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

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ASIA PACIFIC

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

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APVMA, 12-11-24

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

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Approved active constituents

2024-11-24

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

2024-11-12

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:

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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

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

Proposed revisions to the Categorisation Guidelines in 2025

2024-11-22

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

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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.

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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

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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.

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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>

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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

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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

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REACH Update

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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

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REACH Update

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~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>

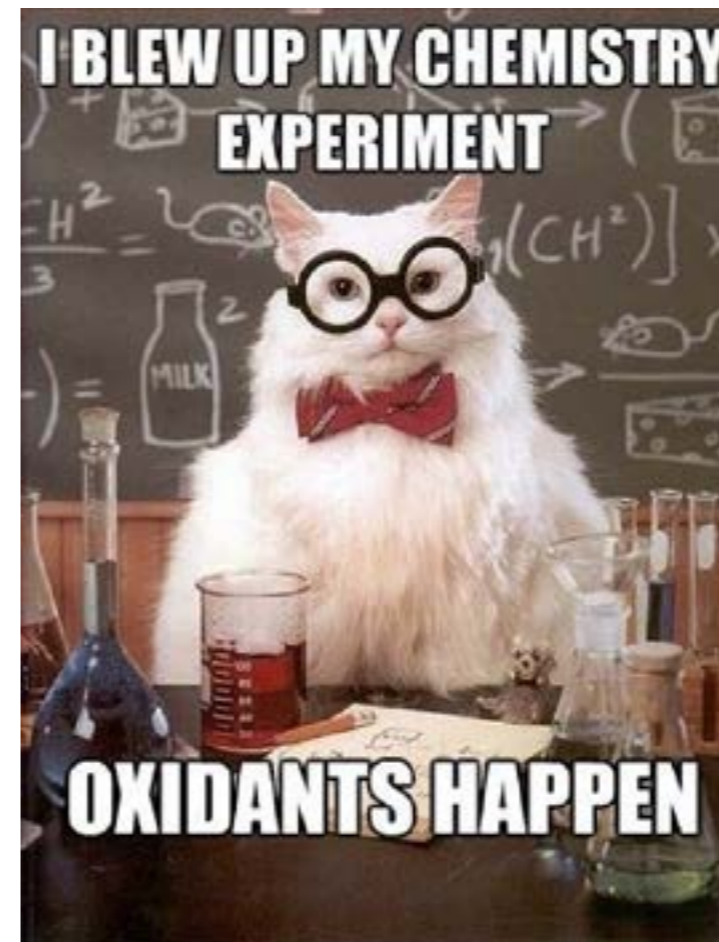
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Chemistry Experiment

2024-11-29



more awesome stuff at ThumbPress.com

<https://www.pinterest.com/pin/388857749050496285/>

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Hazard Alert

NOV. 29, 2024

Carbon Tetrachloride

2024-11-29

USES [2,3]

Carbon tetrachloride has been produced in large quantities to make refrigeration fluid and propellants for aerosol cans. Since many refrigerants and aerosol propellants have been found to affect the earth's ozone layer, the production of these chemicals is being phased out. Consequently, the manufacture and use of carbon tetrachloride has declined a great deal. In the past, carbon tetrachloride was widely used as a cleaning fluid (in industry and dry cleaning establishments as a degreasing agent, and in households as a spot remover for clothing, furniture, and carpeting). Carbon tetrachloride was also used in fire extinguishers and as a fumigant to kill insects in grain. Most of these uses were discontinued in the mid-1960s. Until recently, carbon tetrachloride was used as a pesticide, but this was stopped in 1986.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

General Populations

- Carbon tetrachloride is found in air, water and soil. Inhalation of contaminated air and ingestion of contaminated drinking water are the primary routes of exposure.
- The general public is not likely to be exposed to large amounts of carbon tetrachloride. Populations living close to waste sites or areas of heavy carbon tetrachloride use may have increased risk of exposure.
- Exposure may occur through volatilisation of carbon tetrachloride from tap water during showering, bathing or cooking.
- Carbon tetrachloride is currently banned from use in commercial products.

Occupational Populations

- Inhalation of contaminated air is the primary route of exposure in occupational settings.
- Workers involved in the manufacture of carbon tetrachloride are most likely to be exposed than the general public.

Carbon tetrachloride is an inorganic compound with the formula CCl₄. It is a clear liquid with a sweet odour that evaporates very easily. Carbon tetrachloride does not easily burn and is almost insoluble in water. It is a manufactured chemical and does not occur naturally in the environment. [1,2]

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Routes of Exposure

- **Inhalation** – Predominant route of exposure for general population.
- **Oral** – Major route of exposure for the general population through ingestion of contaminated drinking water.
- **Dermal** – Minor route of exposure through dermal contact with contaminated soil.

HEALTH EFFECTS [4]

Acute Health Effects

- Acute inhalation and oral exposures to high levels of carbon tetrachloride have been observed primarily to damage the liver (swollen, tender liver, changes in enzyme levels, and jaundice) and kidneys (nephritis, nephrosis, proteinuria) of humans. Depression of the central nervous system has also been reported. Symptoms of acute exposure in humans include headache, weakness, lethargy, nausea, and vomiting.
- Delayed pulmonary oedema (fluid in lungs) has been observed in humans exposed to high levels of carbon tetrachloride by inhalation and ingestion, but this is believed to be due to injury to the kidney rather than direct action of carbon tetrachloride on the lung.
- Acute animal exposure tests in rats, mice, rabbits, and guinea pigs have demonstrated carbon tetrachloride to have low toxicity from inhalation exposure, low-to-moderate toxicity from ingestion, and moderate toxicity from dermal exposure.

Carcinogenicity

- Occasional reports have noted the occurrence of liver cancer in workers who had been exposed to carbon tetrachloride by inhalation exposure; however, the data are not sufficient to establish a cause-and-effect relationship.
- Liver tumours have developed in rats and mice exposed to carbon tetrachloride by gavage (experimentally placing the chemical in their stomachs).
- EPA has classified carbon tetrachloride as a Group B2, probable human carcinogen.

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Hazard Alert

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SAFETY

First Aid Measures [5]

- **Eye Contact:** Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.
- **Skin Contact:** After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.
- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** Allow the victim to rest in a well-ventilated area. Seek immediate medical attention.
- **Ingestion:** Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Personal Protective Equipment [5]

Engineering Controls

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

Personal Protective Equipment

The following personal protective equipment is recommended when handling carbon tetrachloride:

- Splash goggles;
- Lab coat;

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- Vapour respirator (Be sure to use an approved/certified respirator or equivalent);
- Gloves

Personal Protection in Case of a Large Spill:

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

REGULATION

United States

EPA: The Environmental Protection Agency has set a limit for carbon tetrachloride in drinking water of 5 parts of carbon tetrachloride per billion parts of water (5 ppb). The EPA has also set limits on how much carbon tetrachloride can be released from an industrial plant into waste water and is preparing to set limits on how much carbon tetrachloride can escape from an industrial plant into outside air.

OSHA: The United State Occupational Safety & Health Administration has set the following Permissible Exposure Limits (PEL):

General Industry: 29 CFR 1910.1000 Z-2 Table -- 10 ppm TWA; 25 ppm Ceiling for 5 minutes in any 3 hours; 200 ppm Peak

Construction Industry: 29 CFR 1926.55 Appendix A -- 10 ppm, 65 mg/m³ TWA; Skin

Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 10 ppm, 65 mg/m³ TWA; Skin

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for carbon tetrachloride is 5 ppm, 31 mg/m³ TWA; 10 ppm, 63 mg/m³ STEL; Skin; Appendix A2 - Suspected Human Carcinogen

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NIOSH: The National Institute for Occupational Safety and Health has established a Recommended Exposure Limit (REL) for carbon tetrachloride of 2 ppm, 12.6 mg/m³ STEL (60 Minutes); Appendix A - NIOSH Potential Occupational Carcinogens.

REFERENCES

1. http://en.wikipedia.org/wiki/Carbon_tetrachloride
2. <http://www.atsdr.cdc.gov/phs/phs.asp?id=194&tid=35>
3. <http://www.epa.gov/ttn/atw/hlthef/carbonte.html>
4. <http://www.atsdr.cdc.gov/toxguides/toxguide-30.pdf>
5. <http://www.sciencelab.com/msds.php?msdsId=9927342>
6. <http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=195&tid=35>
7. <http://www.safeworkaustralia.gov.au/sites/swa/about/Publications/Documents/772/Workplace-exposure-standards-for-airborne-contaminants.docx>

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Gossip

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Using sunlight to recycle black plastics

2024-11-25

Not all plastics are equal -- some types and colors are easier to recycle than others. For instance, black foam and black coffee lids, which are often made of polystyrene, usually end up in landfills because color additives lead to ineffective sorting. Now, researchers report in ACS Central Science the ability to leverage one additive in black plastics, with the help of sunlight or white LEDs, to convert black and colored polystyrene waste into reusable starting materials.

"Simple, visible light irradiation holds the potential to transform the chemical recycling of plastics, using the additives already found in many commercial products," say the paper's authors, Sewon Oh, Hanning Jiang and Erin Stache.

An emerging strategy for plastic recycling involves using light to help break down plastic into chemically useful materials that can be recycled into new products.

This process requires a helper compound to convert light into the heat needed to break apart polymer bonds.

However, finding the right helper that won't create more waste and is easily incorporated into recycled materials remains a challenge for researchers.

Seeking to create a circular economy for plastic recycling, Stache and a team of researchers took advantage of something already found in black polystyrene waste -- an additive known as carbon black.

The researchers tested a method to recycle lab-made black polystyrene: They ground a mixture of polystyrene and carbon black to a fine powder, placed the powder in a sealed glass vial and then set the vial under high-intensity white LEDs for 30 minutes. The carbon black converted the LED light into heat. The heat then broke apart the polystyrene's molecular structure, creating a mixture of shorter one-, two- and three-styrene units.

And these three components cleanly separated within the reaction apparatus.

In experiments, the team recycled the leftover carbon black and styrene monomer into polystyrene, demonstrating the circularity of the new method.

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Applying the technique to post-consumer black plastic from food containers and coffee cup lids, the researchers cut the waste into small pieces and found that up to 53% of the polystyrene converted to styrene monomer. Waste samples contaminated with canola oil, soy sauce and orange juice broke down slightly less efficiently. When the researchers switched the light source from LEDs to focused sunlight outdoors, they observed a higher reaction efficiency (80%). Additionally, a multicolored mixture of black, yellow, red and colorless polystyrene waste converted to styrene in sunlit conditions at a higher rate (67%) compared to white LEDs (45%). The researchers attribute the higher efficiencies to the greater light intensity achieved by focused sunlight. By demonstrating sunlight's ability to break down colored polystyrene waste, the researchers say that their method could create a closed-loop recycling process for this type of plastic.

Science Daily, 25 November 2024

<https://sciencedaily.com>

Catalysis Reinvented: New Ultra-Thin Nanosheets To Drive Green Energy

2024-11-26

Nagoya University researchers have pioneered a surfactant-based method to create amorphous nanosheets, enabling production from previously inaccessible materials like aluminum and rhodium oxides.

Researchers at Nagoya University in Japan have addressed a significant challenge in nanosheet technology. Their innovative approach employs surfactants to produce amorphous nanosheets from various materials, including difficult-to-synthesize ultra-thin amorphous metal oxides such as aluminum and rhodium. This breakthrough, published in Nature Communications, sets the stage for future advances in the application of these nanosheets such as those used within fuel cells.

The upcoming generation of nanotechnology requires components that are just a few nanometers thick (one billionth of a meter). These ultrathin layers, which are essential for improving functionality, are known as nanosheets.

However, their small size poses difficulties for catalytic reactions. Many of these sheets maintain a regular shape with minimal defects. But catalysis generally relies on these defects for its reactions.

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Furthermore, their production is challenging due to the absence of layers, rendering traditional exfoliation techniques that depend on layering ineffective. This limitation has confined their production to typical materials, such as carbon and silica, rather than metal oxides and oxyhydroxides using materials like rhodium that are useful in technology.

A Novel Solution: Surfactant-Assisted Synthesis

To bridge this gap, a research group led by Assistant Professor Eisuke Yamamoto and Professor Minoru Osada at the Institute for Materials and Systems Research (IMaSS) at Nagoya University devised an adaptable synthesis method.

The process starts with a solid-state surfactant, which aids in arranging the metal ions within its framework, particularly in the areas between its layers, known as the interlayer space. Since amorphous nanosheets do not have layers, the surfactant layers serve as a substitute.

Osada is enthusiastic about the beauty of the process. "The surfactant crystals actually synthesized are beautiful under an optical microscope," he enthuses. "It is possible to confine a variety of metal ions in these surfactant crystals and create a variety of crystals."

Water is then added, which interacts with the metal ions that have been arranged in the surfactant layers. It triggers a reaction known as hydrolysis that leads to the partial breakdown of these ions and the formation of small, isolated clusters.

The clusters can be arranged into an organized structure with the help of a solvent, specifically a chemical called formamide. This organization is directed by the initial crystal shapes of the surfactant through a process known as templating, where the metal clusters create sheets that replicate the shape of the surfactant crystals.

Achievements and Potential Applications

This method created amorphous nanosheets about 1.5 nm thick using gallium ions. Building on this success, Yamamoto and Osada applied the technique to synthesize others from challenging metal oxides and oxyhydroxides such as aluminum and rhodium.

"Amorphous nanosheets on this scale should have excellent catalytic activity, attributed to numerous defects resulting from their disordered structure," explains Professor Osada. "These defects are excellent active

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sites for catalytic reactions. These amorphous sheets offer a vastly different functionality compared to traditional nanosheets.”

This innovative method not only synthesizes a variety of nanosheets with different metal species but also allows the combination of multiple metal types in one sheet, opening doors to new materials and properties.

“The new classes of materials synthesized through this technique are expected to drive advancements in the fields of two-dimensional and amorphous materials, potentially leading to novel physical properties and applications,” Osada said.

As catalytic reactions are important in fuel cells, the researchers are excited about the prospect of their research being used to generate the next generation of environmentally friendly power.

Sci Tech Daily, 26 November 2024

<https://scitechdaily.com>

Meat has a distinct taste, texture, aroma. A biochemist explains how plant-based alternatives mimic the real thing

2024-11-25

When you bite into a juicy hamburger, slice into the perfect medium-rare steak or gobble down a plateful of chicken nuggets, your senses are most likely responding to the food’s smell, taste, texture and color. For a long time, these four attributes set meat apart from other food groups.

But in recent years, food companies have started to focus on the development of meat alternatives. Many people believe that transitioning away from meat-heavy diets can help with environmental sustainability as well as improve their own health.

The two main focuses of research have been on plant-based meat alternatives and lab-grown meat. Both have interesting challenges. Lab-grown meat requires growing animal cells and generating a meat product. Plant-based meat alternatives use plant materials to recreate animal-like structures and flavors.

Major food companies that have generated plant-based meat alternatives that consumers seem to enjoy include Impossible, Beyond Meat, Mosa Meat and Quorn.

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From a scientific perspective, the development of plant-based meat alternatives is especially intriguing, because food manufacturers and researchers attempt to create products with similar textures, flavors, appearances and nutrient compositions to those juicy hamburgers or tender chicken fingers.

As a biochemist who teaches students about how food fuels our bodies, I focus my research on the composition and the production of these products and how they can mimic animal meat is intriguing to me.

Animal meats are composed primarily of protein, fat and water, with small amounts of carbohydrates, vitamins and minerals. The animal tissue consumed is typically muscle, which has a distinctive shape made from fibers of protein that are bundled together with connective tissue.

The size and shape of the protein fibers influence the texture of the meat. The amount and identity of natural lipids—fats and oils—found within a specific muscle tissue can influence the protein structure, and therefore the flavor, tenderness and juiciness, of the meat. Meat products also have a high water content.

Typically, plant-based meat alternatives are made using nonanimal proteins, as well as chemical compounds that enhance the flavor, fats, coloring agents and binding agents. These products also contain more than 50% water. To produce plant-based meat alternatives, the ingredients are combined to mimic animal muscle tissue, and then supplemented with additives such as flavor enhancers.

Developing a meatlike texture

Most meat replacements are derived from soy protein because it is relatively cheap and easily absorbs both water and fat, binding these substances so they don’t separate. Some companies will use other proteins, such as wheat gluten, legumes—lentils, chickpeas, peas, beans—and proteins from seed oils.

Since most animal meats include some amount of fat, which adds flavor and texture to the product, plant-based meat alternative manufacturers will often add fats such as canola oil, coconut oil or sunflower oil to make the product softer and tastier.

Proteins and fats don’t easily mix with water—that’s why the ingredients in salad dressings will sometimes separate into layers. When using these components, food manufacturers need to emulsify, or mix them, together. Emulsification is essential to making sure the proteins, fats and water form

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an integrated network with an appealing texture. Otherwise, the food product can end up greasy, spongy or just plain disgusting.

Many vegan meat alternatives also use gelling agents that bind water and fat. They help with emulsification because they contain starch, which interacts strongly with water and fat. This allows for more of a mixed network of the proteins, fats and water, making them meatier and more appealing to consumers.

Creating a product with a meatlike texture is not just a dump and stir process. Since animal meat is primarily muscle tissue, it has a unique spatial arrangement of the proteins, fats and water.

In order to mimic this structure, manufacturers use processes such as stretching, kneading, folding, layering, 3D printing and extrusion. Right now, the most popular processing method is extrusion.

Extrusion is a method by which the dry ingredients—plant proteins and fats—are fed into a machine along with a steady stream of water. The inner part of the machine rotates like a screw, combining the molecules, converting the structure of the plant material from spherical shapes to fibers.

Each plant protein behaves differently in the manufacturing process, so some plant-based meat alternatives might use different ingredients, depending on their structures.

Phys Org, 25 November 2024

<https://phys.org>

'Absolute miracle' breakthrough provides recipe for zero-carbon cement

2024-05-23

Concrete and steel production are major sources of CO₂ emissions, but a new solution from Cambridge could recycle both at the same time. Throwing old concrete into steel-processing furnaces not only purifies iron but produces "reactivated cement" as a byproduct. If done using renewable energy, the process could make for completely carbon-zero cement.

Concrete is the world's most used building material, and making it is a particularly dirty business – concrete production alone is responsible for

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about 8% of total global CO₂ emissions. Unfortunately it's not easy to recycle back into a form that can be used to make new concrete structures.

Scientists have of course been investigating ways to make concrete greener. That can include changing the recipe to switch out the most polluting ingredients – specifically limestone – or designing concrete so that it absorbs more CO₂ from the air after it's laid. For the new study, Cambridge researchers investigated how waste concrete could be converted back into clinker, the dry component of cement, ready to be used again.

"I had a vague idea from previous work that if it were possible to crush old concrete, taking out the sand and stones, heating the cement would remove the water, and then it would form clinker again," said Dr. Cyrille Dunant, first author of the study. "A bath of liquid metal would help this chemical reaction along, and an electric arc furnace, used to recycle steel, felt like a strong possibility. We had to try."

An electric arc furnace needs a "flux" material, usually lime, to purify the steel. This molten rocky substance captures the impurities, then bubbles to the surface and forms a protective layer that prevents the new pure steel from becoming exposed to air. At the end of the process, the used flux is discarded as a waste material.

So for the Cambridge method, the lime flux was swapped out for the recycled cement paste. And sure enough, not only was it able to purify the steel just fine, but if the leftover slag is cooled quickly in air, it becomes new Portland cement. The resulting concrete has similar performance to the original stuff.

Importantly, the team says this technique doesn't add major costs to either concrete or steel production, and significantly reduces CO₂ emissions compared to the usual methods of making both. If the electric arc furnace was powered by renewable sources, it could essentially make for zero-emission cement.

The technique has already been trialed in furnaces that produce a few dozen kilograms of cement, and the researchers say the first industrial-scale trials are underway this month, where it would be producing about 66 tons of cement in two hours. The researchers say that the process could scale up to produce one billion tonnes of "electric cement" by 2050.

"Producing zero emissions cement is an absolute miracle, but we've also got to reduce the amount of cement and concrete we use," said Professor

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Julian Allwood, who led the research. "Concrete is cheap, strong and can be made almost anywhere, but we just use far too much of it. We could dramatically reduce the amount of concrete we use without any reduction in safety, but there needs to be political will to make that happen.

"As well as being a breakthrough for the construction industry, we hope that Cambridge Electric Cement will also be a flag to help the government recognize that the opportunities for innovation on our journey to zero emissions extend far beyond the energy sector." A patent has been filed for the process, as the first step towards commercialization.

The research was published in the journal Nature. The team describes the work in the video below.

New Atlas, 23 May 2024

<https://newatlas.com>

Simple lab-free test to detect bacteria in fluids from water to urine

2024-11-26

A novel new test for bacteria in fluids makes it as easy as observing a colour change to confirm the presence of disease-causing pathogens, promising much easier diagnostic tests and greater food safety.

Engineers and biochemists at McMaster university have brought their skills together to make it possible for untrained users to confirm contamination in fluids using a biogel test that changes colour in the presence of such bacteria as E. coli, listeria and other frequent testing targets.

The test uses harmless bacteriophages embedded in the gel to locate target bacteria in a sample of fluid such as lake water, urine or a container of milk, even in low concentrations.

Bacteriophages are the most common form of life on Earth. Each form of bacteriophage is specialized to destroy one form of bacteria.

In the test, phages -- as they are called informally -- find and attack the target bacteria in a sample, causing the bacteria to release microscopic amounts of intracellular material which the test can read, triggering a colour change that is readily visible to the eye. If the sample is clean, the colour stays the same.

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The new process takes just hours, producing results much more quickly than lab cultures, which can take two days to generate results.

"We've been using phages' destructive power to kill bacteria and resolve infections for years," says Zeinab Hosseinidoust, an associate professor of biomedical and chemical engineering who holds the Canada Research Chair in Bacteriophage Bioengineering. "Here, we're channelling that power in another way. Because phages can burst bacteria open, they can give us quick access to the biological components of those bacteria that we use to confirm their presence."

The test, described in a new paper published in the journal Advanced Materials, is the latest in a series of technologies the group has developed, all aimed at placing simple technology within reach of producers, retailers, consumers and medical professionals.

"Now we have a tool that can be used in food samples, environmental samples and clinical samples," says coresponding author Tohid Didar, an associate professor of mechanical and biomedical engineering who holds the Canada Research Chair in Nano-Biomaterials. "Today, people who suspect they may have a urinary-tract infection must visit a doctor and sometimes wait days for a result. This technology would make it very easy for people to tests themselves at home and get a result in a matter of hours."

The group's previous work includes creating a portable testing library to match phages to otherwise untreatable antibiotic-resistant infections, a contamination test incorporated into food packaging, and a temperature-stable storage system for live vaccines.

The group confirmed the concept of their newest test using urine samples from patients at Hamilton Health Sciences, and in all cases, results from the experimental test produced the same results as traditional lab tests. The test also worked accurately to detect E. Coli in lake water samples.

The new test can be adapted to any bacterium by using bacteriophages and DNA probes that specifically target microbes such as listeria and salmonella.

"Phages can knock on every biological door, but they will only enter the ones they are programmed to find," says Carlos Filipe, a professor of chemical engineering and a senior author on the paper. "That specificity is a huge advantage for quick and precise detection, even at low levels."

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Such a test could have provided early and accurate detection in the recent listeria contamination of plant-based milk that killed two, sickened 10 and caused wide recalls in Canada, the researchers say.

“This technology could be helpful in rapidly limiting outbreaks,” says co-author Akansha Prasad, a Vanier Scholar and PhD student in biomedical engineering. “If you had something in your fridge that you were concerned about, this test could let you know if it was safe for consumption.”

Testing for contamination in complex fluids such as milk, blood or urine is especially challenging, making simple, reliable alternatives such as the new test very useful, say the researchers, who hope to work with commercial partners to bring the technology to the marketplace.

“Once we have the appropriate approvals and partnerships to move this test to market, it could be very useful in many settings,” says the paper’s lead author Hannah Mann, a PhD student in chemical engineering and bioengineering. “About 12 per cent of Canadians don’t have access to municipal piped water, for example, and this could bring them a lot of peace of mind.”

Science Daily, 26 November 2024

<https://sciencedaily.com>

Countries announce new steps to reduce methane emissions at Cop29

2024-11-26

Four more countries have signed up to the global methane pledge that was created at Cop26 in 2021 bringing the total number to 159 countries to date. New signatories include countries with large oil and gas sectors that are significant emitters of methane such as Azerbaijan and Tajikistan.

While research suggests that methane emissions have not declined in recent years, the EU’s Methane Import Standard, implemented this year, is already having an impact globally with current and would-be trade partners taking measures to ensure their oil, gas and coal exports meet the qualifications.

The Cop29 climate change conference, which is being held in Baku, Azerbaijan, has also provided an opportunity for countries that joined the methane pledge in 2021 to review progress, mobilise finance and showcase technology with the goal of cutting global methane emissions by at least 30% below 2020 levels by 2030.

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Methane is often referred to as ‘low-hanging fruit’ when it comes to climate action because mitigation is relatively easy. A significant proportion – 30% globally in 2017 – of anthropogenic methane is emitted during extraction of fossil fuels. ‘Using currently available technologies, we can cut methane emissions by at least 45% by 2030,’ says James Turitto, director of global campaigns at Clean Air Task Force (CATF). This is enough to avoid 0.3°C of warming by the 2040s.

In Baku, there’s a shift in the narrative – ‘super pollutants’ are taking centre stage. Methane, nitrous oxide and even hydrofluorocarbons are dominating certain discussions. Methane’s warming potential is more potent than carbon dioxide in the short term meaning cutting it can have an immediate impact on global warming. ‘The fact that methane is even garnering attention from governments is a sea change from just a few years ago. We would have never expected a country like Turkmenistan, who is a major producer of oil and gas and a major emitter of methane, would have become so open to addressing the issue,’ says Turitto. This is being recognised as countries begin to tie methane into their nationally determined contributions (NDCs) to counter climate change. NDCs are pledges made by countries to cut greenhouse gas emissions under the Paris Agreement on climate change.

Now, more than 30 countries have endorsed the Cop29 declaration on reducing methane from organic waste. Solid waste – food and plant remains, paper waste and industrial sludge in landfills – is the third largest source of human-made methane, behind agriculture and the oil and gas sector. The Cop29 presidency included organic waste as a priority for the first time, marking a significant milestone for the waste sector. The new signatories to action on organic waste include the US and Russia, who are collectively responsible for nearly half of methane emissions from this source. They have pledged to set specific targets to reduce methane from organic waste within future NDCs. Affordable and feasible strategies already exist to combat this methane such as minimising organic waste, diverting it for treatment and reducing emissions at landfills through gas capture technologies. Over \$500 million (£400 million) in new funding was announced at Cop29 for methane abatement across the energy, waste and agricultural sectors.

Turning these commitments into action will be a crucial step in reducing global methane emissions. ‘To support this effort, the Climate and Clean Air Coalition and CATF recently launched a global initiative to help middle- and low-income countries tackle methane pollution,’ explains Turitto, adding that knowledge exchange enables the sharing of good practice,

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as well as resources like methane satellites to help all parties fulfil their pledges.

Chemistry World, 26 November 2024

<https://chemistryworld.com>

Natural substance from edible cyanobacterium could combat skin aging by enhancing collagen

2024-11-22

Cyanobacteria, or blue-green algae, have existed for billions of years, adapting to a diverse range of environments. Their remarkable ability to photosynthesize and make their own food, as well as their adaptability across a variety of habitats, make them a subject of focus for the research fraternity.

One such cyanobacterium native to Japan—*Aphanothece sacrum*, also known as *Suizenji-nori*—has been extensively studied for its bioactive properties and potential health benefits. Notably, *A. sacrum* accumulates natural compounds known as saclipins A and B in response to drought stress. These compounds are significant due to their ability to absorb ultraviolet (UV)-A and UV-B rays, making them potential skin-protective agents.

In 2023, Professor Hakuto Kageyama, Dean of the Graduate School of Environmental and Human Sciences at Meijo University, Japan, along with his colleagues, discovered saclipins in *A. sacrum*. Their research paper highlighted the unique characteristics of saclipins, such as UV-absorbing capacity and anti-aging properties like antioxidative and antiglycative activities.

Prof. Kageyama states, "This unique characteristic makes saclipins ideal for use in skin application or as an oral supplement. Moreover, this finding inspired me to explore additional activities of saclipins that can be applied in the skincare and cosmetic industry."

Based on their initial findings, Prof. Kageyama, along with Yoshie Uchida and Masaki Honda from Meijo University and Rungaroon Waditee-Sirisattha, from Chulalongkorn University, Thailand, carried out further study in 2024 to assess the anti-aging properties of the saclipins. This study was published in *ACS Agricultural Science & Technology*.

In this study, the researchers dried and powdered *A. sacrum* to extract saclipins and tested it for its anti-aging properties. The researchers

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investigated the chemical properties of saclipins by examining their stability under light and heat conditions. Next, they tested the scavenging activity of singlet oxygen to analyze the antioxidant potential and physiological effect on skin health.

"We examined how saclipins affect skin-related processes such as elastase inhibition and the production of collagen and hyaluronic acid, which contribute to skin firmness and moisture," explains Prof. Kageyama.

In addition, the study also assessed the tyrosinase inhibitory activity of saclipins. Tyrosinase plays a crucial role in melanin production and contributes to skin pigmentation.

Researchers observed that saclipins had strong inhibitory activity against elastase and promoted the production of collagen and hyaluronic acid in human skin fibroblasts. These results indicate that saclipins have the effect of improving skin quality. In addition, saclipins inhibited tyrosinase and suppressed melanin production in mouse B16 melanoma cells.

The team used both purified saclipins A and B as well as saclipin-containing extracts prepared from dried *A. sacrum* for evaluation. The results demonstrated that the extracts showed similar activity compared to the fresh ones.

Prof. Kageyama says, "The extracts also had an equal or increased activity than the purified ones, which suggests an easier formulation and cheaper manufacturing, making it a viable option for skincare products."

As is well known, skin aging is a prevalent concern worldwide and has boosted the global market for skincare products.

"The growing demand for endangered *A. sacrum* and the discovery of saclipins may also encourage its large-scale production, rejuvenating the aquaculture industry, promoting conservation efforts, and preventing its extinction," adds Prof. Kageyama.

These findings thus provide valuable insights into the role of saclipins as an anti-aging formula found in the edible cyanobacterium *A. sacrum*, alongside its other known beneficial activities.

Phys Org, 22 November 2024

<https://phys.org>

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Protein Disruptions May Trigger Alzheimer's Memory Loss

2024-11-27

A new study from the University of Liverpool represents a significant step forward in scientists' understanding of Alzheimer's disease.

Researchers have shed new light on how mechanical signalling in the brain is disrupted and could lead to the condition which accounts for 60-80% of dementia cases worldwide.

The team of investigators, led by Professor Ben Goult at the University of Liverpool, have examined the role of two proteins found in the brain and suggest the stability of their relationship to one another is crucial for memory formation and maintenance. Disruptions in this mechanical signalling pathway could lead to the disease. This is the first time this connection has been identified and could pave the way for therapeutic interventions.

The newly published paper proposes that Amyloid Precursor Protein (APP), known for its role in the formation of the amyloid plaques in the brain, that are a characteristic feature in Alzheimer's disease (AD), directly interacts with talin, a synaptic scaffold protein. For the first time, it's suggested the talin-APP interaction is crucial for the mechanical integrity of synapses in the brain and that the misprocessing of APP observed in Alzheimer's, disrupts mechanical signalling pathways, leading to synaptic degeneration and memory loss, thereby contributing to the progression of AD. The paper further shows that if talin is removed from cells in culture then the processing of APP is dramatically altered.

Professor Ben Goult, University of Liverpool said: "Alzheimer's disease is a cruel neurodegenerative disorder characterised by memory loss and cognitive decline. It is a global health challenge, yet little is known about the underlying mechanisms that lead to the disease. However, this paper gives us a new piece of the puzzle and significantly advances research.

"Our paper outlines that APP is fundamental for the mechanical coupling of synapses in the brain and how the processing of APP is part of a mechanical signalling pathway that maintains synaptic integrity. However, misprocessing of APP, due to altered mechanical cues, disrupts this pathway, leading to the synaptic degeneration observed in Alzheimer's and could explain the memory loss associated. What's most exciting is our paper highlights the intriguing possibility that repurposing currently available cancer drugs that stabilize focal adhesions might represent a way

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to restore mechanical integrity at synapses. Whilst currently this is only a theoretical prediction, our current research is focussed on testing whether this represents a novel approach to slow the progression of Alzheimer's.

"Further research is needed to test the theories that emerge from these new findings. However, this marks a significant moment in better understanding this disease and could move us closer to early diagnosis and treatment."

Technology Networks, 27 November 2024

<https://technologynetworks.com>

Scientists synthesize unsymmetrical ureas using non-phosgene method

2024-11-27

Unsymmetrical ureas can form multiple stable hydrogen bonds with proteins. Since drugs containing urea functional groups display unique biological activities when interacting with their targets, they play an important role in drug development and medicinal chemistry. As a result, finding efficient methods for synthesizing unsymmetrical ureas is important to these fields.

Current industrial synthesis of urea compounds mainly uses a three-step method involving phosgene, which generates a large amount of corrosive hydrochloric acid. Now, however, a joint research group from China has achieved one-step carbonylative synthesis of unsymmetrical urea using a non-phosgene route.

The associated study, titled "Synchronous recognition of amines in oxidative carbonylation toward unsymmetric ureas," was recently published in Science.

The catalytic oxidative carbonylation of amines is the most direct route for producing urea. However, when two different amines are used as substrates, it is difficult to differentiate them in terms of reactivity. Both symmetric and unsymmetrical ureas are generated simultaneously, making it difficult to control selectivity.

The research group, led by Prof. He Lin of the Lanzhou Institute of Chemical Physics (LICP) of the Chinese Academy of Sciences and Prof. Lei Aiwen from Wuhan University, employed a synchronous recognition strategy that integrates a novel reaction mechanism—a nucleophilic carbonylation half-reaction (recognizing primary amines) and a radical

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carbonylation half-reaction (recognizing secondary amines)—into a catalytic amine oxidative carbonylation reaction.

This strategy relies on subtle differences in the physicochemical properties of different amines, enabling identification of a unique reaction window for the one-step synthesis of unsymmetrical ureas by a non-phosgene route.

The new carbonylation mode is applicable not only to alkyl amines but also to various aromatic and halogenated amines.

Through catalytic carbonylation, NH_3 was activated to react with secondary amines, resulting in the synthesis of corresponding unsymmetrical ureas. Intramolecular recognition of primary and secondary amines occurred as expected. Nearly one hundred combinations yielded predominantly unsymmetric products, further confirming the unique reaction mechanism.

“We can use either CO or CO_2 to achieve process re-engineering for the synthesis of nitrogen-containing carbonyl compounds by the phosgene method,” said Prof. He.

Phys Org, 27 November 2024

<https://phys.org>

Drugs which switch on vitamin A in the body may stave off MND, research suggests

2024-09-20

Drugs that switch on vitamin A in the body may also help stave off conditions such as motor neurone disease (MND), raising hopes of new treatments, research suggests.

Scientists found drugs which target the specific receptors necessary to activate vitamin A may be therapeutic for diseases that lead to deterioration of the brain.

They found that when disease conditions were simulated in the laboratory, the “super-activation” of the vitamin A signalling system helped protect against the type of damage that can occur in diseases such as MND.

Professor Peter McCaffery, chairman of medical sciences at the University of Aberdeen who led the study, said: “We discovered that these drugs bind

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and turn on the ‘retinoic acid receptor’, a key protein involved in activation of vitamin A in the body.

“Our research provides the first steps to identify new targets for drugs that may then lead to future therapies.”

MND affects 5,000 adults in the UK at any one time and no treatments currently exist that will improve the condition for more than just a few months.

Once the disease progresses it leads to the death of the motor neurons essential for muscle control, resulting in progressive muscle weakness, and in most cases the disease is fatal in a few years.

Explaining the research process, Azita Kouchmeshky, neuroscientist at the University of California in San Francisco and one of the authors of the study, said: “We tested these drugs in a series of studies on neurons grown in a dish.

“Chemicals were added to the neurons that caused harm similar to the changes that occur in diseases such as MND or ALS (Amyotrophic lateral sclerosis).

“Usually, these chemicals will cause the neurons to die. However, the application of the drugs that bind to the retinoic acid receptor significantly reduced the number of cells that died off.

“The same drugs were also tested in mice and were found to induce changes that suggest they may also be effective in the body.”

The research paper is published in *Frontiers in Neuroscience*.

Andy Whiting, chief executive of Nevrargenics Ltd and emeritus professor at Durham University, designed and synthesised the drugs the team used.

He said: “There is a total lack of genuinely disease-modifying drugs out there for neurodegeneration in general, and Amyotrophic lateral sclerosis specifically. We are committed to changing that and delivering hope for MND sufferers in the first instance.

“This is one further step along the road to deliver new therapeutics for such globally challenging diseases.”

The research was funded by the Chief Scientist Office, the Sprint-MND/MS PhD programme and the Motor Neurone Disease Association.

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Dr Nicholas Cole, head of research at the MND Association, said: "We are delighted to be supporting such valuable early work which we hope will go towards aiding the discovery of potential new therapies which could be put forward for clinical testing.

"The hope of course, is that through continuing public support, collaboration and partnership working we will find solutions to unpick the complex nature of MND which will lead to an effective treatment."

The Independent, 20 September 2024

<https://independent.co.uk>

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Visible light-powered catalysts clean up 'forever chemicals'

2024-11-27

Chemists in China and the US have discovered catalysts enabling light-driven reactions that can break down fluorine-containing chemicals that are attracting concern as pollutants. Two research groups separately harnessed a powerful new class of carbon-based catalysts that help break bonds between carbon and fluorine atoms, avoiding using and producing other harmful chemicals. 'Our approach can remove almost all the fluorine,' says Yan-Biao Kang from University of Science and Technology of China (USTC) in Hefei.

The world knows per- and polyfluoroalkyl substances (PFAS) better as 'forever chemicals'. They include materials such as polytetrafluoroethylene (PTFE), commonly known as Teflon. PFAS contain many fluorine atoms, which prevent other substances from readily reacting or interacting with them. That's useful in making pans non-stick and coats waterproof, but means the substances linger, polluting the environment.

Worse still, chemicals like perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are linked to health concerns in people. PFAS's stability has also made disposal a challenge. PTFE can't be recycled, and defluorinating it can require temperatures above 500°C, or difficult-to-handle chemicals such as ammonia and alkali or alkali-earth metals.

Bright ideas

That made PFAS an appealing challenge for new 'organic photoredox catalysts', explains Garret Miyake from Colorado State University, US. Designing such catalysts, which harvest light to perform reduction and oxidation reactions, is 'a maturing field', Miyake adds. As his team made more powerful catalysts, they looked at breaking carbon-fluorine bonds, 'which are some of the strongest bonds that are made in chemistry'.

Kang explains that redox photocatalysts absorb visible light, causing electrons within their structure to gain energy. The higher-energy electrons can transfer to other molecules to do reduction reactions. Usually these are based on precious metals like ruthenium or iridium.

The USTC team discovered a twisted carbon-based organic molecule containing interconnected aromatic rings that was a very strong reduction photocatalyst, called KQGZ.1 The researchers first tested it on a fluorobenzene molecule. 'Interestingly, the PTFE coated stirring

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bars turned to black after these reactions,' Kang explains. 'This finding encouraged us to explore whether the defluorination of PTFE is possible.'

Breaking the unbreakable

In purple LED light, the catalyst became a bright yellow-green colour, showing an electron had been excited to a high-energy state. It injects an electron into a carbon-fluorine bond, Kang says, making that bond unstable, and leading to it breaking. 'This process will continue until [it removes] almost all the fluorine atoms,' Kang tells Chemistry World. As well as PTFE, the approach defluorinated other PFAS including PFOA and PFOS.

Miyake and his colleagues, meanwhile, developed an organic photoredox catalyst system based on a flat molecule called BPI, also with interconnected aromatic rings.² Their catalyst also changes colour when excited. It could break down PFAS including PFOA, but not PTFE, because it couldn't dissolve in the reaction conditions they used. Miyake says that the way the USTC team's catalyst can 'break down Teflon is really impressive.'

Miyake's teammate Niels Damrauer, from the University of Colorado, Boulder, stresses that a particularly important part of his team's new paper is that it helps show how these catalysts work. Miyake adds that his team also shows that the catalyst can transform carbon-fluorine bonds to synthesise new molecules.

Jinyong Liu from the University of California, Riverside, calls the papers 'perfect examples' of how chemistry 'can contribute to solving environmental challenges.' 'In the past, people believed that only by providing high energy, such as low wavelength UV, could PFAS be effectively degraded,' he explains. 'Now, with just organic molecules as the catalyst and visible light as the energy source, the new photocatalytic system showed great performance that even the UV systems could not achieve.'

Chemistry World, 27 November 2024

<https://chemistryworld.com>

New Study: Why You Should Toss Black Takeout Containers—Stat!

2024-10-31

If you wanted to, you could easily identify types of food from their takeout container. Clear plastic clamshell? That's a salad waiting to be shaken. Flat, square box? You know there's a pizza in there. White wax paper secured

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with a rubber band? Get ready to dig into a sub. Black container with a plastic top? That screams sushi or Chinese food.

While you're no doubt happy to get your hands on the food, a new study from the environmental health research and advocacy group Toxic-Free Future suggests that you shouldn't be too happy if you see a black plastic container: Researchers found that these containers may contain toxic flame retardants. Read on for everything you need to know.

Get Reader's Digest's Read Up newsletter for more news, humor, travel, tech and fun facts all week long.

What makes black plastic dangerous?

The short answer: It's the materials that are being used to make black plastics. "Toxic flame retardants are ending up in black plastic household products because of lax rules on hazardous plastic chemicals and dirty plastic recycling," explains Megan Liu, the lead author on the study, which was published in the journal *Chemosphere*, and the science and policy manager at Toxic-Free Future.

These chemicals, which include harmful compounds like deca-BDE, TBBPA and RDP, are permitted in the black plastic that is used to manufacture electronics—not items that we handle on a daily basis and certainly not those that touch our food. "Our results strongly support our hypothesis that black electronic plastics with toxic flame retardants are 'recycled' into products like toys, food packaging and spatulas," says Liu. "The toxic flame retardants contaminate these products, resulting in unnecessary exposures to harmful chemicals."

What makes these chemicals harmful? "Organohalogen flame retardants are a dangerous class of chemicals due to their persistence, tendency to build up in our bodies and food chain, and toxicity even at low levels of exposure," Liu says. "They are associated with a variety of impacts on human health, including carcinogenicity, endocrine disruption, neurotoxicity and reproductive and developmental toxicity."

Is it safe to eat takeout delivered in black plastic?

In Liu's opinion—and in the numerical proof from her study—it's not. "Flame retardants can leach out of kitchen utensils into food, and it's alarming to think that we could be eating flame retardants," she says.

As proof, she points to the cancer-causing flame retardant deca-BDE, which has been banned in the United States and the European Union

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because of how dangerous it is to human health. “We found levels of deca-BDE between 5 to 1,200 times greater than the European Union’s limit of 10 ppm, including a level of 11,900 ppm in a sushi tray,” says Liu. “This is outrageous when you consider the fact that people eat off of sushi trays!”

What other types of black plastic items are potentially dangerous?

Takeout containers like sushi trays were not the only black plastic items that were analyzed in the study. The researchers also looked at kitchen utensils, toys and hair accessories and found the presence of harmful chemicals. “We, of course, didn’t test all black plastic items, but who knows where else these chemicals could be hiding?” asks Liu. “We are already exposed to toxic flame retardants in a variety of ways, and it is worrisome that we found them in products that touch our food or that children play with.”

What should you do with black plastic items?

Toss, don’t recycle, the ones you have, along with the other kitchen items you need to throw out, and then avoid them as much as possible in the future. “Taking steps to replace black plastic kitchen utensils with safer options like stainless steel or wood can help reduce the risk of toxic flame retardants contaminating food,” suggests Liu. The same goes for toys that you buy for the kids in your life: If you have the option to choose one that’s not made from black plastic, opt for that.

“Other simple ways to reduce exposure to toxic flame retardants include regular cleaning and ventilating to clear out chemicals accumulating in dust or air,” Liu adds. “More ways to reduce your exposure to dust include frequent hand-washing, regular wet-dusting and mopping and vacuuming.”

As for those sushi trays? Maybe make it a date night out the next time you’re craving a California roll.

Readers Digest, 31 October 2024

<https://rd.com>

Countries announce new steps to reduce methane emissions at Cop29

2024-11-26

Four more countries have signed up to the global methane pledge that was created at Cop26 in 2021 bringing the total number to 159 countries

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to date. New signatories include countries with large oil and gas sectors that are significant emitters of methane such as Azerbaijan and Tajikistan.

While research suggests that methane emissions have not declined in recent years, the EU’s Methane Import Standard, implemented this year, is already having an impact globally with current and would-be trade partners taking measures to ensure their oil, gas and coal exports meet the qualifications.

The Cop29 climate change conference, which is being held in Baku, Azerbaijan, has also provided an opportunity for countries that joined the methane pledge in 2021 to review progress, mobilise finance and showcase technology with the goal of cutting global methane emissions by at least 30% below 2020 levels by 2030.

Methane is often referred to as ‘low-hanging fruit’ when it comes to climate action because mitigation is relatively easy. A significant proportion – 30% globally in 2017 – of anthropogenic methane is emitted during extraction of fossil fuels. ‘Using currently available technologies, we can cut methane emissions by at least 45% by 2030,’ says James Turitto, director of global campaigns at Clean Air Task Force (CATF). This is enough to avoid 0.3°C of warming by the 2040s.

In Baku, there’s a shift in the narrative – ‘super pollutants’ are taking centre stage. Methane, nitrous oxide and even hydrofluorocarbons are dominating certain discussions. Methane’s warming potential is more potent than carbon dioxide in the short term meaning cutting it can have an immediate impact on global warming. ‘The fact that methane is even garnering attention from governments is a sea change from just a few years ago. We would have never expected a country like Turkmenistan, who is a major producer of oil and gas and a major emitter of methane, would have become so open to addressing the issue,’ says Turitto. This is being recognised as countries begin to tie methane into their nationally determined contributions (NDCs) to counter climate change. NDCs are pledges made by countries to cut greenhouse gas emissions under the Paris Agreement on climate change.

Now, more than 30 countries have endorsed the Cop29 declaration on reducing methane from organic waste. Solid waste – food and plant remains, paper waste and industrial sludge in landfills – is the third largest source of human-made methane, behind agriculture and the oil and gas sector. The Cop29 presidency included organic waste as a priority for the first time, marking a significant milestone for the waste sector. The new signatories to action on organic waste include the US and Russia, who

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are collectively responsible for nearly half of methane emissions from this source. They have pledged to set specific targets to reduce methane from organic waste within future NDCs. Affordable and feasible strategies already exist to combat this methane such as minimising organic waste, diverting it for treatment and reducing emissions at landfills through gas capture technologies. Over \$500 million (£400 million) in new funding was announced at Cop29 for methane abatement across the energy, waste and agricultural sectors.

Turning these commitments into action will be a crucial step in reducing global methane emissions. 'To support this effort, the Climate and Clean Air Coalition and CATF recently launched a global initiative to help middle- and low-income countries tackle methane pollution,' explains Turitto, adding that knowledge exchange enables the sharing of good practice, as well as resources like methane satellites to help all parties fulfil their pledges.

Chemistry World, 26 November 2024

<https://chemistryworld.com>

Team solves a nearly 200-year-old challenge in polymers to offer independent control of stiffness and stretchability

2024-11-27

Researchers at the University of Virginia School of Engineering and Applied Science have developed a new polymer design that appears to rewrite the textbook on polymer engineering. No longer is it dogma that the stiffer a polymeric material is, the less stretchable it has to be.

"We are addressing a fundamental challenge that has been thought to be impossible to solve since the invention of vulcanized rubber in 1839," said Liheng Cai, an assistant professor of materials science and engineering, and chemical engineering.

That's when Charles Goodyear accidentally discovered that heating natural rubber with sulfur created chemical crosslinks between the strand-like rubber molecules. This crosslinking process creates a polymer network, transforming the sticky rubber, which melts and flows in the heat, into a durable, elastic material.

Ever since, it's been believed that if you want to make a polymer network material stiff, you have to sacrifice some stretchability.

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That is, until Cai's team, led by Ph.D. student Baiqiang Huang, proved otherwise with their new "foldable bottlebrush polymer networks." Their work, "A universal strategy for decoupling stiffness and extensibility of polymer networks," is on the cover of the Nov. 27 issue of Science Advances.

'Decoupling' stiffness and stretchiness

"This limitation has held back the development of materials that need to be both stretchable and stiff, forcing engineers to choose one property at the expense of the other," Huang said. "Imagine, for example, a heart implant that bends and flexes with each heartbeat but still lasts for years."

Huang first-authored the paper with postdoctoral researcher Shifeng Nian and Cai.

Crosslinked polymers are everywhere in products we use, from automobile tires to home appliances—and they are increasingly used in biomaterials and health care devices.

Some applications the team envisions for their material include prosthetics and medical implants, improved wearable electronics, and "muscles" for soft robotic systems that need to flex, bend and stretch repeatedly.

Stiffness and extensibility—how far a material can stretch or expand without breaking—are linked because they originate from the same building block: the polymer strands connected by crosslinks. Traditionally, the way to stiffen a polymer network is to add more crosslinks.

This stiffens the material but doesn't solve the stiffness-stretchability trade-off. Polymer networks with more crosslinks are stiffer, but they don't have the same freedom to deform, and they break easily when stretched.

"Our team realized that by designing foldable bottlebrush polymers that could store extra length within their own structure, we could 'decouple' stiffness and extensibility—in other words, build in stretchability without sacrificing stiffness," Cai said. "Our approach is different because it focuses on the molecular design of the network strands rather than crosslinks."

How the foldable design works

Instead of linear polymer strands, Cai's structure resembles a bottlebrush—many flexible side chains radiating out from a central backbone.

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Critically, the backbone can collapse and expand like an accordion that unfolds as it stretches. When the material is pulled, the hidden length inside the polymer uncoils, allowing it to elongate up to 40 times more than standard polymers without weakening.

Meanwhile, the side chains determine stiffness, meaning that stiffness and stretchability can finally be controlled independently.

This is a “universal” strategy for polymer networks because the components that make up the foldable bottlebrush polymer structure are not restricted to specific chemical types.

For example, one of their designs uses a polymer for the side chains that stays flexible even in cold temperatures. But using a different synthetic polymer, one that is commonly used in biomaterial engineering, for the side chains can produce a gel that can mimic living tissue.

Like many of the novel materials developed in Cai’s lab, the foldable bottlebrush polymer is designed to be 3D-printable. This is true even when mixed with inorganic nanoparticles, which can be designed to exhibit intricate electric, magnetic or optical properties.

For example, they can add conductive nanoparticles, such as silver or gold nanorods, which are critical to stretchable and wearable electronics.

“These components give us endless options for designing materials that balance strength and stretchability while harnessing the properties of inorganic nanoparticles based on specific requirements,” Cai said.

Phys Org, 27 November 2024

<https://phys.org>

It might be wrecking the climate, but carbon dioxide is actually good for your cells

2024-11-26

The cells in our bodies are like bustling cities, running on an iron-powered system that uses hydrogen peroxide (H₂O₂) not just for cleaning up messes but also for sending critical signals. Normally, this works fine, but under stress, such as inflammation or a burst of energy use, oxidative stress damages cells at the genetic level.

This is because iron and H₂O₂ react in what’s known as the Fenton reaction, producing hydroxyl radicals, destructive molecules that attack DNA and

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RNA indiscriminately. But there’s a catch. In the presence of carbon dioxide – that pesky gas disrupting global climate systems – our cells gain a secret weapon in the form of bicarbonate which helps keep pH levels balanced.

A team of University of Utah chemists has discovered that bicarbonate doesn’t just act as a pH buffer but also alters the Fenton reaction itself in cells. Instead of producing chaotic hydroxyl radicals, the reaction instead makes carbonate radicals, which affect DNA in a far less harmful way, according to Cynthia Burrows, a distinguished professor of chemistry and senior author of a study published this week in PNAS.

“So many diseases, so many conditions have oxidative stress as a component of disease. That would include many cancers, effectively all age-related diseases, a lot of neurological diseases,” Burrows said. “We’re trying to understand cells’ fundamental chemistry under oxidative stress. We have learned something about the protective effect of CO₂ that I think is really profound.”

Co-authors include Aaron Fleming, a research associate professor, and doctoral candidate Justin Dingman, both members of the Burrows Laboratory.

Without bicarbonate or CO₂ present in experimental DNA oxidation reactions, the chemistry is also different. The free radical species generated, hydroxyl radical, is extremely reactive and hits DNA like a shotgun blast, causing damage everywhere, Burrows said.

In contrast, her team’s findings show that the presence of bicarbonate from dissolved CO₂ changes the reaction to make a milder radical striking only guanine, the G in our four-letter genetic code.

“Like throwing a dart at the bullseye where G is the center of the target,” Burrows said. “It turns out that bicarbonate is a major buffer inside your cells. Bicarbonate binds to iron, and it completely changes the Fenton reaction. You don’t make these super highly reactive radicals that everyone’s been studying for decades.”

What do these findings mean for science? Potentially a lot.

For starters, the team’s discovery shows cells are a lot smarter than previously imagined, which could reshape how we understand oxidative stress and its role in diseases like cancer or aging.

But it also raises the possibility that many scientists studying cell damage have been conducting laboratory experiments in ways that don’t reflect

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the real world, rendering their results suspect, Burrows said. Chemists and biologists everywhere grow cells in a tissue culture in an incubator set to 37 degrees Centigrade, or body temperature. In these cultures, carbon dioxide levels are raised to 5%, or about 100 times more concentrated than what's found in the atmosphere.

The elevated CO₂ recreates the environment the cells normally inhabit as they metabolize nutrients, however, it is lost when researchers start their experiments outside the incubator.

"Just like opening up a can of beer. You release the CO₂ when you take your cells out of the incubator. It's like doing experiments with a day-old glass of beer. It's pretty flat. It has lost the CO₂, its bicarbonate buffer," Burrows said. "You no longer have the protection of CO₂ to modulate the iron-hydrogen peroxide reaction."

She believes bicarbonate needs to be added to ensure reliable results from such experiments.

"Most people leave out bicarbonate/CO₂ when studying DNA oxidation because it is difficult to deal with the constant outgassing of CO₂," Burrows said. "These studies suggest that to get an accurate picture of DNA damage that occurs from normal cellular processes like metabolism, researchers need to be careful to mimic the proper conditions of the cell and add bicarbonate, i.e. baking powder!"

Burrows anticipates her study could result in unintended outcomes that may someday benefit research in other areas. Her lab is seeking new funding from NASA, for example, to study the effect of CO₂ on people confined to enclosed spaces, such as inside of space capsules and submarines.

"You've got astronauts in a capsule living and breathing, and they are exhaling CO₂. The problem is how much CO₂ can they safely handle in their atmosphere? One of the things we found is that, at least in terms of tissue culture, CO₂ does have a protective effect from some of the radiation damage these astronauts might experience. So what you might want to do is push up that CO₂ level. You certainly don't want to go very high, but having it slightly higher might actually have a protective effect against radiation, which generates hydroxyl radicals."

Science Daily, 26 November 2024

<https://sciencedaily.com>

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Harvesting water from air: Copolymer solution uses water-loving differential to induce desorption

2024-11-27

Harvesting water from the air and decreasing humidity are crucial to realizing a more comfortable life for humanity. Water-adsorption polymers have been playing a key part in atmospheric water harvesting and desiccant air conditioning, but desorption so that the polymers can be efficiently reused has been an issue.

Now, Osaka Metropolitan University researchers have found a way to make desorption of these polymers more efficient. The findings are published in ACS ES&T Water.

Usually, heat of around 100°C is required to desorb these polymers, but Graduate School of Engineering student Daisuke Ikegawa, Assistant Professor Arisa Fukatsu, Associate Professor Kenji Okada, and Professor Masahide Takahashi developed a liquid moisture adsorbent that requires only a temperature of around 35°C to do so.

This became possible through the use of random copolymers of polyethylene glycol, which adsorbs water well, and polypropylene glycol, which adsorbs water slightly less well. The difference in their water-loving properties created a transfer mechanism that broke down the water clusters, freeing the water more easily.

"This technology has the potential to be applied not only to water supply in arid regions and places with limited energy resources, but also to ensuring access to water in times of disaster and emergency," Dr. Fukatsu said.

"Improvements to this technology are also expected to lead to reductions in greenhouse gases and more efficient use of water resources," Professor Takahashi added. "From now on, we will aim to improve the liquid moisture adsorbent and increase the efficiency of the entire system in order to make it practical."

Phys Org, 27 November 2024

<https://phys.org>

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Millions at Risk? Mysterious Compound Discovered in American Tap Water

2024-11-27

Chloronitramide anion, a newly identified by-product of chloramine use in water disinfection, raises concerns due to its unknown toxicity and high concentrations in U.S. tap water, prompting calls for further study and reconsideration of chloramine use.

Many public water systems in the United States rely on inorganic chloramines to disinfect drinking water, but the byproducts of their decomposition have remained largely unknown. In a recent study, researchers unveiled the chloronitramide anion—a compound whose presence has been suspected for 30 years but whose identity was only recently confirmed.

Detected in the tap water of millions of Americans, this compound's toxicity remains untested, prompting calls for immediate toxicological evaluation and raising questions about the safety of chloramine in public water supplies. For over a century, chemical disinfection of public water supplies has effectively reduced waterborne disease by killing pathogens in drinking water. Inorganic chloramines, like monochloramine (NH_2Cl) and dichloramine (NHCl_2), have become widely used in the U.S. for this purpose and are used to treat the tap water of nearly one-third of Americans.

However, for decades, chloramine decomposition has been suspected of producing elusive chemical by-products, including potential nitrogen-containing compounds with unknown toxicity. One such disinfection by-product, referred to simply as an “unidentified product”, remains uncharacterized despite being first identified more than 40 years ago.

Breakthrough in Identifying Chloronitramide Anion

By combining classic synthesis methods with advanced analytical techniques like high-resolution mass spectrometry and nuclear magnetic resonance (NMR) spectroscopy, Julian Fairey and colleagues isolated and identified chloronitramide anion (Cl-N-NO_2^-) as a previously unidentified product of inorganic chloramine decomposition. Fairey et al. measured chloronitramide anion content in a range of chloraminated water systems in the U.S., detecting levels as high as ~100 micrograms per liter ($\mu\text{g/l}$), which surpasses the typical regulatory limits for many disinfection by-products (60–80 $\mu\text{g/liter}$).

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Notably, this compound was absent in water systems that used alternative disinfectants. Although direct toxicological studies have not yet been conducted, the authors caution that computational analyses suggest that chloronitramide anion may not be benign, emphasizing the need for an immediate toxicological assessment and quantification in source waters, finished drinking waters, and wastewater effluents.

“The findings of Fairey et al. may trigger a reevaluation of the wisdom of chloraminating public water supplies,” writes Daniel McCurry in a related Perspective. “Regardless of whether chloronitramide anion is found to be toxic or not, its discovery warrants a moment of reflection for water researchers and engineers.”

Sci Tech Daily, 27 November 2024

<https://scitechdaily.com>

Improved catalyst turns harmful greenhouse gases into cleaner fuels, chemical feedstocks

2024-11-26

A chemical reaction can convert two polluting greenhouse gases into valuable building blocks for cleaner fuels and feedstocks, but the high temperature required for the reaction also deactivates the catalyst. A team led by the Department of Energy's Oak Ridge National Laboratory has found a way to thwart deactivation. The strategy may apply broadly to other catalysts.

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 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.

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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 fabrics 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.”

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.

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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.

“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.

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“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.”

wScience Daily, 26 November 2024

<https://sciencedaily.com>

Cobalt ions, not covalent organic frameworks themselves, drive catalytic activity, study finds

2024-11-26

Covalent organic frameworks (COFs) are less stable as catalysts than previously thought but remain highly active. COFs are promising designer catalysts, for example for the sustainable production of chemicals and fuels. Their properties can be adjusted very specifically to catalyze a desired reaction based on their precise tunability, both in terms of molecular structure and chemical compositions.

However, researchers at Ruhr University Bochum, Germany, and the Max Planck Institutes for Solid State Research (MPI-FKF) and for Sustainable Materials (MPI-SusMat) have shown that the catalytic activity is not generated by the COFs themselves. Instead, the cobalt ions detach from the scaffold and transform into oxidic nanoparticles that actually facilitate the catalysis. The team describes these results in the journal *Advanced Science*.

“With the knowledge gained from this study, we will be able to design catalysts from organic frameworks and nanoparticles that are significantly more efficient than COFs designed before,” says Professor Kristina Tschulik from Ruhr University Bochum and the RESOLV Cluster of Excellence, who came up with the idea for the study jointly with Professor Bettina Lotsch from the MPI-FKF.

“As an electrochemist, I’ve always wondered a bit about how the catalytic activity of COFs actually comes about,” says Tschulik.

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Stable under harsh reaction conditions?

The Bochum-based group led by Tschulik started a collaboration with researchers from Stuttgart led by Lotsch, who are experts in the synthesis of COFs. Both teams are part of the Collaborative Research Center 1333, based at the University of Stuttgart.

Researchers with Pouya Hosseini, Andrés Rodríguez-Camargo and Liang Yao analyzed the catalytic activity of several cobalt-containing COFs in the so-called oxygen evolution reaction. This reaction occurs in many industrially important reactions, for example in the electrolysis of water to produce hydrogen.

“The reaction conditions in the oxygen evolution reaction are harsh,” explains Tschulik. “There is actually only one catalyst—iridium oxide—that remains stable.” However, an increasing number of studies have reported that COFs are also long-term stable in this reaction.

In the first step, the research team analyzed the COFs electrochemically during the oxygen evolution reaction. In fact, the conversion took place with high activity over several cycles. However, Tschulik had already seen the recorded current potential curves in a different context.

As part of the Collaborative Research Center 247, the scientist had been working for seven years with cobalt oxide nanoparticles as catalysts that generate precisely this curve shape. The group therefore started a more complex material characterization, supported by a team of researchers from MPI-SusMat led by Christina Scheu, who are experts in electron microscopy.

Scaffolds prevent nanoparticles from clumping together

These analyses showed that oxidic cobalt nanoparticles are formed from the cobalt-containing scaffold compounds, which take over the catalytic work. This conversion takes place immediately when the electrode is immersed in the basic solution.

“However, the porous COF scaffolds still fulfill an important purpose,” says Tschulik, explaining another result of the analyses. “They provide a suitable reaction environment and hold the nanoparticles in place. Normally, the particles tend to aggregate, which means that less of their catalytic surface is accessible and they deactivate.”

In their publication, the authors also provide suggestions on how catalyst-loaded COFs could be produced in a targeted manner in the future so

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that they remain stable and catalytically active even under harsh reaction conditions.

Phys Org, 26 November 2024

<https://phys.org>

Quantum Breakthrough Allows Researchers To Create “Previously Unimaginable Nanocrystals”

2024-11-27

Replacing organic solvents with molten salt enables researchers to create “previously unimaginable nanocrystals.”

The type of semiconductive nanocrystals known as quantum dots is not only expanding the forefront of pure science but also playing a crucial role in practical applications, including lasers, quantum QLED televisions and displays, solar cells, medical devices, and other electronics.

A new technique for growing these microscopic crystals, recently published in *Science*, has not only found a new, more efficient way to build a useful type of quantum dot, but also opened up a whole group of novel chemical materials for future researchers’ exploration.

“I am excited to see how researchers across the globe can harness this technique to prepare previously unimaginable nanocrystals,” said first author Justin Ondry, a former postdoctoral researcher in UChicago’s Talapin Lab.

The team—which included researchers from the University of Chicago, University of California Berkeley, Northwestern University, the University of Colorado Boulder, and Argonne National Laboratory—achieved these remarkable results by replacing the organic solvents typically used to create nanocrystals with molten salt—literally superheated sodium chloride of the type sprinkled on baked potatoes.

“Sodium chloride is not a liquid in your mind, but assume you heat it to such a crazy temperature that it becomes a liquid. It looks like liquid. It has a similar viscosity as water. It’s colorless. The only problem was that nobody ever considered these liquids as media for colloidal synthesis,” said Prof. Dmitri Talapin at the UChicago Pritzker School of Molecular Engineering (UChicago PME) and the Chemistry Department.

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Why salt?

Quantum dots are among the more well-known nanocrystals, not only for their wide commercial uses but for the recent 2023 Nobel Prize in Chemistry given to the team that discovered them.

“If there is a material from the world of nano that has had an impact on society in terms of applications, it’s the quantum dot,” said UC Berkeley Prof. Eran Rabani, a co-author of the paper.

However, much of the previous research on quantum dots, including the Nobel work, was around dots grown using combinations of elements from the second and sixth groups on the periodic table, Rabani said. These are called “II-VI” (two-six) materials.

More promising materials for quantum dots can be found elsewhere on the periodic table.

Materials found in the third and fifth groups of the periodic table (III-V materials) are used in the most efficient solar cells, the brightest LEDs, the most powerful semiconductor lasers, and the fastest electronic devices. They would potentially make great quantum dots, but, with few exceptions, it was impossible to use them to grow nanocrystals in solution. The temperatures required to make these materials were too high for any known organic solvent.

Molten salt can handle the heat, making these previously inaccessible materials accessible.

“This distinct advance of molten salt synthesis that Prof. Talapin’s group has pioneered for the first time many materials for which previously colloidal synthesis was simply unavailable,” said co-author Richard D. Schaller, who has a joint appointment with Argonne National Laboratory and Northwestern University. “Fundamental as well as applied advances can now be made by with many of these newly available materials and at the same time there is now a whole new synthetic frontier available to the community.”

The Quantum Age

One of the reasons researchers synthesizing nanocrystals overlooked molten salt was because of its strong polarity, said UChicago graduate student Zirui Zhou, second author of the new paper.

Salt’s positively charged ions and negatively charged ions have a strong pull toward each other. Small things like nanocrystals have small surface

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charges, so researchers assumed the charge would be too weak to push back as salt's ions pull in. Any growing crystals would be crushed before they could form a stable material.

Or so previous researchers thought.

"It's a surprising observation," Zhou said. "This is very contradictory to what scientists traditionally think about these systems."

The new technique can mean new building blocks for better, faster quantum and classical computers, but for many on the research team, the truly exciting part is opening up new materials for study.

"Many eras in human history are defined by the materials humanity had available—think 'Bronze Age' or 'Iron Age,'" Ondry said. "In this work, we have unlocked the ability to synthesize nearly a dozen new nanocrystal compositions which will enable future technologies."

Sci Tech Daily, 27 November 2024

<https://scitechdaily.com>

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