involved in the production of ethylene and ethanol, this study provides a foundation for developing more efficient and sustainable catalytic processes.

The findings not only advance scientific knowledge but also offer practical solutions for reducing CO2 emissions and promoting sustainable chemical production.

Phys Org, 12 September 2024

https://phys.org

MIT Chemists Decode the Molecular Armor That Preserves Dinosaur Collagen

2024-09-08

MIT researchers have discovered that special atomic-level interactions prevent water molecules from breaking down the peptide bonds in collagen, a finding that explains how dinosaur fossils could retain collagen structures for over 195 million years. This discovery suggests a deeper resilience at the molecular level, challenging previous notions of peptide bond durability.

How Collagen Survives in Ancient Fossils

Collagen, a protein found in bones and connective tissue, has been found in dinosaur fossils as old as 195 million years. That far exceeds the normal

half-life of the peptide bonds that hold proteins together, which is about 500 years.

A new study from MIT offers an explanation for how collagen can survive for so much longer than expected. The research team found that a special atomic-level interaction defends collagen from attack by water molecules. This barricade prevents water from breaking the peptide bonds through a process called hydrolysis.

Key Atomic Interaction Protects Collagen

"We provide evidence that that interaction prevents water from attacking the peptide bonds and cleaving them. That just flies in the face of what happens with a normal peptide bond, which has a half-life of only 500 years," says Ron Raines, the Firmenich Professor of Chemistry at MIT.

Raines is the senior author of the new study, which was published on September 4 in ACS Central Science. MIT postdoc Jinyi Yang PhD '24 is the lead author of the paper. MIT postdoc Volga Kojasoy and graduate student Gerard Porter are also authors of the study.

Water-Resistance

Collagen is the most abundant protein in animals, and it is found in not only bones but also skin, muscles, and ligaments. It's made from long strands of protein that intertwine to form a tough triple helix.

"Collagen is the scaffold that holds us together," Raines says. "What makes the collagen protein so stable, and such a good choice for this scaffold, is that unlike most proteins, it's fibrous."

In the past decade, paleobiologists have found evidence of collagen preserved in dinosaur fossils, including an 80-million-year-old Tyrannosaurus rex fossil, and a sauropodomorph fossil that is nearly 200 million years old.

Over the past 25 years, Raines' lab has been studying collagen and how its structure enables its function. In the new study, they revealed why the peptide bonds that hold collagen together are so resistant to being broken down by water.

Peptide Bonds and Their Resistance to Water

Peptide bonds are formed between a carbon atom from one amino acid and a nitrogen atom of the adjacent amino acid. The carbon atom also forms a double bond with an oxygen atom, forming a molecular structure

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called a carbonyl group. This carbonyl oxygen has a pair of electrons that don't form bonds with any other atoms. Those electrons, the researchers found, can be shared with the carbonyl group of a neighboring peptide bond.

Because this pair of electrons is being inserted into those peptide bonds, water molecules can't also get into the structure to disrupt the bond.

Experimental Evidence of Collagen's Durability

To demonstrate this, Raines and his colleagues created two interconverting mimics of collagen — the one that usually forms a triple helix, which is known as trans, and another in which the angles of the peptide bonds are rotated into a different form, known as cis. They found that the trans form of collagen did not allow water to attack and hydrolyze the bond. In the cis form, water got in and the bonds were broken.

"A peptide bond is either cis or trans, and we can change the cis to trans ratio. By doing that, we can mimic the natural state of collagen or create an unprotected peptide bond. And we saw that when it was unprotected, it was not long for the world," Raines says.

"This work builds on a long-term effort in the Raines Group to classify the role of a long-overlooked fundamental interaction in protein structure," says Paramjit Arora, a professor of chemistry at New York University, who was not involved in the research. "The paper directly addresses the remarkable finding of intact collagen in the ribs of a 195-million-old dinosaur fossil, and shows that overlap of filled and empty orbitals controls the conformational and hydrolytic stability of collagen."

"No Weak Link"

This sharing of electrons has also been seen in protein structures known as alpha helices, which are found in many proteins. These helices may also be protected from water, but the helices are always connected by protein sequences that are more exposed, which are still susceptible to hydrolysis.

"Collagen is all triple helices, from one end to the other," Raines says. "There's no weak link, and that's why I think it has survived."

Alternative Theories

Previously, some scientists have suggested other explanations for why collagen might be preserved for millions of years, including the possibility that the bones were so dehydrated that no water could reach the peptide bonds.

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"I can't discount the contributions from other factors, but 200 million years is a long time, and I think you need something at the molecular level, at the atomic level in order to explain it," Raines says.

For more on this study, see How Dinosaur Bones Defy Scientific Expectations of Decay.

Sci Tech Daily, 8 September 2024

https://scitechdaily.com

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