CHEMWATCH

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ASIA PACIFIC

Transporting hazardous substances – updated guidance

2024-09-09

Many hazardous substances are classified as dangerous goods for transport by land, sea or air.

That means you need to follow the dangerous goods rules when you transport these hazardous substances. This includes identifying dangerous goods with their UN numbers and other dangerous goods information.

To make following these rules easier, we've updated our guidance on UN numbers and transporting dangerous goods.

We've added tips on how to find UN numbers, how to check if hazardous substances are classed as dangerous goods, and where to get specific guidance on land, sea, and air transport.

Read More

New Zealand EPA, 09-09-24

https://www.epa.govt.nz/hazardous-substances/classification/un-numbers/

Update on proposed restrictions for three persistent organic pollutants

2024-09-09

The consultation for our planned restrictions on three persistent organic pollutants (POPs) recently added to the Stockholm Convention on Persistent Organic Pollutants closed on 4 September 2024.

The three POPs affected are:

- **Methoxychlor** – legacy pesticide not used in New Zealand
- **Dechlorane Plus** – flame retardant used in adhesives and sealants, mainly in motor vehicle cable and wire coatings
- **UV-328** – a UV inhibitor used to protect surfaces like paints against discolouration from sunlight.

We may need to include some of the exemptions provided under the convention, as Dechlorane Plus and UV-328 are used widely in various industries.

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The feedback we've received will help us determine which exemptions are most appropriate for New Zealand.

Read More

New Zealand EPA, 09-09-24

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

New insecticide public consultation closed

2024-09-09

The consultation has closed on an application for Sivanto Prime, a new insecticide used on various crops to control sucking insects such as aphids, springtails, and wheat bugs.

Sivanto Prime contains flupyradifurone, an active ingredient that is new to Aotearoa New Zealand, but has been approved in countries including Australia and the United States.

We are now evaluating and reviewing the written submissions. Four submitters have requested to be heard at a hearing.

Read More

New Zealand EPA, 09-09-24

https://environmentalprotectionauthority.cmail19.com/t/r-l-tdiktujd-bhyidukjjd-h/

Still time to have your say on proposed new rules for treated seed

2024-09-09

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

Chemicals that are used to treat seed in New Zealand are currently regulated, but treated seed that is imported into New Zealand is not.

Our proposed new rules mean treated seed importers and manufacturers would have to make sure any seed is treated only with a substance containing active ingredients approved for use in New Zealand.

We are currently considering a request to extend the consultation period.

Submissions currently close at 5.00 pm Wednesday 9 October 2024, but any changes will be communicated via email and the consultation webpage.

Read More

New Zealand EPA, 09-09-24

https://www.epa.govt.nz/public-consultations/open-consultations/proposed-group-standard-for-treated-seed/

AMERICA

House trio urges FDA to end foot-dragging, ban toxic formaldehyde in hair straighteners

2024-09-11

Three House lawmakers are calling out the Food and Drug Administration for its yearslong delay in banning hair-straightening treatments that contain or emit cancer-causing formaldehyde. They urge the FDA to heed mounting evidence of the chemical's health risks and end its use.

The three, Reps. Ayanna Pressley (D-Mass.), Shontel Brown (D-Ohio) and Nydia Velázquez (D-N.Y.), in late August sent a letter to FDA Commissioner Robert Califf questioning the agency's years of inaction. Without a ban on formaldehyde in hair straighteners, salon workers and customers alike are exposed to the harmful substance any time the products are used.

In 2021, EWG petitioned the FDA to ban formaldehyde from hair-straightening and -smoothing treatments. We highlighted the extensive research underscoring the risks of chemical exposure and called on the agency to swiftly ban its use in these products.

Despite these concerns, the FDA has failed to protect people from this dangerous chemical. It's unclear when, or if, it will respond to the petition – but urgent action is vital.

Read More

EWG, 11-09-24

https://www.ewg.org/news-insights/news/2024/09/house-trio-urges-fda-end-foot-dragging-ban-toxic-formaldehyde-hair

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Toxic mess: DOD giving safe water only to areas with PFAS three times higher than EPA limit

2024-09-09

The Defense Department is under fire for a new memo revealing it will prioritize providing clean drinking water only to communities polluted by the toxic "forever chemicals" at levels much higher than new federal limits.

To qualify for safer water, well owners must have a water supply three times more polluted than strict new federal PFAS drinking water limits allow.

The September 3 memo does not explain how or why the military chose the "three times" threshold. The decision lets the Pentagon off the hook for supplying, in a timely manner, as much safe water as it would need to if it followed the stricter limits. So it would not be obligated to give safe drinking water immediately to communities near dozens of bases in at least 21 states, where PFAS have been detected above the federal limits but below the three-times threshold.

"This is just another example of the DOD's reluctance to clean up the PFAS mess they've made, even as service members and local communities suffer from contaminated drinking water and the health harms from exposure to these toxic chemicals," said Jared Hayes, a senior policy analyst at the Environmental Working Group.

In April, the Environmental Protection Agency finalized new limits for six PFAS: PFOA, PFOS, GenX, PFBS, PFNA and PFHxS. These maximum contaminant levels are 4 parts per trillion, or ppt, for PFOA and PFOS and a hazard index for GenX, PFBS, PFNA and PFHxS. They are among the toughest health protections against PFAS in the world.

But the new military policy delays action until more research is done unless PFOA or PFOS levels exceed 12 ppt, at least 30 ppt for PFHxs, GenX and PFNA, or if they score a hazard index of at least 3.

"It's no surprise that the DOD is dragging its feet yet again," said Hayes. "Its decision to delay action unless PFAS levels are three times higher than the EPA's limits is a predictable but disgraceful move.

"By ignoring the EPA's science-based limits, the Pentagon is essentially saying that some level of contamination is tolerable. The military is gambling with the health and safety of countless Americans who rely on clean drinking water, and it's unacceptable," added Hayes.

Read More

EWG, 09-09-24

https://www.ewg.org/news-insights/news-release/2024/09/toxic-mess-dod-giving-safe-water-only-areas-pfas-three-times

EUROPE

Energy justice from the bottom up: developing a framework to guide energy poverty policy

2024-09-12

The energy system is undergoing a fundamental transformation, involving technological change as well as changes to ways of using and consuming energy, to regulations, and to the roles of actors. The concept of energy justice should be incorporated into this transformation to ensure a just transition and can provide a lens for assessing energy policies taking place in sociotechnical systems. Energy poverty, while a policy priority, is an ongoing energy justice issue in EU, despite policy efforts, affecting around 50 million people. Current understandings of drivers of energy poverty are criticised for being too narrow. Hence, policy efforts in this direction might exacerbate existing injustices rather than alleviate them. Both individual and social factors of the socio-technical system, which influence energy behaviours, need to be better understood and incorporated in policy assessment and design to ensure justice concerns are properly addressed. Current frameworks for assessing energy justice are criticised for being too top down, lacking transparency or being difficult to operationalise. We aim to address some of these shortcomings by applying a participatory bottom-up approach to framework development. We carry out a participatory qualitative analysis that explores the sociotechnical context of energy poverty and the conceptualisation of energy justice according to key energy actors and households. We derive guideline energy justice criteria, in the context of energy poverty. Our findings may provide useful guidance for policy-makers when assessing energy poverty alleviation policies, as well as provide a foundation for the development of future context-sensitive assessment tools. This brief shares the findings from our recent report.

Read More

European Commission, 12-09-24

https://publications.jrc.ec.europa.eu/repository/handle/JRC138427

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Practical guide for the use of the EU Ecolabel in the green public procurement of absorbent hygiene products

2024-09-13

The EU Ecolabel and EU GPP are two European policy instruments that can be used by public procurers in a synergistic manner by matching supply and demand signals to green the market.

Suppliers receive general demand signals for greener products. But public procurers are often reluctant to state specific green criteria in calls for competition because of uncertainty about what exactly to ask for and the availability of compliant products on the market.

These practical guidelines help procurers to draw up technical specifications and award criteria in calls for the green public procurement of absorbent hygiene products.

Compliance with the recommended EU GPP critera is automatically verified by products carrying the EU Ecolabel and, in some cases, potentially by products carrying other ISO 14024 type I ecolabels.

Read More

European Commission, 13-09-24

https://publications.jrc.ec.europa.eu/repository/handle/JRC138564

Heavy-duty vehicles - procedures for in-service verification of CO2 emissions

2024-09-12

Summary

The EU sets CO2 performance standards for heavy-duty vehicles (Regulation (EU) 2019/1242) as part of its strategy to achieve its greenhouse gas emissions targets for 2021-2030.

This act sets out the detailed procedures for verifying CO2 emissions and fuel consumption of heavy-duty vehicles in service (in-service verification).

Feedback: Open

Feedback period: 12 September 2024 - 10 October 2024 (midnight Brussels time)

The Commission would like to hear your views.

This draft act is open for feedback for 4 weeks. Feedback will be taken into account for finalising this initiative. Feedback received will be published on this site and therefore must adhere to the feedback rules.

More about draft acts

In order to contribute you'll need to register or login using your existing social media account.

Read More

European Commission, 12-09-24

https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13849-Heavy-duty-vehicles-procedures-for-in-service-verification-of-CO2-emissions_en

Slovak Environment Minister rejects EU directive on household fossil fuel charges

2024-09-09

Slovakia has failed to include charges for emissions from heating and road transport in its latest amendment to its Emissions Trading Act, despite an EU directive requiring member states to do so by 25 September, with Environment Minister Tomáš Taraba (SNS) urging Brussels to revise the directive instead.

Slovakia has already missed the deadline for implementing the updated version of the EU Emissions Trading Directive (EU ETS) twice – first on 31 January 2023 and again after an extension to 30 June 2024 granted due to delays in other EU member states.

In July, the Commission issued a formal notice to 26 member states, giving them two months to transpose the directive into national law.

The EU ETS directive targets the most polluting sectors, such as heavy industry and energy, and requires them to pay for their greenhouse gas emissions. The scheme has successfully reduced emissions from these sectors by around 47% between 2005 and 2023 and is driving investment in cleaner technologies as the cost of emissions continues to rise yearly.

However, emissions from the heating and transport sectors have not seen similar reductions. Therefore, EU countries, including Slovakia, have agreed

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to introduce a second, parallel EU ETS 2 for transport and heating fuels in 2022.

From the outset, critics raised concerns about the social impact of the new system.

Taraba echoed these concerns and cited them for not including a levy on emissions in the buildings and transport sectors in the amendment to the Emissions Trading Act approved by the Slovak government last week.

Read More

EURACTIV, 09-09-24

https://www.euractiv.com/section/politics/news/slovak-environment-minister-rejects-eu-directive-on-household-fossil-fuel-charges/

INTERNATIONAL

The Global Demand for Chemistry Is Growing. Can U.S. Policies and Regulatory Action Meet This Demand?

2024-08-30

As the global economy grows and prospers, so will demand for chemicals. According to data from the Independent Commodity Intelligence Services (ICIS), demand for chemicals1 is expected to increase by 30% over the next decade. Much of that growth will be in emerging economies where millions of consumers will be transitioning into a middle-class lifestyle.

In the United States (U.S.), chemical demand is expected to grow by nearly 15% by 2033, driven in large part by new manufacturing capacity and infrastructure investment incentivized by recent once-in-a generation legislation, including the Inflation Reduction Act, the Bipartisan Infrastructure Law, and the CHIPS Act. More than 80% of basic and specialty chemicals are consumed by the industrial sector, and these new laws have helped increase demand for these chemicals. In addition, manufacturing is returning to the U.S. as post-COVID disruptions brought into focus the need for shorter supply chains.

To support the growing demand for chemistry products in the U.S., manufacturers are investing in new production to make the innovative chemistries needed to produce clean energy, semiconductors, and other manufactured goods and building products. American manufacturing depends on a robust supply chain for thousands of chemistries and U.S.

chemical capacity is expected to grow 10% over the next decade, less than the expected 15% growth in demand.

Learn more at: https://www.americanchemistry.com/chemistry-in-america/news-trends/blog-post/2024/the-global-demand-for-chemistry-is-growing-can-us-policies-and-regulatory-action-meet-this-demand
Read More
American Chemistry Council, 30-08-24
https://www.americanchemistry.com/chemistry-in-america/news-trends/blog-post/2024/the-global-demand-for-chemistry-is-growing-can-us-policies-and-regulatory-action-meet-this-demand

The EUDR needs corrective action to work

2024-09-09

The EU Deforestation Regulation in its current form will result in perverse outcomes that harm the world's poorest farmers – but they can be avoided, writes Eddy Martono.

Palm oil is Indonesia's largest non-mineral export. It is Indonesia's largest export to the European Union. It supports 2.6 million smallholders in Indonesia, employing 17 million people. It supports jobs and livelihoods across the country, particularly in rural areas. It's lifted millions of people out of poverty across Indonesia's 17,000 islands.

Europe is one of the largest global consumers of palm oil, but it has a love-hate relationship with the crop. It's an essential in European staples, from hazelnut spreads to detergents. It had – up until recently – even found a place within Europe's renewable energy programs. Why? Because it is cheap, useful across a range of industries, and extremely competitive.

This competitiveness – particularly in renewable fuels – has led to a backlash. The EU has imposed a broad swathe of protectionist barriers through antidumping duties, countervailing duties and an effective renewables ban. Some of these have attempted a justification – Indonesia's historic deforestation rates have been mentioned – but others are just plain protectionism.

These measures have brought EU-Indonesia relations to a nadir, with direct rebukes from Indonesia's president.

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Read More

EURACTIV, 09-09-24

https://www.euractiv.com/section/energy-environment/opinion/the-eudr-needs-corrective-action-to-work/

REACH Update

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ECHA to SME registrants: check your company size

2024-09-10

If your company is micro, small or medium-sized (SME), check that you have stated your company size correctly in REACH-IT when registering your substance. If the size was declared incorrectly, inform ECHA to avoid an administrative charge.

Helsinki, 10 September 2024 – ECHA is continually initiating new verifications on the size of companies who have declared they are an SME at the time of their REACH registration.

If you realise that the company size you declared at the time of your registration was smaller than it actually was, contact ECHA's Helpdesk without undue delay.

If ECHA identifies the error during the verification process, you will have to pay an administrative charge of up to EUR 19 900, in addition to the difference to the correct registration fee. However, if you inform ECHA about the correct company size before the verification process begins, you will not have to pay the administrative charge, but only the difference to the correct registration fee.

Help on how to determine your company size is available on ECHA's website.

Remember to upload documents that support your SME status in REACH-IT. Also, regularly check your REACH-IT account for new messages and tasks and keep your registrations and contact details up to date.

Read More

ECHA, 10-09-24

https://echa.europa.eu/-/echa-to-sme-registrants-check-your-company-size

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Janet's Corner

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Laboratory Retriever

2024-09-27

https://www.rd.com/list/chemistry-jokes/

Bromine

2024-09-27

Bromine is a chemical element with the symbol Br, an atomic number of 35, and an atomic mass of 79.904. It is in the halogen element group. At ambient temperature bromine is a brownish-red liquid. It has a similarly coloured vapour with an offensive and suffocating odour. It is the only non-metallic element that is liquid under ordinary conditions, it evaporates easily at standard temperature and pressures in a red vapour that has a strong disagreeable odour resembling that of chlorine. Bromine is less active chemically than chlorine and fluorine but is more active than iodine; its compounds are similar to those of the other halogens. Bromine is soluble in organic solvents and in water. [1,2]

USES [2,3]

Bromine is used in industry to make organobromo compounds. A major one was dibromoethane an agent for leaded gasoline, before they were largely phased out due to environmental considerations. Other organobromines are used as insecticides, in fire extinguishers and to make pharmaceuticals. Bromine is used in making fumigants, dyes, flameproofing agents, water purification compounds, sanitises, medicinals, agents for photography and in brominates vegetable oil, used as emulsifier in many citrus-flavoured soft drinks.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Routes of Exposure

- Following the release of bromine into water, you could be exposed by drinking the contaminated water.
- If food becomes contaminated with bromine, you could be exposed by eating the contaminated food.
- Following release of bromine gas into the air, you could be exposed by breathing the fumes.
- Skin exposure to bromine could occur through direct contact with bromine liquid or gas.
- Bromine gas is heavier than air, so it would settle in low-lying areas.

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HEALTH EFFECTS [4]

Acute Health Effects

- Breathing bromine gas could cause you to cough, have trouble breathing, get a headache, have irritation of your mucous membranes (inside your mouth, nose, etc.), be dizzy, or have watery eyes.
- Getting bromine liquid or gas on your skin could cause skin irritation and burns. Liquid bromine that touches your skin may first cause a cooling sensation that is closely followed by a burning feeling.
- Swallowing bromine-containing compounds (combinations of bromine with other chemicals) would cause different effects depending on the compound. Swallowing a large amount of bromine in a short period of time would be likely to cause symptoms such as nausea and vomiting (gastrointestinal symptoms).
- Showing these signs and symptoms does not necessarily mean that a person has been exposed to bromine.

Other Effects

Bromine is toxic to mucous membranes. The substance may be toxic to kidneys, liver, cardiovascular system, central nervous system (CNS) and thyroid. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. WARM water MUST be used. Get medical attention immediately.
- **Skin Contact:** In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention 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:** 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 if symptoms appear.

Workplace Controls & Practices [4]

- **Engineering Controls:** Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protective Equipment [5]

- **Personal Protection:** Face shield, full suit, vapour respirator (be sure to use an approved/certified respirator or equivalent), gloves and boots.
- **Personal Protection in Case of a Large Spill:** Splash goggles, full suit, vapour respirator, boots and gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION

United States

- **OSHA:** The Occupational Safety & Health Administration has set the following Permissible Exposure Limits (PEL) for bromine:
- **General Industry:** 29 CFR 1910.1000 Z-1 Table -- 0.1 ppm, 0.7 mg/m3 TWA

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- **Maritime:** 29 CFR 1915.1000 Table Z-Shipyards -- 0.1 ppm, 0.7 mg/m3 TWA
- **ACGIH:** American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for bromine of 0.1 ppm, 0.66 mg/m3 TWA; 0.2 ppm, 1.3 mg/m3 STEL
- **NIOSH:** The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for bromine of 0.1 ppm TWA; 0.3 ppm STEL

REFERENCES

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2. http://www.lenntech.com/periodic/elements/br.htm
3. http://www.bt.cdc.gov/agent/bromine/basics/facts.asp
4. http://www.sciencelab.com/msds.php?msdsId=9927659
5. https://www.osha.gov/dts/chemicalsampling/data/CH_221800.html
6. http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/772/Workplace-exposure-standards-airborne-contaminants.pdf

Sunlight turns CO2 and methane into valuable gases for fuel and industry

2024-09-17

Taking a leaf out of the book of plants, scientists have used a photosynthesis blueprint to harness the power of sunlight and turn two of the most destructive greenhouse gases into useful, prized chemicals that can be then used for the production of fuels and play a vital role in manufacturing.

Researchers from McGill University have developed a novel process known as photo-driven oxygen-atom-grafting, which uses gold, palladium and gallium nitride as a catalyst to chemically transform carbon dioxide and methane into carbon monoxide and green methanol when exposed to sunlight.

"Imagine a world where the exhaust from your car or emissions from a factory could be transformed, with the help of sunlight, into clean fuel for vehicles, the building blocks for everyday plastics, and energy stored in batteries," said co-first author Hui Su, from McGill's Department of Chemistry. "That's precisely the kind of transformation this new chemical process enables."

While the processes are covered thoroughly in the paper, essentially the method kicks off a chain reaction that sees an oxygen atom detach from the carbon dioxide and hop onto a methane molecule, converting it to green methanol. While it still has its downsides – such as high flammability and practicality, requiring larger fuel-tank sizes – this type of renewable methanol produces between 60-95% less CO2 emissions than conventional fuels. It's also scalable, adaptable to carbon-capture methods of production, and doesn't rely on fossil fuels.

Carbon monoxide (CO) is also produced as a byproduct, and while being known as the silent killer because of its poisonous and odorless properties, it's also the focus of medical research and how it could help with inflammation and in treating acute lung injury, sepsis and organ transplants.

"By tapping into the abundant energy of the sun, we can essentially recycle two greenhouse gases into useful products," said lead author Chao-Jun Li, a professor in the Department of Chemistry and a Canada Research Chair in Green/Organic Chemistry. "The process works at room temperature and doesn't require the high heat or harsh chemicals used in other chemical reactions,"

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In the way that plants convert CO2 and H2O into energy and oxygen, with the aid of sunlight, this novel method in a way does similar, with abundant and readily available resources. The products that catalyze the CO2 and methane aren't cheap, however, they're robust for ongoing photo-driven oxygen-atom-grafting that drives this chemical reaction.

"This innovation offers a promising path towards Canada's target of net-zero emissions by 2050 and turns an environmental challenge into an opportunity for a more sustainable future," said co-first author Jing-Tan Han, a PhD student in the Department of Chemistry.

The study was published in the journal Nature Communications.

Source: McGill University

New Atlas, 17 September 2024

https://newatlas.com

New Samarium Catalyst Reduces Costs and Boosts Pharmaceutical Reaction Efficiency

2024-09-21

The ligand enables the use of more stable trivalent samarium compounds, which are reduced to divalent samarium when exposed to visible-light irradiation.

Samarium (Sm), a rare earth metal, holds significant value in organic chemistry due to the effectiveness of its divalent compounds in carrying out single-electron transfer reductions. Samarium iodide (SmI2), a relatively stable compound, can function under mild conditions at room temperature, making it an essential tool in the production of pharmaceuticals and biologically active substances.

However, most reactions require SmI2 in quantities equal to or greater than the stoichiometric amount and necessitate the use of harmful chemicals, making the process resource-intensive and expensive to manage.

Several approaches have been studied to reduce the amount of Sm reagents to catalytic amounts. However, most of the currently available methods require harsh conditions and highly reactive reducing agents and still require significant amounts of Sm, typically 10–20% of the raw materials. Considering the high cost of Sm, there is a significant

demand for an efficient catalyst system that uses minimal Sm under mild conditions.

Breakthrough in Samarium Catalyst Efficiency

In a recent breakthrough, a research team from Chiba University in Japan, led by Assistant Professor Takahito Kuribara from the Institute for Advanced Academic Research and the Graduate School of Pharmaceutical Sciences, developed an innovative method that significantly reduces the amount of Sm. The team developed a 9,10-diphenyl anthracene (DPA)-substituted bidentate phosphine oxide ligand for coordination to trivalent samarium, enabling the use of visible light to facilitate Sm-catalyzed reductive transformations. They call this ligand a visible-light antenna.

Assistant Professor Kuribara explains, "Antenna ligands are known to help in the excitation of lanthanoid metals like Sm. Previously, we reported a DPA-substituted secondary phosphine oxide ligand capable of reduction-oxidation reactions under visible light. Inspired by this, we designed a new DPA-substituted bidentate phosphine oxide ligand that uses visible light to reduce the amount of Sm to a catalytic level."

The team included Ayahito Kaneki, Yu Matsuda, and Tetsuhiro Nemoto from the Graduate School of Pharmaceutical Sciences at Chiba University. Their study was recently published in the Journal of the American Chemical Society.

Through a series of experiments, the research team showed that using the Sm catalyst in combination with DPA-1 under blue-light irradiation produced high yields of up to 98% for pinacol coupling reactions of aldehydes and ketones, which are commonly used in pharmaceuticals. Remarkably, these reactions could proceed with only 1-2 mol% of the Sm catalyst, a significant reduction compared to the stoichiometric amounts typically required. Furthermore, the reactions could proceed even with mild organic reducing agents like amines, in contrast to the highly reducing agents previously used.

Mechanism Behind DPA-1's Effectiveness

The results showed that the addition of a small amount of water improved yields, while excess water inhibited the reaction. In comparison, DPA-2 and DPA, which have similar structures to DPA-1, yielded poor results.

To understand why DPA-1 was so effective, the researchers studied the emission characteristics of the Sm catalyst and DPA-1 combination. They found that DPA-1, with its visible-light antenna, functions as a

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multifunctional ligand that coordinates with Sm, selectively absorbs blue light, and efficiently transfers electrons from the antenna to Sm.

The researchers successfully applied the Sm catalyst and DPA-1 combination to various molecular transformation reactions, including carbon-carbon bond formation and carbon-oxygen and carbon-carbon bond cleavage, which are crucial for drug development. Moreover, by utilizing visible light as an energy source, they also achieved molecular transformations that combined Sm-based reduction with photo-oxidation.

"Our new visible-light antenna ligand reduced the amount of Sm to 1–2 mol%, a significant decrease compared to the stoichiometric amounts typically required, by utilizing low-energy visible light," remarks Assistant Professor Kuribara. Adding further, he says, "Importantly, we were able to use trivalent Sm as the starting material, which is more stable and easier to handle as compared to divalent Sm."

Overall, this study provides valuable insights for further development and design of Sm-based catalysts, marking a significant step forward in organic chemistry by enabling efficient Sm-catalyzed reductive transformations under mild conditions with minimal Sm loading.

Sci Tech Daily, 21 September 2024

https://scitechdaily.com

Scientists discover a single-electron bond in a carbon-based compound

2024-09-25

The discovery of a stable single-electron covalent bond between two carbon atoms validates a century-old theory.

Covalent bonds, in which two atoms are bound together by sharing a pair of electrons, form the scaffolding that underpins the majority of organic compounds.

In 1931, the Nobel Laureate Linus Pauling suggested that covalent bonds made from just a single, unpaired electron could exist, but these single-electron bonds would likely be much weaker than a standard covalent bond involving a pair of electrons.

Since then, single-electron bonds have been observed, but never in carbon or hydrogen — the hunt for one-electron bonds shared between carbon atoms has stymied scientists.

Now, a team of researchers from Hokkaido University has isolated a compound in which a single electron is shared between two carbon atoms in a remarkably stable covalent bond, known as a sigma bond.

Their findings are published in the journal Nature.

"Elucidating the nature of single-electron sigma-bonds between two carbon atoms is essential to gain a deeper understanding of chemical-bonding theories and would provide further insights into chemical reactions," explains Professor Yusuke Ishigaki, of the Department of Chemistry at Hokkaido University, who co-authored the study.

The single-electron bond was formed by subjecting a derivative of hexaphenylethane, which contains an extremely stretched out paired-electron covalent bond between two carbon atoms, to an oxidation reaction in the presence of iodine.

The reaction produced dark, violet-colored crystals of an iodine salt.

The team used X-ray diffraction analysis to study the crystals and found that the carbon atoms in them were extremely close together, suggesting the presence of single-electron covalent bonds between carbon atoms.

They were then able to confirm this using a form of chemical analysis called Raman spectroscopy.

"These results thus constitute the first piece of experimental evidence for a carbon-carbon single-electron covalent bond, which can be expected to pave the way for further developments of the chemistry of this scarcely-explored type of bonding," Takuya Shimajiri, the lead author of the paper and now at the University of Tokyo, says.

Science Daily, 25 September 2024

https://sciencedaily.com

Small-Molecule Drug Shows Potential for Hard-To-Treat Cancers

2024-09-24

Experts from the University's Centre for Targeted Protein Degradation (CeTPD), working with Boehringer Ingelheim scientists, have developed a breakthrough small-molecule drug, a "protein degrader".

This molecule, called ACBI3, could potentially lead to new therapies independent of KRAS mutation type, improving outcomes for all patients

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with cancers caused by KRAS mutations. The research is published in reputed journal Science.

Potential treatment for millions of cancer patients

KRAS is the most mutated gene in cancer with mutations occurring in 17%–25% of all cancers, affecting millions of patients worldwide. It plays a crucial role in tumor growth, as it is important for driving uncontrolled proliferation of tumor cells. Targeting KRAS function is a primary focus of cancer drug discovery. However, currently approved treatments can only address one of many KRAS gene mutations, called G12C, leaving more than half of patients with cancers driven by KRAS without a targeted treatment option.

The molecule ACBI3 developed by multi-disciplinary teams in the laboratory of Professor Alessio Ciulli and Boehringer Ingelheim is based on a class of small molecules called PRoteolysis TArgeting Chimeras (PROTACs). ACBI3 has been shown to be able to rapidly eliminate 13 out of the 17 most common KRAS mutants with high potency and selectivity. KRAS degradation by ACBI3 was also more efficacious than using KRAS small molecule inhibition, and induced effective tumor regression in mouse models, validating KRAS degradation as a novel therapeutic concept.

"It is exciting to collaborate with Boehringer Ingelheim to explore a novel therapeutic avenue for so many cancer patients in need," said Professor Ciulli, Director of the CeTPD, corresponding author of the study.

"By joining forces with external partners that share our vision and drive to innovate new medicines, and scientific leaders such as Prof. Ciulli, one of the world's pioneers in PROTACs and molecular glues, we can explore the full potential of novel therapeutic avenues", said Dr. Peter Ettmayer, co-corresponding author in the study and head of Drug Discovery Vienna at Boehringer Ingelheim.

A new way of fighting tumor cells

PROTACs represent a new class of drug candidates with the potential to tackle cancer targets, which were previously considered "undruggable", by degrading them.

PROTACs are formed by two-pronged small molecules. One 'prong' binds to the target disease-causing protein. The other 'prong' recruits a protein called E3 ligase that is a part of the cell's natural disposal system (the ubiquitin-proteasome). Once in close proximity, the E3 ligase tags the

target protein, labelling it as "expired" so that it is then rapidly degraded by the ubiquitin-proteasome.

Discovering ACBI3

To get to this compound, the team, co-led by Johannes Popow, Christiane Kofink and Andreas Gollner at Boehringer Ingelheim in Vienna and William Farnaby at Dundee (co-first authors) set out to directly target as wide a range as possible of the oncogenic KRAS mutations by rationally designing degraders for them, instead of attempting to inhibit them, which is the most commonly used approach used for cancer targets.

Starting from high-quality small-molecule 'prongs' for KRAS at one end, linked to the E3 ligase von Hippel-Lindau (VHL) protein at the other end, they identified a first compound that was very promising at bringing the two proteins so close that they 'sticked' together, a featured often referred to as that of a 'molecular glue'. This offered the team an attractive starting point for further investigation.

The team succeeded in co-crystalizing the three components KRAS, the PROTAC and VHL. Using X-ray crystallography they could visualize the structure of this complex down to atomic detail, helping them to understand how the small molecule was able to recruit the two proteins together. Based on this understanding the team was able to improve the compound and enhance its activity as degrader step by step, in a rational and focused manner.

Joining forces with the global scientific community

Importantly, Boehringer Ingelheim plans to make the KRAS degrader compound ACBI3, freely available for the scientific community through its opnMe® portal, without any strings attached, which could catalyze future research on this important target.

opnMe® is the open science portal of Boehringer Ingelheim. It harnesses innovation by linking the best experts from across the globe with Boehringer scientists. opnMe® fosters independent scientific innovation with free, high-quality molecules for research purposes, research funding for new ideas on select molecules or scientific questions and PostDoc grants.

"Sharing this tool with the research community at large, will enable scientists to study the consequences and potential of degrading a key

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cancer-driving protein with the ultimate aim of transforming the lives of people living with cancer," Dr. Ettmayer added.

Technology Networks, 24 September 2024

https://technologynetworks.com

New catalyst developed for sustainable propylene production from biomass

2024-09-24

Achieving carbon neutrality requires the effective use of renewable biomass. In the production of biodiesel, for instance, glycerol is generated as a major byproduct. Researchers at Osaka Metropolitan University have developed a new catalyst that efficiently converts a derivative of glycerol into bio-based propylene, contributing to sustainable chemical production.

Propylene is typically produced from petroleum and is widely used in the manufacture of plastics, such as automobile bumpers and food containers.

The research team, led by Associate Professor Shin Takemoto and Professor Hiroyuki Matsuzaka from the Graduate School of Science, developed a catalyst that selectively breaks down the oxygen-carbon bond in allyl alcohol, a derivative of glycerol, to produce bio-based propylene.

The newly developed catalyst enables the selective reduction of allyl alcohol to propylene with high efficiency, using renewable energy sources such as hydrogen or electricity.

The catalyst contains a special molecule known as a metalloligand, which is designed to facilitate the reversible binding of two metals within the catalyst.

This feature enhances the reaction's efficiency, provides high selectivity, and minimizes the formation of byproducts.

"Our research offers a sustainable alternative to conventional propylene production methods and can contribute to the development of an environmentally friendly chemical industry," said Professor Takemoto. "We look forward to further advancing this technology and exploring its broader applications."

Science Daily, 24 September 2024

https://sciencedaily.com

Breaking Thermodynamic Barriers: Japanese Create First 4- and 5-Layer Perovskites

2024-09-20

Nagoya University researchers synthesized new multilayered perovskites, finding that their ferroelectric properties change based on the number of layers. This discovery could greatly enhance future electronic device development.

A research team from Nagoya University in Japan has successfully synthesized 4- and 5-layered versions of the key electrical material, perovskite. In their analysis of the material's ferroelectric properties, they discovered a unique feature: the ferroelectric mechanisms switch based on whether the number of layers is odd or even. This finding is expected to significantly advance the development of new electronic devices due to the material's versatile characteristics. The study was published in the Journal of the American Chemical Society.

Perovskites are a class of materials that share a specific crystal structure made up of calcium titanium oxides. Electronic devices often use perovskites because they exhibit a property called ferroelectricity. Ferroelectricity allows for the control and reversal of electric polarization by an external electric field. This feature makes perovskites useful for electronic devices such as memory, capacitors, actuators, and sensor devices, which use on and off states.

To improve functionality and reduce the environmental impact of these products, researchers are developing new compositions, structures, and lead-free ferroelectrics. Perovskites, especially Dion-Jacobson (DJ)-type layered perovskites, are becoming an important class of materials in this research.

Ferroelectric Properties of DJ-Type Perovskites

DJ-type perovskites have a layered octahedral structure, which makes the layers asymmetrical, giving them ferroelectric properties. The ferroelectric properties are caused by the shifting of positive and negative ions when an outside field is applied, causing rotation and tilting of the octahedra due to size mismatches. This tilting lowers the symmetry of the material, further contributing to ferroelectric behavior.

Minoru Osada, of Nagoya University's Institute of Materials and Systems for Sustainability (IMaSS), explained that researchers consider layered

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perovskites unexplored materials due to the decline in thermodynamic stability as the thickness of the perovskite layers increases.

To overcome this, the research group developed a new synthesis method, known as the template synthesis method, that enables the synthesis of multilayer structures by layering perovskite layers one by one and aligning their octahedrons in the manner of building blocks.

"In the template synthesis method, the number of layers can be increased by one layer by using a three-layer system as the starting material and reacting it with SrTiO3," Osada said. "By repeating the reaction, the number of perovskite layers can be digitally controlled according to the number of reactions, allowing the synthesis of a multilayer structure. By applying the template synthesis method, we synthesized four- and five-layered perovskites for the first time."

Unique Behavior of Multilayer Perovskites

Intriguingly, when they tested the material, they found that it behaved strangely, exhibiting different dielectric constants and Curie temperature depending on the number of layers.

"We found that the number of layers plays an important role in this system, and that it has a unique function to switch to the conventional direct ferroelectricity model when the number of layers is odd and to the new indirect ferroelectricity model when the number is even," Osada said.

Their approach provides a new opportunity to expand the range of ferroelectric materials beyond the thermodynamically stable phases. This achievement is expected to greatly expand the material search space in the development of ferroelectrics and provide important guidelines for the development of new materials and functions that are difficult to realize with existing materials and technologies.

Sci Tech Daily, 20 September 2024

https://scitechdaily.com

Fighting Antibiotic Resistance With Graphene Spikes and Fridge Magnet Technology

2024-09-24

With strong bactericidal properties, graphene has the potential to become a game changer in the fight against antibiotic-resistant bacteria. So far there have been no efficient ways to control these properties – and thus

no way to make use of graphene's potential in healthcare. Now researchers at Chalmers University of Technology, in Sweden, have solved the problem by using the same technology found in an ordinary fridge magnet. The result of which, is an ultra-thin acupuncture-like surface that can act as a coating on catheters and implants – killing 99.99 percent of all bacteria on a surface.

Healthcare-associated infections are a widespread problem around the world, causing great suffering, high healthcare costs and a heightened risk of increased antibiotic resistance. Most infections occur in connection with the use of various medical technology products such as catheters, hip prostheses, knee prostheses and dental implants, where bacteria are able to enter the body via a foreign surface. At Chalmers University of Technology, researchers have been exploring how graphene, an atomically thin two-dimensional graphite material, can contribute to the fight against antibiotic resistance and infections in healthcare. The research team has previously been able to show how vertically standing graphene flakes prevent bacteria from attaching to the substrate. Instead, the bacteria are cut to pieces on the razor-sharp flakes and die.

"We are developing a graphene-based, ultra-thin, antibacterial material that can be applied to any surface, including biomedical devices, surgical surfaces and implants to exclude bacteria. Since graphene prevents bacteria from physically attaching to a surface, it has the added advantage that you do not risk increasing antibiotic resistance, unlike with other chemical alternatives, such as antibiotics," says Ivan Mijakovic, professor of systems biology at Chalmers University of Technology and one of the authors of the recently published study.

Kills 99.99% of bacteria on a surface

However, the researchers have been facing a challenge. Although its bactericidal properties can be demonstrated in the laboratory, the researchers have not yet managed to control the orientation direction of the graphene flakes– and subsequently not been able to apply the material on surfaces used on medical devices used in healthcare. So far, the bactericidal properties of graphene have only been able to be controlled in one specific direction: the flow direction of the manufacturing process. But now the Chalmers researchers have had a promising breakthrough for a practical application in healthcare - and beyond.

"We have managed to find a way to control the effects of graphene practically in several different directions and with a very high level of

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uniformity of the orientation. This new orientation method makes it possible to integrate graphene nanoplates into medical plastic surfaces and get an antibacterial surface that kills 99.99% of the bacteria that try to attach. This paves the way for significantly greater flexibility when you want to manufacture bacteria-killing medical devices using graphene", says Roland Kádár, professor of rheology at Chalmers University of Technology.

Unpreceded efficiency by controlling magnetic fields

By arranging earth magnets in a circular pattern making the magnetic field inside the array arrange in a straight direction, the researchers were able to induce a uniform orientation of the graphene and reach a very high bactericidal effect on surfaces of any shape.

The method, published in Advanced Functional Materials, is called "Halbach array" and means that the magnetic field inside the magnet array is strengthened and uniform while it is weakened on the other side, enabling a strong unidirectional orientation of graphene. The technology is similar to what you would find in a refrigerator magnet.

"This is the first time the Halbach array method has been used to orient graphene in a polymer nanocomposite. Now that we have seen the results, of course we want these graphene plates to get introduced in the healthcare sector so that we can reduce the number of healthcare-related infections, reduce suffering for patients and counteract antibiotic resistance", says Viney Ghai, researcher in Rheology and Processing of Soft Matter at Chalmers University of Technology.

The new orientation technology shows significant potential in other areas, for example in batteries, supercapacitors, sensors and durable water-resistant packaging materials.

"Given its broad impact across these areas, this method truly opens up new horizons in material alignment, providing a powerful tool for the successful design and customization of nanostructures that biomimic the intricate architectures found in natural systems," says Roland Kádár.

Technology Networks, 24 September 2024

https://technologynetworks.com

Yellow food dye could give doctors a new way to look beneath the skin

2024-09-18

A dye commonly found in food and cosmetics can be used to reversibly turn the surface tissues of a living mouse transparent. The novel technique, which the researchers call counterintuitive, requires no specialised equipment and allows the direct visualisation of anatomical features like muscle fibres, blood vessels and organs.

'To make transparent mice in life is one of the dreams in our field,' explains Hiroki Ueda, a synthetic biologist at Riken Centre for Biosystems Dynamics Research in Japan, who was not involved in the study.

Body tissue is opaque, in part, due to the varying refractive indexes of different components. Water-rich constituents, like cytosol, have low refractive indexes, while protein or lipid-based components have higher ones, with these mismatches causing light to scatter rather than penetrate tissue.

Existing methods for eliminating refractive index disparities can create transparent tissue. However, these kill living creatures as they use optical clearing agents (OCAs) that are toxic, such as tetrahydrofuran or acrylamide, and require the removal of molecules like lipids or water.

To investigate the possibility of achieving optical transparency in tissues using molecules that are strong absorbers of light, researchers from Stanford University, US modelled tartrazine and other similar molecules with promising optical properties. They found that water-soluble dyes could, theoretically, reduce the contrast in refractive indexes between water and lipids, reducing light scattering, turning tissues transparent.

The team tested tartrazine, a water-soluble yellow azo dye already widely used in food, medicines and cosmetics, by dissolving it in an otherwise opaque suspension of colloidal silica. At 0.6M, the dye rendered the solution completely transparent in the red region of the visible spectrum, something that would take far higher concentrations of other OCAs like glycerol. The researchers further validated the technique by testing the dye on a muscle tissue model and thin slices of chicken breast.

Encouraged by the results, the researchers moved on to applying tartrazine topically to the scalp of a live, anaesthetised mouse. Using laser speckle contrast imaging, they were able to visualise the cerebral

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blood vessels in the mouse's head, without removing the scalp as would normally be required.

Rubbing tartrazine into the abdominal skin of a mouse similarly rendered it transparent in the red region of the visible spectrum, meaning its internal organs could be seen. Applying the dye topically to a mouse hindlimb let the researchers identify the periodic structures of sarcomeres, the contractile units of muscle fibres. By combining topical tartrazine with fluorescence microscopy imaging in mice engineered to express a bright red fluorescent protein in their cholinergic neurons, the researchers were able to visualise the movement of the middle part of the small intestine. In all cases, the transparency could be reversed by simply rinsing the skin with water.

Tests revealed that tartrazine diffuses through tissue at a much higher rate compared with other OCAs, creating transparency faster. As far lower concentrations of tartrazine are needed, there is also none of the shrinking and warping of tissues due to dehydration that occur with conventional OCAs.

Ueda says that the applications of this method for in vivo imaging of animals are numerous and immediate. However, he thinks that the application is, at least for now, likely 'limited to probably animal research'.

'Currently, this study has only been conducted on animals,' explains Guosong Hong, a materials science and engineering researcher at Stanford, and one of the authors. 'However, if the same technique could be applied to humans, it could offer a variety of benefits in biology, diagnostics and even cosmetics. Instead of invasive procedures, this technology could enable non-invasive methods for diagnosing conditions deep within the body.' The team are now testing the safety and biocompatibility of their approach in human skin.

While the researchers' models predict the possibility of identifying other molecules with long absorption wavelengths and sharp absorption peaks that could be even more efficient OCAs, Ueda feels that 'to use [a] chemical or dye which is already approved to be a safe in human study for a long time and also [at a] higher dosage' was 'a great approach' as it may help expedite use in humans.

Chemistry World, 18 September 2024

https://chemistryworld.com

Electron backscatter diffraction elucidates the microstructure of alkali metals deposited in a battery

2024-09-25

Lithium and sodium metal anodes play a crucial role in the further development of high-performance solid-state batteries. In order to favorably influence the electrochemical properties of these highly reactive alkali metals, understanding their microstructure is essential.

For the first time, a method developed at Justus Liebig University Giessen (JLU), in collaboration with an international research team from the U.S. and Canada, has succeeded in elucidating the microstructure of alkali metals deposited in a battery.

The elucidation of the microstructure of lithium or sodium opens up entirely new approaches to influencing the properties of the battery. The results have been published in Nature Materials.

The microstructure of metals—i.e., their internal structure on the scale of a few nanometers to several micrometers—is crucial in determining their electrochemical properties. For most metals that are technologically utilized today, this structure has been extensively studied, and in many cases, specific properties can be achieved through targeted control of the microstructure.

However, the situation has been different for the alkali metals lithium and sodium used in batteries. This is because these metals are chemically very reactive. Their surfaces are almost immediately covered with thick reaction layers in nearly all environments, making it impossible to determine their microstructure.

But now, researchers in materials science and chemistry from JLU, the University of California, Santa Barbara (U.S.), and the University of Waterloo (Canada) have demonstrated, for the first time, a method to determine the microstructure of both electrochemically deposited lithium and sodium metal.

For this purpose, the team from Giessen, led by Prof. Dr. Jürgen Janek from the Institute of Physical Chemistry at JLU, developed a sequence of preparation and analysis steps at very low temperatures and under inert gas conditions, culminating in the determination of the local metal structure using so-called electron backscatter diffraction.

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With this method, the team was able to demonstrate how electrochemically grown metal layers of lithium and sodium, with thicknesses of up to 100 micrometers, are structured.

"The grain size of the produced layers was surprising to us, and the results provide important insights into the growth mechanism," said Janek, who is also a member of the POLiS (Post Lithium Energy Storage) excellence cluster.

"The findings on sodium metal will also give a strong boost to the work in POLiS, whose mission includes the exploration of sodium batteries."

The development of solid-state batteries is associated with the hope for particularly powerful, safe, and long-lasting electrochemical energy storage systems. The use of ceramic solid electrolytes could enable the application of lithium and sodium metal electrodes in high-performance batteries.

However, there are still challenges in using metal electrodes, especially due to the strong tendency of the metals to deform during electrochemical cycling. This affects both the charging and discharging processes.

During battery discharge, pores form in the metal, while during metal deposition in the charging step, microscopic metal structures, known as dendrites, often form, which can cause short circuits.

In the pursuit of more efficient solid-state batteries that can compete with conventional lithium-ion batteries, lithium (or sodium) metal should ideally only form during the first charging step, to avoid the handling difficulties associated with highly reactive alkali metal foils.

For about 10 years, the development of solid-state batteries has been driven by intensive research efforts worldwide, and the team from Giessen, led by Prof. Janek, is among the world's leading research groups. Prof. Janek has successfully collaborated for years with the teams in Santa Barbara and Waterloo, who were significantly involved in this study.

"Imaging the microstructure of lithium and sodium was considered very challenging and had only rarely been reported—and even then, only from simple foil surfaces.

"Thanks to the meticulous preliminary work, the two lead authors of our study succeeded in cutting lithium and sodium electrodes, preparing

them in cross-section, and imaging them using electron backscatter diffraction," says Janek.

"This success was only possible through the consistent collaboration of various specialists at JLU and the excellent equipment of the Center for Materials Research. The collaboration with colleagues in Santa Barbara and Waterloo was also crucial for the proper material selection."

Phys Org, 25 September 2024

https://phys.org

Sustainable catalysts efficiently break down pharmaceuticals in polluted waters

2024-09-26

Carnegie Mellon University scientists have found that an environmentally friendly process involving a TAML catalyst and hydrogen peroxide effectively degrades several antibiotics and other drugs found in municipal secondary wastewater and contaminated river and lake water.

The drugs are representative of the hundreds of chemical micropollutants of concern found globally in wastewater as well as in rivers and streams that supply drinking water.

"This work presents a low-cost, broadly applicable, safe and sustainable solution for purification of pharmaceutical-contaminated waters using an extremely low concentration of catalyst and peroxide," said Terry Collins, the Teresa Heinz Professor of Green Chemistry and Director of the Institute for Green Science at Carnegie Mellon.

The results, published in the journal ACS Sustainable Chemistry and Engineering, show that a next-generation TAML catalyst exhibits unprecedented efficacy in activating hydrogen peroxide (H2O2) at ultra-low concentrations.

Because of a quirk with the catalyst—it lasts longer and does more work as its concentration is lowered—the amounts of TAML and H2O2 needed to run the entire process can be dropped substantially in consequence, which ultimately will reduce operating costs.

"When you combine the technical aspects with the cost and environmental performances, our innovation can provide an effective, affordable and versatile solution for removing micropollutants from water," Collins said.

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The Carnegie Mellon investigators evaluated the ability of the next-gen TAML, called NewTAML, to degrade six high-concern drugs—four common antibiotics, a synthetic estrogen and a nonsteroidal anti-inflammatory drug—first in laboratory water spiked with the drugs, and then under more real-world conditions, including in spiked municipal secondary wastewater and water from rivers and a lake.

Many of the more than 4,000 prescription medications used for human and animal health ultimately find their way into the environment, according to the U.S. Geologic Survey. Over the last few decades, scientists have found a wide variety of pharmaceuticals in natural waterways.

The drugs, which are excreted or flushed down the toilet because they are expired or unused, can slip through the purification processes at wastewater treatment plants and contaminate receiving waters. Long-term exposure to these and other micropollutants can adversely affect, often severely, the health and behavior of wildlife, including insects, fish, birds and more.

Conventional wastewater treatment methods do not fully eliminate these micropollutants. And newer, advanced wastewater treatment processes, including ozonation and sorption onto activated carbon, are costly to implement and maintain, limiting their usefulness outside of large, wealthy cities. Collins said he anticipates that the TAML/peroxide method can fill the gap.

"What's now most exciting to me is that TAML/peroxide is so much easier to apply than anything out there," Collins said. "All you need do is mix solutions of ultra-dilute TAML and very dilute peroxide into drug-contaminated waters and wait until the active pharmaceutical ingredients can no longer be detected.

"The full process takes from minutes to hours depending on how much TAML and peroxide you add, always at very low concentrations."

TAML catalysts are bioinspired, miniaturized replicas of naturally occurring peroxidase enzymes. Developed iteratively over decades by Collins and researchers in Carnegie Mellon's Institute for Green Science, the catalysts have previously achieved impressive technical performances in removing micropollutants from urban wastewater. NewTAML surpasses earlier versions.

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In laboratory tests, chemistry doctoral student Xiaowei Ma found that a minuscule amount of the NewTAML and a small amount of hydrogen peroxide degraded all six drugs, whether individually or in a mixture.

After six hours of treatment under the prescribed conditions, five of the drugs were nondetectable and one, ciprofloxacin, was 95.4% degraded. All of the spiked drugs started at concentrations much higher than typically found in wastewaters.

"Our work shows that infinitesimal amounts of TAML and very small amounts of peroxide easily remove representative active pharmaceutical ingredients from lab, river and municipal secondary wastewaters with roughly equal efficacy, opening the possibility of treating not only urban wastewaters but also environmental waters," Ma said.

The researchers' next step is to advance testing to the field. Collins has patented the most advanced versions of the catalysts, and the intellectual property is licensed to Sudoc, a startup company working to bring TAML-based solutions to the market. Sudoc, Inc. recently raised $20 million in capital from various investors to, among other things, help launch its TAML/peroxide system into the European water treatment market.

Past studies with TAMLs have shown their enormous potential to provide clean, safe, more effective alternatives to existing industrial and commercial practices and to provide ways to remediate other pressing environmental problems that currently lack solutions.

Phys Org, 26 September 2024

https://phys.org

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Curiosities

Cheap, scalable carbon capture method also rejuvenates rivers

2024-09-26

A technique originally developed to combat acid rain has the potential to pull an enormous amount of carbon dioxide out of the atmosphere – while helping to deacidify oceans, restore rivers and boost biodiversity and fish populations.

Decarbonization is a brutally difficult and expensive challenge for some sectors – so bulk carbon capture initiatives will definitely be needed as humanity fights to keep the most devastating impacts of climate change at bay.

And while huge direct air capture plants like Project Bison in Wyoming and the Mammoth plant in Iceland can definitely play a part, Canadian company CarbonRun is one of several putting forth a solution that's based on the ocean.

The UN describes Earth's oceans as "the world's greatest ally against climate change," already absorbing some 25% of humanity's carbon emissions, as well as soaking up 90% of the excess heat these emissions are creating. But this mechanism can only help for so long; ocean acidification as well as dramatically rising sea temperatures are combining to significantly reduce the ocean's ability to absorb and sequester carbon.

CarbonRun's play is to supercharge the carbon-capturing ability of seawater, while simultaneously helping to rehabilitate damaged river ecosystems and re-balancing pH back toward normal.

The technology involved is remarkably simple: whopping big limestone rock-crushing 'doser' silos that draw river water through, add alkaline limestone powder and return it back into the river.

It's a technique that's already well proven in restoring rivers that have become uninhabitable to marine life due to acid rain; the alkaline material pushes the river's pH back towards neutral, and before long, the fish and other creatures return.

But limestone, also known as calcium carbonate, also reacts directly with carbon dioxide in the water, turning it into a stable bicarbonate that sinks to the bottom and keeps the carbon there more or less permanently, allowing the water to absorb more carbon dioxide from the atmosphere.

You do need rather a lot of limestone – about two tons per ton of carbon you wish to remediate – but CarbonRun says there are more than enough acid-degraded river systems around the world to make a significant contribution to global CO2 reduction.

Deploying its system on these large, acidified river systems alone, the company says it could "draw down 10-15% of the required carbon dioxide to meet the global need projected by 2050." That would certainly be a trajectory-altering contribution.

Of course, there are practicalities involved; you need cheap sources of limestone as close as possible to the site, as well as transport and logistics solutions that don't make too much CO2 in their own right. You need to convince locals in a variety of different regions that filling their poor broken river with rock dust won't just make things worse – and worse, you need to satisfy local regulations and get the idea past local government officials.

And if you want to apply the same idea to the oceans themselves, you need to prove it actually works in this far more chaotic environment; the New York Times details some of the trials and tribulations faced by groups trying to ramp this form of geoengineering up at the ocean scale, potentially by having ships secrete alkaline chemicals as they travel across the seas.

But CarbonRun has some pretty decent backing behind it. For example, Frontier, a group including Google parent company Alphabet, as well as Meta, Stripe and Shopify, is in to the tune of US$25 million, for a pilot project expected to capture some 55,442 tons of CO2 by 2029.

According to the back of my envelope here, that equates to a less-than-stellar cost of US$450-odd per ton captured. But that's still a huge improvement on the direct air capture business, which is currently pulling CO2 down at a rate of around US$1,200 per ton, with aspirations of reaching the US$400-$600 level by 2030.

For reference, the World Economic Forum says carbon capture prices will need to get below US$200 before the technology is likely to reach widespread adoption at scale.

According to Frontier, this limestone dust solution could hit that level reasonably rapidly: "CarbonRun has a credible, near-term trajectory to less than $100/ton," reads Frontier's "case for CarbonRun," going on to explain how: "Limestone is widely available and cheap. Limestone dosers

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are a simple, inexpensive and proven technology which makes R&D costs minimal. They're easy to operate and can largely be automated, limiting labor costs."

It's rare to see a technology with so many potential benefits at the local and global scale, but this solution's apparent economic viability, combined with an impressive set of local ecological and biodiversity benefits, certainly looks very promising.

We look forward to hearing a lot more about this initiative and others like it.

Source: CarbonRun via New York Times

New Atlas, 24 September 2024

https://newatlas.com

Seriously, stop microwaving your food in plastic

2024-09-22

Inside your refrigerator and pantry, plastic is everywhere. There's plastic wrap, storage bags and bins, clamshell takeout containers, beverage bottles, and condiment tubs, of course. Plastics (synthetic polymers) are also a component of the multi-layer material that make up chip bags and encase granola bars. Tin, steel, and aluminum cans, like the type that might hold beans or a soda, are lined with plastic. Even many paper products, such as paper cups and frozen food trays, are coated in–you guessed it–plastic.

So how worried should you be about the plastic cradling your next meal? Is it safe?

The answer depends on multiple factors, experts tell Popular Science–but plastic panic isn't something to dismiss and there are ways to reduce your exposure risk.

The unsettling science of plastic exposure

For decades, scientists have known that certain compounds present in some plastics can leach out of packaging into food, and end up ingested and absorbed. Bisphenol A (BPA), for instance, has been known to migrate from wrapper or liner to food and accumulate in living organisms, including people, since the 1990s. And some studies have demonstrated potential health impacts from ingestion of BPA, which can mimic the hormone estrogen. Though the consequences of low-level BPA exposure

are debated, recent research has identified cognitive and behavioral effects associated with the levels found in food, particularly in infants and children, says Joe Braun, a professor of epidemiology at Brown University's School of Public Health.

In response to the research findings, BPA has been phased out of some applications. It's no longer used in baby bottles, in accordance with FDA regulations, for instance. However, it still shows up in lots of other food packaging, like many can liners, and emerging studies indicate that replacement compounds may be just as problematic. Such patterns have repeated multiple times throughout environmental health and epidemiology history, notes Braun. Often, chemicals such as pesticides or flame retardants that are known to be harmful will be swapped out for alternatives once they've gotten enough negative attention. But these replacements are usually not well-studied and can turn out to be similarly damaging. "With the current regulatory framework, there's not a lot of testing that goes on of those [new] substances to know whether they're harmful," Braun says.

Beyond BPA, other chemicals like phthalates (and their alternatives)–used as softeners and plasticizers to make hard plastics more flexible–are well-known to cause health problems ranging from preterm birth to increased asthma risk and neurodevelopmental disorders, and can leach into food from packaging. PFAS (aka forever chemicals) are associated with increased cancer risk, and are also present in plastics as a byproduct of manufacturing. These, too, end up in plastic-stored food and beverages.

Dose is a critical aspect of assessing chemical exposure risk. Very small amounts of some compounds may be harmless, while larger volumes can trigger disease. But it's often difficult to determine exactly how much of any given compound is coming from food and packaging versus another source, or if the amount regularly ingested is enough to trigger problems. Nonetheless, a January study published in the Journal of the Endocrine Society, scientists estimate that the disease burden of exposure to harmful chemicals in plastic adds up to hundreds of billions of dollars in medical costs for Americans over the course of a single year.

More worrying: The handful of well-understood chemicals is dwarfed in number by the amount of compounds present in plastic food packaging that we know far less about, yet are still inadvertently ingesting. One large review study published earlier this week in the Journal of Exposure Science & Environmental Epidemiology determined that more than 3,500 chemicals found in food packaging and processing materials have made

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their way into human bodies. The bulk of these compounds were from food contact with plastics, but other materials like recycled paper and cardboard also contain lots of chemicals known to migrate into food, says Jane Muncke, senior study author and an environmental toxicologist and managing director of the non-profit Food Packaging Forum.

Though this new study doesn't establish if or how each of these thousands of chemicals is affecting us, it does demonstrate that we're being exposed to a whole lot in our day-to-day diets. And that there are massive holes in our knowledge of what that means. For example, oligomers, which are short-chain polymers that are an accidental byproduct of plastic manufacturing, are common in food packaging and processing materials, and are known to leach into foods. "We don't know anything, really, about their toxicity," Muncke says. "It's concerning. That's one of the data gaps I think needs to be studied more."

Still, even thorough studies of isolated compounds often don't provide enough information, say both Munke and Braun, because reality is far more complex. We don't just take in one chemical at a time. Through food packaging and our wider environments, "we're exposed to a chemical soup of these things," Braun says. "We know less about the impact of all of these chemicals together on health than we do about each component." So far, the few studies that do exist of multiple chemical exposure interactions suggest that compounds can exacerbate one another and that the harms add up, Braun notes.

What can you do?

It's alarming to consider all of the places plastic infiltrates our food supply and the ways it could be affecting us. Yet eliminating all plastic from your pantry could easily become a full-time job. Instead of worrying and working yourself into a tizzy, there are ways to take realistic actions to minimize your risk of chemical exposure at home.

Heat, surface area, duration of contact, and basic chemistry are all useful factors to consider when making a choice about how to store food.

First of all, DO NOT MICROWAVE FOODS IN PLASTIC. "Higher temperatures facilitate the leaching of chemicals and the release of microplastics," says Martin Wagner, a biologist studying plastic exposure at the Norwegian University of Science and Technology. "Never microwave in plastic," agrees Philip Landrigan, an epidemiologist and public health physician at Boston College. Avoid storing hot foods, like fresh-off-the-stove soups, in plastic containers as well, says Braun.

Then, consider the relative amount of food to plastic contact. Liquids, powders, and grains all have lots of surface area to absorb chemicals, notes Muncke. Single-serving containers result in a higher plastic to food ratio, so it is wise to opt for the bulk option where possible. And food stored in plastic for months at a time is more of a concern than something sitting in plastic overnight or for a couple of days in the fridge. Non-perishables and pantry staples, like flour, rice, and cooking liquids are better kept over the long term in glass, stainless steel, or ceramic vessels, she says.

Finally, high fat and high acid foods can pull more chemicals out of a storage container. Oils, vinegars, cheeses, tomato sauce, and sodas are more reactive and "can be a driver for migration," Muncke tells Popular Science. Consider purchasing versions of these items that don't come in plastic or plastic-lined cans.

As a bonus, most of these changes have dual benefits: reducing the negative health risks of chemical exposure and cutting the amount of single-use plastic that ends up land-filled, says Braun.

However, compromise is inevitable and plastics do have uses. For instance, plastic wraps, though they may carry some health risks, are usually one of the most effective means of short term storage to prevent food spoilage. Reducing food waste and costs are reasonable goals, and it may be tough to find alternate storage methods that work as well and are equally flexible, notes Braun. Though again, glass, ceramic, and stainless steel vessels are all reusable and chemically inert– so if you can fit your food in there, go for it. But be wary–not all reusable kitchen products live up to their sustainability claims.

Ultimately, you don't need to be perfect to make beneficial changes, stresses Muncke. "I think the most important thing is don't drive yourself crazy," she says. There are aspects of our individual chemical exposure risk we can control, but lots that we can't. "There's only so much you can do as a consumer."

In the long term, a more complete solution to the risks posed by plastic packaging will have to come through policy. Currently, food packaging is regulated from an "innocent until proven guilty" perspective, says Braun. Companies put chemicals out in packaging and then we learn if they're harmful after the fact, in stark contrast to the rigorous safety testing that

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something like pharmaceuticals must undergo before they're approved for use, he adds. "I think the whole paradigm has to be shifted."

Popular Science, 22 September 2024

https://popsci.com

Researchers find food dye used in Doritos can make mice skin transparent

2024-09-10

The next time you eat a bag of Doritos, remember that the dusty orange color on your fingerprints might hold the answers to transforming medical procedures.

Researchers at Stanford University recently made the discovery that the food dye, Tartrazine, commonly found in foods like Doritos, has the ability to turn skin transparent temporarily.

They conducted a study on mice, where they applied a mixture of water and tartrazine onto their skin. It resulted in a visibility so clear that inside of their skin, muscle, and tissues were apparent.

This phenomenon, known as optical tissue clearing, is a growing idea in medical research as it creates the possibility for non-invasive procedures and surgery.

How the dye works

To understand the mechanism of the water-Tartrazine mixture, it's important to first acknowledge the anatomy of our skin.

As the composition of human tissue consists of a variety of materials like water and fats, when light hits our skin, it scatters. This is why our skin appears opaque.

To combat this issue, Stanford researchers utilized the reddish color of Tartrazine to help absorb the incoming light. The dye molecules allowed less light to scatter, thus allowing for a more transparent view of the inside of the skin.

After application, the mixture essentially works similar to that of face creams, slowly seeping into the skin. Once absorbed, the mixture changes the appearance of the skin. To reverse this effect, you simply have to wash off the mixture.

When considering medical procedures that require cutting skin, many factors make this new method more preferable. The ease of application and reversibility, alongside the abundance and availability of the food dye being utilized, are just some of the advantages to this process.

In efforts to test the scope of this technique, the same mixture was applied to the scalp of the mice as well. The results showed clearer visibility of the brain blood vessels, similar to the transparency seen in the abdomen and limbs.

While the researchers found favorable outcomes, they emphasize that there are still some limitations to the technique. Particularly, the difficulty of eliminating light scattering on all parts of the body, as different tissues have different make-ups.

The full research article published in Science, the renowned academic journal of the American Association for the Advancement of Science (AAAS), offers a thorough walkthrough of the experiment.

The current state of healthcare

Although this research experiment showed promising results, the technique has yet to be tested on humans. Thus, for healthcare related to medical optical imaging, the current scope for human patients is limited to procedures like endoscopies.

Wired, 10 September 2024

https://wired.me

Sustainable metal-recycling method reduces cost and greenhouse gas emissions

2024-09-25

A research team led by Rice University's James Tour has developed a method to recycle valuable metals from electronic waste more efficiently while significantly reducing the environmental impact typically associated with metal recycling.

Metal recycling can reduce the need for mining, which decreases the environmental damage associated with extracting raw materials such as deforestation, water pollution and greenhouse gas emissions.

"Our process offers significant reductions in operational costs and greenhouse gas emissions, making it a pivotal advancement in sustainable

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recycling," said Tour, the T.T. and W.F. Chao Professor of Chemistry and professor of materials science and nanoengineering.

The research team's work was published in Nature Chemical Engineering on Sept. 25.

Innovative technique

The new technique enhances the recovery of critical metals and builds upon Tour's earlier work in waste disposal using flash Joule heating (FJH). This process involves passing an electric current through a material to rapidly heat it to extremely high temperatures, transforming it into different substances.

The researchers applied FJH chlorination and carbochlorination processes to extract valuable metals, including gallium, indium and tantalum, from e-waste. Traditional recycling methods such as hydrometallurgy and pyrometallurgy are energy-intensive, produce harmful waste streams and involve large amounts of acid.

In contrast, the new method eliminates these challenges by enabling precise temperature control and rapid metal separation without using water, acids or other solvents, significantly reducing environmental harm.

"We are trying to adapt this method for recovery of other critical metals from waste streams," said Bing Deng, former Rice postdoctoral student, current assistant professor at Tsinghua University and co-first author of the study.

Efficient results

The scientists found that their method effectively separates tantalum from capacitors, gallium from discarded light-emitting diodes and indium from used solar conductive films. By precisely controlling the reaction conditions, the team achieved a metal purity of over 95% and a yield of over 85%.

Moreover, the method holds promise for the extraction of lithium and rare Earth elements, said Shichen Xu, a postdoctoral researcher at Rice and co-first author of the study.

"This breakthrough addresses the pressing issue of critical metal shortages and negative environmental impacts while economically incentivizing recycling industries on a global scale with a more efficient recovery process," Xu said.

Other study authors include Jaeho Shin, Yi Cheng, Carter Kittrell, Justin Sharp, Long Qian, Shihui Chen and Lucas Eddy of Rice's Department of Chemistry and Khalil JeBailey of Rice's Department of Materials Science and NanoEngineering.

Phys Org, 25 September 2024

https://phys.org

"Writing" With Atoms Could Transform Materials Fabrication for Quantum Devices

2024-09-25

A new technology to continuously place individual atoms exactly where they are needed could lead to new materials for devices that address critical needs for the field of quantum computing and communication that cannot be produced by conventional means, say scientists who developed it.

A research team at the Department of Energy's Oak Ridge National Laboratory created a novel advanced microscopy tool to "write" with atoms, placing those atoms exactly where they are needed to give a material new properties.

"By working at the atomic scale, we also work at the scale where quantum properties naturally emerge and persist," said Stephen Jesse, a materials scientist who leads this research and heads the Nanomaterials Characterizations section at ORNL's Center for Nanophase Materials Sciences, or CNMS. "We aim to use this improved access to quantum behavior as a foundation for future devices that rely on uniquely quantum phenomena, like entanglement, for improving computers, creating more secure communications and enhancing the sensitivity of detectors."

To accomplish improved control over atoms, the research team created a tool they call a synthescope for combining synthesis with advanced microscopy. The researchers used a scanning transmission electron microscope, or STEM, transformed into an atomic-scale material manipulation platform. The synthescope will advance the state of the art in fabrication down to the level of the individual building blocks of materials. This new approach allows researchers to place different atoms into a material at specific locations; the new atoms and their locations can be selected to give the material new properties.

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"Classical computers use bits, which can be either 0 or 1, and do calculations by flipping these bits," said ORNL's Ondrej Dyck, a materials scientist contributing to the research. "Quantum computers use qubits, which can be both 0 and 1 at the same time. The qubits can also become entangled, with one qubit connected to the state of another. This entangled system of qubits can be used to solve certain problems much faster than classical computers. The tricky part is keeping these delicate qubits stable and working correctly in the real world.

"One strategy to tackle these challenges is to build and operate at the scale where quantum mechanics exist more naturally—at the atomic scale. We realized that if we have a microscope that can resolve atoms, we may be able to use the same microscope to move atoms or alter materials with atomic precision. We also want to be able to add atoms to the structures we create, so we need a supply of atoms. The idea morphed into an atomic-scale synthesis platform—the synthescope."

That is important because the ability to tailor materials atom-by-atom can be applied to many future technological applications in quantum information science, and more broadly in microelectronics and catalysis, and for gaining a deeper understanding of materials synthesis processes. This work could facilitate atomic-scale manufacturing, which is notoriously challenging.

"Simply by the fact that we can now start putting atoms where we want, we can think about creating arrays of atoms that are precisely positioned close enough together that they can entangle, and therefore share their quantum properties, which is key to making quantum devices more powerful than conventional ones," Dyck said.

Such devices might include quantum computers — a proposed next generation of computers that may vastly outpace today's fastest supercomputers; quantum sensors; and quantum communication devices that require a source of a single photon to create a secure quantum communications system.

"We are not just moving atoms around," Jesse said. "We show that we can add a variety of atoms to a material that were not previously there and put them where we want them. Currently there is no technology that allows you to place different elements exactly where you want to place them and have the right bonding and structure. With this technology, we could build structures from the atom up, designed for their electronic, optical, chemical or structural properties."

The scientists, who are part of the CNMS, a nanoscience research center and DOE Office of Science user facility, detailed their research and their vision in a series of four papers in scientific journals over the course of a year starting with proof of principle that the synthescope could be realized. They have applied for a patent on the technology.

"With these papers, we are redirecting what atomic-scale fabrication will look like using electron beams," Dyck said. "Together these manuscripts outline what we believe will be the direction atomic fabrication technology will take in the near future and the change in conceptualization that is needed to advance the field."

By using an electron beam, or e-beam, to remove and deposit the atoms, the ORNL scientists could accomplish a direct writing procedure at the atomic level.

"The process is remarkably intuitive," said ORNL's Andrew Lupini, STEM group leader and a member of the research team. "STEMs work by transmitting a high-energy e-beam through a material. The e-beam is focused to a point smaller than the distance between atoms and scans across the material to create an image with atomic resolution. However, STEMs are notorious for damaging the very materials they are imaging."

The scientists realized they could exploit this destructive "bug" and instead use it as a constructive feature and create holes on purpose. Then, they can put whatever atom they want in that hole, exactly where they made the defect. By purposely damaging the material, they create a new material with different and useful properties.

"We're exploring methods to create these defects on demand so we can place them where we want to," Jesse said. "Since STEMs have atomic-scale imaging capabilities, and we work with very thin materials that are only a few atoms in thickness, we can see every atom. So, we are manipulating matter at the atomic scale in real time. That's the goal, and we are actually achieving it."

To demonstrate the method, the researchers moved an e-beam back and forth over a graphene lattice, creating minuscule holes. They inserted tin atoms into those holes and achieved a continuous, atom-by-atom, direct writing process thereby populating the exact same places where the carbon atom had been with tin atoms.

"We believe that atomic-scale synthesis processes could become a matter of routine using relatively simple strategies. When coupled with

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automated beam control and AI-driven analysis and discovery, the synthescope concept offers a window into atomic synthesis processes and a unique approach to atomic-scale manufacturing," Jesse said.

Technology Networks, 25 September 2024

https://technologynetworks.com

Researcher develops low-sugar ice cream with smooth texture

2024-09-25

Wageningen researcher Qi Wang has developed a new variant of low-sugar ice cream that mimics the texture and melting properties of traditional ice cream. By replacing half of the sugar with broken-down proteins or the sweetener xylitol, she succeeded in creating a smooth ice cream without the graininess often associated with low-sugar versions. However, the flavor still needs refinement.

By reducing sugar in the ice cream, the cold treat becomes less unhealthy. Such low-sugar ice cream has been around for a while, but it does not appeal to everyone. It often has a grainy texture and melts either faster or slower than regular ice cream. "Our tongue is very sensitive and detects even the slightest differences," says Ph.D. candidate Wang.

To tackle this issue, she developed a low-sugar ice cream that closely resembles the texture and melting behavior of regular ice cream. Wang successfully defended her thesis today with the Physics and Physical Chemistry of Foods group.

Antifreeze agent

Although a scoop of ice cream may look simple, at a microscopic level it is actually a complex food, consisting of fat droplets, ice crystals, air bubbles, and unfrozen syrup water. Sugar plays a key role in maintaining this structure, particularly the ice crystals. "Sugar acts as an antifreeze agent," explains Wang.

Like salt on icy roads, sugar helps to prevent ice crystal formation, which improves the mouthfeel: the best ice creams contain small ice crystals. The larger they are, the grittier and less creamy the ice cream becomes.

Wang set out to find other substances that could function like sugar in this regard. "We selected molecules that we expected, based on their structure, to be able to do something similar," explains her supervisor, Elke Scholten.

This led them to the sweetener xylitol, the amino acid lysine, and a blend of peptides and amino acids.

In a professional ice cream maker, Wang mixed the ingredients for ice cream and replaced half of the sugar with one of these substances, along with a larger molecule to maintain viscosity, such as larger peptides or maltodextrin. The result: three new variants of low-sugar ice cream, flavored with vanilla and sweetener.

Salty taste

In the lab, Wang used special equipment to measure the properties of the new ice cream.

"We melted it on a fine mesh," she explains. "By recording the droplets that fall through, we can calculate how quickly the ice cream melts."

She also used a device that punctures the ice cream to assess its hardness. The results were comparable to regular ice cream. But, of course, taste is a crucial factor too. Thus, Wang prepared the ice cream in a special food-safe laboratory and invited ninety participants to evaluate it.

The participants agreed that the low-sugar ice cream had the same soft, creamy texture and melted in a similar fashion as regular ice cream. However, the low-sugar variants received a lower overall rating.

On a scale of zero to nine, the variant made with broken-down proteins, as well as the one with lysine, scored around 4.5, compared to 7.5 for the regular ice cream. This was largely due to an aftertaste caused by the proteins, which gave the ice cream a slightly salty or bitter taste, according to Wang.

The variant with xylitol performed slightly better, with a score of 6.5, though the test panel also detected some aftertaste here. Nevertheless, Wang believes this aftertaste need not be an issue per se.

"The ice cream we have made is very plain, with no special flavors or toppings. If we optimize it with flavors like caramel or coffee, they could potentially mask the taste of the proteins," says Wang.

Wang's commitment to her low-sugar ice cream is clear from her future plans. While she aims to gain more experience working in the food industry in the Netherlands, she has not given up on her ice cream dream.

"In ten years' time, I hope to open my own ice cream parlor, selling low-sugar ice cream," says the newly minted doctor.

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Provided by Wageningen University

Phys Org, 25 September 2024

https://phys.org

Nanopore sequencing set to transform our understanding of proteins

2024-09-23

A new protein sequencing method, which uses a biological motor to pull a protein through a tiny nanopore, could revolutionise protein analysis. The researchers at the University of Washington have also achieved a significant breakthrough in detecting post-translational modifications, including phosphorylation, to full-length protein structures at single molecule resolution.

The human genome has about 20,000 genes, yet researchers have identified 1 million different protein structures, or proteoforms. This diversity arises from genetic mutations and post-translational modifications – such as the addition of chemical groups or carbohydrate chains – that alter protein functions. These modifications play a key role in regulating complex biological processes and can also influence disease development, including cancer, Alzheimer's and autoimmune disorders. Mapping this diversity could greatly enhance our understanding of cellular functions and extend opportunities for more specific disease interventions, but traditional methods struggle to deal with the three-dimensional structure of proteins.

To overcome this, Jeff Nivala's lab, in collaboration with Oxford Nanopore Technologies, has developed a system for full-length protein sequencing using nanopore-sensing technology. 'This innovative technique enables researchers to read long, intact polypeptide strands, offering new possibilities for understanding complex biological processes and diseases', a spokesperson for Oxford Nanopore said.

Nanopore-sensing technology, optimised for genomic DNA sequencing, works by drawing a long biopolymer through a biological channel – a nanopore – using an electric field. Structural variations are identified by measuring changes in the electric current applied across the nanopore. As different chemical groups cause different disruptions, this gives them a unique chemical signature that is used to decode the polymer sequence.

Before a protein can be passed through a nanopore for sequencing, its secondary and tertiary structures must be unfolded. Nivala's team first modified a protein of interest by attaching a negatively charged 'tail' to draw the protein towards the pore when an electric current is applied. They also added a bulky 'stopper' sequence, which prevents the protein from passing completely through the channel. The stopper has a binding site for the enzyme ClpX, isolated from Escherichia coli, 'which helps "unfold" and pull the protein through the nanopore', explains Nivala. 'ClpX has a unique stepping mechanism that allows it to move proteins in approximately two-amino-acid steps.' The amplitude of the electrical current across the channel varies as the protein is pulled through the nanopore – a consequence of the amino acids present. These changes in amplitude can then be used to determine the protein's sequence.

ClpX's activity is not flawless, however, as it loses its grip on certain stretches of amino acids. Nivala's team made use of this apparent imperfection to strategically insert 'slipping sequences' into the protein chains the researchers were attempting to sequence. 'We could control the speed and direction of the protein's movement, allowing us to reread sections and improve accuracy,' says Nivala. 'The ability to control this motion allowed us to develop a more detailed picture of the protein's sequence.'

To interpret variations in electric current, the researchers developed an neural network named 'aminocaller'. To demonstrate its potential, they systematically quantified and mapped enzyme-induced modifications in a protein that was 295 amino acids long, achieving over 98% accuracy and identifying more than 100 protein variants in a single experiment. This is a 'huge step forwards' notes Aleksei Aksimentiev at the University of Illinois, who was not involved in the project.

Despite its promise, the need to attach 'tail' sequences to the proteins and the added complexity of interpreting current measurements for unknown sequences poses significant challenges for high-throughput protein sequencing. 'The challenge is to make something that can be used by anyone rapidly and easily without requiring them to have some kind of high-level expertise,' says Yujia Qing, an organic chemist, at the University of Oxford, who was not involved in the study.

Chemistry World, 23 September 2024

https://chemistryworld.com

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"Golden Lettuce" genetically engineered to pack 30 times more vitamins

2024-09-16

Most of us don't eat as much fruit and veggies as we know we should, but that goal might now be a bit more achievable. Scientists in Spain have engineered a new "Golden Lettuce" with 30 times more nutrients than the regular green stuff.

Lettuce isn't the most exciting vegetable, but you'll often find it padding out sandwiches, wraps, stews and other meals as a way to cram in extra nutrients (and cut restaurant costs). But maybe there's a way to get more health benefits out of less lettuce.

A team from the Research Institute for Plant Molecular and Cellular Biology (IBMCP) has now genetically engineered the humble lettuce to boost its nutrients. Specifically, they increased the levels of an antioxidant called beta-carotene, which your body uses to make vitamin A. This is important for healthy vision, immune function, and cell growth, and is thought to be protective against Alzheimer's, heart disease and some kinds of cancer.

Beta-carotene is usually found in high amounts in vegetables like carrots, pumpkin, and sweet potato. As you might guess, the common theme across those veggies is an orange color, and the new lettuce is no exception. Higher amounts of beta-carotene stains the leaves a striking yellow color, hence the nickname Golden Lettuce.

The levels of beta-carotene in the Golden Lettuce leaves were up to 30 times higher than those of regular lettuce. Not only that, but these antioxidants were more bioaccessible too, meaning our digestive systems can extract them more easily from our food.

Increasing those levels wasn't completely straightforward, however. Beta-carotene is normally produced in a plant's chloroplasts, the cellular structures that perform photosynthesis – but if you jam too much in there, it reduces the plant's ability to gain energy from sunlight. So, the team found a way to move the antioxidant into different parts of the plant cells.

"Our work has successfully produced and accumulated beta-carotene in cellular compartments where it is not normally found by combining biotechnological techniques and treatments with high light intensity," said Manual Rodríguez Concepción, lead author of the study.

This Golden Lettuce could soon join a genetically enhanced salad with more nutritious radishes and peas, and antioxidant-rich purple tomatoes and potatoes.

The research was published in the Plant Journal.

New Atlas, 16 September 2024

https://newatlas.com

Researchers innovate sustainable metal-recycling method

2024-09-25

Metal recycling can reduce the need for mining, which decreases the environmental damage associated with extracting raw materials such as deforestation, water pollution and greenhouse gas emissions. "Our process offers significant reductions in operational costs and greenhouse gas emissions, making it a pivotal advancement in sustainable recycling," said Tour, the T.T. and W.F. Chao Professor of Chemistry and professor of materials science and nanoengineering.

Innovative technique

The new technique enhances the recovery of critical metals and builds upon Tour's earlier work in waste disposal using flash Joule heating (FJH). This process involves passing an electric current through a material to rapidly heat it to extremely high temperatures, transforming it into different substances.

The researchers applied FJH chlorination and carbochlorination processes to extract valuable metals, including gallium, indium and tantalum, from e-waste. Traditional recycling methods such as hydrometallurgy and pyrometallurgy are energy-intensive, produce harmful waste streams and involve large amounts of acid.

In contrast, the new method eliminates these challenges by enabling precise temperature control and rapid metal separation without using water, acids or other solvents, significantly reducing environmental harm.

"We are trying to adapt this method for recovery of other critical metals from waste streams," said Bing Deng, former Rice postdoctoral student, current assistant professor at Tsinghua University and co-first author of the study.

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Efficient results

The scientists found that their method effectively separates tantalum from capacitors, gallium from discarded light-emitting diodes and indium from used solar conductive films. By precisely controlling the reaction conditions, the team achieved a metal purity of over 95% and a yield of over 85%.

Moreover, the method holds promise for the extraction of lithium and rare Earth elements, said Shichen Xu, a postdoctoral researcher at Rice and co-first author of the study.

"This breakthrough addresses the pressing issue of critical metal shortages and negative environmental impacts while economically incentivizing recycling industries on a global scale with a more efficient recovery process," Xu said.

Other study authors include Jaeho Shin, Yi Cheng, Carter Kittrell, Justin Sharp, Long Qian, Shihui Chen and Lucas Eddy of Rice's Department of Chemistry and Khalil JeBailey of Rice's Department of Materials Science and NanoEngineering.

The Defense Advanced Research Projects Agency, U.S. Army Corps of Engineers, Rice Academy Fellowship and startup funds from Tsinghua supported this study.

Science Daily, 25 September 2024

https://sciencedaily.com

Breaking Barriers in Hydrogen Science: New Techniques Promise Brighter Tomorrows

2024-09-24

Hydrogen isotopes are vital for modern medicine and sustainable energy, but their separation has been inefficient and costly.

New research using metal-organic frameworks shows promise in improving this process at room temperature, spearheaded by a well-funded German research group training the next generation of scientists.

Protium, also known as hydrogen-1, is the most abundant hydrogen isotope. Its heavier counterpart, deuterium, is increasingly important in pharmaceuticals, enhancing drug stability and effectiveness. Together with tritium, deuterium forms a "super-heavy" hydrogen fuel for nuclear

fusion, a sustainable energy source of the future. However, purifying these isotopes efficiently and affordably remains a challenge due to their similar physical properties. Current methods of isotope separation are energy-intensive and lack efficiency.

Challenges in Isotope Separation

"It has been known for almost 15 years that porous metal-organic frameworks can, in principle, be used to purify and separate hydrogen isotopes. However, this has only been possible at very low temperatures, around minus 200 degrees Celsius – conditions that are very costly to implement on an industrial scale," says Professor Knut Asmis from the Wilhelm Ostwald Institute for Physical and Theoretical Chemistry at Leipzig University and spokesperson for the Research Training Group.

He adds that the separation mechanism is based on the strongly favored adsorption of one of the isotopes present on one of the free metal centers in the porous solid. Adsorption is a process by which atoms, ions, or molecules from a gas or liquid adhere to a solid, often porous, surface.

Advances in Hydrogen Isotope Research

The doctoral researchers of the 1,2,3H Research Training Group Elvira Dongmo, Shabnam Haque, and Florian Kreuter, who are all members of one of the research groups led by Professor Thomas Heine (TU Dresden), Professor Knut Asmis, and Professor Ralf Tonner-Zech (both Leipzig University), have now gained a deeper insight into the influence of the framework environment on binding selectivity. This means the question of why one of the isotopes is more likely to stick than the other. This was deciphered in detail in the present study through a synergistic interplay between state-of-the-art spectroscopy, quantum chemical calculations, and chemical binding analysis on a model system.

"For the first time, we have been able to show the influence of the individual atoms of the framework compounds on adsorption. We can now optimize them in a targeted manner in order to obtain materials with high selectivity at room temperature," says Heine.

Collaborative Research and Training Efforts

The 1,2,3H Research Training Group, funded by the German Research Foundation (DFG) with 5.4 million euros over 4.5 years, has been training more than 20 doctoral researchers since October 2021. It combines the expertise of Leipzig University, TU Dresden, the Helmholtz-Zentrum Dresden-Rossendorf, and the Leibniz Institute of Surface Engineering in

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order to develop novel materials, more effective drugs, and more sensitive detection methods by bundling funding for basic research and training in the field of hydrogen isotopes. The second cohort of around 15 to 20 doctoral researchers will begin their three-year structured doctoral program on 1 October 2024.

Sci Tech Daily, 24 September 2024

https://scitechdaily.com

Technical Notes

SEP. 27, 2024

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

CHEMICAL EFFECTS

Microplastics in ecosystems: Critical review of occurrence, distribution, toxicity, fate, transport, and advances in experimental and computational studies in surface and subsurface water

A review of liquid crystal monomers (LCMs) as emerging contaminants: Environmental occurrences, emissions, exposure routes and toxicity

Investigation of the biological activity and toxicity of bioactive silver nanoparticles synthesized via Vitex agnus-castus seed extract on honey bees

ENVIRONMENTAL RESEARCH

Environmental toxicology of microplastic particles on fish: A review

Impact of seasonal changes and environmental conditions on suspended and inhalable microplastics in urban air

PHARMACEUTICAL/TOXICOLOGY

Oncology Dose Selection in Subsequent Indications: What Can We Learn From FDA-approved Oncology Drugs?

A Phase I Open-Label Study of Cediranib Plus Etoposide and Cisplatin as First-Line Therapy for Patients With Extensive-Stage Small-Cell Lung Cancer or Metastatic Neuroendocrine Non-Small-Cell Lung Cancer

OCCUPATIONAL

Radiation exposure during simulated equine head and limb fan beam standing computed tomography appears safe for personnel using lead shielding

Exploration of microRNAs from blood extracellular vesicles as biomarkers of exposure to polycyclic aromatic hydrocarbons