CHEMWATCH

Bulletin Board

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OCT. 18, 2024

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ASIA PACIFIC

Toxic Threads? The Hidden Dangers Of Ultra-Fast Fashion

2024-10-10

Ultra-fast fashion sites such as Shein and Temu have surged in popularity in Australia and across the globe.

Australians are the world's biggest fashion consumers and they are increasingly turning to these online retailers and marketplaces, which offer trendy clothing at incredibly low prices, amid the cost-of-living crisis.

These shopping sites have faced widespread criticism for worker exploitation and the use of unsustainable materials. But an equally alarming issue that's less often discussed is the presence of harmful chemicals in some of their products.

Cotton, polyester, wool, rubber: When you're shopping for clothes or shoes, you've probably noticed most items are labelled with the material each item is made from. But the fibre composition disclosed on the label is only one part of the picture.

What is never disclosed on a care label is the colourant used to dye or print on a garment, or the many other chemical additives that are part of regular fabric finishes.

Some of these chemicals are used to make plastic flexible; others stop fabric from wrinkling, are used for waterproofing and stain resistance, or lurk in synthetic materials such as polyester or nylon.

These invisible parts of the clothes we wear against our skin require interrogation.

Recent investigations have revealed alarming levels of harmful chemicals in ultra-fast fashion items.

In August 2024, South Korean authorities found that some clothing items from retailer Shein, as well as online marketplaces Temu and AliExpress, contained harmful substances, including carcinogens, at levels hundreds of times over the legal limit.

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Read More

Code Blue, 10-10-24

https://codeblue.galencentre.org/2024/10/toxic-threads-the-hidden-dangers-of-ultra-fast-fashion/

APVMA decision to immediately cancel all products with chlorthal dimethyl

2024-10-10

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has cancelled the registration and use of all products containing chlorthal dimethyl, also known as Dacthal or DCPA. Chlorthal dimethyl is a herbicide used in vegetable crops, turf and cotton.

This is an immediate cancellation of the 12 products in Australia containing chlorthal dimethyl, no phase out period applies. Farmers and retailers may continue to the hold products until further notice but must not use it. The use of chlorthal dimethyl as an agricultural chemical product is now illegal.

The APVMA's assessment found there is an immediate risk to human health due to direct exposure:

- during mixing
- loading and applying the chemical
- from residue remaining on treated crops and turf for up to 5 days following application.

The primary risk is to unborn babies via maternal exposure. Effects may include low birth weight, impaired brain development, decreased IQ, and impaired motor skills later in life. Pregnant workers who may have concerns about exposure are advised to consult with their physician.

Information on the product recall process will be issued shortly.

The products cancelled are:

Product name	Registration number
Nufarm Chlorthal-Dimethyl 900 Herbicide	59137
Imtrade Pterodactyl 900 WG Pre-Emergence Herbicide	65212
KDPC Prethal 750WG Herbicide	67445
Novaguard Chlorthal 750 WG Herbicide	68349
Ezycrop Chlorthal 750 WG Herbicide	69085
Farmalinx Dynamo 750 Herbicide	69626
AC Discord 750 WG Herbicide	69680
MacPhersons Chlorthal 900 WG Herbicide	81334
Lawthal 750WG Herbicide	83116
Hemani Chlorthal 750 WG Herbicide	85327
Titan Chlorthal 900 WG Pre-Emergence Herbicide	88705
Dacthal 900 WG Pre-Emergence Herbicide	93154

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APVMA, 10-10-24

https://www.apvma.gov.au/news-and-publications/media-releases/apvma-decision-immediately-cancel-all-products-chlorthal-dimethyl

AMERICA

EPA Issues Test Order for PFAS Used in Manufacturing Under National Testing Strategy

2024-10-09

The U.S. Environmental Protection Agency issued the fifth Toxic Substances Control Act (TSCA) Test Order requiring testing on per- and polyfluoroalkyl substances (PFAS) under EPA's National PFAS Testing Strategy, the latest action taken under EPA's PFAS Strategic Roadmap to confront contamination from "forever chemicals" nationwide.

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This action orders Innovative Chemical Technologies, The Chemours Company, Daikin America, Inc., Sumitomo Corporation of Americas, and E.I. Du Pont de Nemours and Company to conduct and submit testing on 3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl prop-2-enoate, also known as 6:2 fluorotelomer acrylate or 6:2 FTAc. 6:2 FTAc is used to manufacture plastics, resins, textiles, apparel, leather and other chemicals. Between one million and 20 million pounds are produced per year.

"PFAS in our air, water, and in our bodies cause serious health effects like cancer and heart and liver problems," said Michal Freedhoff, the Assistant Administrator for the Office of Chemical Safety and Pollution Prevention. "That's why it's so important for us to collect as much information as we can on these chemicals – to learn more about the potential environmental and human health impacts of PFAS and take any necessary steps to address them."

Summaries of studies of 6:2 FTAc exposures to rodents suggest it causes changes in blood cell counts, liver and kidney size, and animal behavior. Further, the chemical structure of 6:2FTAc suggests that it may cause cancer.

PFAS such as 6:2FTAc can build up in our bodies and the environment over time. Even small amounts can significantly contribute to people's long-term exposure and health risk for cancers, impacts to the liver and heart, and immune and developmental damage to infants and children.

EPA finds that 6:2 FTAc may present an unreasonable risk of injury to health or the environment, given the hazard and exposure concerns for this chemical specifically and for PFAS generally. The information EPA receives under this order, especially toxicity information, will improve the agency's understanding not only of human health effects of 6:2 FTAc, but also of the potential effects of over a hundred PFAS that are structurally similar to 6:2 FTAc. The information will also add to EPA's overall knowledge of this category of PFAS.

Read More

US EPA, 09-10-24

https://www.epa.gov/newsreleases/epa-issues-test-order-pfas-used-manufacturing-under-national-testing-strategy

EPA issues final rule requiring replacement of lead pipes within 10 years

2024-10-09

The Biden-Harris Administration has issued a final rule requiring drinking water systems across the country to identify and replace lead pipes within 10 years. The Lead and Copper Rule Improvements (LCRI) also require more rigorous testing of drinking water and a lower threshold requiring communities to take action to protect people from lead exposure in water. In addition, the final rule improves communication within communities so that families are better informed about the risk of lead in drinking water, the location of lead pipes, and plans for replacing them. This final rule is part of the President's commitment to replace every lead pipe in the country within a decade, making sure that all communities can turn on the tap and drink clean water.

Alongside the Lead and Copper Rule Improvements, EPA is announcing $2.6 billion in newly available drinking water infrastructure funding through the Bipartisan Infrastructure Law. This funding will flow through the drinking water state revolving funds (DWSRFs) and is available to support lead pipe replacement and inventory projects. Additionally, 49% of the funding must be provided to disadvantaged communities as grant funding or principal forgiveness that does not have to be repaid. EPA is also announcing the availability of $35 million in competitive grant funding for reducing lead in drinking water. Communities are invited to apply directly for grant funding through this program. Additional federal funding is available to support lead pipe replacement projects and EPA has developed a website identifying available funding sources.

Read More

US EPA, 09-10-24

https://smartwatermagazine.com/news/us-epa/epa-issues-final-rule-requiring-replacement-lead-pipes-within-10-years

The EPA has new regulations for lead in drinking water. Here's what they mean for Massachusetts

2024-10-10

Drinking water systems in Massachusetts must replace all lead pipes within 10 years, according to new federal regulations announced this week.

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The Environmental Protection Agency will provide nearly $53.5 million to help Massachusetts meet this goal, though industry advocates warn this will not be enough to fully cover the cost without price hikes for water customers.

The new rule, announced on Tuesday, also lowers the so-called "action level" for lead from 15 to 10 parts per billion. Water systems that continuously exceed this level are required to conduct additional outreach and offer water filters to consumers.

There is no safe level of lead, according to the EPA. Lead is a potent neurotoxin that, in children, can harm mental and physical development, slow learning and irreversibly damage the brain. In adults, lead exposure can cause increased blood pressure, kidney damage and other health risks.

Read More

Wbur, 10-10-24

https://www.wbur.org/news/2024/10/10/epa-lead-drinking-water-massachusetts

EUROPE

The persistence of energy poverty in the EU

2024-08-21

This report offers a comprehensive analysis of the persistence of energy poverty in the European Union (EU). The primary objective is to analyse the duration and magnitude of energy poverty over time and to identify the socioeconomic and demographic factors contributing to this persistence. Employing longitudinal data from the European Union Statistics on Income and Living Conditions (EU-SILC), the study uses multilevel, mixedeffects regression models to assess the impact of individual-level factors such as sex, age, and household size changes. It also examines macro-level variables like social protection expenditure and energy intensity per dwelling. The research highlights the significant proportion of the EU population that experiences energy poverty persistently and uncovers pronounced differences across Member States, with certain countries exhibiting higher rates of longstanding energy poverty. The report acknowledges data limitations, such as missing information for specific countries and years, which restricted the analysis of expenditure-based indicators and certain socio-demographic characteristics. Despite

these constraints, the study provides valuable insights into the persistency of energy poverty across the EU, supporting the need for standardised energy poverty indicators that integrate expenditure data. The findings underscore the importance of integrated policy interventions and further research to address this enduring social challenge.

Read More

European Commission, 21-08-24

https://publications.jrc.ec.europa.eu/repository/handle/JRC138409

Addressing the environmental and climate footprint of buildings

2024-09-30

The report assesses the current state of Europe's buildings stock and looks at what is needed to make Europe's buildings more sustainable. Renovating existing buildings with sustainable materials while improving climate resilience and working with nature are key. The report also explores what policy actions are needed to achieve that by 2050.

Read More

European Environment Agency, 30-09-24

https://www.eea.europa.eu/en/analysis/publications/addressing-the-environmental-and-climate-footprint-of-buildings

Safe and sustainable alternatives could reduce use of PFAS in textiles and enhance reuse and recycling

2024-09-17

Textiles are one of the biggest sources of PFAS pollution in Europe. Polyfluorinated alkyl substances (PFAS), a group of highly persistent chemicals, are widely used in many textile-based products including clothing, carpets and other household goods for waterproofing, oil, dirt and heat protection, and increased durability.

However, they also persist over time and may accumulate in humans, animals and the environment, increasing the risk of serious health and environmental impacts.

The EEA briefing offers an overview on how the ongoing process to restrict the use of PFAS in the EU could have an impact on the possibility to reuse

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and recycle used textiles. It is based on a larger report commissioned for the EEA and it complements work done by other EU agencies, including the European Chemicals Agency (ECHA).

PFAS in textiles in Europe's circular economy

Available information suggests that alternatives are available to replace PFAS in the majority of different textile categories. For some categories of textiles, however, alternatives are lacking or there is inconclusive evidence to assess their technical and economic feasibility. These include, for example, some types of personal protective equipment for firefighters.

Read More

European Environment Agency, 17-09-24

https://www.eea.europa.eu/en/newsroom/news/reduce-use-of-pfas-in-textiles

World Ozone Day: EU continues to phase out gases harming the ozone layer

2024-09-16

The European Environment Agency (EEA) has published new data, collected annually from companies, on the production, import, export, destruction, and use of ozone-depleting substances as raw materials in the EU. The data show how the EU has met its obligations under the Montreal Protocol and tracks progress on the more ambitious EU Ozone Regulation.

In 2023, the consumption (production and imports minus destruction and exports) of ozone-depleting substances in the EU stood at +1,306 metric tonnes, up from -2,954 tonnes in 2022. The production of controlled ozone-depleting substances in the EU was 20% lower than in 2022 while imports of these substance declined by 2%. These volumes are less than 1% of the total ODS that were consumed in Europe when the Montreal Protocol was agreed in 1986.

The EU is also committed to fully phasing out the consumption of hydrofluorocarbons (HFCs) by 2050. While progress to date is promising there remains a significant need for technological development to replace F-gases with less harmful alternatives, for example, in refrigerant use. F-gases were introduced as replacements for the ozone-depleting substances. They don't harm the ozone layer but as greenhouse gases they have a very high warming impact on the climate.

Read More

European Environment Agency, 16-09-24

https://www.eea.europa.eu/en/newsroom/news/world-ozone-day

Commission launches consultation on draft methodology for low- carbon hydrogen

2024-09-27

The European Commission is today launching a 4-week call for feedback on the draft delegated act which clarifies the methodology for evaluating the emission savings of low-carbon hydrogen and fuels. This secondary legislation is required under the revised EU hydrogen and gas market legislation that entered into force over the summer. The draft text complements the rules already in place for renewable hydrogen and renewable fuels of non-biological origin (RFNBOs) and is consistent with their methodology for a life cycle assessment of the total greenhouse gas emissions of these fuels.

The feedback from this consultation will feed into the Commission's deliberations on the final text. Upon finalisation, the text of the delegated act will be passed to the European Parliament and the Council of Ministers for a 2-month period. If the Parliament and the Council do not object during this time, the delegated act is formally published in the Official Journal and enters into force.

Read More

European Commission, 27-09-24

https://energy.ec.europa.eu/news/commission-launches-consultation-draft-methodology-low-carbon-hydrogen-2024-09-27_en

Drone trial to test water quality expands

2024-10-10

A trial which uses drones to monitor water quality is expanding.

Northumbrian Water will use the drones to test coastal waters and estuaries across north-east England, following test flights in Bishop Auckland earlier this year.

The equipment would make it cheaper and easier to gather data in hard-to-reach areas, as the water company currently relied on manual collection, it said.

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The company said it would continue with manual checks to understand the reliability of the technology.

The data collected by drone would be reviewed and any issues with water quality would be investigated as standard procedure, Northumbrian Water added.

The Project Kingfisher trial was a "world first" for the water industry, the firm said, and was named after the way the aircraft hover and dip in and out of water.

'Real-time data'

The trial would show how drone operations could help water companies to proactively respond to problems and improve worker safety, the firm said.

Manually collecting water samples could be "challenging or simply not possible" in some locations, and the travel could sometimes take several hours, making the process time-consuming and inefficient, Northumbrian Water said.

Technical policy manager John Edwards said: "We know that water quality is an incredibly important topic at the moment – so it's great that we are able to use these innovative trials."

Read More

BBC, 01-10-24

https://www.bbc.com/news/articles/c70wxd80w65o

Italy, Germany join carmakers in call to rethink internal combustion engine ban

2024-09-27

Rome and Berlin are siding with the European automotive industry in calling for the EU to relax CO2 emissions standards for cars as the bloc aims to end the sale of new petrol and diesel models by 2035.

Italy and Germany are mustering support from other EU members for a call to relax EU targets for reducing car CO2 emissions and reconsider a 2035 ban on the sale of petrol and diesel models, Italian Industry Minister Adolfo Urso said in Brussels Wednesday evening.

It was now "certain" that the ban – actually a zero limit on tailpipe emissions – would not be achieved, and the two

countries plan to propose at an EU Council summit Thursday that a review clause in the legislation be brought forward from the end of 2026 to early 2025, Urso said.

Echoing recent warnings from manufacturers, Urso said Europe's car industry had "collapsed" and predicted "tens of thousands" of redundancies in the sector unless the EU changed course.

The EU had two choices, the Italian minister said: firstly, to keep the target and create the conditions to allow the car industry to achieve it – an approach favoured by German economy minister Robert Habeck. "Or if we fail to do all this we just have to…postpone the objectives," he said.

Read More

EuroNews, 27-09-24

https://www.euronews.com/my-europe/2024/09/25/italy-germany-join-carmakers-in-call-to-rethink-internal-combustion-engine-ban

INTERNATIONAL

Emissions Gap Report 2024 launch

2024-10-10

The Emissions Gap Report (EGR) is UNEP's annual institutional series report that is launched in advance of the annual climate negotiations. The EGR tracks the gap between where global emissions are heading with current country commitments and where they ought to be to limit warming to well below 2°C and pursuing 1.5°C in line with the Paris Agreement temperature goals. Each edition explores ways to bridge the emissions gap, tackling specific issue(s) of interest and relevance to the negotiations each year.

The persistent focus of the report this year is on the need and options to accelerate climate action and deliver global ambition levels aligned with the Paris Agreement temperature goals in the next generation of Nationally Determined Contributions, due in 2025.

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Read More

UNEP, 10-10-24

https://www.unep.org/events/publication-launch/emissions-gap-report-2024-launch

New fund to support chemicals and waste management in developing economies

2024-10-01

One year after its adoption in Bonn, the Global Framework on Chemicals today launched its first call for projects targeting the safe and sustainable management of chemicals and waste. The selected projects are expected to work on green and sustainable solutions and to channel actions to prevent and minimize harm from chemicals and waste in some of the world's most disadvantaged countries.

"Pollution and waste constitute a daily crisis for people's health, undermine economic activity, and leave nature permanently scarred," said Sheila Aggarwal-Khan Director of the UNEP Industry and Economy Division. "Today the historic Framework is turning from text into practice and providing concrete benefits for those at the frontlines of this crisis."

At the Fifth International Conference on Chemicals Management, held in September 2023 in Bonn, delegates from around the world representing governments, private sector, civil society, academia and youth adopted the Framework. During the conference this dedicated trust fund was set up to support low-and middle-income countries, including small island developing states, in addressing chemicals, including products and waste in line with international standards.

Selected projects will receive 300,000 to 800,000 USD for up to three years to support transformative change to prevent and minimize harm from chemicals and waste and to protect the environment and human health, including vulnerable groups and workers. Such projects will need to have co-financing and in-kind contributions of at least 25 per cent. Governments can apply for funding as well as civil society networks, subject to an agreement with the respective government.

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Save the date - 2nd workshop on Roadmap towards phasing out animal testing for chemical safety assessments

2024-10-09

It will be another opportunity to discuss certain roadmap elements with Member States and stakeholders, as the Commission Interservice Steering Group develops them and three specific working groups.

The workshop follows on from the first held in December 2023, related to the Communication from the Commission on the European Citizens' Initiative (ECI) "Save cruelty-free cosmetics – Commit to a Europe without animal testing" (25.7.2023, COM(2023)5041).

In this Communication, the Commission committed to developing a roadmap towards ultimately phasing out animal testing for chemical safety assessments. The roadmap will outline milestones and specific actions that would be prerequisites for a transition towards animal-free chemical legislation.

This second workshop is an opportunity for all stakeholders interested in the process to get involved. We plan to discuss critical elements related to developing, validating and implementing non-animal methods and their uptake across chemical legislation.

Registration for the workshop is open until 11 October. Participation is free of charge.

Read More

European Commission, 09-10-24

https://environment.ec.europa.eu/events/roadmap-towards-phasing-out-animal-testing-chemical-safety-assessments-2024-10-25

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Janet's Corner

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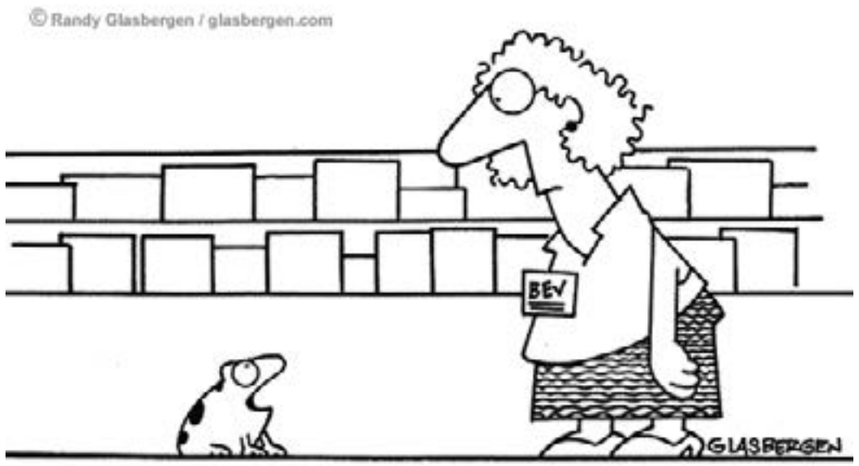
Get Well

2024-10-18



https://www.glasbergen.com/

Acetonitrile

2024-10-18

USES [2,3]

Acetonitrile is predominantly used as a solvent in the manufacture of pharmaceuticals, for spinning fibres and for casting and moulding of plastic materials, in lithium batteries, for the extraction of fatty acids from animal and vegetable oils, and in chemical laboratories for the detection of materials such as pesticide residues. In addition, acetonitrile is used in dyeing textiles and in coating compositions as a stabiliser for chlorinated solvents and in perfume production as a chemical intermediate.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

Sources of acetonitrile emissions into the air include:

- Manufacturing and industrial facilities;
- Automobile exhaust; and
- Volatilisation from aquatic environments.
- Individuals may be exposed to acetonitrile through breathing contaminated air, from smoking tobacco or proximity to someone who is smoking; or
- Through skin contact in the workplace

Routes of Exposure

The main routes of exposure to acetonitrile are via the inhalation of vapours and contact with the skin and eyes. Absorption through intact skin occurs rapidly. Ingestion is an unlikely route of exposure.

HEALTH EFFECTS [4]

Acute Health Effects

- Concentrations up to 500 parts per million (ppm) acetonitrile through inhalation exposure cause irritation of mucous membranes in humans, and higher concentrations can produce weakness, nausea, and convulsions.
- Tests involving acute exposure of rats, mice, rabbits, cats, and guinea pigs have shown acetonitrile to have moderate to high acute toxicity

Acetonitrile is the chemical compound with the formula CH3CN. This colourless liquid is the simplest organic nitrile. It is produced mainly as a by-product of acrylonitrile manufacture. Acetonitrile is very soluble in water and mixes with most organic solvents, e.g. alcohols, esters, acetone, ether, benzene, chloroform, carbon tetrachloride and many unsaturated hydrocarbons. It does not mix with petroleum ether and many saturated hydrocarbons. Acetonitrile is incompatible with water, acids, bases, oleum, perchlorates, nitrating agents, reducing agents and alkali metals. Acetonitrile decomposes

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from oral exposure and moderate acute toxicity from inhalation exposure.

Carcinogenicity

- No pertinent data concerning the carcinogenicity of acetonitrile in humans were located.
- The National Toxicology Program (NTP) completed a 2-year carcinogenesis inhalation study on acetonitrile and concluded that there was equivocal evidence of carcinogenicity in male rats, and no evidence in male or female mice or in female rats.
- EPA has classified acetonitrile as a Group D, not classifiable as to human carcinogenicity.

Other Effects

- No information is available on the reproductive or developmental effects of acetonitrile in humans.
- Animal studies appear to suggest that acetonitrile may cause developmental and reproductive effects such as a decrease in average foetal body weight and a significant increase in the number of malformed offspring.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention.
- **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. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
- **Serious Inhalation:** Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband.

If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

- **Ingestion:** If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Workplace Controls & Practices [4]

- When using acetonitrile, exhaust ventilation or other engineering controls should be used to keep the airborne concentrations of vapours below their respective threshold limit value.
- Eyewash stations and safety showers should be located proximal to the work-station.

Personal Protective Equipment [5]

When handling acetonitrile the following personal protective equipment is recommended:

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

Personal Protection in Case of a Large Spill:

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

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REGULATION

United States

- **OSHA:** The Occupational Safety & Health Administration has established a Permissible Exposure Limit (PEL) for acetonitrile of 40 ppm, 70 mg/m3 TWA
- **ACGIH:** The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) is 20 ppm, 34 mg/m3 TWA; Skin; Appendix A4 - Not Classifiable as a Human Carcinogen
- **NIOSH:** The National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)is 20 ppm, 34 mg/m3 TWA

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4. http://www.sciencelab.com/msds.php?msdsId=9927335
5. http://www.osha.gov/dts/chemicalsampling/data/CH_216700.html

New material combines strength and stiffness with sound-damping properties

2024-10-16

Vibration-absorbing, sound-damping materials such as sheets of rubber and expanded foam tend to be thick, bulky and soft. A new material is a big exception to that tendency, however, as it absorbs vibrations while staying stiff and thin.

Ordinarily, if you want to build a structure which is strong and unyielding yet also capable of absorbing troublesome vibrations, you have to combine load-bearing rigid materials with softer substances. Another option is to incorporate mechanical shock absorbers into the structure.

In either case, the finished product will be heavier, bulkier, and more expensive than it would have been if only rigid materials were used. That's where the new composite material comes in.

Developed by Ioanna Tsimouri, Andrei Gusev and Walter Caseri at the ETH Zurich research institute, it consists of ultra-thin stacked layers of stiff material connected by even thinner layers of an elastic polymer. More specifically, the initial prototypes consisted of 0.2- to 0.3-mm-thick glass plates interspersed with layers of PDMS (polydimethylsiloxane) silicone that were just a few hundred nanometers thick.

This ratio was important, as computer models indicated that in order to perform as desired, the composite needed to be at least 99% stiff material (by volume) and less than 1% polymer. "There is very little of a damping effect if the polymer layer is too thin," says Tsimouri, who led the study. "If it is too thick, the material is not stiff enough."

Samples of the material withstood standard three-point bending strength tests, while also exhibiting excellent damping qualities down to a temperature of -125 ºC (-193 ºF).

In a demonstration of the composite's properties – which can be seen in the video below – sheets of the material and of standard glass were dropped from a height of 25 cm (9.8 in) onto a tabletop. While the glass bounced into the air and made a loud clattering noise, the composite didn't bounce and made a subdued sound.

It is hoped that once the technology is developed further, different versions of the material could be utilized in applications such as windows, machine housings, automobile parts and even aerospace components. And as an added bonus, the current glass-based version of the composite

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can be completely recycled, since the small amounts of PDMS decompose into glass when melted.

A paper on the study was recently published in the journal Composites Part B: Engineering.

New Atlas, 16 October 2024

https://newatlas.com

High-Dose Lithium May Help Alleviate Long COVID Fatigue and Brain Fog

2024-10-02

A small University at Buffalo clinical trial has found that at low doses, lithium aspartate is ineffective in treating the fatigue and brain fog that is often a persistent feature of long COVID; however, a supplemental dose-finding study found some evidence that higher doses may be effective.

Published in JAMA Network Open on Oct. 2, the study was led by Thomas J. Guttuso, Jr., MD, professor of neurology in the Jacobs School of Medicine and Biomedical Sciences at UB and a physician with UBMD Neurology.

"It's a negative study with a positive twist," Guttuso concludes.

Because long COVID is believed to stem from chronic inflammation and lithium has known anti-inflammatory actions, Guttuso had recommended that a patient of his try low-dose lithium for persistent long COVID symptoms. He was surprised when this patient reported a near full resolution of fatigue and brain fog within a few days of initiating lithium aspartate at 5 milligrams a day.

Relief from symptoms

Based on this single case, Guttuso became interested in lithium aspartate as a potential treatment for long COVID and recommended it to other such patients.

According to Guttuso, 9 of 10 long COVID patients he treated with lithium aspartate 5-15mg a day saw very good benefit in terms of improvements to their fatigue and brain fog symptoms.

"Based on those nine patients, I had high hopes that we would see an effect from this randomized controlled trial," says Guttuso. "But that's the nature of research. Sometimes you are unpleasantly surprised."

The randomized controlled trial showed no benefit from 10-15 milligrams a day of lithium aspartate compared to patients receiving a placebo.

After one patient from the study subsequently increased the lithium aspartate dosage to 40 milligrams a day and experienced a marked reduction in fatigue and brain fog symptoms, Guttuso decided to then conduct a dose-finding study designed to explore if a higher dose of lithium aspartate may be effective.

The three participants who completed the dose-finding study reported greater declines in fatigue and brain fog with the higher dose of 40-45 milligrams per day. This was especially true in the two patients with blood lithium concentrations of 0.18 and 0.49 millimoles per liter (mmol/L) compared to one patient with a level of 0.10mmol/L who saw partial improvements.

"This is a very small number of patients, so these findings can only be seen as preliminary," says Guttuso. "Perhaps achieving higher blood levels of lithium may provide improvements to fatigue and brain fog in long COVID."

Dosage may be too low

He notes that it is possible the randomized controlled trial was ineffective because the dose of lithium aspartate that was used was too low.

"The take-home message is that very low dose lithium aspartate, 10-15 milligrams a day, is ineffective in treating the fatigue and brain fog of long COVID," says Guttuso. "Perhaps we need to do another randomized controlled trial that uses higher lithium aspartate dosages that achieve blood lithium levels of 0.18-0.50mmol/L to determine if they could be effective."

An estimated 17 million people have long COVID in the U.S., and worldwide the number is estimated at 65 million.

"There currently are no evidence-based therapies for long COVID," says Guttuso. He hopes that the National Institutes of Health will view lithium as worth studying through a trial with higher dosages; the NIH is allocating an additional $500 million to study long COVID therapies that appear to be promising.

Guttuso adds that if a subsequent randomized controlled trial finds that higher dosages of lithium aspartate are effective, long COVID patients would still need to discuss taking it with their health care providers; in addition, he says, if they do begin taking it at higher dosages, blood lithium levels should be monitored.

Technology Networks, 2 October 2024

https://technologynetworks.com

Visible light energy yields two-for-one deal when added to carbon dioxide recycling process

2024-10-17

By combining visible light and electrochemistry, researchers have enhanced the conversion of carbon dioxide into valuable products and stumbled upon a surprising discovery. The team found that visible light significantly improved an important chemical attribute called selectivity, opening new avenues not only for CO2 conversion but also for many other chemical reactions used in catalysis research and chemical manufacturing.

One way that chemists recycle CO2 into valuable products is through a process called electrochemical reduction, where a stream of CO2 gas moves through an electrolysis cell that breaks the CO2 and water down into carbon monoxide and hydrogen, which then can be used to make new desired hydrocarbon products, said University of Illinois Urbana-Champaign chemistry professor Prashant Jain.

"However, the reaction is sluggish, and the process requires large electrodes containing a lot of expensive catalyst material such as gold or copper, so our lab has been pursuing ways to speed up the process so that less catalyst material is required, making it a more viable option for the alternative fuels industry," said Jain.

The new study, led by Jain and former graduate student Francis Alcorn and published in the Proceedings of the National Academy of Sciences, details a method that combines the action of visible light with electrodes coated in nanoparticles of gold-copper alloy to induce CO2 reduction at a much higher rate and allow for more controlled selectivity than seen with current methods.

"These new electrodes act like tiny antennae that seek out photons in the visible light range and couple them with the chemical reaction pathway," Jain said.

In the lab, the electrodes are immersed in a solution of CO2, water and an electrolyte to enhance conductivity. The team then applies a voltage across the electrode while a visible light laser illuminates its surface. The

resulting reaction rapidly produces carbon monoxide—from splitting the CO2—and hydrogen, which comes from splitting water molecules.

"We were very excited to see the boost in productivity when visible light was used. However, we were not expecting to find that using visible light would have a major impact on chemical selectivity, which is the important advance here," Jain said.

In catalysis, chemical selectivity is the ability of a chemical reaction to favor or target one type of pathway or molecule over another. In this study, the researchers found that the water-splitting reaction that forms hydrogen gas was selectively enhanced by using light. This led the team to experiment further and model their results with the help of Northwestern University chemistry professor George Schatz and postdoctoral researcher Sajal Kumar Giri.

"The results suggest that visible light offers a unique opportunity to adjust the ratio of carbon monoxide to hydrogen gas produced, a crucial factor for the industrial production of synthetic gas," Jain said. "This finding paves the way for a more sustainable and efficient energy future."

Using light to help boost chemical reactions is not without its controversy, though, Jain said. Because adding light to a chemical reaction will also add heat, it was essential for the team to run careful measurements and control experiments to determine if it was simply the heating effect of light that led to faster reaction rates and selectivity.

"We ran experiments with and without the laser at the exact same temperature produced by light excitation and ruled out heating as being responsible," Jain said. "Rather, electric fields and directed charge flow induced by light excitation were responsible for the enhanced productivity and increased selectivity of water splitting, which is captured in the simulations by our collaborators."

The team still has some challenges to face as they forge ahead. For instance, the repeated use of the nanoparticle-based electrode will inevitably lead to degradation over time, especially under a scaled-up scenario required for industrial application. Additionally, the overall energy efficiency of the process and light management will need further research and improvement.

"What we found with this study presents completely new ways of thinking about electrochemistry and catalysis," Jain said. "By using light, we enhance the activity of this catalyst, but surprisingly, we also change the

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selectivity. This will open up new chemical pathways that make different products. And why stop at CO2 reduction or water splitting? This could be applied to many other catalytic reactions important to the chemical industry."

Phys Org, 17 October 2024

https://phys.org

A mushroom for colorectal cancer therapy

2024-10-17

Novel chemical compounds from a fungus could provide new perspectives for treating colorectal cancer, one of the most common and deadliest cancers worldwide. In the journal Angewandte Chemie, researchers have reported on the isolation and characterization of a previously unknown class of metabolites (terpene-nonadride heterodimers). One of these compounds effectively kills colorectal cancer cells by attacking the enzyme DCTPP1, which thus may serve as a potential biomarker for colorectal cancer and a therapeutic target.

Rather than using conventional cytostatic drugs, which have many side effects, modern cancer treatment frequently involves targeted tumor therapies directed at specific target molecules in the tumor cells.

However, the prognosis for colorectal cancer patients remains grim -- there is a need for new targets and novel drugs.

Targeted tumor therapies are mostly based on small molecules from plants, fungi, bacteria, and marine organisms.

About half of current cancer medications were developed from natural substances.

A team led by Ninghua Tan, Yi Ma, and Zhe Wang at the China Pharmaceutical University (Nanjing, China) chose to use Bipolaris victoriae S27, a fungus that lives on plants, as the starting point in their search for new drugs.

The team first analyzed metabolic products by cultivating the fungus under many different conditions (OSMAC method, one strain, many compounds). They discovered twelve unusual chemical structures belonging to a previously unknown class of compounds: terpene-nonadride heterodimers, molecules made from one terpene and one nonadride unit.

Widely found in nature, terpenes are a large group of compounds with very varied carbon frameworks based on isoprene units.

Nonadrides are nine-membered carbon rings with maleic anhydride groups.

The monomers making up this class of dimers termed "bipoterprides" were also identified and were found to contain additional structural novelties (bicyclic 5/6-nonadrides with carbon rearrangements).

Nine of the bipoterprides were effective against colorectal cancer cells.

The most effective was bipoterpride No. 2, which killed tumor cells as effectively as the classic cytostatic drug Cisplatin.

In mouse models, it caused tumors to shrink with no toxic side effects.

The team used a variety of methods to analyze the drug's mechanism: bipoterpride 2 inhibits dCTP-pyrophosphatase 1 (DCTPP1), an enzyme that regulates the cellular nucleotide pool.

The heterodimer binds significantly more tightly than each of its individual monomers.

The activity of DCTPP1 is elevated in certain types of tumors, promoting the invasion, migration, and proliferation of the cancer cells while also inhibiting programmed cell death.

It can also help cancer cells to resist treatment. Bipoterpride 2 inhibits this enzymatic activity and disrupts the -- pathologically altered -- amino acid metabolism in the tumor cells.

The team was thus able to identify DCTPP1 as a new target for the treatment of colorectal cancer and bipoterprides as new potential drug candidates.

Science Daily, 17 October 2024

https://sciencedaily.com

Scientists discover fastest degrading bioplastic in seawater

2024-10-17

Scientists at the Wood Hole Oceanographic Institution (WHOI) have been working for years to find out what types of plastics have the shortest and longest lifespans in the ocean, and what types of plastic products, like straws and food wrappers, most commonly contribute to plastic pollution.

With more biodegradable materials being developed, like cellulose diacetate (CDA)—a plastic-like polymer derived from wood pulp—researchers are racing to ensure they can replace traditional plastics without causing harm to ocean environments.

Now after years of testing, a new version of CDA was found to be the fastest degrading bioplastic material tested in seawater—and it's a promising replacement for other foam plastic materials, like Styrofoam, which can linger in the environment for many years.

In a paper published in ACS Sustainable Chemistry & Engineering, WHOI scientists Bryan James, Collin Ward, Chris Reddy, Yanchen Sun, and Kali Pate, found that adding small pores—called foaming—to CDA material made it degrade 15 times faster than solid CDA, and even faster than paper.

"What excites me most about this study is its translational nature. This study is the culmination of years of research focusing on understanding the fundamental controls on CDA biodegradation in the ocean," said Ward, senior author on the study. He and the WHOI team partnered with scientists from bioplastic manufacturing company Eastman, who contributed as co-authors, and supplied materials for the study.

"We translated the foundational knowledge into the design of a new material that simultaneously meets consumer needs and degrades in the ocean faster than any other plastic material we know of, even faster than paper. It's a great success story in a field that often focuses on the negative aspects of plastic pollution rather than working towards solutions to the problem," Ward added.

The study involved monitoring both foamed CDA and solid CDA in a tank of continuously flowing seawater from Martha's Vineyard Sound, at a specially designed lab at WHOI. The researchers also control the temperature, light exposure, and other environmental variables to mimic the natural marine environment.

"Using continuous flowing seawater tanks enables us to bring the dynamics of the microbially active ocean into the lab. The ocean is continually changing, and it was important that we replicated this environment by replenishing microbes and nutrients, making for a much more environmentally realistic experiment," lead author James explained.

After 36 weeks, the team found that the CDA foams lost 65–70% of their original mass.

In a previous study using their dynamic seawater tank, the researchers tested straws made of standard plastic, paper, solid CDA, and foamed CDA, and found that the solid CDA and paper straws reduced in mass the quickest.

Scientists then compared two straws made from CDA, one made from solid CDA and one from foam CDA, and found that the degradation rate of the foam straw was 190% faster than its solid counterpart, resulting in a shorter projected environmental lifetime than the paper straws.

"As a materials scientist and engineer, it's been exciting to demonstrate that foams can be materially efficient, meaning they achieve functionality using the least amount of material possible, reducing cost and many environmental impacts," said James. "In addition, when they are made from biodegradable plastics, they can be one of the least persistent forms of a material."

Replacing Styrofoam plastic and single-use plastics, such as take-away containers that routinely leak into the ocean and are not biodegradable, are one of the most urgent uses for this material, according to the study authors.

Foamed CDA products are already entering the market with Eastman launching a compostable, lightweight tray made of foamed CDA, designed to replace plastic trays used in existing industrial food packaging.

"Partnerships between industry and academia are essential for accelerating solutions to the most urgent global challenges, where academia can provide unique insights, and industry partners can use those insights to develop solutions at scale," said Jeff Carbeck, Vice President of Corporate Innovation of Eastman.

"That is how our collaboration with WHOI works; they significantly broadened our understanding of how our commercial and developmental materials degrade."

Carbeck highlighted that this study demonstrates the potential that CDA foam holds in helping address challenges with single-use plastic packaging.

"The properties of foams make them ideally suited for many packaging and insulation applications, and this research shows that foams made of

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biodegradable materials will rapidly degrade in the marine environment, should they accidentally end up there. Embracing biodegradable materials for consumer goods is a critical step towards preserving our environment, reducing plastic pollution, and fostering sustainability for future generations," he said.

"One of the advantages of teaming with an industry partner is that we can ensure the new technology is scalable. One of the criteria when designing the new material was that it had to be a drop-in, turn-key replacement for Styrofoam goods, meaning that the companies that convert the raw CDA into the biodegradable foam don't have to invest in new equipment," Ward explained.

"Advancing new plastics not made from fossil fuels, are compostable, and don't persist in the environment as pollution, can be a win for consumers and the environment."

Phys Org, 17 October 2024

https://phys.org

Peptides and Plastics Combine To Create Soft, Sustainable, Electronic Materials

2024-10-10

Using peptides and polymer chains, scientists at Northwestern University have developed a new type of flexible nano-ribbon material that can switch polarity in response to very low external voltages, allowing it to record and store digital information like a computer memory chip.

The new material is highly energy efficient, biocompatible and made from sustainable materials. The researchers believe that their soft material could give rise to new types of ultralight electronic devices, be woven into smart fabrics or be used for sticker-like medical devices. The research is published in Nature.

Combining peptides and plastics

Peptide amphiphiles are a class of peptide-based self-assembling molecules previously developed at Northwestern University. When placed in water, the self-assembling molecules form filaments made up of peptides and a lipid "tail" segment.

The secret behind the researchers' innovative new material is replacing this lipid tail with tiny molecular fragments of a plastic, called polyvinylidene fluoride (PVDF).

PVDF is already well known for its unusual electronic properties. It is piezoelectric, meaning it can generate electrical signals when pressed or squeezed. It is also a ferroelectric plastic; ferroelectric materials contain tiny, spontaneously polarized electric dipoles in their structure that can flip their orientation when subject to an external electric field.

Most ferroelectrics used in today's technologies are hard materials that contain rare or toxic metals, such as lead and niobium, which is what makes PVDF stand out.

"PVDF was discovered in the late 1960s and is the first known plastic with ferroelectric properties," said lead study author Samuel I. Stupp, the Board of Trustees professor of materials science and engineering, chemistry, medicine and biomedical engineering at Northwestern University. "It has all the robustness of plastic while being useful for electrical devices. That makes it a very high-value material for advanced technologies. However, in pure form, its ferroelectric character is not stable, and, if heated above the so-called Curie temperature, it loses its polarity irreversibly."

For their new material, Stupp's team synthesized miniature segments of polymer containing only between three to seven vinylidene fluoride units, which were used to replace the lipid tails of the peptide amphiphiles.

Innovative new electroactive materials

When the miniature plastic segments were combined with the peptides, the plastic segments were effectively stabilized by the naturally-occurring beta-sheet structures formed by the peptides.

As a result, the final materials were equally ferroelectric and piezoelectric as PVDF, but were more stable, and could switch polarity using extremely low external voltages. This kind of stable polarity flipping is a crucial property for devices that are used to store information, as it can be harnessed to record data written in binary code.

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

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can generate polarity in multiple directions around a circle rather than one or two specific directions."

The researchers also found that various mutations in the peptide sequence could be used to further tune the ferroelectric properties of their new material.

A breakthrough for low-power electronics

This new breakthrough in soft ferroelectric materials is exciting for multiple reasons, the researchers said. Firstly, compared to other hard ferroelectric materials – and even soft ones such as PVDF – the new material requires incredibly low voltages to flip their polarity.

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

The new materials are also more sustainable than other ferroelectric plastics, as they are more biodegradable and lend themselves to being reused without the need for harmful solvents or high-energy recycling processes.

With further development, the researchers believe that this new type of soft ferroelectric material could be used to create energy-efficient microscopic memory chips, sensors and energy storage units. They could also be combined with other technologies, such as smart textiles, to create new wearable devices.

"We imagine a future where you could wear a shirt with air conditioning built into it or rely on soft bioactive implants that feel like tissues and are activated wirelessly to improve heart or brain function," Stupp said.

"It's not practical to put hard materials into our organs or in shirts that people can wear. We need to bring electrical signals into the world of soft materials. That is exactly what we have done in this study."

"We are now considering the use of the new structures in non-conventional applications for ferroelectrics, which include biomedical devices and implants as well as catalytic processes important in renewable energy," Stupp continued. "Given the use of peptides in the new materials,

they lend themselves to functionalization with biological signals. We are very excited about these new directions."

Technology Networks, 10 October 2024

https://technologynetworks.com

Great cable challenge aims to tackle copper crunch

2024-10-08

E-waste is one of the fastest growing waste streams in the world, and the UK is the second largest contributor globally. We must tackle e-waste to help recover valuable and critical materials contained within it and to limit the environmental and human health impacts of e-waste that is improperly processes or mismanaged.

We need these materials for the technologies that will help us decarbonise as a society, as well as in other sectors such as healthcare and defence, but some of them are facing supply chain issues. RSC analysis estimates that we need a significant investment of around 350,000 tonnes of copper to meet government targets for wind and solar power by 2030.

Worryingly, copper production is struggling to meet demand already and we are potentially facing an imminent and substantial imbalance between copper supply and copper demand. Copper is just one of the many vital materials that are needed for the energy transition, others such as lithium, indium and rare earth elements are already classed as 'critical minerals' in the UK.

Ahead of International E-Waste Day, we're supporting Recycle Your Electricals in launching 'The Great Cable Challenge' – a nationwide campaign urging us all to collect and pass on the millions of cables sitting idle across UK households, with the goal of collectively recycling one million cables.

Izzi Monk, RSC Policy Adviser for the Environment, urges people to look to the future and do what they can. "The UK needs to wake up to just how important copper is in achieving our greener future – our analysis suggests we need a significant investment of around 350,000 tonnes for wind and solar power generation by 2030.

"We are potentially facing imminent and substantial supply concerns where we won't be able to meet the global demand for this vital material. That's why we're calling for the government to commit to a strategic, joined-up approach to materials that considers these supply risks.

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"Upping secondary sourcing of copper through recycling is a really important route towards greater supply security – the government needs to invest in technologies and infrastructure to make sure recycling can be grown without creating worse environmental, social and health impacts. As a nation, if we can crack the formula for recycling the copper we already have, we can make a real difference for the future of our planet."

The ongoing fight against e-waste and for a circular economy - find out more...

Starting with the 2019 launch of the award-winning Precious Elements campaign, the RSC has been consistently highlighting the challenges of managing e-waste.

This year, Izzi Monk gave oral evidence to the Environmental Audit Committee inquiry on electronic waste and a circular economy, as well as responding to a government consultation and call for evidence on e-waste. Both gave us the opportunity to set out some of the major challenges with e-waste currently, and our calls to government. We also launched our call for the development and delivery of a strategy – co-ordinated by central government – to enable a circular economy of materials in the UK.

You can write to your elected representative about this campaign. If you'd like to learn more about e-waste, our critical minerals docuseries is a good starting point, or you can listen to this episode of BBC R4's Inside Science.

E-waste amnesty – could you organise one too?

Marking International E-Waste Day, we have regularly held a technology/e-waste amnesty at our Cambridge and London offices, supporting our colleagues in their own efforts to avoid stockpiling electricals that could be usefully recycled.

The first one, held in 2019 to mark our precious elements campaign and International Year of the Periodic Table, produced some surprising results – not only did we see a huge range of e-waste items, from drills and laptops to phones and gaming devices, the cable spaghetti that came with the defunct devices was a large proportion of the overall waste in its own right. Fast forward five years and we're supporting the Recycle your electricals campaign on this very topic.

Could you organise a tech amnesty at your workplace, school, university or community centre? There are a range of organisations who could support

you, so check out the Great Cable Challenge site for more information on where to start.

Royal Society of Chemistry, 8 October 2024

https://rsc.org

Visible light energy yields two-for-one deal when added to CO2 recycling process

2024-10-17

By combining visible light and electrochemistry, researchers have enhanced the conversion of carbon dioxide into valuable products and stumbled upon a surprising discovery. The team found that visible light significantly improved an important chemical attribute called selectivity, opening new avenues not only for CO2 conversion but also for many other chemical reactions used in catalysis research and chemical manufacturing.

One way that chemists recycle CO2 into valuable products is through a process called electrochemical reduction, where a stream of CO2 gas moves through an electrolysis cell that breaks the CO2 and water down into carbon monoxide and hydrogen, which then can be used to make new desired hydrocarbon products, said University of Illinois Urbana-Champaign chemistry professor Prashant Jain. "However, the reaction is sluggish, and the process requires large electrodes containing a lot of expensive catalyst material such as gold or copper, so our lab has been pursuing ways to speed up the process so that less catalyst material is required, making it a more viable option for the alternative fuels industry."

The new study, led by Jain and former graduate student Francis Alcorn and published in the Proceedings of the National Academy of Sciences, details a method that combines the action of visible light with electrodes coated in nanoparticles of gold-copper alloy to induce CO2 reduction at a much higher rate and allow for more controlled selectivity than seen with current methods.

"These new electrodes act like tiny antennae that seek out photons in the visible light range and couple them with the chemical reaction pathway," Jain said.

In the lab, the electrodes are immersed in a solution of CO2, water and an electrolyte to enhance conductivity. The team then applies a voltage across the electrode while a visible light laser illuminates its surface. The

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resulting reaction rapidly produces carbon monoxide -- from splitting the CO2 -- and hydrogen, which comes from splitting water molecules.

"We were very excited to see the boost in productivity when visible light was used. However, we were not expecting to find that using visible light would have a major impact on chemical selectivity, which is the important advance here," Jain said.

In catalysis, chemical selectivity is the ability of a chemical reaction to favor or target one type of pathway or molecule over another. In this study, the researchers found that the water-splitting reaction that forms hydrogen gas was selectively enhanced by using light. This led the team to experiment further and model their results with the help of Northwestern University chemistry professor George Schatz and postdoctoral researcher Sajal Kumar Giri.

"The results revealed that visible light offers a unique opportunity to adjust the ratio of carbon monoxide to hydrogen gas produced, a crucial factor for the industrial production of synthetic gas," Jain said. "This finding paves the way for a more sustainable and efficient energy future."

Using light to help boost chemical reactions is not without its controversy, though, Jain said. Because adding light to a chemical reaction will also add heat, it was essential for the team to run careful measurements and control experiments to determine if it was simply the heating effect of light that led to faster reaction rates and selectivity.

"We ran experiments with and without the laser at the exact same temperature produced by light excitation and ruled out heating as being responsible," Jain said. "Rather, electric fields and directed charge flow induced by light excitation were responsible for the enhanced productivity and increased selectivity of water splitting, which is captured in the simulations by our collaborators," Jain said.

The team still has some challenges to face as they forge ahead. For instance, the repeated use of the nanoparticle-based electrode will inevitably lead to degradation over time, especially under a scaled-up scenario required for industrial application. Additionally, the overall energy efficiency of the process and light management will need further research and improvement.

"What we found with this studypresents completely new ways of thinking about electrochemistry and catalysis," Jain said. "By using light, we enhance the activity of this catalyst, but surprisingly, we also change the

selectivity. This will open up new chemical pathways that make different products. And why stop at CO2 reduction or water splitting? This could be applied to many other catalytic reactions important to the chemical industry."

Illinois Researchers Maya Chattoraj and Rachel Nixon also contributed to this study. The National Science Foundation, the U.S. Department of Energy, the Robert C. and Carolyn J. Springborn Endowment and the Future Interdisciplinary Research Explorations Grant supported this research.

Jain also is affiliated with the Materials Research Laboratory, physics, and the Illinois Quantum Information Science and Technology Center at Illinois.

Science Daily, 17 October 2024

https://sciencedaily.com

Beyond hydrogen bonding: new definitions for secondary bonding interactions to end confusion

2024-10-01

Proposals for the new definition of the tetrel bond will be available for community review in 2025, according to the International Union of Pure and Applied Chemistry's (Iupac) committee chair Giuseppe Resnati. The announcement follows the release of the pnictogen bond recommendations earlier this year as part of a 20-year mission to formally clarify the terminology around secondary bonding interactions after decades of confusion and misuse.

As a fundamentally non-visual discipline, chemistry needs clear and well-defined nomenclature to provide a reliable and meaningful way for researchers to convey their findings to others. While the hydrogen bond is universally recognised by the chemistry community, its more obscure relatives – the halogen, pnictogen, chalcogen and tetrel bonds – are often overlooked, either misnamed or misclassified as other types of interaction. In recent decades, this widespread misuse of terminology created a disjointed and inconsistent base of knowledge within the literature which, in 2004, Iupac decided to tackle head-on.

As the professional organisation responsible for standardisation in chemistry, Iupac brings together researchers from across the chemical sciences to create a universal scientific language. All recommendations hold a legal status, with feedback and consensus from the wider

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community playing a vital role in every new project. But as chemistry evolves, so must its terminology, meaning a huge part of the organisation's role is to challenge existing definitions and conventions which no longer reflect a modern understanding of chemistry.

Naming problems

Secondary bonding interactions are a prime example of this very issue. These weak, non-covalent interactions underpin research areas as diverse as catalysis, supramolecular chemistry and biological chemistry, with hydrogen bonds the most widely recognised example.

For over 60 years, it was believed that hydrogen was the only element capable of forming these bonds and the terms 'secondary bonding interaction', 'non-covalent bond' and 'hydrogen bond' were often used relatively interchangeably. Research in the 70s later identified halogen atoms participating in similar interactions and subsequent studies demonstrated that other p-block elements could also form analogous bonds.

This greater nuance, coupled with the lack of specific names and definitions for these newly discovered interactions created a degree of confusion in the field. 'People were using this terminology wrongly in the literature or proposing new names and definitions. Different communities were using different terms to say exactly the same thing,' says Pierangelo Metrangolo, a supramolecular chemist and Iupac officer. 'We realised there was a need to distinguish each of these interactions clearly.'

Metrangolo, as part of an Iupac committee, has spent the last 20 years working on projects to develop a series of definitions and supporting documentation to help researchers more effectively identify and classify these secondary bonding interactions. Each recommendation includes an explanation of the key features of the bond, followed by a list of characteristic experimental and theoretical evidence for the interaction.

'People need to have authoritative documents they can refer to where there's a clear definition, but also a long list of notes where you can get the parameters. If many of the conditions are met, you know you've encountered that kind of interaction,' says Metrangolo.

Earlier this year, the team released a definition for the pnictogen bond – the group 15 analogue of the hydrogen bond – with a final recommendation for group 14's tetrel bond expected in several years' time. Crucially, this definition, as with others in the series, emphasises

the fundamental nature of the interaction. The named donor atom (the pnictogen) acts as the electrophile, creating a predominantly electrostatic attraction towards a nucleophilic region of the acceptor. 'The aim was to stress that, due to an anisotropic distribution of the electron density resulting from the covalent bonds formed by the pnictogen atom to other atoms in the molecule, some of the outer surface can be electrophilic, even for elements commonly perceived as Lewis bases,' explains Resnati.

By explicitly naming interactions according to the electrophilic contributor, the new terms enable a clear distinction between similar bonds, which in turn gives researchers a vital tool to influence those interactions. 'If we can distinguish between a hydrogen bond and a pnictogen bond, we can think about the factors contributing to the force there,' explains Steve Scheiner, another committee member, specialising in computational chemistry. 'But many people don't easily accept the idea that two electronegative atoms can actually form an attractive interaction.'

This lack of awareness is an ongoing issue, with many researchers misclassifying their intermolecular interactions as more familiar hydrogen bonds. However, it was the team's original work on redefining the hydrogen bond back in 2011 that first revealed the extent of this problem and began to take the first steps to address this systemic miscommunication.

Evolved understanding

The hydrogen bond was first identified over 100 years ago and was originally defined as 'a weak electrostatic chemical bond which forms between covalently-bonded hydrogen atoms and a strongly electronegative atom with a lone pair of electrons' – which in practice meant nitrogen, oxygen or fluorine.

However, over the second half of the 20th century, a growing body of evidence suggested that perhaps this narrow definition didn't tell the whole story. 'It was considered early on that a CH group was incapable of forming a hydrogen bond. But in the 50s, some crystal structures were published which looked like they had CH–O hydrogen bonds,' says Scheiner. 'This was quickly poo-pooed by other crystallographers who argued no matter what it looked like, it couldn't be a hydrogen bond because it was a CH.'

The spectroscopic criteria for identifying a hydrogen bond were also called into question. An early characteristic sign was red shifting in the IR spectrum – the covalent bond involving the shared hydrogen produced

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a broader peak shifted towards a lower frequency. However, by 1998, conclusive cases began to emerge where this bond's frequency was actually shifted in the other direction (known as a blue shift), triggering further disagreement as to whether these interactions could be called a hydrogen bond.

In 2004, Iupac formed a committee to evaluate and refine the existing definition of the hydrogen bond to reflect this contemporary understanding and the team were careful to avoid the limitations of the former definition. 'When you have to describe a phenomenon you can focus on many key features – the nature of the interaction, the geometric features etc – but what characterises all these approaches is that you make an emphasis of one feature over the others,' says Resnati who joined the team in 2010. 'The decision made when we started this was not to focus on the understanding of the interaction which may evolve with time, not on any one feature of the interaction, but on the very essence.'

After seven years, having evaluated an immense body of literature documenting this evolving understanding of the hydrogen bond, the team proposed a new definition alongside a list of criteria and characteristics to support researchers in confidently identifying this type of bond.

'The hydrogen bond is an attractive interaction between a hydrogen atom from a molecule or a molecular fragment X–H in which X is more electronegative than H, and an atom or a group of atoms in the same or a different molecule, in which there is evidence of bond formation.'

But, despite the extensive supporting explanation, the new definition initially proved controversial. Ingrained opinions about the nature of hydrogen bonding from across the community made reaching a consensus particularly challenging and ultimately the paper went to over 20 referees before receiving final approval in 2011.

Expanding across the periodic table

It was during the course of this collaborative and cross-disciplinary discussion that the team identified the other key problem with Iupac's existing definition framework – missing terminology. The lack of clarity around these more recently discovered interactions left researchers to propose their own definitions for these intermolecular bonds, causing confusion and inconsistency throughout the literature.

The term 'halogen bond', in particular, was widely misused and in 2010 the halogen bond definition project was proposed, with the analogous group 14–16 project initiated shortly after. At a fundamental level, each of these interactions is part of the same wider phenomenon: the uneven distribution of electron density can create a localised electropositive region, even on an electronegative atom. The resulting electrostatic attraction to a nearby nucleophilic region then creates a (typically) weak bond whose identity is determined by the electrophilic atom.

While the changing valency across the periodic table leads to some differences, the underlying principle behind hydrogen, halogen, chalcogen and pnictogen bonds is the same. Resnati's team were keen to ensure consistency across this series of definitions, taking the semantic structure of the new hydrogen bond definition as a model for the rest. 'The extension of the mindset adopted in the new definition of the hydrogen bond to other elements was quite straightforward and reaching a consensus for the halogen and the chalcogen bonds was indeed much easier,' he says.

The recent pnictogen bond definition proved a little more challenging in this regard as the greater valency and more varied nature of the group's elements complicated the definition process. 'In group 15 you move from elements which are typically giving covalent bonds – nitrogen – to elements which are metals – bismuth – so to arrive at a consensus with people with non-minor differences in the concept of their use, bonding and interactions was really tough,' Resnati explains. The project addressed these issues with the final definition:

'[A] weak attractive interaction between an electrophilic region on a pnictogen atom in a molecular entity (wherein the pnictogen is involved in other stronger bonds) and a nucleophilic region in another, or the same, molecular entity.'

This additional complexity meant the team spent a total of six years working on the pnictogen bond definition, almost double the time spent on the halogen and chalcogen bonds. However, this effort has not gone unappreciated by the research community.

Clarity at last

Statistics compiled by American Chemical Society (ACS) publications demonstrate the extent to which the chemical community has embraced this new terminology. Following the release of the definition in 2013, halogen bonds were mentioned an average of 73 times a year across all

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ACS papers, compared with an average of just nine times a year in the 20 years preceding the project's announcement. A similar trend is also emerging for 2019's chalcogen bond, with an average of nine times more annual mentions since the recommendation was published.

Clear and specific terminology also streamlines the process of research itself, providing citable terms for researchers to use in publications. 'It's simplified my life,' says Anthony Cozzolino, a supramolecular chemist at Texas Tech University. 'The definitions help unify the field and give searchable names which, in turn, helps me identify the research that I want to be looking through and target my efforts.' At the same time, the prevalence of secondary bonding interactions across so many different parts of chemistry brings researchers into contact with other research areas which can then guide new strategies drawn from both fields together.

But more widely, the attention surrounding these definitions has shone a light on these interactions as an important and growing area of research. 'Having the Iupac definitions lends credence to the field that makes it easier to push in new directions,' says Cozzolino. 'In terms of funding, you can show there's precedent for this chemistry which gives weight to grant applications.'

A huge part of the success of these definitions has been the emphasis placed on consensus – a requirement for all Iupac definitions – and the ACS's Committee on Nomenclature, Terminology, and Symbols (NTS) is just one of the professional bodies invited to offer feedback on the early proposals. 'Definitions help us all speak the same language and align around consistent meanings,' says Clay Harris, strategic initiatives leader for the ACS's NTS committee. 'We value opportunities like this to help ensure that proposals work for chemistry practitioners and our global community of members. These positive interactions support the evolution of common terminology used in the global practice of chemistry.'

Resnati's team are now working on the final definition in the series but the committee expect arriving at a consensus for group 14's tetrel bond will prove the most challenging yet. The central importance of carbon in so many areas of chemistry, and the contrast with the wildly different properties and behaviours of heavier group members such as lead will likely make the details of the final definition difficult to establish and it could be years before the final definition is published. 'To arrive at a common opinion shared by chemists with such different backgrounds will be truly challenging but I think that the previous definitions – hydrogen,

halogen, chalcogen, pnictogen – are proving that the approach is meaningful,' says Resnati.

Chemistry World, 1 October 2024

https://chemistryworld.com

MAX phases boost electrocatalytic biomass upgrading

2024-10-17

Biomass is among the most abundant renewable resources on Earth. Through catalytic conversion, biomass can upgrade into a series of fuels and chemicals which can substitute traditional fossil resources, thus playing a crucial role in achieving the "carbon peaking and carbon neutrality" target.

A group of Chinese scientists have developed a novel MAX phase with single-atom-thick cobalt layers, achieving high-efficiency electrocatalysis of 5-hydroxymethylfurfural (HMF) oxidation coupled with hydrogen evolution. The work is published in the Chemical Engineering Journal.

MAX phases are a family of layered ternary metal carbides or nitrides that have attracted great attention as structural materials due to their outstanding structural diversities, mechanical properties, and application potential.

Prof. Zhang Jian's team at the Ningbo Institute of Materials Technology and Engineering (NIMTE) of the Chinese Academy of Sciences (CAS), in cooperation with Prof. Huang Qing's team at NIMTE and Prof. LI Youbing at Soochow University, introduce cobalt, a highly catalytic and cost-effective transition metal, into the A-site of MAX phases.

The obtained V2(Sn2/3Co1/3)C MAX phase was applied as a high-efficiency electrocatalyst for the HMF oxidation along with hydrogen evolution in an alkaline electrolyte. This achieved complete biomass HMF conversion and a 94.4% 2,5-furandicarboxylic acid (FDCA) yield at 1.60 V throughout six hours in the two-electrode system.

Additionally, the FDCA production rate reached 8.02±0.64 mmolFDCA gcat.-1 h-1 in the 100 mM HMF electrolyte, surpassing many traditional electrocatalysts and thermocatalysts.

Density functional theory (DFT) calculations indicated that the Co-Sn synergy in the A-site facilitated the adsorption and electrocatalytic

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conversion of HMF, therefore transforming MAX phases from structural materials into functional materials.

Moreover, HMF can significantly inhibit the surface reconstruction of MAX phases and competitive oxygen evolution reaction. Therefore, the structure of MAX phases remained intact even after the electrolysis in a harsh 1 M KOH alkaline electrolyte.

The excellent electrocatalytic performance and structural stability of biomass upgrading demonstrated the broad potential of MAX phases for applications in energy storage, green catalysis, and other challenging chemical environments.

Phys Org, 17 October 2024

https://phys.org

Thousands of cleaning supplies may contain substances linked to health problems

2024-10-14

When you go through the chore of cleaning your home, you hope the end result is a safer, healthier environment for you and your loved ones. But some of the products you are using might put your health at risk.

"Many people assume that when you're buying something on the shelf or if it's for sale in a store, that there's no risk to it or they know exactly what they're getting," said Tasha Stoiber, a senior scientist at the Environmental Working Group, a nonprofit organization that researches and advocates for safer products. "That just isn't the case."

On the American market, the EWG has found that more than 2,000 cleaning supplies may contain substances linked to health problems including asthma, chemical burns and cancer risks.

It can be hard to tell exactly what is safe and what is not when shopping at the store. This is especially true with the prevalence of "greenwashing," or when companies utilize tactics in their product labeling or marketing to appear more natural and environmentally safe, said Jennie Romer, the deputy assistant administrator for pollution prevention at the US Environmental Protection Agency.

"People are becoming more aware of how these things can have an effect on our health," Stoiber said. "In the United States, there is really poor transparency."

Cleaning your home well is important for disease prevention, said Brian Sansoni, senior vice president of communications, outreach and membership at the American Cleaning Institute.

"The proper use of cleaning products contributes to public health and quality of life in homes, offices, schools, health care facilities, restaurants and throughout our communities every single day," he added. "Everyone who has dealt with the coronavirus pandemic or cold and flu season can certainly recognize this fact."

Here is what experts want you to know about cleaning products and how to make safer choices.

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The chemicals in your cleaners

Cleaning products may contain volatile organic compounds, or VOCs, which include hundreds of different chemicals, said Dr. Natalie Johnson, associate professor of environmental and occupational health at Texas A&M University School of Public Health.

Volatile organic compounds are gases that can be emitted from solid or liquid products, according to the EPA. These chemicals can cause problems such as eye, nose and throat irritation and damage to the liver, kidney and central nervous system, the federal agency said.

The impact of these chemicals depends on how often you are exposed to them and to what degree; and the concentration of VOCs are often much higher indoors, the EPA said.

One big problem is that the list of potentially harmful chemicals is long, and sometimes it can be hard to tell from an ingredients list exactly what you will be exposed to if you use a product, Romer said.

Fortunately, there are resources to help quickly reference the best choices on the shelves when you are shopping, Johnson said.

The EPA has a Safer Choice label, and products that qualify for the designation do not contain chemicals linked to cancer, fertility problems and other risks to health, Romer said.

Romer's husband was just at the store to restock on laundry detergent but forgot which kind they like to buy. After a quick search on the Safer Choice database, he was able to find which of the products on that store's shelves met the EPA's criteria, she said.

Volatile organic compounds are a broad category of chemicals –– some of which are naturally occurring, some helpful in dissolving dirt, grease and stains, Sansoni said. And manufacturers have taken steps to manage their emissions, he added.

"Regulators have placed limitations on the VOCs in most consumer products over the past three decades and industry has been working with governments and regulators to minimize VOC concentrations to keep them well below levels that would be considered harmful," Sansoni said.

It's not just what you use. It's how you use it

It's not just what you are using, but how you are using your cleaning products that could be of concern, experts say.

Some of the risks from using cleaners in your home come from using them improperly, such as mixing bleach with products that contain ammonia –– which can be found in tile or multipurpose cleaners, for example, Romer said.

Mixing disinfectants can also cause dangerous fumes, she added.

"That's why it's always important to read and follow the instructions or the directions on a product label," Romer said.

Frequency of use can also increase the risk that concerning chemicals pose, Johnson said.

"Our oldest adage in toxicology is that it's the dose that makes the poison," she said.

It's also essential to be mindful of exposures for people who are especially susceptible, including pregnant people, those with asthma and children, Johnson added.

"Children aren't just little adults," she said. "They're still developing. … A lot of my research looks at how exposure to air pollutants during pregnancy or early infancy may predispose children for long-term disease risk, such as allergy development, especially asthma."

Cleanser changes can start small

Going home and clearing out your cleaning supply cabinet isn't going to completely fix the problem, Stoiber said.

"It's impossible to avoid all exposures just through shopping alone … but paying attention to these things can make a difference," she added.

Small changes can make a big difference, and it's good to take one step at a time to keep from being overwhelmed when limiting exposures to concerning chemicals, Stoiber said.

Throwing out all the cleansers you have and starting over isn't good from an environmental perspective, so instead start by taking inventory, Romer said.

You may find that some of those products are recommended by the EPA or EWG, she added.

For the rest of them, once you use up a cleanser, try replacing it with a recommended option, Johnson said.

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A lot of cleaning can also be done with things you already have in your kitchen like vinegar, baking soda and lemon juice, Stoiber said.

Another way to reduce exposure to potentially risky chemicals has nothing to do with the cleansers you are using but does involve more cleaning.

"Keep up on vacuuming and dusting," Stoiber said. "A lot of these chemicals … they don't stay in products. And when they are deposited into dust, and then we either stir up that dust, inhale that dust, or it's on our hands and we forget to wash our hands and eat, then we're exposed to those chemicals through dust."

Make sure you are vacuuming regularly and dusting surfaces with a damp cloth to reduce the traces of those products you are breathing in, she added.

CNN, 14 October 2024

https://edition.cnn.com

Magnet-free induction motor aims to nearly halve carbon emissions

2024-10-15

Two great minds in permanent-magnet-free motor design are fusing their know-how to create an even more capable inductive electric motor. Mahle and Valeo have teamed up to introduce what they call the Inner Brushless Electrical Excitation (iBEE) system, a form of e-machine that eliminates the need for sensitive rare earths, promises powerful performance and sends lifecycle carbon emissions right off a tall, steep cliff.

We've been watching Mahle's work in the permanent-magnet-free motor space closely since it detailed a cheaper, more efficient motor design free from rare earths in 2021. The German automotive supplier has been using wireless induction with a rotor configuration it calls the Magnet-free Contactless Transmitter (MCT).

The MCT system replaces the physical magnets and mechanically brush-powered electromagnetic windings commonly used in motor rotor designs with wound coils magnetized via inductive electricity sent from a wireless transmitter. Not only does the setup eliminate dependence on rare earths, and the supply, mining and pricing issues that go along with them, but it also cuts out the physical wear-and-tear and necessary maintenance related to physical brushes. Mahle says the MCT layout also allows for more compact packaging thanks to using fewer components.

For its part, French automotive supplier Valeo has focused on magnet-free electric motor stators and control systems, working with Renault on its next-gen E7A motor design, planned for a 2027 launch. Its power-dense hairpin copper winding technology is integral to the E7A's stator design.

The new joint development agreement between the two companies will combine Mahle's magnet-free rotor technology with Valeo's inverter and motor control technology to create an even more advanced evolution of magnet-free motor design for upper segment vehicles. The new iBEE axle will offer an output range between 220 and 350 kW (295 and 469 hp).

Mahle and Valeo also plan to work on a motor cooling system aimed at achieving a superior continuous-to-peak power ratio. Mahle has used an oil cooling system as the backbone of its SCT motor, the "endurance champion" that blurs the line between peak and continuous power by running continuously at over 90% peak power. While the original SCT motor used permanent magnets, it was also designed to work with the inductive MCT layout.

The two companies aim to cut overall carbon footprint by more than 40% as compared to a permanent-magnet e-motor with equivalent power. That's a further improvement upon the 30% reduction goal of Valeo and Renault's work on the E7A motor.

Valeo and Mahle plan to complete initial prototype testing by the end of 2024.

New Atlas, 15 October 2024

https://newatlas.com

Study links coil to increased risk of breast cancer

2024-10-17

Women who use a contraceptive coil have been warned they may have a slightly higher risk of developing breast cancer.

A study found an "unexpected" association between the use of an intrauterine system (IUS), also known as an hormonal coil, and an increased risk of the cancer in women aged 15 to 49.

According to the findings, there were 14 extra cases of breast cancer per 10,000 women using a levonorgestrel-releasing intrauterine system (LNG-IUS) for five years, compared with a similar number of women not using the contraception.

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Research has found that prolonged use of the contraceptive pill slightly increases breast cancer risk, but it was thought that using the coil would not increase breast cancer risk because of the much lower levels of hormone exposure to the whole body.

According to the NHS, an IUS is a small plastic T-shape that a doctor or nurse puts into your womb.

It stops pregnancy by releasing the hormone progestogen into the womb.

This differs from a copper coil, or IUD, which does not use hormones and stops pregnancy by releasing copper into the womb.

Dr Lina Morch, team leader at the Danish Cancer Society's Research Centre and who led the new study, said the risk identified needs to be taken "seriously".

She added: "For some, a hormonal IUD may still be the best choice.

"However, if a woman is approaching her 30s and 40s, when the risk of breast cancer is no longer minimal, it may make sense to consider other contraceptive options, such as a copper IUD."

Dr Channa Jayasena, reader in reproductive endocrinology, Imperial College London, said: "The levonorgestrel-releasing intrauterine systems (LNG-IUS) is a highly effective form of contraceptive for women.

"It is well known that prolonged use of the contraceptive pill slightly increases breast cancer risk.

"However, we have always assumed that the LNG-IUS would not increase breast cancer risk due to the much lower levels of hormone exposure to the whole body.

"The results of this study are therefore highly unexpected."

Dr Mangesh Thorat, consultant breast surgeon, Homerton University Hospital, Queen Mary University of London (QMUL), said: "Similar to the British study (Fitzpatrick and colleagues) published last year, this study shows a small increase in the risk of breast cancer associated with the use of such coils.

"The existing evidence suggests that the increase in the risk is similar to that with oral contraceptive use.

"It is worth noting that this association has been known for at least a few years and a broad consensus exists among the medical fraternity that the

overall benefits of hormonal contraception outweigh the harms like such small increase in the risk of developing breast cancer."

He added: "The risk increases with increasing age and it is reasonable for women near 40 years of age to have a discussion with their healthcare practitioner regarding non-hormonal modes of contraception."

The study, published in the journal Jama, was conducted using data from nearly 160,000 women in Denmark, where LNG-IUS is the preferred hormonal contraception among premenopausal women older than 30 years.

Independetnt, 17 October 2024

https://independent.co.uk

Synthetic molecular switch enables 'painting' with natural light

2024-10-16

Liquid crystals exist in a phase of their own. They can flow like liquids, but because their molecules are arranged in a somewhat orderly way, they can be easily manipulated to reflect light. This flexibility has made liquid crystals the go-to material for energy-efficient phone, TV, and computer display screens.

In a new study in Nature Chemistry, researchers at Dartmouth and Southern Methodist University hint at other applications for liquid crystals that might one day be possible, all powered by natural light. They include liquid crystal lasers, display screens that could be easily printed and erased, and microscopic tags that could be added to bank notes to deter counterfeiters.

At the heart of these fantastical gadgets is a synthetic molecular switch that can trigger shape changes in liquid crystals that allow them to reflect different colors. Designed in the lab of Ivan Aprahamian, a Dartmouth professor of chemistry, the switch is made up of the organic molecule triptycene and a class of compounds called hydrazones that can flip on and off with a pulse of light.

In the study, Aprahamian and his colleagues show that the hydrazones can be attached to triptycene in such a way that the molecule's symmetry breaks, making it chiral. Chiral molecules come in two mirror-image forms that, like our hands, can't be completely superimposed on each other.

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When chiral triptycene interacts with a liquid crystal molecule, it sets in motion a chain of events that causes other liquid crystal molecules to fall in line, rearranging themselves in twisted, DNA-like helices.

In helical form, liquid crystals reflect ambient light at different wavelengths based on their pitch, or how far apart the coils in their helical structure are spaced; stretching and compressing the helix triggers color changes. In nature, chameleons and cephalopods also take advantage of structural features to instantly blend in with their surroundings without any pigment changes to their skin.

"By increasing or decreasing the pitch of the helical structure, we can control the color it reflects," Aprahamian says. "Think of it as playing an accordion. Instead of compressing and expanding the instrument to control what tone you hear, we use light to control the pitch and the color you see."

The study provides vivid reproductions of Edvard Munch's The Scream and Van Gogh's The Starry Night as proof. The images were produced in Alexander Lippert's lab at SMU with a microscope rejiggered into a mini slide projector.

In a process reminiscent of multi-color screen printing, researchers used the tiny projector to beam light through a series of stencils on a makeshift screen made of liquid crystals doped with chiral triptycene. New colors were added, one by one, by shining the light for varying lengths of time on the part of the screen left exposed by the stencil.

"Once the pattern is painted in, it can stay there for days," says Lippert, a study co-author and associate professor at SMU. "You can also erase it and go back to a blank canvas."

Aprahamian's lab has designed hydrazone switches before, but this version is the first to prove capable of reflecting visible color from a liquid crystal. It is also the first time that a stable, long-lasting multicolored image was projected on a liquid crystal display using a dopant that can switch on and off.

In earlier experiments, Aprahamian tried making the switchable dopant with a chiral molecule called isosorbide. Though liquid crystals would interact with isosorbide and form a helical structure, they did not reflect visible light. At a 2016 conference in Telluride, an MIT chemistry professor suggested to Aprahamian that he give triptycene a try.

Chiral triptycene turned out to be a breakthrough because of how efficiently it's able to transfer chiral information to the liquid crystals, Aprahamian says. Relatively few molecules are needed to marshal a large number of liquid crystals into a new configuration to alter their properties.

"It is known as the sergeant and soldiers' effect," Aprahamian says. "A few chiral 'sergeant' molecules control the properties of a large number of achiral 'soldier' molecules."

The study describes in detail what happens at the molecular level, which can help researchers further investigate liquid crystals for new applications.

"We can now build on this knowledge to create better liquid crystal dopants," says the study's first author, Indu Bala, an assistant professor at the Indian Institute of Technology, Mandi, who worked on the project as a postdoctoral researcher at Dartmouth.

Phys Org, 16 October 2024

https://phys.org

Your skin tone impacts how well your medications work

2024-10-15

A new review has highlighted how skin tone can affect the safety and effectiveness of some medications and why the current way we run clinical drug trials needs to change to include more historically underrepresented populations.

Clinical trials are essential for evaluating the effectiveness and safety of medications in human subjects. While the overarching goal of biomedical research is to improve the health and well-being of an entire population, participants in clinical trials tend to be far from diverse. An analysis of 32,000 individuals who participated in new drug trials in the US during 2020 found that only 8% were Black, 6% Asian, 11% Hispanic, and 30% were aged 65 and older.

A new review by Simon Groen, an assistant professor of evolutionary systems biology in the Institute of Integrative Genome Biology at the University of California, Riverside, and Sophie Zaaijer, a consultant and researcher affiliated with UC Riverside who specializes in diversity, equity, and inclusion (DEI) in clinical trials, investigated how one aspect of race – skin tone – affects how medications work.

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"Our review paper concludes that melanin, the pigment responsible for skin color, shows a surprising affinity for certain drug compounds," said Groen. "Melanin's implications for drug safety and dosing have been largely overlooked, raising alarming questions about the efficacy of standard dosing since people vary a lot in skin tones."

The key cells in human skin tone are melanocytes, which make melanin-containing melanosomes, and keratinocytes, which store them. The number and characteristics of melanosomes within skin layers determine variations in tone, from light to dark. Dark skin contains a higher proportion of individual large melanosomes, whereas light skin contains higher levels of clusters of mini-melanosomes. In light skin, melanosomes are concentrated in the stratum basale, the deepest skin layer, while in dark skin, they're distributed more diffusely throughout the layers.

A person's unique combination of the two primary forms of melanin – pheomelanin and eumelanin – is responsible for skin, hair, and eye color. Eumelanin, more than pheomelanin, plays a significant role in drug interactions due to its chemical structure, which gives it a high affinity for binding with various substances, including basic or neutrally charged drugs and metal ions. Examples of compounds with an affinity for binding with eumelanin include cocaine, nicotine, the analgesic acetaminophen, antibiotics ampicillin, ciprofloxacin, and penicillin G, antidepressants clomipramine and imipramine, and the antipsychotic medications chlorpromazine, clozapine, and haloperidol.

Let's consider the antipsychotic clozapine: the only FDA-approved medication for treatment-resistant schizophrenia. A 2023 study used a genome-wide association study (GWAS) to examine clozapine metabolism within and between different ancestral backgrounds: European, sub-Saharan African, north African, southwest Asian, and east Asian. It found that, at the same dose, sub-Saharan African ancestry was associated with lower clozapine concentrations in the plasma compared to European ancestry.

Despite being the body's largest organ, the skin has been largely overlooked for its potential interactions between eumelanin and drug pharmacokinetics (what the body does to a drug; how it moves into, through and out of the body) and pharmacodynamics (what a drug does to the body; the biochemical, physiologic, and molecular effects of a drug). Studies have shown that variations in skin eumelanin levels – and therefore skin tone – can influence nicotine use and dependence, which

has implications for darker-skinned folks using nicotine skin patches as smoking cessation aids.

"Are we inadvertently shortchanging smokers with darker skin tones if they turn to these patches in their attempts to quit?" asked Groen.

The researchers argue that current guidelines for clinical trials fail to adequately address the impact of skin pigmentation on drug interactions.

"This oversight is particularly concerning given the push for more diverse clinical trials, as outlined in the [FDA]'s Diversity Action Plan," Zaaijer said. "But current early-stage drug development practices still primarily focus on drug testing in white populations of Northern European descent."

Under the provisions of the recently enacted Food and Drug Omnibus Reform Act (FDORA), the FDA requires sponsors of phase 3 clinical trials or "other pivotal studies of a drug" to submit a Diversity Action Plan designed to increase enrollment of participants from historically underrepresented populations. A 'sponsor' is defined as someone – an individual, pharmaceutical company, academic institution, private or other organization – who takes responsibility for and initiates a clinical investigation.

"The FDA published their draft guidelines recently," Zaaijer said. "Once final in a few months, they will mandate considering patient diversity in clinical trials and preclinical R&D [research and development]. The next step is to provide guidance on what pharmacokinetic variables should be tested in drug R&D pipelines in their pursuit to [sic] equitable drugs."

It's a step in the right direction, but change will take some time.

"In terms of risk profile testing, drugs are most often tested on one or a few human cell models that mostly come from donors of Northern European descent," said Zaaijer. "Drugs are then tested in a rodent model. If these tests are successful, drug companies push the drug through to clinical trials. But are drugs ready to be given to a diverse patient group if they haven't first been tested, for example, on human cell models of different ancestries? Would you bungee jump off a bridge if you know the ropes have not been tested for your weight category? Unlikely. So why is this currently acceptable with drugs?"

As a fix, Groen and Zaaijer have proposed that pharmaceutical companies use differently pigmented 3D human skin models to assess the binding properties of new drugs across different skin tones.

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"Skin pigmentation should be considered as a factor in safety and dosing estimates," said Zaaijer. "We stand on the brink of a transformative era in the biomedical industry, where embracing inclusivity is not just an option anymore but a necessity."

The researchers also encourage patients and clinical trial participants to ask questions like, 'Has this drug been tested to see if it's safe for people from different ancestral backgrounds, like mine?'

"If different ancestral backgrounds are taken into consideration in the early stages of drug discovery, then diverse groups of people may have more trust in the drug development process and enroll in clinical trials because they will be better informed of any potential associated risks," said Groen.

The perspective article was published in the journal Human Genomics.

New Atlas, 15 October 2024

https://newatlas.com

New discovery reveals how diatoms capture carbon dioxide so effectively

2024-10-17

Tiny diatoms in the ocean are masters at capturing carbon dioxide (CO2) from the environment. They fix up to 20 percent of the Earth's CO2. A research team at the University of Basel, Switzerland, has now discovered a protein shell in these algae that is necessary for efficient CO2 fixation. This groundbreaking discovery can provide ideas for bioengineering approaches to reduce CO2 in the atmosphere.

Diatoms are too small to see with the naked eye, yet they are one of the most productive algae species in the ocean and play an important role in the global carbon cycle. Using photosynthesis, they absorb large amounts of CO2 from the environment and convert it into nutrients that feed much of the life in the ocean. Despite their importance, it has remained largely unknown how diatoms carry out this process so efficiently.

Researchers led by Prof. Ben Engel at the Biozentrum of the University of Basel together with researchers at the University of York, UK, and the Kwansei-Gakuin University in Japan have now discovered a protein shell that plays a key role in the diatoms' CO2 fixation. Using cutting-edge imaging technologies such as cryo-electron tomography (cryo-ET), the researchers were able to reveal the molecular architecture of the so-called

PyShell protein sheath and decipher its function. The results of the studies have now been published in two articles in Cell.

PyShell crucial for efficient CO2 fixation

In plants and algae, photosynthesis takes place in chloroplasts. Inside these chloroplasts, energy from sunlight is harvested by thylakoid membranes and then used to help the enzyme Rubisco fix CO2.

However, algae have an advantage: they pack all their Rubisco into small compartments called pyrenoids, where CO2 can be captured more efficiently. "We have now discovered that diatom pyrenoids are encased in a lattice-like protein shell," says Dr. Manon Demulder, author on both studies. "The PyShell not only gives the pyrenoid its shape, but it helps create a high CO2 concentration in this compartment. This enables Rubisco to efficiently fix CO2 from the ocean and convert it into nutrients."

When the researchers removed the PyShell from the algae, their ability to fix CO2 was significantly impaired. Photosynthesis and cell growth were reduced. "This showed us how important the PyShell is for efficient carbon capture -- a process that is crucial for ocean life and the global climate," says Manon Demulder.

Bioengineering for CO2 reduction?

The discovery of the PyShell could also open promising avenues for biotechnological research aimed at combatting climate change -- one of the most pressing challenges of our time. "First of all, we humans must reduce our CO2 emissions to slow the pace of climate change. This requires immediate action," says Ben Engel.

"The CO2 that we emit now will remain in our atmosphere for thousands of years. We hope that discoveries such as the PyShell can help inspire new biotechnology applications that improve photosynthesis and capture more CO2 from the atmosphere. These are long-term goals, but given the irreversibility of CO2 emissions, it is important that we perform basic research now to create more opportunities for future carbon-capture innovations."

Science Daily, 17 October 2024

https://sciencedaily.com

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This year's chemistry Nobel proves it's hard to make predictions

2024-10-18

In March 2016, the Google-owned software company DeepMind put its game-playing algorithm AlphaGo up against Lee Sedol, one of the world's best players at the ancient strategy game of Go. AlphaGo won. It was a milestone moment for AI – mastering a game of such creative complexity was widely regarded as an impossible task for a machine. At the time, I speculated (not very seriously) how long it would be until a future 'AlphaChemistry' would pick up a Nobel prize. In the end, it took about 8 years.

Demis Hassabis, who founded DeepMind and led the team behind AlphaGo, went on to build the protein structure prediction program Alphafold with his Google colleague John Jumper, and for that work the pair picked up one half of this year's Nobel prize in chemistry. The other half went to David Baker, for his work on designing new proteins from scratch. Both DeepMind and Baker's lab are today at the forefront of using machine learning algorithms and AI in chemistry, and this year's award has been seen as a recognition of the immense scientific potential of AI. Indeed, the physics prize was awarded specifically for developments in machine learning. Yet as the science itself shows, the true potential of these discoveries is probably something we haven't predicted.

David Baker's first few words in the Nobel prize press conference were: 'I stood on the shoulders of giants.' That's a truism in science that we generally take for granted, but it has seldom been so accurate. Not only did protein design and structure prediction rely on knowledge from across the sciences – computer science, neuroscience, biology, chemistry and more – but they also quite literally built upon a mountain of data generated by those scientists. And not just the giants – anyone who has ever solved a protein structure (even me, many years ago) added a pebble to that pile.

About 70 years ago, there was only one protein structure: myoglobin, solved using x-ray diffraction in 1957. That effort alone took a couple of decades of work and James Kendrew and Max Perutz shared a Nobel for doing it – one of the earliest awards for the structural biology science that has become such a strong theme in the chemistry prize. More structures, new techniques and many more Nobels followed and by about 20 years ago, when I was making my tiny contribution, the protein data bank contained around 24,000 protein structures. Now there are over 200,000.

And its thanks those decades of experimental work that AI models such as Alphafold and Baker's Rosetta became possible. In Alphafold's case, that has resulted in predicted structures for all 200 million known proteins.

That's an application very few of those previous generations could have imagined. Nor would many have predicted that these achievements would rely on computer science more than our understanding of biomolecular chemistry. So this work not only democratises science by making a huge volume of knowledge publicly available, but also by showing how vital scientific questions can be framed in new ways to be tackled by other fields. Interesting problems attract curious minds and talented people, and the great news for science is that those people don't necessarily have to be experts in polypeptide chemistry or biophysics (although it does still help: Jumper and Baker are also protein chemistry experts).

Exactly what impact all this will have is impossible to tell, and it will likely be both more and less than we would predict. As Derek Lowe has discussed, the idea that drug discovery will be revolutionised is probably overselling things at the moment. Knowing protein structure is a good start, but it doesn't tackle many of the really difficult aspects of that process. Similarly, there are many other questions that we still don't have answers for. While we can predict protein folds, or design entirely new proteins, we don't know how that folding process works, for example.

At each stage, we know a little more, and we see how much more is left to know. The likes of laureates such as Kendrew, Perutz and Dorothy Hodgkin took the first steps in showing how molecular structure is implicated in biological function. As the volume of structures has grown, to the point where we can predict every known protein, so has our understanding that the relationship is not so easily explained. The atomistic idea that we can (and should) build our understanding of biology stepwise upwards from its molecular basis is too limited.

The lesson of this year's prize is that we seldom know how useful a discovery or invention is going to be. Nor can we say what questions will become important in future, and where the answers to those next questions will come from. But if we keep on adding pebbles to the pile, then tomorrow someone else can climb a little higher.

Chemistry World, 18 October 2024

https://chemistryworld.com

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Scientists discover chemical probes for previously 'undruggable' cancer target

2024-10-15

Hormone-driven cancers, like those of the breast and prostate, often rely on a tricky-to-target protein called Forkhead box protein 1 (FOXA1). FOXA1 mutations can enable these types of cancers to grow and proliferate. Today, FOXA1 is notoriously difficult to block with drugs—but that may soon change.

Scripps Research scientists have identified a crucial binding site on FOXA1 that could pave the way for future cancer treatments. The team's findings, which were published in Molecular Cell on October 15, 2024, also mapped out how tiny drug-like chemical compounds—called small molecules—interact with the protein.

While examining protein interactions on a large scale, investigators in the lab of co-corresponding author Benjamin Cravatt, Ph.D., the Norton B. Gilula Chair in Biology and Chemistry, determined that small molecules could, in fact, interact with FOXA1.

"FOXA1 had historically been considered undruggable," says Cravatt. "It's thought to lack the types of surfaces that small molecule drugs can bind to, which is likely why it's been so difficult to target the protein."

Following its discovery, Cravatt's lab teamed up with the lab of Michael Erb, Ph.D., to better understand how those molecules might affect the functions of FOXA1.

Both Cravatt and Erb used two forms of activity-based protein profiling (ABPP), a technique that Cravatt's lab pioneered to capture protein activity on a global scale. The dual approach allowed them not only to determine whether a small molecule could bind to FOAX1 at all, but also to pinpoint the exact binding site.

Erb and his group are particularly interested in how certain genes are turned "on" and "off" by proteins called transcription factors, and how this leads to cell states that cause cancer. Transcription factors like FOXA1 bind to specific regions of DNA and control whether a gene is activated (turned "on") or repressed (turned "off"). This regulation is essential to how cells function and respond to changes—such as in the case of hormone-driven cancers, which often depend on FOXA1 to grow.

"FOXA1 is a master regulator of gene control, or what we call a lineage-defining factor," says Erb, the study's co-corresponding author and an

associate professor in the Department of Chemistry. "We found a specific site on FOXA1 that can bind to small molecules, which is a tremendously important discovery since transcription factors like FOXA1 are not only attractive targets for cancer, but also many other diseases."

Because it's so rare to find a small molecule binding site on a transcription factor, the discovery was unexpected.

"A common analogy is that drugs bind to proteins like keys inside a lock, but the prevailing attitude is that most transcription factors don't have binding sites to unlock," adds Erb. "The binding site on FOXA1 is like a hidden lock; without the ABPP technology as it exists today, it's hard to imagine how we would have discovered it."

Another surprising finding: FOXA1 usually binds to a distinct sequence of DNA bases to control gene regulation—but binding FOXA1 to small molecules changed the sequences that it preferred, allowing the protein to target different genes than it normally would.

This discovery may help future researchers understand how such molecules affect gene regulation in cancer. If small molecules alter FOXA1's DNA preferences, they could influence which genes are turned on or off—potentially affecting cancer growth.

"We found small molecules could impact FOXA1's ability to interpret the information written into the genome," says Erb.

Furthermore, the team determined that certain mutations in FOXA1 affected areas close to where small molecules could attach to the protein. These mutations changed how FOXA1 interacted with DNA—in the exact same way that the small molecules did.

"This suggests that a hotspot for cancer-associated mutations is also a hotspot for small molecule binding events," points out Erb.

Contrary to what they originally thought, the researchers found that small molecules couldn't just attach to FOXA1 on their own. Instead, they could only bind to FOXA1 when the protein was already bound to DNA sequences—meaning the effectiveness of small molecules as cancer treatments probably relies on FOXA1's interactions with DNA.

Looking ahead, Erb and Cravatt plan to explore the optimization of FOXA1 ligands into antagonists of its function and cancer growth, as well as to use ABPP to search for small molecule binding sites on transcription factors beyond FOXA1 that are currently considered undruggable.

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"Now that we've created chemical probes to study FOXA1, we hope our research inspires the development of drugs that can target the protein," says Cravatt.

In addition to Cravatt and Erb, authors of the study include Sang Joon Won, Yuxiang Zhang, Christopher J. Reinhardt, Lauren M. Hargis, Nicole S. MacRae, Kristen E. DeMeester, Evert Njomen, Jarrett R. Remsberg and Bruno Melillo of Scripps Research.

Phys Org, 15 October 2024

https://phys.org

Chemistry: Light broadens the scope of alkene synthesis

2024-10-15

Chemists from the National University of Singapore (NUS) have developed a straightforward method to convert common chemicals like carboxylic acids, alcohols, and alkanes directly into valuable alkenes.

Alkenes play a crucial role in producing everyday products such as plastics, synthetic rubber, and fine chemicals, making them indispensable in modern chemistry and industry.

Despite significant advances in alkene production, a simple and flexible way to transform a wide variety of starting materials into alkenes has remained a major challenge.

This difficulty arises as existing methods for olefin synthesis are limited using aldehydes/ketones or alkenes as the starting materials.

Recently, Associate Professor Wu Jie and his research group from the Department of Chemistry at the NUS Faculty of Science, together with Professor Zhao Yu, also from the same department, introduced a groundbreaking solution.

This work was conducted in collaboration with Professor Ma Jun-an from Tianjin University, China.

Their new method combines two known chemical reactions -- photocatalytic radical addition and Norrish type II reaction -- into a single, seamless process powered by light.

The researchers used an easily accessible and reusable chemical called vinyl ketone as the "olefination reagent" to help create alkenes.

By fine-tuning the reaction parameters of the vinyl ketone, they were able to enhance the reaction while minimising unwanted side reactions.

These findings were published in the journal Nature Chemistry.

This versatile method simplifies the production of valuable alkenes from abundant feedstock chemicals including carboxylic acids, alcohols, and alkanes, which were previously difficult or impossible to create.

Its uniqueness lies in its robust one-pot operation, the wide range of accessible starting materials, and its ability to simplify the synthesis of complex bioactive molecules.

Moreover, late-stage on-demand olefination of multifunctional molecules can be achieved through selective radical generation from acids, alcohols or alkanes.

This protocol presents a complementary approach to traditional olefination methods, making it a highly valuable addition to the research toolkit for alkene synthesis.

Assoc Prof Wu said, " As detailed in the research paper, this method provides an easy way to create useful alkenes from many different starting materials. In the future, we plan to extend this method to work with even more types of feedstock chemicals and to explore the control of alkene geometry. We believe our work will become a valuable tool for research in the pharmaceutical and agricultural fields."

Science Daily, 15 October 2024

https://sciencedaily.com

Japanese Scientists Develop a Greener Way To Produce Chemical Building Blocks

2024-10-09

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

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

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

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

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

Traditional Methods and Their Limitations

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

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

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

Benefits of the AEM Electrolyzer Method

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

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

Sci Tech Daily, 9 October 2024

https://scitechdaily.com

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Nanomineralogy of thorite in the supergiant Huayangchuan uranium ore deposit: Revealing a new geochemical behavior of actinide in environment

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Degradation assessment of high-density polyethylene (HDPE) debris after long exposure to marine conditions

Titanium exposure and gestational diabetes mellitus: associations and potential mediation by perturbation of amino acids in early pregnancy