CHEMWATCH

Bulletin Board

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DEC. 06, 2024

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Bulletin Board

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ASIA PACIFIC

Veterinary chemical products and approved labels

2024-11-12

Pursuant to the Agricultural and Veterinary Chemicals Code scheduled to the Agricultural and Veterinary Chemicals Code Act 1994, the APVMA hereby gives notice that it has registered or varied the relevant particulars or conditions of the registration in respect of the following products and has approved the label or varied the relevant particulars or conditions of the approval in respect of the containers for the chemical product, with effect from the dates shown.

Table 6: Veterinary products based on existing active constituents

Application no.	144699
Product name	Quad Multi-Combination Sheep Drench
Active constituents	37.5 g/L closantel, 34 g/L levamisole (as levamisole hydrochloride), 25 g/L albendazole, 1 g/L abamectin
Applicant name	Four Seasons Agribusiness Pty Ltd
Applicant ACN	115 133 189
Date of registration	24 October 2024
Product registration no.	95108
Label approval no.	95108/144699
Description of the application and its purpose, including the intended use of the chemical product	Registration of a 37.5 g/L closantel, 34 g/L levamisole (as levamisole hydrochloride), 25 g/L albendazole, 1 g/L abamectin oral suspension product for the treatment and control of worms in sheep

Read More

APVMA, 12-11-24

https://www.apvma.gov.au/news-and-publications/publications/gazette/gazette-23-12-november-24

Approved active constituents

2024-11-12

Pursuant to the Agricultural and Veterinary Chemicals Code scheduled to the Agricultural and Veterinary Chemicals Code Act 1994, the APVMA hereby gives notice that it has approved or varied the relevant particulars or conditions of the approval of the following active constituents, with effect from the dates shown.

Table 8: Approved active constituents

Application no.	142052
Active constituent	Ametryn
Applicant name	Syngenta Australia Pty Ltd
Applicant ACN	002 933 717
Date of approval	18 October 2024
Approval no.	94312
Description of the application and its purpose, including the intended use of the active constituent	Approval of the active constituent ametryn for use in agricultural chemical products

Read More

APVMA, 12-11-24

https://www.apvma.gov.au/news-and-publications/publications/gazette/gazette-23-12-november-24

Licensing of veterinary chemical manufacturers

2024-11-22

Pursuant to Part 8 of the Agricultural and Veterinary Chemicals Code (Agvet Code), scheduled to the Agricultural and Veterinary Chemicals Code Act 1994, the APVMA hereby gives notice that it has taken action with respect to the licensing of the following veterinary chemical manufacturers with effect from the dates shown.

For a comprehensive listing of all licensed manufacturers please see the APVMA website.

New licenses

The APVMA has issued the following licenses under subsection 123(1) of the Agvet Code:

Table 10: New licenses issued by the APVMA under subsection 123(1) of the Agvet Code

	Licence number		Address	Product types	Steps of	Date issued
Alltech Lienert Australia Pty LTD	2274	008 293 007	7 Durham Street Forbes NSW 2871	Category 2: Pellets Category 4: Premixes	Quality	17 October 2024
Inline	2198	120 276 995	28 Horizon Drive	Category 2: creams	Quality	30 October 2024
Scientest Analytical Services Pty Ltd	6250	116 585 936	64 Blanck Street Ormeau QLD 4208	Category 6: all dosage forms	Analysis and testing (physical	31 October 2024

Read More

APVMA, 12-11-24

https://www.apvma.gov.au/news-and-publications/publications/gazette/gazette-23-12-november-24

Proposed revisions to the Categorisation Guidelines in 2025

2024-11-24

We propose to revise the Industrial Chemicals Categorisation Guidelines (the Guidelines) in September 2025.

The revisions mainly affect the list of chemicals with high hazards for categorisation (the list), which is a downloadable resource that some importers and manufacturers must use when working out their introduction category. We invite your comments on the proposed revisions.

Have your say by 5 December 2024:

Updating the Guidelines

The Guidelines (which include the list) were originally published in July 2020. They were updated on 24 April 2024 and 24 September 2024. We

intend to update the Guidelines and list annually from here on, unless an urgent change is required.

- The updates would come into effect in September each year, to coincide with the start of the registration year.
- We propose to consult publicly on the changes in September/October of the preceding year.
- We would publish the final changes 6 months before they come into effect for changes that may have a regulatory impact.

This consultation and publication schedule provides stakeholders with certainty about the timing of public consultations and time to prepare for upcoming changes that may affect them.

Read More

AICIS, 22-11-24

https://www.industrialchemicals.gov.au/consultations/proposed-revisions-categorisation-guidelines-2025

AMERICA

FDA Update on Phthalates in Food Packaging and Food Contact Applications

2024-10-29

The U.S. Food and Drug Administration (FDA) responded to objections on the agency's final rule that removed the authorized food contact uses of most phthalates because industry abandoned these uses. The FDA evaluated the objections and concluded that they did not provide a basis for modifying the final rule. However, the FDA is working on an updated safety assessment of the remaining authorized uses, including considering information we have received through our request for information, and phthalates are included on the list of select chemicals under FDA review.

The FDA issued the final rule in 2022 which granted a petition demonstrating that industry has abandoned the food contact use of most phthalates that were previously authorized for food contact uses. An objection from several public interest groups followed. Today's response to this objection explains that the FDA's action on the final rule was reasonable.

The FDA also received objections to the agency's denial of a separate food additive petition requesting that the agency revoke authorized food contact uses of 28 phthalates due to alleged safety concerns. We have concluded that the objectors have not established a basis for modifying or revoking the denial order as requested in the objections.

Today's response to these objections explains that we denied the food additive petition because it did not establish, through data and information, sufficient support to take the requested action of grouping the 28 phthalates as a class and revoking the authorizations for the 28 phthalates on the basis that they were unsafe as a class. Fundamental to the petition was the claim that all 28 phthalates could be reviewed together as a class, applying data from one chemical to the entire set of 28. The FDA assessment found that available information does not support grouping all 28 phthalate chemicals into a single class assessment.

For the 28 phthalates that were the subject of the safety-based petition, we note that the authorization of 23 of the 28 phthalates were no longer in use and have been revoked in the final rule issued at the same time as the denial of the safety-based petition.

We will continue to keep the food industry and the public informed of updates related to our activities on phthalates in food contact applications. Up to date information is available on the FDA's phthalates page.

Read More

US FDA, 29-10-24

https://www.fda.gov/food/hfp-constituent-updates/fda-update-phthalates-food-packaging-and-food-contact-applications

Pesticide Registration Review; Proposed Decisions for Several Pesticides; Notice of Availability

2024-11-05

EPA is conducting its registration review of the chemicals listed in the table 1 of unit I pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) section 3(g) (7 U.S.C. 136a(g)) and the Procedural Regulations for Registration Review at 40 CFR part 155, subpart C. FIFRA Section 3(g) provides, among other things, that pesticide registrations are to be reviewed every 15 years. Consistent with 40 CFR 155.57, in its final registration review decision, EPA will ultimately determine whether

a pesticide continues to meet the registration standard in FIFRA section 3(c)(5) (7 U.S.C. 136a(c)(5)). As part of the registration review process, the Agency has completed a proposed interim or proposed decision for each of the pesticides listed in table 1 of unit I.

The registration review docket for a pesticide includes documents related to the registration review case. Among other things, these documents describe EPA's rationales for conducting additional risk assessments for the registration review of the pesticides included in table 1 of unit I, as well as the Agency's subsequent risk findings and consideration of possible risk mitigation measures. The proposed interim and proposed registration review decisions are supported by the rationales included in those documents.

Read More

US Federal Register, 05-11-24

https://www.federalregister.gov/documents/2024/11/05/2024-25618/pesticide-registration-review-proposed-decisions-for-several-pesticides-notice-of-availability

Consumer demands drive sustainable trends in packaging design

2024-11-08

Shifting consumer attitudes and the increased demand for eco-friendly solutions continue to shape changes to the way goods are packaged and distributed across industries. Key trends in the shifting packaging landscape include the rise of biodegradable and compostable materials, such as PLA and mycelium, which decompose naturally and reduce environmental impact compared to traditional plastics. Minimalist packaging design is also gaining popularity, focusing on reducing waste, cutting costs, and using recyclable materials like cardboard and paper. Additionally, reusable and refillable packaging solutions are becoming more common, particularly in sectors like cosmetics and food, as part of the zero-waste movement. Companies adopting these sustainable packaging strategies can reduce waste, lower costs, and build stronger relationships with eco-conscious consumers, ultimately contributing to a more sustainable future.

Read More

RPRA, 08-11-24

https://rpra.ca/the-hub/consumer-demands-drive-sustainable-trends-in-packaging-design/

Toronto relaunches ChemTRAC program to track hazardous substances

2024-11-21

With the relaunch of a program which implements Toronto's community right to know bylaw, advocates hope reductions in harmful chemical exposures will follow.

While environmental and workplace exposures are known and significant contributors to the burden of cancer and other diseases, cancer prevention efforts mostly continue to focus on individual modifiable risk factors such as smoking, diet and lack of exercise. Thus, the onus for cancer prevention is shifted to individual workers and residents.

In Ontario occupational cancers claim more worker lives than traumatic injuries by far. Conservative estimates conclude that occupational exposures are responsible for an estimated 2 to 10 per cent of newly diagnosed cancers, but some believe it may be as high as 20 per cent. Similarly, environmental carcinogens are associated with two to as much as 19 per cent of all new cancer cases in Ontario each year.

With the substantial contribution of environmental and occupational carcinogens bold policy initiatives with the potential for population level impacts are much needed and long overdue.

Read More

HSC Workers Health & Safety, 21-11-24

https://www.whsc.on.ca/What-s-new/News-Archive/Toronto-relaunches-ChemTRAC-program-to-track-hazardous-substances

EUROPE

Czechia, Italy push to postpone fines for missing emission targets

2024-11-04

Czech Transport Minister Martin Kupka (ODS, ECR) revealed the plan on CNN Prime News on Sunday, expressing concern that the recent drop in demand for electric vehicles across the EU will make it increasingly difficult for carmakers to meet the required 15% reduction in emissions by 2025.

"They can't meet the target because interest in electric cars has fallen across the European Union," Kupka explained.

To meet these targets, European carmakers need to increase the proportion of electric vehicles in their fleets, driven by EU regulations that aim for a 100% reduction in emissions by 2035. However, recent market trends show declining electric vehicle sales, causing concern among manufacturers and policymakers.

Kupka also pointed out that Czechia formally proposed the delay two weeks ago, with Italy joining shortly afterwards. Germany has also indicated its support, with German Economy Minister Robert Habeck (Greens) - a strong supporter of e-mobility - agreeing that a temporary suspension of the fines would benefit the industry.

Kupka stressed that forcing manufacturers to pay penalties for not meeting quotas would reduce the funds available for further investment in electric vehicle technology, which could hinder the sector's progress in the long term.

Read More

Euractiv, 04-11-24

https://www.euractiv.com/section/politics/news/czechia-italy-push-to-postpone-fines-for-missing-emission-targets/

Climate report shows the largest annual drop in EU greenhouse gas emissions for decades

2024-11-05

EU greenhouse gas emissions fell by 8.3% in 2023, compared to 2022, reveals the latest climate action progress report by the European Commission. The report states that net greenhouse gas emissions are now

37% below 1990 levels. Over the same period, EU Gross Domestic Product (GDP) grew by 68%. This points to the fact that reducing emissions and economic growth are compatible. It also confirms that the EU remains on track to reach its goal of reducing emissions by at least 55% by 2030.

Among the report's findings are:

- a record 16.5% decrease in 2023 emissions from power and industrial installations that are listed under the EU Emissions Trading System.
- a 24% decrease in emissions from electricity production and heating, under the EU Emissions Trading System, driven by the growth of renewable energy sources, in particular wind and solar energy.
- the EU Emissions Trading System generated revenues of €43.6 billion in 2023 for climate action investments.
- around a 2% decrease in 2023 of overall buildings, agriculture, domestic transport, small industry and waste emissions.
- an 8.5% increase in 2023 in the EU's natural carbon absorption, reversing the recent declining trend in the land use and forestry sector.

Read More

European Commission, 05-11-24

https://commission.europa.eu/news/climate-report-shows-largest-annual-drop-eu-greenhouse-gas-emissions-decades-2024-11-05_en

New IUCLID Service Release (v8.13.2)

2024-11-11

The latest service release of IUCLID is now available, bringing a host of fixes and improvements to enhance user experience and functionality.

This release does not introduce any format changes but focuses on resolving existing issues and implementing valuable enhancements.

Among the key fixes, the document comparison functionality has been restored, text wrapping for long strings has been improved, and the .csv file upload mapping for phrases in picklists has been corrected.

Key improvements include enhanced data entry with full-screen mode for rich text fields and an improved date-picker control. The automatic selection of legal entity in dossier headers upon creation has been added, along with the ability to re-order records in multi-reference fields.

This release also contains specific user group enhancements such as improved validation rules and report templates. For EU CLP (Poison Centres), the labelling calculator has been extended to include non-GHS hazard statements, and the PCN report now displays new hazard classes. Improvements for EU PPP include better filtering of mixture components, a new report for analytical methods, and enhanced quality rules. For EU BPR, a new set of quality rules is introduced for active substance applications.

Read More

IUCLID News, 11-11-24

https://iuclid6.echa.europa.eu/view-article/-/journal_content/title/new-iuclid-service-release-v8.13.2

New substance evaluation conclusions published

2024-11-15

- Bis(isopropyl)naphthalene (EC 254-052-6, CAS 38640-62-9), evaluated by Sweden.
- Imidazolium compounds, 2-C17-unsatd.-alkyl-1-(2-C18-unsatd. amidoethyl)-4,5-dihydro-N-methyl, Me sulfates (EC 931-745-8), evaluated by Sweden.

Read More

ECHA, 15-11-24

https://echa.europa.eu/information-on-chemicals/evaluation/community-rolling-action-plan/corap-table

Assessment of regulatory needs report published

2024-11-15

Report for the following substance group is now available on our website:

- Fluoride salts with counterions of low hazard

If you have questions or feedback related to the assessment work, you can send them to us using this webform.

Read More

ECHA, 15-11-24

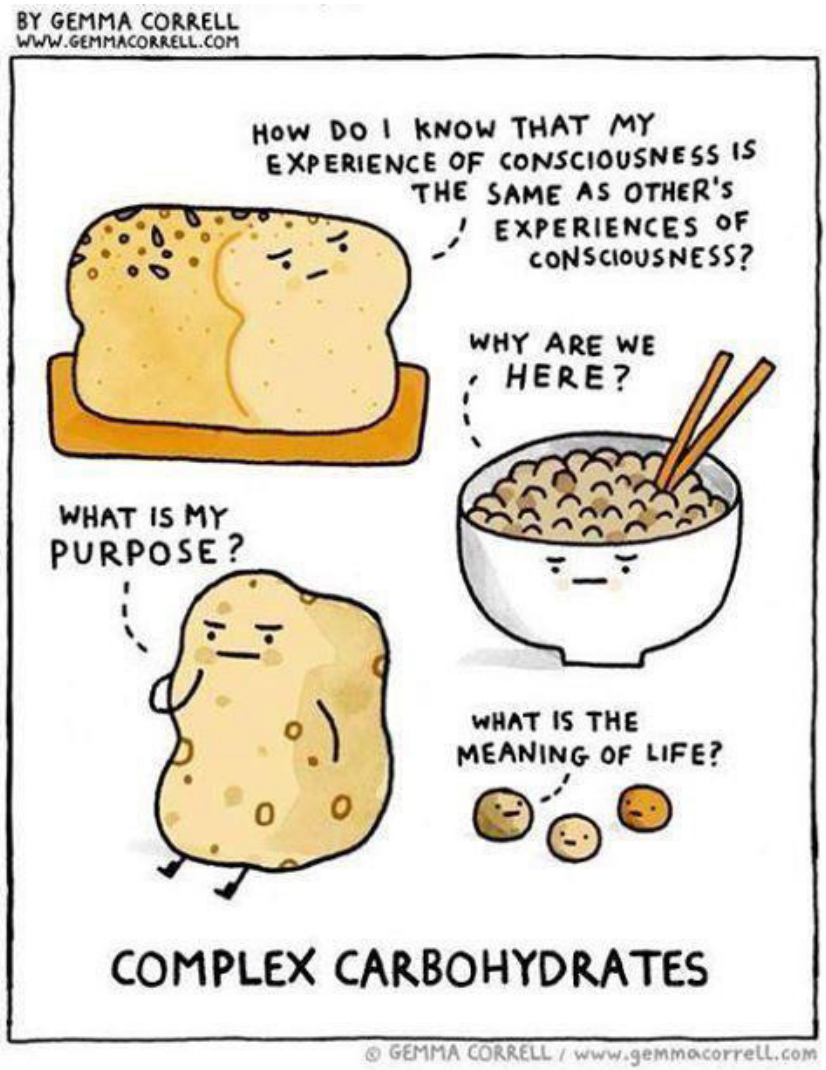
https://echa.europa.eu/assessment-regulatory-needs

Janet's Corner

DEC. 06, 2024

Complex Carbohydrates

2024-12-06



www.gemmacorrell.com

1,2-Dichloropropane

2024-12-06

USES [2,3]

1,2-Dichloropropane is an intermediate in the production of perchloroethylene and other chlorinated chemicals. [1] It is also used in making lead free gasoline, paper coating, soil fumigant for nematodes, and insecticide for stored grain. [3] It was once used as an industrial solvent and was found in paint strippers, varnishes, and furniture finish removers but some of these uses have been discontinued.

1,2-Dichloropropane is an organic compound with the molecular formula C3H6Cl2, it is classified as a chlorocarbon. 1,2-Dichloropropane is a colourless, flammable liquid with a chloroform-like odour. It is moderately soluble in water and readily evaporates into air. It does not occur naturally in the environment. [1,2]

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Air levels of 1,2-dichloropropane are usually quite low.
- 1,2- Dichloropropane is found in a few drinking water supplies, and most of those are from groundwater sources.
- Occupational exposure to 1,2-dichloropropane may result during its production, its use in chemical reactions and as an industrial solvent, and evaporation from wastewater that contains the chemical.
- Workers involved in cleaning up hazardous waste or spill sites that contain 1,2- dichloropropane may also be exposed.

Routes of Exposure

1,2-Dichloropropane can enter the body if a person breathes air or drinks water contaminated with it, or if a person's skin comes in contact with it. If 1,2- dichloropropane is present at a waste site near homes that use wells as a source of water, the well water could be contaminated. A route of major exposure in the past was by accidentally or intentionally drinking cleaning products that contained 1,2-dichloropropane, but these cleaning materials are no longer produced in the United States. Experiments with animals have shown that when 1,2-dichloropropane enters the body through eating or drinking, it is quickly removed in the urine and faeces and by the lungs when the animal breathes out. 1,2-Dichloropropane may enter the lungs of workers exposed where it is used indoors as a solvent. If 1,2-dichloropropane is released at a waste site and evaporates into the air, a person may breathe in 1,2-dichloropropane for a short time before it disperses. When the chemical was a part of some paint strippers, varnishes, and furniture finish removers, exposure of the skin through contact with

these products occurred; however, the amount of 1,2-dichloropropane that entered through the skin is unknown. Soil around a waste site may be contaminated with 1,2-dichloropropane, but it is not known how much 1,2-dichloropropane enters the body through the skin upon contact with contaminated soil.

HEALTH EFFECTS [4]

Acute Health Effects

Drinking 1,2-dichloropropane by humans (i.e., drinking cleaning solutions) has produced poisoning. At these high levels of exposure, effects include dizziness, headache, nausea, injury to the liver and kidneys, anaemia, coma and, ultimately, death. Breathing high levels of 1,2-dichloropropane by humans, as in deliberate breathing of vapours from cleaning solutions, produces similar effects.

EPA has found short-term exposures to 1,2-dichloropropane at levels above the MCL to potentially impair the functions of the liver, kidneys, adrenal glands, bladder, and the gastrointestinal and respiratory tracts.

Carcinogenicity

There is some evidence that 1,2-dichloropropane may have the potential to cause cancer from a lifetime exposure at levels above the MCL.

1,2-Dichloropropane breathed or eaten for a short time has not been reported to produce cancer in humans, but long-term exposure by mouth in animals has produced evidence of liver cancer in mice and breast cancer in female rats. The significance of the animal cancer studies to humans is not well understood. Irritation of the skin after contact with 1,2-dichloropropane has been seen in both humans and rabbits.

Other Effects

1,2-Dichloropropane has not been shown to cause birth defects in humans or animals, but a delay in the growth of bones has been seen in foetal rats following exposure of the mother rats.

SAFETY

First Aid Measures [5]

- **If inhaled:** If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

- **In case of skin contact:** Wash off with soap and plenty of water. Consult a physician.
- **In case of eye contact:** Flush eyes with water as a precaution.
- **If swallowed:** Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling 1,2-Dichloropropane:

- **Eye/face protection:** Face shield and safety glasses should be used. Equipment for eye protection should be tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
- **Skin protection:** Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product.

REGULATION

United States

EPA: The United States Environmental Protection Agency has set a Maximum Contaminant Level (MCL) of 0.005 parts per million (0.005 ppm) for 1,2-dichloropropane in drinking water. The EPA recommends that the level of 1,2dichloropropane in lakes and streams should be limited to 0.52 parts per billion (0.52 ppb) to prevent possible human health effects from drinking contaminated water or eating contaminated fish. Any release to the environment greater than 1,000 pounds of 1,2-dichloropropane must be reported to the EPA.

OSHA: The Occupational Safety and Health Administration has set a workplace air concentration limit of 75 ppm over an 8-hour workday, 40-hour workweek.

REFERENCES

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4. http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=162

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7. http://www.safeworkaustralia.gov.au/sites/swa/about/Publications/Documents/772/Workplace-exposure-standards-for-airborne-contaminants.docx

New hybrid catalyst developed for clean oxygen production

2024-11-29

A research team at the Institute of Materials Chemistry at TU Wien, led by Professor Dominik Eder, has developed a new synthetic approach to create durable, conductive and catalytically active hybrid framework materials for (photo)electrocatalytic water splitting. The study is published in Nature Communications.

The development of technologies for sustainable energy carriers, such as hydrogen, is essential. A promising way to produce hydrogen (H2) is from splitting water into H2 and oxygen (O2), either electrochemically or using light, or both—a path that the team follows. However, this process requires a catalyst that accelerates the reaction without being consumed. Key criteria for a catalyst include a large surface area for the adsorption and splitting of water molecules, and durability for long-term use.

Zeolitic imidazolate frameworks (ZIFs), a class of hybrid organic/inorganic materials with molecular interfaces and numerous pores, offer record surface areas and ample adsorption sites for water as catalysts. They consist of single metal ions, such as cobalt ions, which are connected by specific organic molecules, called ligands, through what is called coordination bonds. Conventional ZIFs only contain a single type of organic ligand.

"These ZIFs often lack stability in water under electrocatalytic conditions to ensure long-term application. Furthermore, their rather low electronic conductivity also limits their effectiveness in electrocatalytic applications," says Eder.

To address these challenges, the team has developed a way to design ZIFs using two or more organic ligands. "We needed to be careful to mix both ligands in a way that creates a uniform distribution throughout the framework, while preserving the original ZIF structure," explains Zheao Huang, the study's lead author. Therefore, the team comprehensively investigated a series of ligand combinations and process parameters and was finally able to identify the best suited ligand pair.

Synergistic benefits of mixing two organic ligands

The authors found that this modification has significantly improved the ZIF stability, extending its durability during electrocatalytic water splitting from a few minutes to at least one day.

Through in-depth investigations using a wide range of experimental spectroscopic and microscopic techniques, supported by computational theory in collaboration with Central China Normal University, the team observed that the precise mixing of the two ligands synergistically strengthened the coordination bond with the cobalt metal. As a result, the porous framework did not collapse during the (photo)electrocatalytic tests.

"Instead, we observed that after just a few minutes of the reaction a very thin film of just a few nanometers, made of cobalt oxyhydroxide, was formed on the surface of the ZIF nanoparticles, which prevented further degradation and collapse," says Huang.

Additionally, the combination of two ligands has increased the conductivity of the ZIF material by 10 times, consequently boosting also the oxygen evolution reaction (OER) rate by 10 times.

"Simulations revealed that the two ligands interact in a synergistic way, creating a high density of mobile charge carriers throughout the material," explains Eder. "Although we expected some improvements with this new strategy, we were surprised by how much it enhanced the (photo) electrocatalytic performance of ZIFs."

The team is now exploring this versatile approach for other ZIFs as well as metal-organic frameworks (MOFs) that also lack stability and conductivity in electrocatalytic and (photo)electrocatalytic applications. This innovative approach opens exciting possibilities for designing advanced materials for catalysis, sensing and solar energy conversion technologies, moving us closer to real-world applications.

Phys Org, 29 November 2024

https://phys.org

Glow-in-the-dark wood passively lights homes or parks

2024-12-01

Imagine a glow-in-the-dark designer desk, or wooden fence posts that guide you home with their eerie light. Scientists in Switzerland have developed a way to make glowing wood, with the help of a fungus.

Stumbling on a piece of glowing wood out in the forest sounds like a magical experience, but it is possible. Under specific conditions, certain species of mushroom will fluoresce as they consume wood, although it's rare and hard to recreate.

Now, scientists at Empa have managed to induce those conditions to make glow in the dark wood. The most effective combo turned out to be ringless honey fungus (Desarmillaria tabescens) and balsa wood, which was able to fluoresce for up to 10 days in wavelengths of 560 nanometers – a classic green glow.

Getting the material to that stage takes time though. The researchers found that the fungus and wood need to be incubated together for three months in a very moist environment. During this time the balsa wood absorbs up to eight times its weight in water, and the glow begins only when it's exposed to oxygen. At that point, the enzyme luciferase (also seen in fireflies) kickstarts a reaction that results in emission of a green glow.

On closer inspection, the team found that the fungus breaks down the lignin in the wood, the natural polymer that provides stiffness and compressive strength. However, this doesn't reduce the wood's overall stability, because the cellulose remains intact.

The researchers hope to improve the technique to boost the intensity and lifespan of the bioluminescent wood. The ultimate goal, they say in the paper, would be to provide energy-saving lighting in homes or public spaces. While here it would be embedded into "dead" wood, other research has investigated making living plants that glow for the same goals.

The research was published in the journal Advanced Science. The team describes the work in the video below – you might want to switch on the English subtitles though.

New Atlas, 1 December 2024

https://newatlas.com

Combo-drug treatment to combat Melioidosis

2024-12-03

Melioidosis -- a bacterial infection that causes fever, pneumonia, and sepsis -- presents two enormous challenges for infectious disease experts: it kills roughly half the people who contract it and it is extremely tough to treat even in countries with advanced health care systems.

The pathogen that causes melioidosis is so virulent it was used as a biologic warfare agent in World Wars I and II. Treatment demands an expensive, long-term IV and antibiotic regimen that is difficult to enact in southeast Asia and northern Australia where melioidosis is prevalent. And

while the disease itself is rare in the United States, the first known case of environmental transmission occurred here in 2022.

Princeton Chemistry's Seyedsayamdost Lab offers a promising treatment for this neglected tropical disease with a combination of low-dose antibiotics that targets the pathogen but leaves gut microbiome bacteria unscathed.

The researchers' approach could herald a shift in the way we use antibiotics. By attacking the pathogen's unique and hidden metabolic "vulnerabilities," the lab offers a new tool in the global challenge to counteract antibiotic resistance and uncover similar combination therapies for other diseases.

"Virtually all antibiotics are A-bombs. They are broad-spectrum and we use them in such high doses that they eradicate nearly everything in and around them, notably bacteria that protect us. That's a problem," said Mohammad Seyedsayamdost, professor of chemistry. "We found that even low doses of antibiotics reveal susceptibilities that are difficult to detect but can be leveraged, once known. That was the 'aha' moment.

"Low-dose or subinhibitory doses of antibiotics don't affect growth of the pathogen but have a significant impact on its physiology and metabolism. And once we noticed that, we took advantage of this very unique response to combat an organism that is really difficult to kill."

The lab's research, Combatting melioidosis with chemical synthetic lethality, was published in the Proceedings of the National Academy of Sciences (PNAS) in collaboration with the Davis Lab at Emory University and the Chandler lab at the University of Kansas.

"To me, the most exciting part of this paper is its potential to change how we think about antibiotic development," said the paper's lead author and former Mo Lab graduate student Yifan Zhang. "We've known for a long time that antimicrobial resistance is a growing global crisis, and yet the pipeline for new antibiotics has been alarmingly slow. With this study, our goal was to take a different approach -- one that doesn't just focus on finding a new 'silver bullet,' but instead looks at how we can outsmart pathogens by exploiting their metabolic vulnerabilities.

"This work also reinforces how important it is to think beyond traditional boundaries in science," added Zhang, now a medical student at Robert Wood Johnson. "Combining ideas from the oncology space with our knowledge of microbiology and microbial metabolism, required us to

challenge a lot of assumptions about how antibiotics 'should' work. It's exciting to see those risks pay off with a discovery that could genuinely help patients."

Looking at the pathogen through HiTES

Melioidosis is caused by the bacterium Burkholderia pseudomallei. One traditional method of determining antibiotic efficacy against it is by looking for signs of Burkholderia growth with the unaided eye or through a simple assay, and then treating it with a broad-spectrum antibiotic that kills everything in its path: antibiotic as blunt instrument.

But the Mo Lab used another method, High Throughput Elicitor Screening (HiTES), a technology for which Seyedsayamdost was awarded a 2020 MacArthur Prize, to peer deeply into the metabolome for clues to bacterial vulnerability.

HiTES revealed that this pathogen's metabolism is altered dramatically with low-dose antibiotics. In essence, low-dose trimethoprim opens up a secondary, previously unknown, metabolite stress response in the pathogen. Under these conditions, the researchers found the folate biosynthetic enzyme FolE2 to be conditionally essential, an enzyme that's not widely found in bacteria and that, ironically, makes it easy to exploit.

By using an approach called chemical synthetic lethality, they were able to successfully combine trimethoprim with a natural product, dehydrocostus lactone (DHL), to inhibit the function of FolE2, cutting off this secondary response on which the bacteria relies for survival … and doing it in a way that selectively kills the pathogen without annihilating the gut's essential bacteria.

"Basically we accomplished the molecular version of synthetic lethality, a well-known genetics phenomenon, wherein two mutations are only deadly when combined," said Seyedsayamdost. "You add one molecule, it has no effect. You add a second molecule, it has no effect. But you combine the two molecules -- in this case, trimethoprim and DHL -- and the combination is deadly. We mixed genetics and chemistry, and it worked."

The research also suggests that this combination therapy can be used against any organism to find treatments that are less destructive systemically.

"Ultimately, I hope this research doesn't just stop at Burkholderia pseudomallei," said Zhang. "If we can expand this strategy to other

pathogens, I believe we can open up entirely new avenues for developing treatments that are not only effective but also respect the delicate balance of our microbiomes.

"Knowing that our work has the potential to contribute to targeted, life-saving treatments for such a devastating disease is both humbling and deeply fulfilling. That's the bigger picture that keeps me motivated and excited about where this work can lead."

Science Daily, 3 December 2024

https://sciencedaily.com

Biodegradable polymers show promise for nutrient encapsulation and replacing microbeads in beauty products

2024-12-06

Microplastics are an environmental hazard found nearly everywhere on Earth, released by the breakdown of tires, clothing, and plastic packaging. Another significant source of microplastics is tiny beads that are added to some cleansers, cosmetics, and other beauty products.

In an effort to cut off some of these microplastics at their source, MIT researchers have developed a class of biodegradable materials that could replace the plastic beads now used in beauty products. These polymers break down into harmless sugars and amino acids.

"One way to mitigate the microplastics problem is to figure out how to clean up existing pollution. But it's equally important to look ahead and focus on creating materials that won't generate microplastics in the first place," says Ana Jaklenec, a principal investigator at MIT's Koch Institute for Integrative Cancer Research.

These particles could also find other applications. In the new study, Jaklenec and her colleagues showed that the particles could be used to encapsulate nutrients such as vitamin A. Fortifying foods with encapsulated vitamin A and other nutrients could help some of the 2 billion people around the world who suffer from nutrient deficiencies.

Jaklenec and Robert Langer, an MIT Institute Professor and member of the Koch Institute, are the senior authors of the paper, which appears in Nature Chemical Engineering. The paper's lead author is Linzixuan (Rhoda) Zhang, an MIT graduate student in chemical engineering.

Biodegradable plastics

In 2019, Jaklenec, Langer, and others reported a polymer material that they showed could be used to encapsulate vitamin A and other essential nutrients. They also found that people who consumed bread made from flour fortified with encapsulated iron showed increased iron levels.

However, since then, the European Union has classified this polymer, known as BMC, as a microplastic and included it in a ban that went into effect in 2023. As a result, the Bill and Melinda Gates Foundation asked the MIT team if they could design an alternative that would be more environmentally friendly.

The researchers, led by Zhang, turned to a type of polymer that Langer's lab had previously developed, known as poly(beta-amino esters). These polymers, which have shown promise as vehicles for gene delivery and other medical applications, are biodegradable and break down into sugars and amino acids.

By changing the composition of the material's building blocks, researchers can tune properties such as hydrophobicity (ability to repel water), mechanical strength, and pH sensitivity. After creating five different candidate materials, the MIT team tested them and identified one that appeared to have the optimal composition for microplastic applications, including the ability to dissolve when exposed to acidic environments such as

The researchers showed that they could use these particles to encapsulate vitamin A, as well as vitamin D, vitamin E, vitamin C, zinc and iron. Many of these nutrients are susceptible to heat and light degradation, but when encased in the particles, the researchers found that the nutrients could withstand exposure to boiling water for two hours.

They also showed that even after being stored for six months at high temperature and high humidity, more than half of the encapsulated vitamins were undamaged.

To demonstrate their potential for fortifying food, the researchers incorporated the particles into bouillon cubes, which are commonly consumed in many African countries. They found that when incorporated into bouillon, the nutrients remained intact after being boiled for two hours.

"Bouillon is a staple ingredient in sub-Saharan Africa, and offers a significant opportunity to improve the nutritional status of many millions of people in those regions," Jaklenec says.the stomach.

In this study, the researchers also tested the particles' safety by exposing them to cultured human intestinal cells and measuring their effects on the cells. At the doses that would be used for food fortification, they found no damage to the cells.

Better cleansing

To explore the particles' ability to replace the microbeads that are often added to cleansers, the researchers mixed the particles with soap foam. This mixture, they found, could remove permanent marker and waterproof eyeliner from skin much more effectively than soap alone.

Soap mixed with the new microplastic was also more effective than a cleanser that includes polyethylene microbeads, the researchers found. They also discovered that the new biodegradable particles did a better job of absorbing potentially toxic elements such as heavy metals.

"We wanted to use this as a first step to demonstrate how it's possible to develop a new class of materials, to expand from existing material categories, and then to apply it to different applications," Zhang says.

The researchers are working on further testing the microbeads as a cleanser and potentially other applications, and they plan to run a small human trial later this year. They are also gathering safety data that could be used to apply for GRAS (generally regarded as safe) classification from the U.S. Food and Drug Administration and are planning a clinical trial of foods fortified with the particles.

The researchers hope their work could help to significantly reduce the amount of microplastic released into the environment from health and beauty products.

"This is just one small part of the broader microplastics issue, but as a society we're beginning to acknowledge the seriousness of the problem. This work offers a step forward in addressing it," Jaklenec says.

"Polymers are incredibly useful and essential in countless applications in our daily lives, but they come with downsides. This is an example of how we can reduce some of those negative aspects."

Phys Org, 6 December 2024

https://phys.org

Chemical structure's carbon capture ability doubled

2024-12-03

Oregon State University scientists have found a way to more than double the uptake ability of a chemical structure that can be used for scrubbing carbon dioxide from factory flues.

The study involving metal-organic frameworks, or MOFs, is important because industrial activities, among them burning fossil fuels for energy, account for a significant percentage of the greenhouse gas in the Earth's atmosphere. In the United States, 16% of total carbon dioxide emissions are from industry, according to the Environmental Protection Agency.

OSU researchers led by Kyriakos Stylianou of the College of Science worked with a copper-based MOF and found that its effectiveness at adsorbing carbon dioxide more than doubled when first exposed to ammonia gas.

"The capture of CO2 is critical for meeting net-zero emission targets," said Stylianou, associate professor of chemistry. "MOFs have shown a lot of promise because of their porosity and their structural versatility."

MOFs are crystalline materials made up of positively charged metal ions surrounded by organic "linker" molecules known as ligands. The metal ions make nodes that bind the linkers' arms to form a repeating structure that looks something like a cage; the structure has nanosized pores that adsorb gases, similar to a sponge.

MOFs can be designed with a variety of components, which determine the MOF's properties, and there are millions of possible MOFs, Stylianou said. More than 100,000 of them have been synthesized by chemistry researchers, and the properties of hundreds of thousands of others have been predicted.

In addition to the capture of carbon dioxide and other types of gases, MOFs can be used as catalysts and for energy storage, drug delivery and water purification.

When exposed to ammonia gas, the MOF in this study, mCBMOF-1, showed a carbon uptake capacity comparable to or greater than that of the traditional amine-based sorbents that are widely used for carbon dioxide capture in industrial applications. And compared to amine-based sorbents, MOFs are more stable and can be regenerated using less energy -- in this case, by immersion in water.

"The MOF is activated by removing water molecules to expose four closely positioned open copper sites," Stylianou said. "Then we introduce the ammonia gas, which causes one of the sites to be occupied by an ammonia molecule. The remaining sites attract CO2, promoting interaction with ammonia to form carbamate species."

The carbamates -- compounds with a range of uses in industry, agriculture and medicine -- are released during the water immersion that regenerates the MOF's pristine structure, making it reusable for ongoing carbon capture.

The findings emphasize that MOF structures can be tailored with functional groups to enhance their interactions with specific target molecules, such as carbon dioxide, Stylianou said; similar strategies could be applied to other MOFs and gases.

"Our study's use of sequential pore functionalization to enhance CO2 uptake without significantly increasing regeneration energy is a terrific development," he said. "The formation of a copper-carbamic acid complex within the pores suggests strong and selective interactions with CO2, which is crucial for ensuring that CO2 is preferentially adsorbed over other gases in flue emissions."

The study, published in JACS Au, was supported by Saudi Aramco and Baydin Inc.

Collaborators included Oregon State University graduate student Ankit Yadav and postdoctoral scholar Andrzej Gladysiak as well as scientists from the University of California, Berkeley, Nanjing Normal University and the Institute of Materials Science of Barcelona.

Science Daily, 3 December 2024

https://sciencedaily.com

China bans sale of three critical elements and 'superhard materials' to the US

2024-12-06

The Chinese government has banned the export of critical minerals to the US that are crucial for semiconductors, military equipment and other industries. The critical elements include gallium, germanium, antimony and 'superhard materials' such as diamond, cubic boron nitride and other related materials.

The 3 December announcement by China's Ministry of Commerce appears to be in response to new US restrictions on exports of certain semiconductor equipment to China, which were announced by the US Commerce Department the previous day.

Gallium and germanium have unique properties that make them important components in semiconductors and essential for manufacturing various other modern technologies. Antimony – a metalloid – is mostly used in flame retardants and lead-acid batteries, but also for various military applications like night vision goggles, explosives, nuclear weapons production and infrared sensors, according to the US International Trade Commission. China produces 98% of the world's gallium.

In its announcement, China also stated that when it comes to exporting other so-called 'dual-use items', which can have military as well as civilian uses, such as graphite, a 'stricter end-user and end-use review' will be implemented.

'China has lodged serious protests with the US for once again updating the export controls on semiconductors and sanctioning Chinese companies, and maliciously suppressing China's technology progress,' Chinese foreign ministry spokesperson Lin Jian stated during a press conference on 3 December. 'Such practices gravely disrupt the international economic and trade order, destabilise global industrial and supply chains, and harm the interests of all countries.'

Recent analysis by the US Geological Survey (USGS) estimated that there could be a $3.4 billion (£2.7 billion) decrease in US GDP if China implements a total ban on exports of gallium and germanium. 'Losing access to critical minerals that make up a fraction of the value of products like semiconductors and LEDs can add up to billions of dollars in losses across the economy,' warned Nedal Nassar, who heads minerals intelligence research at the USGS and was the report's lead author.

US president-elect Donald Trump, who assumes the White House helm on 20 January, has announced plans to levy an additional 10% tariff on goods coming into the US from China.

Chemistry World, 6 December 2024

https://chemistryworld.com

Study Captures the Aging Process of Muscles at the Cellular Level

2024-12-03

As muscles age, their cells lose the ability to regenerate and heal after injury. Cornell Engineering researchers have created the most comprehensive portrait to date of how that change, in mice, unfolds over time and across the complicated architecture of muscle tissue.

"The fundamental question that drove the initial study was really a question that had perplexed the skeletal muscle biology community," said Ben Cosgrove, associate professor in the Cornell Meinig School of Biomedical Engineering and the paper's senior author. "Does the decline in regeneration seen in old muscles come from changes to the stem cells that drive the repair process themselves, or does it come from changes in the way that they are instructed by other cell types?"

In their study, "Transcriptomic Analysis of Skeletal Muscle Regeneration Across Mouse Lifespan Identifies Altered Stem Cell States," published Nov. 22 in Nature Aging, researchers sampled cells from young, old and geriatric mice at six time points after inducing injury via a variant of snake venom toxin. They identified 29 defined cell types, including immune cells that exhibited differences in their abundance and reaction time between age groups, and muscle stem cells that self-renew in youth but stall out as muscles age.

The detailed assessment of many cell types over time showed discoordination in the process of muscle repair in older mice. Many immune cells, which coordinate tissue repair, show up at the wrong time.

"There's too many of them or too few of them," Cosgrove said. "The immune cells are playing the wrong music. They're out of step with each other in the older muscles."

The research team used a novel method to evaluate senescence – when a cell can no longer divide.

"We developed what we are calling a transfer-learning based method," said lead author Lauren Walter, Ph.D. '24, a doctoral student in Cosgrove's lab at the time of the study. "We used an existing list of genes to score a cell's senescence status and then used that methodology to evaluate senescence across age and regeneration time point."

The study provides a better understanding of the interactions between cell types and how they induce senescence, which could inform efforts to develop drugs that target senescent cells.

"What our dataset provides is a rich template to really investigate what would be the benefits or detriments of removing senescent cells from tissues," Cosgrove said. "The reason why people do this in mouse models is that we can really test out those hypotheses directly so that we can better understand the benefits of targeting senescent cells to improve the repair processes in older individuals."

Technology Networks, 3 December 2024

https://technologynetworks.com

Straining a material's atomic arrangement may make for cleaner, smarter devices

2024-12-05

What's the best way to precisely manipulate a material's properties to the desired state? It may be straining the material's very atoms, according to a team led by researchers at Penn State. The team discovered that "spray painting" atoms of potassium niobate, a material used in advanced electronics, could tune the resulting thin films with exquisite control.

The finding, published in Advanced Materials, could drive environmentally friendly advancements in consumer electronics, medical devices and quantum computing, the researchers said.

The process, called strain tuning, alters a material's properties by stretching or compressing its atoms. The researchers use molecular beam epitaxy (MBE), a technique that involves depositing a layer of atoms on a substrate to form a thin film. In this case, they produced a thin film of strain-tuned potassium niobate.

"This was the first time potassium niobate has been grown using MBE," Gopalan said. "The technique is like spray-painting atoms onto a surface."

According to the researchers, the novel MBE technique itself creates the strain needed to tune the material.

"This method allows the atoms in the thin films to adjust to the underlying material's structure, causing strain," said co-author Sankalpa Hazra, doctoral candidate in materials science and engineering.

"Even a tiny stretch of about 1% can create pressure that would be impossible to achieve by simply pulling or pressing on the material from the outside. This pressure can significantly improve how the material works from a ferroelectric perspective."

Potassium niobate is ferroelectric, or a class of materials with a natural electric charge that can be reversed by applying an external electric field, much like how magnets have a magnetic field that can be flipped.

"Ferroelectrics are sort of like a mini battery that is already charged up permanently by nature," said Venkatraman "Venkat" Gopalan, a professor of materials science and engineering at Penn State and corresponding author of the study.

"Despite not being a household name, ferroelectrics are everywhere in key technologies we take for granted in our daily lives. The internet, for example, relies on converting electrical to optical signals, which is performed by a ferroelectric crystal. These materials can reverse their electric polarity when exposed to an external electric field, a quality that also makes them vital for devices like ultrasound equipment, infrared cameras and precision actuators for advanced machinery."

To "spray paint" the potassium niobate for the study, Gopalan turned to a former Penn State colleague, Darrell Schlom, who is currently the Tisch University Professor in the Department of Materials Science and Engineering at Cornell University. They grew the thin films at the Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM) thin film growth facility, which Schlom co-directs at Cornell. Schlom noted that both he and Gopalan worked at Penn State on the first-ever strain tuning of ferroelectric materials approximately 15 years ago.

"Our role was to help Venkat and Sankalpa realize this material that Venkat has been dreaming about for decades now," Schlom said. "Venkat made thin films of this material during his doctoral work at Penn State, so he knows just how challenging it can be to grow it. For this work, my student Tobias Schwaigert and I helped them grow this material."

Schlom explained that strain engineering works by layering two materials of slightly dissimilar sizes. Imagine raining down atoms onto a surface comprising the same type of atoms but spaced a little differently. If the layer being added is thin enough, it will stretch or compress slightly to match the surface below it.

The small change in spacing creates a strain in the material, similar to how a rubber band stretches when pulled. This strain, controlled by the size and spacing of the atoms on the surface, is what leads to changes in the material's properties, like increasing its temperature limits or improving its ferroelectric performance.

"The superior strength of coupling between strain and polarization in potassium niobate compared to other ferroelectrics allows for a unique opportunity where relatively small amounts of strength can result in colossal tuning of both the ferroelectric structure and polarization of it," Hazra said.

"A primary consequence of this superior strain sensitivity is that the ferroelectric performance of potassium niobate can be remarkably enhanced even surpassing those of lead titanate or lead zirconate titanate, which are considered to be industrial standard levels of ferroelectricity for device applications."

Demonstrating the strain tuning of potassium niobate is particularly noteworthy, Hazra said, because potassium niobate is lead-free. While lead raises human toxicity and environmental concerns, the best ferroelectric materials—such as lead titanate and lead zirconate titanate—tend to include lead.

Without strain tuning, potassium niobate's ferroelectric properties tend not to be as strong as its lead counterparts, but Hazra said the current study shows the potential of potassium niobate as a strong, yet environmentally friendly and safe, ferroelectric material.

According to Hazra, the research team also discovered that strain tuned-potassium niobate's ferroelectric performance remained stable even at high temperatures. Typically, ferroelectric materials, when heated, lose their polarization—meaning they are no longer able to switch their electrical charge.

"In our work, we've shown that applying strain can increase the temperature at which the material loses its ferroelectric properties," Gopalan said. "What's even more impressive is that with just a 1% strain,

we can push that temperature to over 975 degrees Kelvin, which is close to the point where the material starts to degrade."

Next, the researchers need to overcome what they called a "serious hurdle" for practical applications: growing these thin films on silicon, which is widely used in the electronics industry. Gopalan's team is also working on improving the electrical properties of the material by fine-tuning the film growth process. This would enable the use of strain-tuned potassium niobate in practical devices, such as high-temperature memory storage for space exploration, quantum computing and more environmentally friendly high-tech devices.

"With further development, this novel version of the material could become a key player in the next generation of green, high-performance technologies that impact everything from our personal devices to space exploration," Gopalan said.

Phys Org, 5 December 2024

https://phys.org

Cellulose and chitin foam can remove nearly all microplastics from water

2024-12-06

A foam made of cellulose and chitin can remove up to 99.9% of microplastics from water and maintains efficiency after multiple cycles of use.

Microplastic pollution in terrestrial and aquatic environments is escalating at a significant rate and the development of universal approaches for remediation are urgently needed. To find a solution, the team of researchers, who were based in China, set out to design a sustainable and adaptable adsorbent material through supramolecular self-assembly of two of the most abundant polysaccharides in nature: chitin, derived from squid, and cellulose, from cotton.

The resulting biopolymer foam had a highly porous, interconnected structure, with a negatively and positively charged surface, and numerous active sites which, the researchers explained, assured 'multilevel interactions for efficient microplastic removal'.

During initial testing they found that the material was able to efficiently adsorb tiny particles of polystyrene, polymethyl methacrylate,

polypropylene and polyethylene terephthalate owing to multiple intermolecular interactions occurring between the foam and the plastics.

They then investigated whether the foam would perform well in samples of irrigation, lake and coastal water – containing a variety of toxic metals, chemical dyes and other pollutants – and found that the material removed microplastics with 98%–99.9% efficiency. Even after five cycles, the foam had a removal efficiency of between 95% and 98%.

They also found that it had enhanced adsorption performance when coexisting with bacteria and lead(II) in the water.

Chemistry World, 6 December 2024

https://chemistryworld.com

Newly-Designed Nanocrystals Kill Bacteria Under Visible Light

2024-11-28

Newly developed halide perovskite nanocrystals (HPNCs) show potential as antimicrobial agents that are stable, effective and easy to produce. After almost three years, Rice University scientist Yifan Zhu and colleagues have developed a new HPNC that is effective at killing bacteria in a biofluid under visible light without experiencing light- and moisture-driven degradation common in HPNCs. A new method using two layers of silicon dioxide that Zhu and colleagues developed over years of work was used in experiments with lead-based and bismuth-based HPNCs to test their antimicrobial efficacy and stability in water. The study is published in Nano Letters.

HPNCs have unique optical and electrical properties that make them promising candidates for solar power applications, bioimaging and photocatalysis, the acceleration of chemical reactions caused by light in the presence of a catalyst. One such reaction is the production of reactive oxygen species that can inactivate biological contaminants in fluids. However, perovskites are highly prone to degradation in water and biological fluids, limiting their potential in biomedical applications.

"The drawback with these materials has been stability. They're cheap and easy to make but prone to degradation," said study co-author Jun Lou, professor and associate chair of materials science and nanoengineering.

The potential for HPNCs to eliminate contaminants from water has taken center stage in recent years with rising concerns about emerging

pathogens and increasing rates of antibiotic resistance. Research has found that HPNCs can kill bacteria in aqueous environments by producing reactive oxygen species when exposed to light. Reactive oxygen species like singlet oxygen and hydroxide react with the proteins, lipids and genetic material in bacterial cells, effectively destroying them.

In their early attempts to produce a coated HPNC, the researchers used a single layer of silicon dioxide, a material that would protect the perovskite while allowing light transmission. However, a single layer had limited effectiveness with HPNCs losing 63% of their antimicrobial ability within one day. But a thicker layer could hinder or even prevent HPNCs' mechanism of action.

"Transfer of energy from perovskites can produce reactive oxygen species," said Zhu, a postdoctoral research associate in Lou's lab. "The challenge is to get the right thickness to protect the perovskite while still allowing energy transfer."

Zhu and colleagues next developed a method that coated the HPNCs in two layers of silicon dioxide. After multiple attempts the research team devised a strategy to consistently get optimal thicknesses for both layers.

"Two coats are more effective than one thicker coat," said Lou. "It's not just an extension of thickness. We needed a strategy because the coating has to be processed in specific ways."

Next the researchers tested the antimicrobial properties and durability of their new double-coated HPNCs. They selected lead and bismuth because HPNCs made with both metals are highly effective under visible light and produce singlet oxygen rather than hydroxide, which can be harmful to other organisms. Zhu and colleagues found that both HPNC varieties showed little to no antimicrobial properties without light. However, under relatively low levels of visible light, both HPNCs destroyed more than 90% of the E. coli bacteria in the solution after six hours. Additionally, both HPNCs showed very little degradation over the four-day test period.

The double-layer silicon dioxide coating proved effective at protecting HPNCs from degradation while allowing energy transfer; however, the researchers also noted an additional benefit from the coating. Analysis found that after four days in water, the lead-based HPNCs had leached only a small amount of lead into their surroundings.

"The leaching amount of lead was well below (World Health Organization) limits," Zhu said.

The lead-based HPNCs had the best antimicrobial performance, but the bismuth-based materials also performed well.

"The benefit of bismuth is avoiding the use of lead, which is always a concern if put into the body," said Lou. "You want to find the right balance with a material that has good enough performance and that is safe."

The study findings show that HPNCs coated with two layers of silicon dioxide have the potential for use as photocatalytic antimicrobial agents. Eliminating organic contaminants like bacteria in water makes these materials a good candidate for use in water treatment. Further research could also lead to HPNCs that can address other water contaminants and even be used in therapeutics in the future. Such materials will need to undergo further testing under real-life conditions in the field and pass safety tests. However, the findings suggest that HPNCs could be useful in a variety of applications.

"After many years of investment in research into these materials, they are approaching reality," Lou said.

Technology Networks, 28 November 2024

https://technologynetworks.com

Fast-curing silicone ink opens new doors in 3D printing

2024-12-02

Researchers at Lawrence Livermore National Laboratory (LLNL) have developed a new method to 3D print sturdy silicone structures that are bigger, taller, thinner and more porous than ever before.

The team's two-part "fast cure" silicone-based ink for direct ink writing mixes just before printing and sets quickly at room temperature, allowing for longer print times, simplifying the fabrication process, and ensuring structures will not collapse or sag, even in complex shapes and configurations.

Their research appears on the front cover of the October issue of Advanced Materials Technologies.

"There are other methods for silicone direct-ink writing, but this is the simplest solution and the bulletproof one," said Anna Güell Izard, a postdoc in the Materials Engineering Division (MED) and the paper's first author. "There is nothing extra to worry about; you can just print."

Printing made easy

Silicone is a widely used polymer known for its flexibility, resilience and biocompatibility, making it ideal for protective materials, biomedical devices—especially implants and prostheses—flexible electronics, soft robotics and more. 3D printing, a type of additive manufacturing, makes the material even more versatile by fabricating hollow or porous structures that traditional manufacturing cannot.

Direct ink writing (DIW)—where material is forced (extruded) through a nozzle and selectively deposited layer by layer—works best for printing highly viscous materials like silicone. Still, this technique is limited to only manufacturing relatively simple, planar designs due to the low self-supporting capabilities of silicone-based "inks," making it impossible to print tall, overhanging or thin-walled structures.

For a successful print, the machine's accuracy, nozzle quality and ink properties also all need to be perfect, and the structures need to remain stable enough to support their own weight throughout printing and thermal curing in an oven. Printing also needs to finish before the ink begins to set, making it difficult to extrude. The team looked to address these challenges with a novel ink formulation and refined printing process.

Silicone inks contain a catalyst (which speeds up a chemical reaction) and a crosslinker (a substance that chemically joins molecules together) that slowly "gel" together to bind structures.

Like a two-part epoxy, the team's "Fast Cure" (FC) ink separates the cross-linker and catalyst until just before extrusion, when they are continuously mixed as they flow through the nozzle in a process called inline mixing. The chemicals then gel quickly and solidify right away, eliminating print time restrictions, as well as the need for extra steps to harden or cure the materials.

"Since the ink is kept separate, you don't have to worry about the print time because it is not going to solidify in the syringes," said Güell Izard. "It's also sturdier because the layers are gelling as you're printing, so your structure will not start sagging."

Printing the impossible

The FC formulation allows researchers to control the mix-to-print-to-cure time, resulting in increased self-supportive capabilities and improved shape retention. Compared with a one-part baseline, the FC ink had similar rheological (flow) properties and printed two types of woodpiles (a common shape in silicone DIW) that held their shape better and sagged roughly half as much.

Excited with these results, Güell Izard and the team "went crazy" with their discovery and printed configurations that were previously unattainable with silicone such as tall and slender structures, acute and unsupported overhangs and shell-based lattices like gyroids and cubic octets with porosities (empty spaces or voids) of up to 90%.

"These beautiful cubic octets and overhangs turned out of the oven exactly as I printed them with the walls totally firm, while the baseline ink structures collapsed," she said. "It made us feel like we were onto something; that all this magic chemistry was doing its job."

The next steps are testing the limits of the technology and leveraging the two-part setup to fine-tune the ink's properties. For example, the team noted that gel time depends on the amount of catalyst present, so the chemical may have an important role in determining a structure's height and overhanging features. Güell Izard and the team also hope to apply

the concept to other materials and unlock a similarly wide range of new structures.

Phys Org, 2 December 2024

https://phys.org

Window coating reflects heat to cool buildings by 40 degrees

2024-11-15

Cranking up the air conditioner is one way to keep buildings cool, but it guzzles energy. Passive materials can regulate interior temperatures more efficiently, and now scientists in South Korea have developed a new coating that keeps glass much cooler, while still being transparent.

Windows are great for filling rooms with natural light, but they're also a major portal for messing with temperature. When it's cold out, about 30% of the interior heat can escape through the windows, while in hotter times about 76% of the sunlight that hits windows enters as heat.

That's why it's important to plug this gap, ideally without ruining what makes windows appealing in the first place. A new coating, created by researchers at POSTECH and Korea University, could help do just that.

The team designed a material that can radiate heat away while allowing visible light to pass through. It's made up of three layers that have different roles. The topmost layer is polydimethylsiloxane (PDMS), which emits far-infrared radiation, which is felt as heat. The center is a thin layer of silver, which reflects most of the rest of the solar spectrum – however, it's full of micro-scale holes, to allow visible light to pass through.

The third layer is what's called a Bragg mirror, which has been specially designed to reflect wavelengths of the near infrared spectrum, which constitute most of sunlight's heat. This is made up of alternating layers of titanium dioxide and magnesium fluoride.

In tests, the new material was found to keep a glass surface an astonishing 22.1 °C (39.8 °F) cooler than glass coated with just PDMS. That's among the largest cooling effects we've seen with this kind of coating.

The hope is that this material could be applied to windows to keep building interiors cooler without sacrificing light, reducing our reliance on heating and cooling systems that can chew through electricity.

"This technology is ready for mass production and has significant potential in architecture and environmental applications," said Professor Junsuk Rho, corresponding author of the study. "Most importantly, it efficiently dissipates heat and reduces energy consumption, positioning it as a key technology for a sustainable future."

The research was published in the journal Advanced Functional Materials.

New Atlas, 15 November 2024

https://newatlas.com

This "Good" Health Metric Was Just Linked with Elevated Alzheimer's Risk, Research Finds

2024-01-08

It's classically associated with heart health, but a new Australian study finds a mysterious connection that science may need to further probe.

When we think of cholesterol, we tend to associate the concept of it with our hearts and circulatory systems. When a healthcare provider checks your cholesterol levels, they will analyze your cardiovascular disease risk based on the total cholesterol, HDL (high-density lipoprotein), LDL (low-density lipoprotein), and triglyceride numbers.

Generally, HDL, which is often called the "good" cholesterol, is considered protective of arteries at a higher level, while elevated LDL is considered to be problematic and potentially artery-clogging.

A November 2023 study in a regional edition of the prestigious peer-reviewed medical journal, The Lancet, suggests that the "good" HDL could potentially spell bad news for older adults who want to prevent cognitive decline or Alzheimer's. Researchers from top universities in Australia were guided by several studies which had shown that very high levels of HDL were associated with several conditions that can worsen an individual's quality of life, including macular degeneration of the eyes, sepsis and bone fractures, and that HDL levels of this nature could even shorten lifespan.

In addition, while higher levels of HDL cholesterol have been shown to reduce heart-related issues, some research had suggested that high levels of HDL may be associated with dementia in people aged 47 to 68 years. The researchers in this study wanted to see if the same rang true for those most highly at risk for cognitive decline, namely people over the age of 65. This later-onset dementia, they theorized, might be different than the earlier-onset type.

Curiosities

More than 18,000 participants in the study over the age of 65 were evaluated for their cholesterol levels and took a mental acuity test. Then, they were reevaluated every two years. If their performance fell below a certain threshold on the test or they were diagnosed in some other way with cognitive decline, that was documented as dementia.

The researchers discovered that high HDL levels were associated with all forms of dementia in middle-aged and elderly participants. However, those who were 75 years and older saw the greatest risk in relation to high HDL levels.

If you're curious about the HDL numbers that caused concern, the research suggested the "danger zone" for HDL cholesterol appeared to be levels of 80 milligrams deciliter (mg/dL) or greater, resulting in a 27% higher risk for all age groups. (View our cholesterol chart by age to see where experts suggest your levels should fall.) With an adjusted model that took into account different mitigating factors like gender, economic status and lifestyle choices such as smoking and alcohol consumption and exercise habits, the outlook was even worse for those over 75, who saw an estimated 42% increase in dementia risk with the higher HDL readings.

So what gives? Should people who are trying to protect their hearts and their memories while they age eschew cholesterol readings entirely? The researchers emphasize that the study has limitations, and the mechanism causing the association between cholesterol and cognitive decline is unclear. "The possibility also exists that increased dementia and very high HDL are both consequences of a separate and unrelated pathology," they surmised. Plus, other studies have found a protective effect from higher HDL levels. In addition, heavy alcohol use can cause higher HDL levels, but can certainly have negative effects on aging brains, and that nuance might not have been captured in the study.

Overall, a healthy diet low in saturated fat and a regular pattern of exercise is still recommended to optimize cholesterol numbers. The people who exhibited the greatest cognitive decline in the study were less physically active and more frail in general; they also tended to skew female.

The people with HDL levels over 80 mg/dL generally had healthier hearts, were more physically active, and had lower rates of high blood pressure,

diabetes, and kidney disease—all of which have been tied to better brain health in later years.

The Healthy, 8 January 2024

https://thehealthy.com

Machine learning helps optimize polymer production

2024-12-02

Polymers, such as plastics, are essential in many aspects of life and industry, from packaging and cars to medical devices and optic fibers. Their value comes from diverse properties that are largely determined by their monomers—the single chemical units—that make up a polymer. Unfortunately, it can be challenging to control the chemical behavior of monomers during manufacturing to achieve a desired outcome.

Now, a team of researchers led by Professor Mikiya Fujii of the Nara Institute of Science and Technology in Japan have used machine learning to mathematically model the polymerization process and reduce the need for time-consuming and expensive experimentation.

Their results have been published in the journal Science and Technology of Advanced Materials: Methods.

Machine learning algorithms need data, so the researchers designed a polymerization process that would quickly and efficiently generate experimental data to feed into the mathematical model. The target molecule was a styrene-methyl methacrylate co-polymer, which was made by mixing styrene and methyl methacrylate monomers, both already dissolved in a solvent with an added initiator substance, then heating them in a water bath.

The team also used a method called flow synthesis, in which the two monomer solutions are mixed and heated in a constant flow. This allows for better mixing, more efficient heating, and more precise control of heating time and flow rate, which makes it ideal for use with machine learning.

The modeling evaluated the effect of five key variables in the polymerization process: the concentration of the initiator, the ratio of solvent to monomer, the proportion of styrene, the temperature of the reaction, and the time spent in the water bath. The goal was to have an end product with as close to 50% styrene as possible.

Once enough experimental data was available, the machine learning process took only five cycles of calculation to achieve the ideal proportion of styrene to methyl methacrylate.

The results showed that the key was a lower temperature and longer time in the water bath, as well as lowering the relative concentration of the monomer in the solvent. The researchers were surprised to discover that the solvent concentration was just as important as the proportion of monomers going into the mix.

"Our results demonstrate that machine learning not only can explicitly reveal what humans may have implicitly taken for granted but can also provide new insights that weren't recognized before," Professor Mikiya Fujii says.

"The use of machine learning in chemistry could open the door for smarter, greener manufacturing processes with reduced waste and energy consumption."

Phys Org, 2 December 2024

https://phys.org

The FDA Outlawed a Soda Ingredient Banned Around The World. Here's Why.

2024-12-03

An ingredient once commonly used in citrus-flavored sodas to keep the tangy taste mixed thoroughly through the beverage was finally banned for good across the US this year.

The FDA revoked the registration of a modified vegetable oil known as BVO in the wake of recent toxicology studies.

"The proposed action is an example of how the agency monitors emerging evidence and, as needed, conducts scientific research to investigate safety related questions, and takes regulatory action when the science does not support the continued safe use of additives in foods," James Jones, FDA deputy commissioner for human foods, explained when announcing the proposal in 2023.

BVO, or brominated vegetable oil, was used as an emulsifying agent since the 1930s to ensure citrus flavoring agents don't float to the top of sodas. Sticking a dozen bromine atoms to a triglyceride creates a dense oil that floats evenly throughout water when mixed with less dense fats.

Yet that's not BVO's only trick. Animal studies have strongly implied the compound can slowly build up in our fat tissues. With bromine's potential ability to prevent iodine from doing its all-important work inside the thyroid, health authorities around the world have been suspicious of the emulsifier's risks for decades.

In fact, BVO was already banned in many countries, including India, Japan, and nations of the European Union, and was outlawed in the state of California in October 2022 with legislation due to take effect in 2027.

Yet the FDA was slow to convince. In the 1950s, the agency regarded the ingredient as generally recognized as safe (GRAS); an official classification afforded items that have either been appropriately tested or – for ingredients in common use prior to 1958 – don't appear to be harmful.

That changed the following decade when questions were raised over its possible toxicity, prompting the FDA to overturn its GRAS classification for BVO and temporarily limit its use to relatively small concentrations of no more than 15 parts per million exclusively in citrus-flavored drinks.

Data on the risks posed by even these small amounts of BVO over time hasn't been easy to collect, relying heavily on long-term studies that re-evaluate health effects in a significantly-sized sample of people. Yet the evidence slowly mounted.

A UK study in the 1970s found bromine was building up in human tissues, with animal studies linking high concentrations of BVO with heart and behavioral problems.

It took time, and a number of further studies, but on the back of more recent animal studies based on relative concentrations of BVO humans are likely to ingest, the FDA was finally convinced there was sufficient evidence to ban its use altogether.

Most major soda drink companies are fortunately ahead of the game. PepsiCo and Coca-Cola Co. have been phasing the ingredient out of their products over the past decade.

"Over the years many beverage makers reformulated their products to replace BVO with an alternative ingredient, and today, few beverages in the US contain BVO," said Jones.

With suitable alternatives to BVO already being used to make citrus drinks around the world taste tangy down to the very last drop, the ingredient isn't likely to be missed.

An earlier version of this article was published in November 2023, and has since been amended to reflect an update on the FDA decision in July 2024.

Science Alert, 3 December 2024

https://sciencealert.com

Turning Pollution Into Profit: Scientists Solve Decades-Old Catalyst Deactivation Problem

2024-12-04

ORNL researchers created a durable zeolite catalyst that converts methane and carbon dioxide into syngas without degradation at high temperatures. This innovation could revolutionize sustainable chemical production and industrial catalysis.

A chemical reaction capable of transforming two harmful greenhouse gases into valuable components for cleaner fuels and feedstocks faces a challenge: the high temperatures needed for the reaction deactivate the catalyst. Researchers at the Department of Energy's Oak Ridge National Laboratory have developed a solution to prevent this deactivation. This approach could have broader applications for other catalysts as well.

The team improved a reaction called dry reforming of methane that converts methane and carbon dioxide into syngas, a valued mixture of hydrogen and carbon monoxide used by oil and chemical companies worldwide. The team has applied for a patent for their invention as a way to minimize catalytic deactivation.

"Syngas is important because it's a platform for the production of a lot of chemicals of mass consumption," said ORNL's Felipe Polo-Garzon, who, with ORNL's Junyan Zhang, led the study published in Nature Communications.

Improving the catalyst that speeds syngas production could have an enormous impact on global energy security, cleaner fuels, and chemical feedstocks. In countries lacking oil reserves, syngas derived from coal or natural gas is critical for making diesel and gasoline fuels. Moreover, syngas components can be used to make other commodity chemicals. Hydrogen, for example, can be used as a clean fuel or as a feedstock for ammonia to create fertilizer. Methanol, an alcohol that can be made from syngas, is a source of ingredients for producing plastics, synthetic fabric's and pharmaceuticals. Methanol is also a good carrier of hydrogen, which is hard to pressurize and dangerous to transport. As the simplest alcohol,

methanol contains the highest ratio of hydrogen to carbon; it can be safely transported and converted to hydrogen at the destination.

"This [dry reforming of methane] reaction sounds attractive because you are converting two greenhouse gases into a valuable mixture," Polo-Garzon said. "However, the issue for decades has been that the catalysts required to carry out this reaction deactivate quickly under reaction conditions, making this reaction nonviable on an industrial scale."

Challenges in High-Temperature Catalysis

To attain significant conversion of reactants, the reaction must be conducted at temperatures greater than 650 degrees Celsius, or 1,200 degrees Fahrenheit. "At this high temperature, the catalysts undergo two deactivation processes," Polo-Garzon said. "One is sintering, in which you lose surface sites that undertake the reaction. The other is the formation of coke — basically solid carbon that blocks the catalyst from contacting the reactants."

Catalysts work by providing a large surface area for reactions. Metal atoms such as nickel have electronic properties that allow them to temporarily bind reactants, making chemical bonds easier to break and create. Sintering causes nickel particles to clump, reducing the surface area available for chemical reactions.

Likewise, coking chokes a catalyst. "During the reaction on the catalyst surface, methane will lose its hydrogen atoms one by one until only its one carbon atom is left," Zhang said. "If no oxygen bonds to it, leftover carbon will aggregate on the catalyst's nickel surface, covering its active face. This coking deposition causes deactivation. It is extremely common in thermal catalysis for hydrocarbon conversion."

Today, most commercial syngas is made by steam reforming of methane, a process that requires large amounts of water and heat and that also produces carbon dioxide. By contrast, dry reforming of methane requires no water and actually consumes carbon dioxide and methane.

By tuning interactions between the metal active sites and the support during catalyst synthesis, the scientists suppressed coke formation and metal sintering. The new catalyst provides outstanding performance for dry reforming of methane with extremely slow deactivation.

The novel catalyst consists of a crystalline material called a zeolite that contains silicon, aluminum, oxygen, and nickel. The zeolite's supportive framework stabilizes the metal active sites.

"Zeolite is like sand in composition," Zhang said. "But unlike sand, it has a sponge-like structure filled with tiny pores, each around 0.6 nanometers in diameter. If you could completely open a zeolite to expose the surface area, 1 gram of sample would contain an area around 500 square meters, which is a tremendous amount of exposed surface."

To synthesize the zeolite catalyst, the researchers remove some atoms of aluminum and replace them with nickel. "We're effectively creating a strong bond between the nickel and the zeolite host," Polo-Garzon said. "This strong bond makes our catalyst resistant to degradation at high temperatures."

The high-performance catalyst was synthesized at ORNL's Center for Nanophase Materials Sciences. Zili Wu, leader of ORNL's Surface Chemistry and Catalysis group, served as a strategy advisor for the project.

Zhang performed infrared spectroscopy, revealing that nickel was typically isolated and bound by two silicon atoms in the zeolite framework.

At DOE's Brookhaven National Laboratory and SLAC National Accelerator Laboratory, ORNL's Yuanyuan Li led X-ray absorption spectroscopy studies detailing the electronic and bonding structures of nickel in the catalyst. At ORNL, Polo-Garzon and Zhang used a technique called steady-state isotopic transient kinetic analysis to measure catalyst efficiency — the number of times a single active site converts a reactant into a product.

X-ray diffraction and scanning transmission electron microscopy characterized the structure and composition of materials at the nanoscale.

Broad Applications and Future Research

"In the synthesis method, we found that the reason the method works is because we're able to get rid of water, which is a byproduct of the catalyst synthesis," Polo-Garzon said. "We asked colleagues to use density functional theory to look into why water matters when it comes to the stability of nickel."

At Vanderbilt University, Haohong Song and De-en Jiang performed computational calculations showing that removing water from the zeolite strengthens its interactions with nickel.

Next, the researchers will develop other catalyst formulations for the dry reforming of methane reaction that are stable under a broad range of conditions. "We're looking for alternative ways to excite the reactant molecules to break thermodynamic constraints," Polo-Garzon said.

"We relied on rational design, not trial and error, to make the catalyst better," Polo-Garzon added. "We're not just developing one catalyst. We are developing design principles to stabilize catalysts for a broad range of industrial processes. It requires a fundamental understanding of the implications of synthesis protocols. For industry, that's important because rather than presenting a dead-end road in which you try something, see how it performs, and then decide where to go from there, we're providing an avenue to move forward."

Sci Tech Daily, 5 December 2024

https://scitechdaily.com

Catalyst shows promise for efficient CO_2 desorption

2024-12-02

Scientists have developed a ZrO2/Al2O3 packing catalyst that could significantly enhance the efficiency of CO2 desorption, as reported in a study published in Engineering.

The paper is titled "Efficient CO2 Desorption Catalysts: from Material Design to Kinetics Analysis and Application Evaluation."

The research team from Tsinghua University and North China Electric Power University focused on the challenge of energy-intensive CO2 capture via amine scrubbing. The traditional process requires large amounts of high-enthalpy steam for solvent regeneration, leading to high costs.

Heterogeneous catalysis has emerged as a potential solution, but existing studies have mainly focused on powder catalysts, with limited attention to practical applications and long-term durability.

The newly developed ZrO2/Al2O3 catalyst was synthesized using a hydrothermal method. It exhibits strong metal oxide-support interactions, a porous structure, and active Zr–O–Al coordination. These properties promote proton transfer and significantly reduce the energy activation of carbamate decomposition by 40.7%, accelerating CO2 desorption kinetics.

Laboratory and bench-scale demonstrations were conducted to evaluate the catalyst's performance. The results showed that using the packing catalyst can reduce energy consumption by 27.56% and optimize the overall cost by 10.49% based on industrial flue gas. The catalyst also demonstrated excellent stability in alkaline solvents, with negligible metal ion leaching and no adverse effects on the amine solvent structure.

The study further investigated the catalyst's mechanism. Density functional theory calculations revealed that the Zr–O–Al structure enhances the adsorption and activation of H2O molecules, facilitating proton transfer and carbamate decomposition. The catalyst's performance was also compared with other metal oxide catalysts, and it was found to be more efficient in alkaline environments.

Process simulation and economic–environmental evaluation were carried out using Aspen Plus software. The results indicated that the catalytic filler can improve CO2 capture performance, with an optimal catalytic dosage of 60% achieving the highest desorption amount and capture efficiency while minimizing heat duty. The catalytic regeneration process can also reduce the total capture cost and increase CO2 emission reduction.

This research represents a significant step forward in the development of efficient CO2 capture technologies. The ZrO2/Al2O3 catalyst shows great potential for industrial applications, offering a more sustainable and cost-effective solution for reducing CO2 emissions. Future studies may focus on further optimizing the catalyst's performance and exploring its scalability for large-scale industrial use.

Phys Org, 2 December 2024

https://phys.org

A catalyst can turn methane into something useful

2024-12-04

Although it is less abundant than carbon dioxide, methane gas contributes disproportionately to global warming because it traps more heat in the atmosphere than carbon dioxide, due to its molecular structure.

MIT chemical engineers have now designed a new catalyst that can convert methane into useful polymers, which could help reduce greenhouse gas emissions.

"What to do with methane has been a longstanding problem," says Michael Strano, the Carbon P. Dubbs Professor of Chemical Engineering at MIT and the senior author of the study. "It's a source of carbon, and we want to keep it out of the atmosphere but also turn it into something useful."

The new catalyst works at room temperature and atmospheric pressure, which could make it easier and more economical to deploy at sites of methane production, such as power plants and cattle barns.

Daniel Lundberg PhD '24 and MIT postdoc Jimin Kim are the lead authors of the study, which appears in Nature Catalysis. Former postdoc Yu-Ming Tu and postdoc Cody Ritt also authors of the paper.

Capturing methane

Methane is produced by bacteria known as methanogens, which are often highly concentrated in landfills, swamps, and other sites of decaying biomass. Agriculture is a major source of methane, and methane gas is also generated as a byproduct of transporting, storing, and burning natural gas. Overall, it is believed to account for about 15 percent of global temperature increases.

At the molecular level, methane is made of a single carbon atom bound to four hydrogen atoms. In theory, this molecule should be a good building block for making useful products such as polymers. However, converting methane to other compounds has proven difficult because getting it to react with other molecules usually requires high temperature and high pressures.

To achieve methane conversion without that input of energy, the MIT team designed a hybrid catalyst with two components: a zeolite and a naturally occurring enzyme. Zeolites are abundant, inexpensive clay-like minerals, and previous work has found that they can be used to catalyze the conversion of methane to carbon dioxide.

In this study, the researchers used a zeolite called iron-modified aluminum silicate, paired with an enzyme called alcohol oxidase. Bacteria, fungi, and plants use this enzyme to oxidize alcohols.

This hybrid catalyst performs a two-step reaction in which zeolite converts methane to methanol, and then the enzyme converts methanol to formaldehyde. That reaction also generates hydrogen peroxide, which is fed back into the zeolite to provide a source of oxygen for the conversion of methane to methanol.

This series of reactions can occur at room temperature and doesn't require high pressure. The catalyst particles are suspended in water, which can absorb methane from the surrounding air. For future applications, the researchers envision that it could be painted onto surfaces.

"Other systems operate at high temperature and high pressure, and they use hydrogen peroxide, which is an expensive chemical, to drive the methane oxidation. But our enzyme produces hydrogen peroxide from

oxygen, so I think our system could be very cost-effective and scalable," Kim says.

Building polymers

Once formaldehyde is produced, the researchers showed they could use that molecule to generate polymers by adding urea, a nitrogen-containing molecule found in urine. This resin-like polymer, known as urea-formaldehyde, is now used in particle board, textiles and other products.

The researchers envision that this catalyst could be incorporated into pipes used to transport natural gas. Within those pipes, the catalyst could generate a polymer that could act as a sealant to heal cracks in the pipes, which are a common source of methane leakage. The catalyst could also be applied as a film to coat surfaces that are exposed to methane gas, producing polymers that could be collected for use in manufacturing, the researchers say.

Strano's lab is now working on catalysts that could be used to remove carbon dioxide from the atmosphere and combine it with nitrate to produce urea. That urea could then be mixed with the formaldehyde produced by the zeolite-enzyme catalyst to produce urea-formaldehyde.

Science Daily, 4 December 2024

https://sciencedaily.com

Scientists Develop Super-Strong, Eco-Friendly Plastic That Bacteria Can Eat

2024-12-04

Researchers at the Weizmann Institute have developed a biodegradable composite material that could play a significant role in addressing the global plastic waste crisis.

Billions of tons of plastic waste clutter our planet. Most of it accumulates on land, settles in the oceans, or disintegrates into tiny particles called microplastics, which pollute the air and water, infiltrating vegetation as well as the bloodstreams of humans and animals. The threat posed by plastics intensifies each year, as they are composed of massive molecules called polymers that resist biodegradation. Currently, biodegradable plastics account for less than one-fifth of total plastic production, and the processes required to break them down remain relatively cumbersome.

In a study published in ACS Nano, Dr. Angelica Niazov-Elkan, Dr. Haim Weissman and Prof. Boris Rybtchinski of the Molecular Chemistry and Materials Science Department at the Weizmann Institute of Science have created a new composite plastic that degrades easily using bacteria. This new material, produced by combining a biodegradable polymer with crystals from a biological substance, has three major benefits: It is cheap, easy to prepare, and very strong. Also participating in the study were the late Dr. Eyal Shimoni, Dr. XiaoMeng Sui, Dr. Yishay Feldman, and Prof. H. Daniel Wagner.

Currently, many industries are enthusiastically adopting composite plastics, which are made by combining two or more pure materials and possess the various beneficial properties such as lightness and strength. These plastics now serve to manufacture key parts of a wide variety of industrial products, from airplanes and cars to bicycles.

The Rise of Composite Plastics

Seeking to create a composite plastic that would meet the needs of industry while also being environmentally friendly, the Weizmann researchers decided to focus on commonplace, inexpensive source materials whose properties could be improved. They found that molecules of tyrosine – a prevalent amino acid that forms exceptionally strong nanocrystals – could be used as an effective component in a biodegradable composite plastic. After examining how tyrosine combines with several types of polymers, they chose hydroxyethyl cellulose, a derivative of cellulose, which is employed extensively in the manufacture of medicines and cosmetics.

On its own, hydroxyethyl cellulose is a weak material that disintegrates readily. To combine it with tyrosine, the two materials were mixed together in boiling water. When they cooled and dried, an exceptionally strong composite plastic was formed, made of fiber-like tyrosine nanocrystals that grew into the hydroxyethyl cellulose and integrated with it. In one experiment that revealed the new plastic's strength, a 0.04-millimeter-thick strip of the material withstood a load of 6 kilograms.

Moreover, the team discovered that the new material had several other unique characteristics, making it even more useful for industry. Usually, when a material is strengthened, it loses plasticity.

Unique Properties and Industrial Potential

This new composite plastic, however, in addition to being very strong, is also more ductile (malleable) than its core component, hydroxyethyl cellulose. In other words, combining the two materials created a synergy that manifests itself in the emergence of extraordinary properties and, consequently, has massive industrial potential.

Since both cellulose and tyrosine – the crystals of which can be found in various types of hard cheese – are edible, the biodegradable composite plastic can actually be eaten. Is it also tasty? We will have to wait to find out: Since the production process in the lab is not hygienic enough for foodstuffs, the researchers are yet to have a nibble.

Rybtchinski sums up: "The follow-up study that we have already started could advance the commercial potential of this new material, since we have replaced the boiling in water with melting, as is more common in industry. This means that we heat up the biodegradable polymers until they become liquid and then mix in the tyrosine or other suitable materials. If we manage to overcome the scientific and technical challenges involved in this process, we will be able to explore the possibility of producing this new composite plastic on an industrial scale."

Sci Tech Daily, 4 December 2024

https://scitechdaily.com

New hydrogel could preserve waterlogged wood from shipwrecks

2024-12-03

From the RMS Titanic to the SS Endurance, shipwrecks offer valuable -- yet swiftly deteriorating -- windows into the past. Conservators slowly dry marine wooden artifacts to preserve them but doing so can inflict damage. To better care for delicate marine artifacts, researchers in ACS Sustainable.

Chemistry & Engineering developed a new hydrogel that quickly neutralizes harmful acids and stabilized waterlogged wood from an 800-year-old shipwreck.

Wooden artifacts from shipwrecks are drenched with seawater, an environment that enables acid-producing bacteria and wood-eating fungi to thrive.

Curiosities

DEC. 06, 2024

To prevent damage from acid and microbes, conservators usually remove water from these artifacts by freeze-drying or using a process that replaces the water with highly pressurized carbon dioxide or a viscous polymer.

However, these processes can take months and increases brittleness or warps the artifacts.

A newer alternative is to plaster wet, historic wood with a gel that acts like a face mask, infusing the wood with acid-neutralizing or antimicrobial compounds.

But peeling away the mask later can harm the item's surface.

So, Xiaohang Sun and Qiang Chen set out to develop a hydrogel that would disperse acid- and microbe-fighting compounds through the wood and gradually dissolve over time to avoid surface damage.

The researchers began by mixing two polymers with potassium bicarbonate, an acid-neutralizing compound, and silver nitrate, which forms antimicrobial nanoparticles that link the polymers together to form a gel.

By adjusting the amount of silver nitrate, they were able to create hydrogels with different staying power.

Gels with less silver liquified after 3-5 days, and those with more silver remained a gooey solid.

As a proof-of-concept approach, the team pasted hydrogels with varying amounts of silver onto 800-year-old pieces of wood from the Nanhai One shipwreck, which was discovered off China's south coast.

As a proof-of-concept approach, the team pasted hydrogels with varying amounts of silver onto 800-year-old pieces of wood from the Nanhai One shipwreck, which was discovered off China's south coast.

They found that each gel neutralized acid up to 1 centimeter deep after 10 days, but the dissolving gels that contained less silver did so more quickly, after 1 day.

The team also found that artifacts treated with the liquifying gels better maintained their cellular structure and were less brittle than those treated with the solid gels.

CHEMWATCH

Bulletin Board

Curiosities

DEC. 06, 2024

The researchers say their new hydrogel could be used to preserve and strengthen wood from shipwrecks without causing additional damage, enhancing the ability to untangle the mysteries of the past.

Science Daily, 3 December 2024

https://sciencedaily.com

CHEMWATCH

Bulletin Board

Technical Notes

DEC. 06, 2024

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

CHEMICAL EFFECTS

Volatile organic compounds (VOC) metabolites in urine are associated with increased systemic inflammation levels, and smokers are identified as a vulnerable population

ENVIRONMENTAL RESEARCH

The vertical transport and fate of MPs-oil composite pollutants in nearshore environment

Association between acute exacerbation of chronic obstructive pulmonary disease and short-term exposure to ambient air pollutants in France

Assessment of heavy metal concentrations, environmental risks and human health implications in marine sediments along the coastal ecosystems of the Republic of Congo

PHARMACEUTICAL/TOXICOLOGY

Toxicokinetics of benzotriazole UV stabilizer UV-P in humans after single oral administration

Contaminants of emerging concern in an endangered population of common eiders (Somateria mollissima) in the Baltic Sea

OCCUPATIONAL

Successful Strategies for Occupational Health and Safety in Small and Medium Enterprises: Insights for a Sustainable Return to Work

Association between exposure to arsenic, cadmium, and lead and chronic kidney disease: evidence from four practical statistical models

Prevalence of occupational noise-induced hearing loss and its associated factors among marine technicians working on the Royal Malaysian Navy vessels