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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

Guide to managing the risks of rooftop solar installation work

2024-09-09

Our Guide to managing the risks of rooftop solar installation work assists duty holders, primarily PCBUs, to manage the risks to health and safety associated with rooftop solar installation work.

The guide is for anyone who retails, surveys, designs, installs, tests, commissions, repairs, maintains, decommissions or removes rooftop solar systems on residential or commercial structures.

Related guidance:

- Model Code of Practice: How to manage work health and safety risks
- Model Code of Practice: Managing the work environment and facilities
- Model Code of Practice: Managing risks of plant in the workplace
- Model Code of Practice: Managing the risk of falls at workplaces
- Model Code of Practice: Managing the risk of falls in housing construction
- Model Code of Practice: Managing electrical risks in the workplace
- Model Code of Practice: Hazardous manual tasks
- Model Code of Practice: Managing psychosocial hazards at work
- Model Code of Practice: Confined spaces
- Model Code of Practice: How to manage and control asbestos in the workplace
- Model Code of Practice: Managing noise and preventing hearing loss at work
- Guide for managing the risks of working in heat

Publication Date:

09 Sep 2024

Last updated:

09 Sep 2024

Publication type:

Guide

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Read More

Safe Work Australia, 09-09-24

<https://www.safeworkaustralia.gov.au/doc/guide-managing-risks-rooftop-solar-installation-work>

Taking action on herbicide Chlorthal-dimethyl

2024-09-09

We issued a red alert for the herbicide chlorthal-dimethyl on 22 August 2024, advising people to stop using products containing the substance because of significant concerns about its effects on fetal development.

This follows the US EPA banning the use and sale of all products containing the herbicide earlier in August after receiving new information about the human health risks from this substance.

Chlorthal-dimethyl, also referred to as dimethyl tetrachloroterephthalate, DCPA, dacthal, or chlorthal-methyl, is the active ingredient in three products available in New Zealand.

These are used particularly on weeds in onion crops, forest nurseries, and ornamental plants.

We have now consulted with importers, manufacturers, suppliers and users of this herbicide to get a better understanding of how it is being used in New Zealand.

The information we received will inform our decision on actions to manage the use of chlorthal-dimethyl and ensure we continue protecting people and the environment.

Read More

New Zealand EPA, 09-09-24

<https://www.epa.govt.nz/news-and-alerts/alerts/red-alert-warning-for-dcpa-weedkillers/>

Lead impurity levels reduced in paints

2024-09-09

We have significantly reduced the levels of lead impurities allowed in paints and tightened the rules for art materials, such as chalk, crayons, and felt-tip pens.

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The changes are to a series of group standards that cover these products to reduce any potential exposure to lead and further protect people's health and safety.

The key changes we have made are to:

- cut lead impurity limits in paints, including corrosion inhibitors
- require evidence showing lead levels are below the limit
- ensure all graphic materials marketed at children only fit the Graphic Materials Group Standard, which only allows products with no health risks
- cut the levels of migratable lead and other toxic elements allowed in graphic materials marketed for children
- remove the need to give the EPA results of migratable element testing of graphic materials (to match other group standards and international regulators).

Read More

New Zealand EPA, 09-09-24

<https://www.epa.govt.nz/public-consultations/decided/lead-in-paints/>

Updated requirements for graphic material importers and manufacturers

2024-09-09

We have updated the rules for importing and manufacturing graphic materials marketed at children, such as fingerpaints, crayons, and felt-tip pens, as part of our decision to reduce the lead impurity levels allowed in paints.

The key changes for importers and manufacturers of graphic materials marketed at children are:

- products using the Graphic Materials Group Standard must meet the new element migration levels by 1 March 2025
- the Graphic Materials Group Standard is now the only group standard for graphic materials marketed at children
- the notification requirement prior to importing these products is removed

What these changes mean for importers and manufacturers:

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- From 19 September 2024, importers are no longer required to notify the EPA, or seek a letter and customs clearance code, to import these products.
- Notifications received by the EPA by 19 September 2024 will be processed as normal. If your shipment arrives after 19 September 2024, you will receive a letter confirming notification, not a clearance code.
- Importers or manufacturers are still required to hold evidence of the following, and provide to the EPA on request:
 - assignment to the group standard
 - meeting the limits specified in the group standard, including as an analytical test report
- Importers or manufacturers will need to ensure graphic materials previously tested for migration of elements comply with the new levels.
- Products currently being imported or manufactured may need to be re-tested by 1 March 2025 to show they comply with the new levels.

Read More

New Zealand EPA, 09-09-24

https://www.epa.govt.nz/public-consultations/decided/lead-in-paints

AMERICA

Lawrence Berkeley National Laboratory and University of California effectively recycle polyethylene and polypropylene

2024-09-04

Researchers at Lawrence Berkeley National Laboratory and the University of California, Berkeley, have developed a new chemical process to effectively recycle polyethylene and polypropylene plastics. The process converts these plastics into their original hydrocarbon building blocks—monomers used to create new plastics. This innovation could reduce the reliance on fossil fuels for new plastic production and address the large volume of plastic waste that ends up in landfills or oceans. The researchers believe this method could be scaled up for commercial use, helping to make a substantial impact on plastic waste management.

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[Read More](#)

RPRA, 04-09-24

<https://rpra.ca/the-hub/lawrence-berkeley-national-laboratory-and-university-of-california-researchers-effectively-recycle-polyethylene-and-polypropylene/>

Mexico has more than 700,000 producers trained in the management of pollinators, water, and soil

2024-09-04

The Secretariat of Agriculture and Rural Development (Sader) has trained over 700,000 producers in sustainable practices to enhance food security, focusing on pollinators, water, and soil management. Key initiatives include the National Soil Strategy for Sustainable Agriculture (Enasas), the National Strategy for the Conservation and Sustainable Use of Pollinators (ENCUSP), and the Strategic Plan for Climate Change in the Agri-Food Sector (Plecca). These efforts have reduced food insecurity for 10.3 million Mexicans and lifted 1.9 million people out of poverty. Additionally, Chile's Undersecretary of Agriculture emphasized the importance of supporting peasant and indigenous family agriculture to address food security, climate change, and urbanization challenges.

[Read More](#)

Tridge, 04-09-24

<https://www.tridge.com/news/mexico-has-more-than-700000-producers-traine-vnibph>

EPA Takes a Crucial Step Toward Closing a Dangerous Air Toxics Loophole Adopted by the Trump Administration

2024-09-04

The U.S. Environmental Protection Agency today finalized a rule that will provide much-needed health protections from toxic air pollution emitted by industrial facilities, including petrochemical plants.

EPA's action helps address a damaging loophole created by the prior administration that allowed industrial facilities across the country to increase toxic air pollutants and to avoid the vital Clean Air Act

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requirements that are designed to limit the most hazardous airborne contaminants.

"EPA's action helps restore vital protections that limit toxic air pollution, helps people across the country breathe easier, and helps address a reckless loophole adopted by the Trump administration that enabled increases in industrial air toxic pollution," said EDF senior attorney Noha Haggag. "The industrial air toxics addressed by EPA's action today are some of the most dangerous in our lives and include pollution that causes cancer, brain damage in children, and early deaths."

EPA's previous "Once In, Always In" policy addressed major industrial sources of toxic air pollution. Under the Clean Air Act, "major" sources of pollution are defined as those that have the potential to emit hazardous pollutants above a legal threshold. These hazardous pollutants are particularly harmful for human health, and include mercury, which can cause brain damage in developing babies, and benzene, which can cause cancer, as well as alkylated lead compounds, polycyclic organic matter (POM), polychlorinated biphenyls (PCB), furans and dioxins.

[Read More](#)

EDF, 04-09-24

<https://www.edf.org/media/epa-takes-crucial-step-toward-closing-dangerous-air-toxics-loophole-adopted-trump>

Lawmakers Pass EDF Priority Bills for More Equitable, Efficient Climate Action

2024-09-03

EDF urges Governor Newsom to sign SB 310, SB 1221, AB 828, and AB 3264

As California's 2024 Legislative session comes to a close, Environmental Defense Fund applauds state lawmakers for sending four key bills to Governor Gavin Newsom. These bills recognize Tribal sovereignty over cultural burning practices, control ratepayer costs in the transition to clean energy, smarter planning for the clean energy transition, and ensure vulnerable communities and wetlands have safe, affordable groundwater. Newsom has until September 30 to act on these measures.

"California has made bold commitments to confront climate change and environmental injustice," said Katelyn Roedner Sutter, EDF California State Director. "By signing these bills, Governor Newsom can help ensure

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California has the needed policy in place to make those commitments reality.”

[Read More](#)

EDF, 03-09-24

<https://www.edf.org/media/lawmakers-pass-edf-priority-bills-more-equitable-efficient-climate-action>

EUROPE

Prevention, detection, response and mitigation of chemical, biological and radiological threats to agricultural production, feed and food processing, distribution and consumption

2024-09-11

Increasing EU capabilities to assess risks, detect, alert, mitigate and respond to feed and food intentional and accidental contamination from chemical, biological and radiological (CBR) agents, through the entire food chains (soils and agro-production, feed and food industry, transporting, retail and hospitality industry, public catering);

Increasing the understanding on food terrorism threats and on food chain vulnerabilities to intentional and accidental contaminations;

Raising awareness among feed and food companies and authorities to CBR threats arising from malicious use of hazardous agents that pose danger to animal and public health. This should be done under the premises of feed and food as a critical infrastructure and risks pertaining therein;

In addition to raising awareness, proposals should develop possible preparedness, mitigation and response plans for national authorities and the private sector.

[Read More](#)

EFSA, 11-09-24

<https://www.efsa.europa.eu/en/funding-calls/prevention-detection-response-and-mitigation-chemical-biological-and-radiological>

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Future EU MRL amendments: thiacloprid

2024-09-13

Publication expected late 2024

In July 2024, the EU SCoPAFF (Standing Committee on Plants, Animals, Food and Feed) agreed to changes to EU MRLs for an active substance under Regulation (EC) No 396/2005.

We can expect the publication of EU implementing Regulations for the revised MRLs in the next 4-6 months if these pass scrutiny by the European Parliament and Council. The MRLs are likely to come into force 6 months following publication, by mid 2025.

It is expected that EU MRLs will be amended for the following active substance:

- thiacloprid

Find out which commodities are affected by searching for the active substance in the EU MRL database. The related changes will shortly appear in the “not yet applicable” column.

The list above does not include EU MRLs resulting from applications to raise EU MRLs, e.g. to support new PPP uses, or proposals to list active substances on Annex IV of Regulation (EC) No 396/2005 (actives not subject to MRLs).

There are no NI authorisations for thiacloprid on any crop; no amendment or withdrawal action is required as a result of the new EU MRLs for thiacloprid.

[Read More](#)

HSE, 13-09-24

<https://www.hse.gov.uk/>

INTERNATIONAL

Waste Incineration Drives the Triple Planetary Crisis

2024-09-03

Incineration is an outdated, unsustainable method for waste disposal, as burning waste, especially plastics, produces dangerous air emissions and high amounts of toxic ash.

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A comprehensive new report “Waste incineration and the Environment” released today by Arnika, the Centre for Environment Justice and Development (CEJAD) in Kenya, Centre de Recherche et d’Education pour le Développement (CREPD) in Cameroon, Toxics Free Australia (TFA), and IPEN finds that burning waste, especially plastics, produces unsustainable and unmanageable hazardous air emissions and large amounts of highly toxic solid residues (ash), concluding that alternatives to incineration should be implemented globally. Given the challenges faced by the triple planetary crisis of biodiversity loss, climate change, and toxic pollution, the report finds that waste incineration contributes to all three of these interlinked problems.

[Read More](#)

ARNIKA, 03-09-24

<https://arnika.org/en/news/report-waste-incineration-drives-the-triple-planetary-crisis>

New global guidance aims to curb antibiotic pollution from manufacturing

2024-09-03

The World Health Organization (WHO) has published its first-ever guidance on antibiotic pollution from manufacturing. The new guidance on wastewater and solid waste management for antibiotic manufacturing sheds light on this important but neglected challenge ahead of the United Nations General Assembly (UNGA) High-Level Meeting on antimicrobial resistance (AMR) taking place on 26 September 2024.

The emergence and spread of AMR caused by antibiotic pollution could undermine the effectiveness of antibiotics globally, including the medicines produced at the manufacturing sites responsible for the pollution.

Despite high antibiotic pollution levels being widely documented, the issue is largely unregulated and quality assurance criteria typically do not address environmental emissions. In addition, once distributed, there is a lack of information provided to consumers on how to dispose of antibiotics when they are not used, for example, when they expire or when a course is finished but there is still antibiotic left over.

“Pharmaceutical waste from antibiotic manufacturing can facilitate the emergence of new drug-resistant bacteria, which can spread globally

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and threaten our health. Controlling pollution from antibiotic production contributes to keeping these life-saving medicines effective for everyone,” said Dr Yukiko Nakatani, WHO Assistant Director-General for AMR ad interim.

Globally, there is a lack of accessible information on the environmental damage caused by manufacturing of medicines. “The guidance provides an independent and impartial scientific basis for regulators, procurers, inspectors, and industry themselves to include robust antibiotic pollution control in their standards,” said Dr Maria Neira, Director, Department of Environment, Climate Change and Health, WHO. “Critically, the strong focus on transparency will equip buyers, investors and the general public to make decisions that account for manufacturers’ efforts to control antibiotic pollution.”

[Read More](#)

WHO, 03-09-24

<https://www.who.int/news/item/03-09-2024-new-global-guidance-aims-to-curb-antibiotic-pollution-from-manufacturing>

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REACH Update

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Assessment of regulatory needs reports published

2024-09-13

Reports for the following substance groups are now available on our website:

- Simple inorganic silicon compounds
- Esters from dicarboxylic acids and ethoxylated alcohols

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

[Read More](#)

ECHA, 13-09-24

[Assessment of regulatory needs reports published](#)

Ad hoc consultation on harmonised classification and labelling

2024-09-13

We have launched an ad hoc consultation on the harmonised classification and labelling of:

- 3,4-dimethyl-1H-pyrazole (EC 429-130-1, CAS 2820-37-3)

The proposal was submitted by Belgium and was subject to a consultation, which ended on 13 October 2023.

During its July working group meeting, the Committee for Risk Assessment (RAC) asked for further information to assess the reproductive toxicity of this substance. RAC noted that adverse effects were observed on a structurally similar substance 3,4-dimethyl-1H-pyrazol-1-ium dihydrogen phosphate (EC 424-640-9, CAS 202842-98-6).

Consequently, RAC suggested to read-across between the two substances. A read-across proposal relevant to the case is included in this ad hoc consultation.

Have your say through the webform until 25 September 2024. The comments will be published on ECHA's website.

[Read More](#)

ECHA, 13-09-24

<https://echa.europa.eu/>

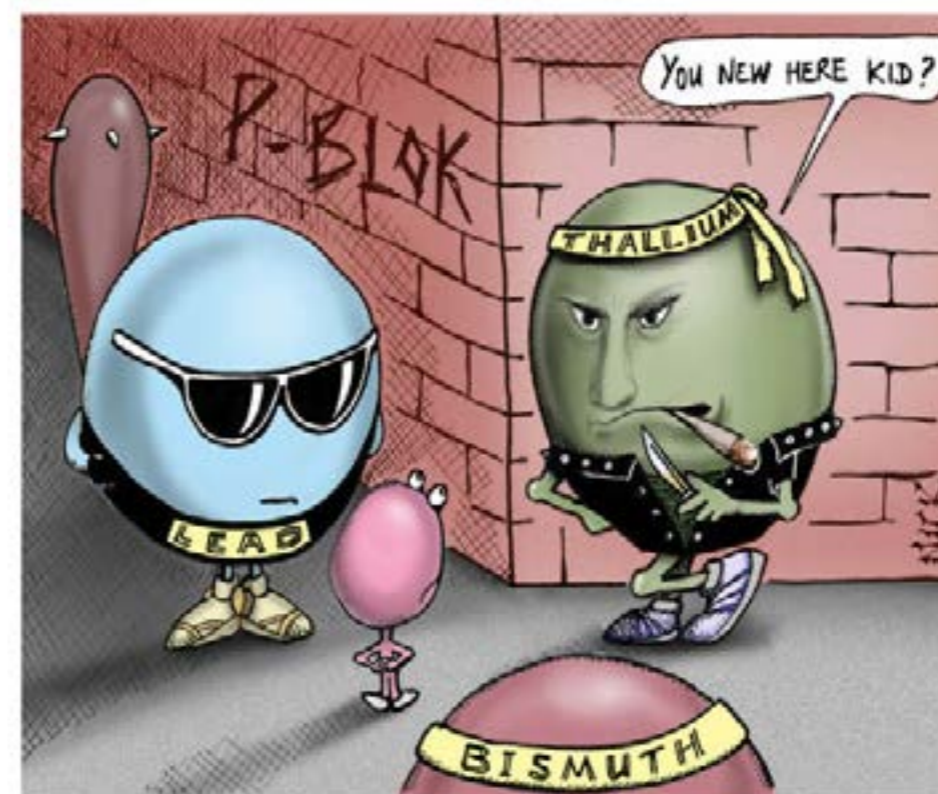
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Janet's Corner

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New Kid

2024-09-20



Unwittingly, and against his mother's advice, Vince the first-row transition metal had been lured far away from home, and now found himself surrounded by heavier elements of the P-block.

<https://www.facebook.com/ChemistryJokes/photos/vince-you-idiot/861351697227779/>

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Hazard Alert

SEP. 20, 2024

Dibenzofuran

2024-09-20

USES [2,3]

Dibenzofuran is used as an insecticide and to make other chemicals.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

- Dibenzofuran has been detected in emissions from combustion of coal, biomass, refuse, diesel fuel, and tobacco.
- It is also found in leachates from commercial coal tar and is formed from the incomplete combustion of propane.
- Dibenzofuran also is a photolytic product of environmental photolysis of chlorinated biphenyl ethers in surface waters by sunlight.
- The primary stationary sources that have reported emissions of dibenzofuran in California are lumber and wood products manufacturers, and manufacture of fabricated metal ordnance and accessories.
- It may be found in coke dust, grate ash, fly ash, and flame soot.

Routes of Exposure

- Occupational exposure may occur through inhalation and dermal contact, particularly at sites engaged in combustion/carbonisation processes, such as coal tar and coal gasification operations.
- Dibenzofuran is released to the ambient air from combustion sources. The general public may be exposed to dibenzofuran through the inhalation of contaminated air or through the consumption of contaminated drinking water or food.
- Since it has been found in tobacco smoke, you can be exposed if you smoke cigarettes or breathe cigarette smoke.

HEALTH EFFECTS [4]

Acute Health Effects

- Dibenzofuran causes skin irritation.
- Exposure to dibenzofuran can irritate the eyes, nose and throat.

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Carcinogenicity

Dibenzofuran has not been tested for its ability to cause cancer in animals. The U.S. Environmental Protection Agency has determined that there is not enough information available to classify dibenzofuran as a cancer causing substance.

Other Effects

Dibenzofuran has not been tested for its ability to affect reproduction.

SAFETY

First Aid Measures [5]

- Inhalation: If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.
- Skin Contact: Wash off with soap and plenty of water. Consult a physician.
- Eye Contact: Flush eyes with water as a precaution.
- Ingestion: Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

Workplace Controls & Practices [4]

Control measures include:

- Ensure there are appropriate engineering controls in place.
- Handle in accordance with good industrial hygiene and safety practice.
- Wash hands before breaks and at the end of workday.

Personal Protective Equipment [5]

Skin Protection:

- Handle with gloves.
- Gloves must be inspected prior to use.
- Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product.
- Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.
- Wash and dry hands.
- The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

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- Full contact Material: Nitrile rubber

Eye Protection

- Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Respiratory Protection

- For nuisance exposures use type P95 (US) or type P1 (EU EN 143) particle respirator.
- For higher level protection use type OV/AG/P99 (US) or type ABEK-P2 (EU EN 143) respirator cartridges.
- Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

REGULATION

United States

No occupational exposure limits have been established by dibenzofuran.

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Bulletin Board

Gossip

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PFAS-free synthesis of fluorinated drugs and pesticides

2024-09-16

Chemists at the University of Amsterdam have developed a method that avoids the use of per- and polyfluoroalkyl substances (PFAS) in the synthesis of fluorinated compounds. Their approach offers a more environmentally-friendly route to compounds with a trifluoromethyl group attached at a sulfur, nitrogen or oxygen, which provides unique features for drug molecules and agrochemicals.¹

Many pharmaceuticals, such as anti-depressants, and agrochemical compounds like pesticides include at least one trifluoromethyl group to enhance hydrophobicity and increase metabolic stability, which improves efficacy and lowers the effective dose required. Bespoke fluorinated reagents are typically needed to introduce these CF₃ groups, but many PFAS compounds are facing legislation in the US, Europe and other parts of the world because they have been linked to health problems such as decreased fertility, developmental effects and cancers. But the University of Amsterdam team, which includes scientists from drug giant AstraZeneca, says its new synthesis protocol offers an alternative because it only requires a caesium fluoride salt – which is not a PFAS – as the fluorine source.

The microfluidic platform passes chlorocarbon chemicals through a packed bed flow reactor containing caesium fluoride salt. The reactor brings the two reagents into close contact resulting in efficient fluorination of the chlorocarbons, producing trifluoromethylated anions. These anions can then be reacted with drug or agrochemical precursors to make the trifluoromethylated molecules of interest.

Ian Cousins, an environmental chemist at Stockholm University in Sweden, says that the X-CF₃ chemistry, where X is S, N or O, is 'an interesting building block' that 'still falls under the broad definition of PFAS'. However, he suggests that if these substances are shown to be fully degradable or mineralisable they could be excluded from forthcoming European regulations governing PFAS.

A recent study², which was part of a larger project that Cousins coordinated called Perforc3 – a Europe-wide doctoral training programme in the field of PFAS contaminants – also looked at a similar approach to this one. But Cousins notes that it found that these prototype substances containing trifluoromethoxy groups also led to 'dead-end persistent metabolites', and therefore he argues that one cannot conclude that they

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are all degradable and recommends that such substances be tested on a case-by-case basis.

Chemistry World, 16 September 2024

<https://chemistryworld.com>

Clay reduces methane in cow burps by 30%

2024-09-18

In case you haven't heard, the methane in cow burps is a major source of greenhouse gases. There may be a new way of addressing that problem, however, as a recent study shows that feeding cows clay reduces their methane emissions by over 30%.

So first of all, yes, we're serious about the cow burps.

Cows produce methane as a byproduct of digesting their high-fiber diet, and belch the gas out on a continuous basis. According to the United Nations Environment Programme, that burped-out methane – from cows and other livestock animals – makes up about 40% of total global methane emissions.

Making matters worse is the fact that methane is approximately 25 times more potent than carbon dioxide at contributing to global warming.

In order to reduce the methane in cow burps, scientists have experimented with cattle feed supplements such as fish oil, seaweed, tropical leaves, and even baby kangaroo poop. Now, halloysite clay is showing promising results.

In a pilot study conducted by Dr. Bhaba Biswas and colleagues at Australia's University of Newcastle, it was found that adding a modified form of the naturally occurring clay to regular cattle feed reduced the animals' methane emissions by more than 30% over a 24-hour period.

According to Biswas, the clay curbs the activity of gut microbes and parasites which produce the methane. The material appears to be harmless to the cattle – after all, they regularly ingest soil when grazing – and in fact could even have health benefits such as reduced gut acidity. It is ultimately passed with the feces.

More research still needs to be conducted, but it is hoped that the modified halloysite could eventually be sold in the form of inexpensive pellets or a paddock spray.

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Biswas and his team are presenting their findings this week at the International Cleanup Conference in Adelaide, Australia.

Source: Scientell

New Atlas, 18 September 2024

<https://newatlas.com>

Blackcurrant Supplements Appear To Minimize Postmenopausal Bone Loss

2024-09-18

As we age, our bones lose density and become more fragile, putting us in danger of breaks and fractures.

This is especially a concern among post-menopausal women who generally have much greater losses in bone density than men in their age group.

Chun previously led a study showing that in mice, blackcurrant supplements helped prevent bone density loss post-menopause. This study showed that the best time for intervention was in the transition between pre- and post-menopause before bone loss has significantly progressed.

With these findings in hand, Chun and her team wanted to see if they would translate to a human population.

They recently published their findings demonstrating blackcurrant's protective effects against bone density loss in the Journal of Nutritional Biochemistry.

The group includes nutritional sciences graduate student Briana Nosal, who is the first author on the paper, kinesiology post-doctoral researcher Staci Thornton, and Elaine Choung-Hee Lee, professor of kinesiology, as well as researchers from UConn Health and the Jackson Laboratory for Genomic Medicine.

Forty peri- and early post-menopausal participants between the ages of 45 and 60 took capsules of blackcurrant powder daily for six months. Participants were randomly assigned to either take one capsule, two capsules, or a placebo. Each capsule was 392 milligrams.

The researchers found that the supplements prevented the loss of whole-body bone mineral density. The group that took two capsules actually

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Gossip

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showed overall increases in bone mineral density at the end of the six-month trial period.

The researchers looked at changes to the gut microbiome and immune system, which interact to play a key role in bone metabolism.

They found that the blackcurrant supplements decreased levels of proteins called interleukin-1 beta and RANKL. Interleukin-1 beta stimulates the expression of RANKL which causes bone resorption and thus a decrease in bone density.

“The reduction in RANKL is important because that can cause shifts toward excessive bone resorption, so we’d want to see a decrease in that,” Nosal says.

This study showed that the decrease in RANKL was directly correlated with an increase in whole body bone density after six months.

Taking the supplements also increased a bacteria found in the gut microbiome called Ruminococcus 2. This led the researchers to infer that it could be one of the bacteria driving the protective effects blackcurrant has on bones. “It’s all related,

and there’s a lot of research showing the gut can regulate various systems in the body,” Nosal says.

These bacteria help degrade polysaccharides and fibers. This is a key function to transform the foods we eat into available energy for our bodies to use.

The researchers identified a total of four proteins that had increased expression in the group that took two supplement capsules. These could serve as potential biomarkers for the changes they observed to bone density to allow researchers or medical professionals to quickly and easily assess if the blackcurrant supplementation is benefitting bone density.

This study is especially important for peri- and early post-menopausal women who have or are at risk of developing osteoporosis. While medications for osteoporosis do exist, compliance is low due to side effects.

If blackcurrant supplements can improve bone density without the same side effects, it could prove an effective alternative for this population.

“This study shows that blackcurrant may be a potential dietary strategy to help in preventing post-menopausal osteoporosis,” Nosal says.

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As the group continues to study the relationship between blackcurrant and its benefits on the body, they will complete additional studies seeking to better understand why exactly they are seeing these results.

“[We want to learn] how all our findings connect to each other,” Nosal says. “Conducting that multi-faceted research will really paint the picture of how everything works, the different mechanisms, and what we can do for next steps.”

Technology Networks, 18 September 2024

<https://technologynetworks.com>

Toxic glass kills 99% of bone cancer without harming healthy cells

2024-09-18

Scientists have demonstrated a new potential treatment for bone cancer. A bioactive glass laced with a toxic metal was able to kill up to 99% of the cancer without harming healthy cells, and could even help regrow healthy bone after.

Osteosarcoma is the most common form of bone cancer, and treatment normally involves surgery to remove the tumor, followed by chemotherapy or radiation therapy to kill off any remaining cancer cells. Even so, it often recurs at the same site, and when it does the prognosis is usually grim.

Now, scientists at Aston University have demonstrated a new method of treating osteosarcoma. It’s based on a material called bioactive glass, which is made up of nanoparticles of glass mixed with metals, and has shown promise in strong, antibacterial dental fillings and bone implants.

This time the metal in question was gallium, which is toxic to cells. Putting that in your bones might sound like a bad idea, but gallium ions are known to enter cells through a particular receptor, which is extremely elevated in cancer. That means the “greedy” cancer cells gobble it up before the healthy bone cells can get to it.

In lab tests, the team cultured healthy bone cells alongside osteosarcoma cells, and treated them with gallium bioactive glass. And sure enough, at concentrations of 5% gallium oxide, the glass was able to kill off 99% of the osteosarcoma cells after 10 days, without harming the healthy bone.

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These bioactive glasses also show promise in regenerating bone. When incubated in simulated body fluid, new bone formation began to appear after a week.

“When we observed the glasses, we could see the formation of a layer of amorphous calcium phosphate/ hydroxy apatite layer on the surface of the bioactive glass particulates, which indicates bone growth,” said Professor Richard Martin, lead author of the study.

Unfortunately, at this stage it seems that adding gallium oxide at concentrations required to kill the cancer cells also stymies regeneration of healthy bone cells, but that’s a challenge that could be overcome with further work, using animal models.

“The safety and effectiveness of these biomaterials will need to be tested further, but the initial results are really promising,” said Dr. Lucas Souza, co-author of the study. “As the next step our work is now split into two fronts: (1) testing the anti-cancer properties of this material upon bone metastatic cells and (2) developing a minimally invasive injectable paste for bone cancer application.”

The research was published in the journal *Biomedical Materials*.

New Atlas, 18 September 2024

<https://newatlas.com>

Revealing the Invisible: Living Cells Can Be Seen With Infrared Light

2024-09-19

IST’s new infrared microscopy technique allows for the detailed imaging of biomolecules in cells, supporting advancements in biotechnology and cellular therapies.

In an effort to advance biotechnology innovations, scientists are working to develop faster, more quantitative, and more accessible ways to observe biomolecules in living cells.

Now, researchers at the National Institute of Standards and Technology (NIST) have developed a new method that allows the use of infrared (IR) light to capture clear images of biomolecules inside cells, something that was previously not possible due to the tendency of the water in cells to absorb infrared radiation.

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NIST’s new method removes the obscuring effects of water in IR-based measurements and allows researchers to determine the amounts of key biomolecules in cells, such as the proteins that direct cell function. The ability to measure changes in living cells could speed up advances in biomanufacturing, cell therapy development, drug development, and more.

Their findings have been published in *Analytical Chemistry*.

Understanding Infrared Microscopy and Its Challenges

Infrared radiation is light that is just beyond what is visible to the human eye. Although we cannot see IR light, we can feel it as heat. In IR microscopy, a material of interest absorbs radiation from a range of wavelengths in the IR spectrum. Scientists measure and analyze the IR absorption spectrum of a sample, producing a set of “fingerprints” to identify molecules and other chemical structures. However, water, the most abundant molecule both inside and outside cells, absorbs infrared strongly and masks the infrared absorption from other biomolecules in cells.

One way to understand this optical masking effect is to compare it to when an airplane passes overhead next to the Sun. With the naked eye, it’s hard to see the airplane because of the Sun, but if you use a special Sun-blocking filter, then you can easily see the airplane in the sky.

“In the spectrum, water absorbs infrared so strongly, and we want to see the absorption spectrum of proteins through the thick water background, so we designed the optical system to uncloak the water contribution and reveal the protein signals,” said NIST chemist Young Jong Lee.

Advancing Cellular Analysis with SAC-IR

Lee developed a patented technique that uses an optical element to compensate for water absorption from IR. Called solvent absorption compensation (SAC), the technique was used with a hand-built IR laser microscope to image cells that support the formation of connective tissue, called fibroblast cells. Over a 12-hour observation period, researchers were able to identify groups of biomolecules (proteins, lipids, and nucleic acids) during stages of the cell cycle, such as cell division. While this may seem like a long time, the method is ultimately faster than current alternatives, which require beam time at a large synchrotron facility.

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This new method, called SAC-IR, is label-free, meaning it does not require any dyes or fluorescent markers, which can harm cells and also produce less consistent results across labs.

The SAC-IR method enabled NIST researchers to measure the absolute mass of proteins in a cell, in addition to nucleic acids, lipids, and carbohydrates. The technique could help establish a foundation for standardizing methods for measuring biomolecules in cells, which could prove useful in biology, medicine, and biotechnology.

“In cancer cell therapy, for example, when cells from a patient’s immune system are modified to better recognize and kill cancer cells before being reintroduced back to the patient, one must ask, ‘Are these cells safe and effective?’ Our method can be helpful by providing additional insight with respect to biomolecular changes in the cells to assess cell health,” said Lee.

Other potential applications include using cells for drug screening, either in the discovery of new drugs or in understanding the safety and efficacy of a drug candidate. For example, this method could help to assess the potency of new drugs by measuring absolute concentrations of various biomolecules in a large number of individual cells or to analyze how different types of cells react to the drugs.

Future Applications and Improvements

The researchers hope to develop the technique further so it can measure other key biomolecules, such as DNA and RNA, with greater accuracy. The technique could also help provide detailed answers to fundamental questions in cell biology, such as what biomolecule signatures correspond with cell viability — in other words if the cell is alive, dying, or dead.

“Some cells are preserved in a frozen state for months or years, then thawed for later use. We don’t yet fully understand how best to thaw the cells while maintaining maximum viability. With our new measurement capabilities, we may be able to develop better processes for cell freezing and thawing by looking at their infrared spectra,” said Lee.

Sci Tech Daily, 19 September 2024

<https://scitechdaily.com>

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Moderate Caffeine Consumption Is Associated With a Lower Risk of Developing Cardiometabolic Diseases

2024-09-17

Regular caffeine intake was found to be associated with a lower risk of new-onset cardiometabolic multimorbidity.

Consuming moderate amounts of coffee and caffeine regularly may offer a protective effect against developing multiple cardiometabolic diseases, including type 2 diabetes, coronary heart disease and stroke, according to new research published in the Endocrine Society’s Journal of Clinical Endocrinology & Metabolism.

Researchers found that regular coffee or caffeine intake, especially at moderate levels, was associated with a lower risk of new-onset cardiometabolic multimorbidity (CM), which refers to the coexistence of at least two cardiometabolic diseases.

The prevalence of individuals with multiple cardiometabolic diseases, or CM, is becoming an increasing public health concern as populations age around the world, notes the study.

Coffee and caffeine consumption could play an important protective role in almost all phases of CM development, researchers found.

“Consuming three cups of coffee, or 200-300 mg caffeine, per day might help to reduce the risk of developing cardiometabolic multimorbidity in individuals without any cardiometabolic disease,” said the study’s lead author Chaofu Ke, M.D., Ph.D., of the Department of Epidemiology and Biostatistics, School of Public Health at Suzhou Medical College of Soochow University, in Suzhou, China.

The study found that compared with non-consumers or consumers of less than 100mg caffeine per day, consumers of moderate amount of coffee (3 drinks per day) or caffeine (200-300 mg per day) had a 48.1% or 40.7% reduced risk for new-onset CM.

Ke and his colleagues based their findings on data from the UK Biobank, a large and detailed longitudinal dietary study with over 500,000 participants aged 37-73 years. The study excluded individuals who had ambiguous information on caffeine intake. The resulting pool of participants included a total of 172,315 individuals who were free of any cardiometabolic diseases at baseline for the analyses of caffeine and a corresponding 188,091 individuals for the analyses of coffee and tea consumption.

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The participants' cardiometabolic diseases outcomes were identified from self-reported medical conditions, primary care data, linked inpatient hospital data and death registry records linked to the UK Biobank.

Coffee and caffeine intake at all levels were inversely associated with the risk of new-onset CM in participants without cardiometabolic diseases. Those who reported moderate coffee or caffeine intake had the lowest risk, the study found. Moderate coffee or caffeine intake was inversely associated with almost all developmental stages of CM.

"The findings highlight that promoting moderate amounts of coffee or caffeine intake as a dietary habit to healthy people might have far-reaching benefits for the prevention of CM," Ke said.

Addressing a Research Gap

Numerous epidemiological studies have revealed the protective effects of coffee, tea and caffeine consumption on morbidity of single cardiometabolic diseases. However, the potential effects of these beverages on the development of CM were largely unknown.

The authors reviewed the available research on this topic and found people with single cardiometabolic disease may have a two-fold higher all-cause mortality risk than those free of any cardiometabolic diseases. By contrast, the researchers found individuals with CM may have an almost 4 to 7 times higher risk of all-cause mortality. The researchers also noted that CM may present higher risks of loss of physical function and mental stress than those with single diseases.

Technology Networks, 17 September 2024

<https://technologynetworks.com>

Organic matter on Mars was formed from atmospheric formaldehyde

2024-09-19

Although Mars is currently a cold, dry planet, geological evidence suggests that liquid water existed there around 3 to 4 billion years ago. Where there is water, there is usually life. In their quest to answer the burning question about life on Mars, researchers at Tohoku University created a detailed model of organic matter production in the ancient Martian atmosphere.

Organic matter refers to the remains of living things such as plants and animals, or the byproduct of certain chemical reactions.

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Whatever the case, the stable carbon isotope ratio ($^{13}\text{C}/^{12}\text{C}$) found in organic matter provides valuable clues about how these building blocks of life were originally formed, giving scientists a window into the past.

As such, it has become a point of interest for Mars expeditions.

For example, the Mars rover Curiosity (operated by NASA) revealed that organic matter found in sediments from that era on Mars are unusually depleted in ^{13}C . It was also discovered that the carbon isotope ratios varied significantly between samples.

However, the reason for this variability was a mystery.

To expand on these findings, a research group led by Shungo Koyama, Tatsuya Yoshida, and Naoki Terada from Tohoku University developed a Martian atmospheric evolution model.

The model focused on formaldehyde (H_2CO), which members of this research team previously determined could feasibly be produced in the ancient Martian atmosphere.

The reason for this choice is that formaldehyde can generate complex organic compounds such as sugars, which are essential for life.

In other words, formaldehyde may be the missing factor that could explain the anomalous values of the Curiosity rover samples.

It could also be a sign of past life.

This model combined a photochemical model with a climate model to estimate the changes in the carbon isotope ratio of formaldehyde on Mars, dating back 3 to 4 billion years.

It revealed that the depletion of ^{13}C in formaldehyde is due to the photodissociation of CO_2 by solar ultraviolet radiation, which results in the preference of one stable isotope over another.

The study also showed that the carbon isotope ratio varied based on factors such as the atmospheric pressure on Mars at the time, the fraction of light reflected by the planet's surface, the ratio of CO to CO_2 , and the amount of hydrogen released by volcanic activity.

"This model provides a possible explanation for previously unexplained findings, such as why ^{13}C was mysteriously depleted," remarks Koyama, a graduate student at Tohoku University.

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This discovery indicates that formaldehyde contributed to the formation of organic matter on ancient Mars, implying that bio-important molecules such as sugars and ribose (a component of RNA, which is present in all living cells) may have been produced on the planet.

These findings were published in *Scientific Reports* on September 17, 2024.

Science Daily, 19 September 2024

<https://sciencedaily.com>

Visible-light-antenna ligand enhances samarium-catalyzed reactions

2024-09-19

Samarium (Sm), a rare earth metal, is important to organic chemists because of the ability of its divalent compounds to efficiently perform single-electron transfer reductions.

Samarium iodide (SmI₂) is moderately stable and can operate under mild conditions at room temperature, making it highly useful for producing pharmaceuticals and biologically active materials. However, most reactions require SmI₂ in quantities equal to or greater than the stoichiometric amount and necessitate the use of harmful chemicals, making the process resource-intensive and expensive to manage.

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

In a recent breakthrough, a research team from Chiba University in Japan, led by Assistant Professor Takahito Kuribara from the Institute for Advanced Academic Research and the Graduate School of Pharmaceutical Sciences, developed an innovative method that significantly reduces the amount of Sm.

The team developed a 9,10-diphenyl anthracene (DPA)-substituted bidentate phosphine oxide ligand for coordination to trivalent samarium, enabling the use of visible light to facilitate Sm-catalyzed reductive transformations. They call this ligand a visible-light antenna.

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

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

Through a series of experiments, the research team showed that using the Sm catalyst in combination with DPA-1 under blue-light irradiation produced high yields of up to 98% for pinacol coupling reactions of aldehydes and ketones, which are commonly used in pharmaceuticals.

Remarkably, these reactions could proceed with only 1–2 mol% of the Sm catalyst, a significant reduction compared to the stoichiometric amounts typically required. Furthermore, the reactions could proceed even with mild organic reducing agents like amines, in contrast to the highly reducing agents previously used.

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

To understand why DPA-1 was so effective, the researchers studied the emission characteristics of the Sm catalyst and DPA-1 combination. They found that DPA-1, with its visible-light antenna, functions as a multifunctional ligand that coordinates with Sm, selectively absorbs blue light, and efficiently transfers electrons from the antenna to Sm.

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

"Our new visible-light antenna ligand reduced the amount of Sm to 1–2 mol%, a significant decrease compared to the stoichiometric amounts typically required, by utilizing low-energy visible light," said Assistant Professor Kuribara.

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“Importantly, we were able to use trivalent Sm as the starting material, which is more stable and easier to handle as compared to divalent Sm.”

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

Phys Org, 19 September 2024

<https://phys.org>

Schottky junction catalysts boost hydrogen production with non-precious metals in water electrolysis

2024-09-19

Electricity-driven water electrolysis has garnered notable attention as an environmentally friendly method for hydrogen production, with high-purity hydrogen being crucial for addressing the energy crisis. Nonetheless, water electrolysis hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) typically require precious metals as electrocatalysts. This limitation has prompted researchers to focus on developing effective non-precious metal catalysts to enhance both the efficiency and cost-effectiveness of water electrolysis.

Carbon nitride(g-C₃N₄) has been widely studied for its tunable semiconducting properties; however, its limited charge mobility and low specific surface area lead to poor catalytic activities for HER and OER. In a study published in the journal *Advanced Powder Materials*, a team of researchers from Xi'an University of Architecture and Technology in China developed two active Schottky junction electrocatalysts (B-C₃N₄@Fe₃C and S-C₃N₄@Fe₃C) using a targeted doping and an interfacial coupling strategy.

“A strategy that rationally constructs built-in electric fields and space charge regions to enhance the redox reaction kinetics on g-C₃N₄ hollow nanotubes was first proposed,” said the study’s senior corresponding author Sining Yun.

The team’s efforts confirmed that internally supported g-C₃N₄ hollow nanotubes possess abundant active regions that facilitate rapid proton and mass transfer.

“Directed doping with B and S precisely modulated the semiconducting properties of g-C₃N₄, resulting in the formation of typical n-type and

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p-type band structures,” continued Yun. “This modulation provided a superior platform for constructing surface-functionalized B-C₃N₄@Fe₃C and S-C₃N₄@Fe₃C Schottky junction catalysts.”

The results revealed that the coupling of Fe₃C and g-C₃N₄ optimizes the energy level of g-C₃N₄ and changes the interfacial charge distribution of g-C₃N₄@Fe₃C, thus enriching OH⁻ and H⁺ at the solid-liquid reaction interface. Notably, B-C₃N₄@Fe₃C and S-C₃N₄@Fe₃C catalysts exhibited stable HER activity and high selectivity for the OER under alkaline medium.

“The B-C₃N₄@Fe₃C||S-C₃N₄@Fe₃C pair requires only a low voltage of 1.52 V to achieve efficient water electrolysis at 10 mA cm⁻², highlighting their excellent electrocatalytic activity and promising stability under long-term alkaline water splitting conditions,” said Guangping Yang, first author of the study.

Phys Org, 19 September 2024

<https://phys.org>

Researchers achieve aluminum molecular ring-based rotaxane and polyrotaxane

2024-09-19

Rotaxanes have garnered interest for their unique structures consisting of mechanically interlocked axles and macrocycles. Numerous organic macrocycles have been employed to construct rotaxanes, including crown ether, cyclobis(paraquat-p-phenylene), calixarene, pillararene, cyclodextrin, and cucurbituril.

Inorganic metal ions with unique electronic configurations have been employed to expand and precisely manipulate macrocycles at the molecular level. However, only one case has been assembled into polymeric rotaxane using the “axle-donor...ring-acceptor” mode. The controlled stepwise preparation of polymeric rotaxanes based on hybrid macrocycles remains a challenge.

In a study published in *Angewandte Chemie International Edition*, a research group led by Prof. Zhang Jian and Prof. Fang Weihui from Fujian Institute of Research on the Structure of Matter of the Chinese Academy of Sciences propose an inverse “ring-donor...axle-acceptor” pattern utilizing Al₁₈ molecular rings, enabling the stepwise assembly of molecules, complexes, and polymers through tailored coordination chemistry.

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The Al8 macrocycle's interior resembles a tubular cavity with one hydrophilic ring Al8(OH)8 and two hydrophobic ports. The inward OH groups bestow the Al8 macrocycle with a unique "ring-H/axle-acceptor" binding pattern, providing abundant interaction sites for a wide range of acceptors, including anions, metal cations, and organic ligands.

Researchers encapsulated a variety of aromatic compounds within the Al8 macrocycle, including single-site carboxylic acid (HNA, HBA) and dual-site bipyridine (bpy). The coordination sites of these aromatic guests all pointed towards the Al8(OH)8 plane, suggesting the potential for constructing an axle structure by introducing a metal cation.

Ag⁺ and Na⁺ were well-suited due to their linear coordination geometry. Consequently, researchers obtained a series of [2]-rotaxanes, each with inner linear complex axles: Ag(bpy)₂⁺, Ag(NA)₂⁻, HAg(BA)₂ and Na(AQS)₂⁻.

Considering the residual uncoordinated N sites in Ag(bpy)₂⁺ axle, researchers carried out further polymerization chemistry research. By increasing the amount of Ag⁺, they obtained a 1D infinite polyrotaxane in which neighboring [2]-rotaxanes were tightly held together by Ag⁺ cation via Ag-N bonds. The Al8 macrocycles were strung on the [Agnbpyn]_n⁺ chain through multiple non-covalent interactions, resembling a famous Beijing snack: Tanghulu (sugar coated hawthorn).

These host-guest complexes exhibit typically reverse saturable absorption responses in nonlinear optical (NLO) measurement. A quantitative evaluation showed that the NLO responses can be significantly enhanced by introducing heavy metal cations, increasing the conjugation of organic guests, and promoting polymerization.

Notably, the Ag(NA)₂⁻ embedded [2]-rotaxane exhibits the best NLO performance with the highest nonlinear absorption coefficient and the lowest limiting threshold, outperforming some reported organic molecules, graphene oxide materials, and traditional crystalline compounds.

This study demonstrates a universal assembly strategy to achieve rotaxane and polyrotaxane constructions. The unique "ring-donor/axle-acceptor" pattern breaks the conventional fixed binding mode, significantly enhancing adjustability for the axle acceptors.

Phys Org, 19 September 2024

<https://phys.org>

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Natural Silk Filtration Material Removes PFAS From Water More Effectively

2024-09-09

Water contamination by the chemicals used in today's technology is a rapidly growing problem globally. A recent study by the U.S. Centers for Disease Control found that 98 percent of people tested had detectable levels of PFAS, a family of particularly long-lasting compounds also known as "forever chemicals," in their bloodstream.

A new filtration material developed by researchers at MIT might provide a nature-based solution to this stubborn contamination issue. The material, based on natural silk and cellulose, can remove a wide variety of these persistent chemicals as well as heavy metals. And, its antimicrobial properties can help keep the filters from fouling.

The findings are described in the journal ACS Nano, in a paper by MIT postdoc Yilin Zhang, professor of civil and environmental engineering Benedetto Marelli, and four others from MIT.

PFAS chemicals are present in a wide range of products, including cosmetics, food packaging, water-resistant clothing, firefighting foams, and antistick coating for cookware. A recent study identified 57,000 sites contaminated by these chemicals in the U.S. alone. The U.S. Environmental Protection Agency has estimated that PFAS remediation will cost \$1.5 billion per year, in order to meet new regulations that call for limiting the compound to less than 7 parts per trillion in drinking water.

Contamination by PFAS and similar compounds "is actually a very big deal, and current solutions may only partially resolve this problem very efficiently or economically," Zhang says. "That's why we came up with this protein and cellulose-based, fully natural solution," he says.

"We came to the project by chance," Marelli notes. The initial technology that made the filtration material possible was developed by his group for a completely unrelated purpose — as a way to make a labelling system to counter the spread of counterfeit seeds, which are often of inferior quality. His team devised a way of processing silk proteins into uniform nanoscale crystals, or "nanofibrils," through an environmentally benign, water-based drop-casting method at room temperature.

Zhang suggested that their new nanofibrillar material might be effective at filtering contaminants, but initial attempts with the silk nanofibrils alone didn't work. The team decided to try adding another material: cellulose,

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which is abundantly available and can be obtained from agricultural wood pulp waste. The researchers used a self-assembly method in which the silk fibroin protein is suspended in water and then templated into nanofibrils by inserting “seeds” of cellulose nanocrystals. This causes the previously disordered silk molecules to line up together along the seeds, forming the basis of a hybrid material with distinct new properties.

By integrating cellulose into the silk-based fibrils that could be formed into a thin membrane, and then tuning the electrical charge of the cellulose, the researchers produced a material that was highly effective at removing contaminants in lab tests.

The electrical charge of the cellulose, they found, also gave it strong antimicrobial properties. This is a significant advantage, since one of the primary causes of failure in filtration membranes is fouling by bacteria and fungi. The antimicrobial properties of this material should greatly reduce that fouling issue, the researchers say.

“These materials can really compete with the current standard materials in water filtration when it comes to extracting metal ions and these emerging contaminants, and they can also outperform some of them currently,” Marelli says. In lab tests, the materials were able to extract orders of magnitude more of the contaminants from water than the currently used standard materials, activated carbon or granular activated carbon.

While the new work serves as a proof of principle, Marelli says, the team plans to continue working on improving the material, especially in terms of durability and availability of source materials. While the silk proteins used can be available as a byproduct of the silk textile industry, if this material were to be scaled up to address the global needs for water filtration, the supply might be insufficient. Also, alternative protein materials may turn out to perform the same function at lower cost.

Initially, the material would likely be used as a point-of-use filter, something that could be attached to a kitchen faucet, Zhang says. Eventually, it could be scaled up to provide filtration for municipal water supplies, but only after testing demonstrates that this would not pose any risk of introducing any contamination into the water supply. But one big advantage of the material, he says, is that both the silk and the cellulose constituents are considered food-grade substances, so any contamination is unlikely.

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“Most of the normal materials available today are focusing on one class of contaminants or solving single problems,” Zhang says. “I think we are among the first to address all of these simultaneously.”

“What I love about this approach is that it is using only naturally grown materials like silk and cellulose to fight pollution,” says Hannes Schniepp, professor of applied science at the College of William and Mary, who was not associated with this work. “In competing approaches, synthetic materials are used — which usually require only more chemistry to fight some of the adverse outcomes that chemistry has produced. [This work] breaks this cycle! ... If this can be mass-produced in an economically viable way, this could really have a major impact.”

Technology Networks, 9 September 2024

<https://technologynetworks.com>

Brain releases feel-good serotonin after swallowing “good food”

2024-09-16

Researchers have discovered a fascinating new link between the gut and the brain: swallowing nutritious food causes the release of the feel-good chemical serotonin. The findings open the door to developing new treatments for eating disorders.

In recent years, scientists have learned a lot about the important connection between the gut and the brain. Eating is particularly interesting as it involves the nervous system interacting with environmental signals (like how food smells) and physiological and metabolic signals.

Researchers from the University of Bonn, Germany, and the University of Cambridge, UK, recently undertook a study to understand better how the esophagus and the brain are connected during eating – more specifically, what happens between these two organs when food is swallowed.

“We wanted to gain a detailed understanding of how the digestive system communicates with the brain when consuming food,” said the study’s corresponding author, Michael Pankratz, from the Life and Medical Sciences Institute (LIMES) at the University of Bonn. “In order to do this, we had to understand which neurons are involved in the flow of information and how they are triggered.”

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Rather than examining the 100 billion-odd neurons in a human brain, the researchers opted for the comparatively far less-crowded body of fruit fly larvae, which contains around 10,000 to 15,000 neurons. They cut whole larvae into thousands of razor-thin slices and scanned the slices using an electron microscope. The scans were used to reconstruct all neurons and target organs of a nerve that connects the nervous system of the larvae's gastrointestinal tract with the brain.

"We used a high-performance computer to create three-dimensional images from these photographs," Pankratz said of the process, which enabled the researchers to see how all the nerve cells were connected to one another, synapse for synapse.

They found a kind of 'stretch receptor' in the larvae's esophagus that was wired to a group of six serotonin-producing neurons in the brain. Serotonin is a chemical messenger involved, amongst other biological functions, in controlling mood; it provides a feeling of euphoria. For that reason, it's sometimes called the 'feel-good chemical.' However, the researchers discovered something very interesting about the way these serotonin neurons respond to food that's been consumed.

"They can detect whether it is food or not and also evaluate its quality," said Andreas Schoofs, who also works at the LIMES Institute and was the study's lead author. "They only produce serotonin if good quality food is detected, which in turn ensures that the larva continues to eat."

Now, by 'good quality food,' the researchers mean food that has nutritional value, not that it's gourmet, which suggests that the neurons perform a sort of quality control on whatever is being swallowed. Food with nutrients is viewed by the brain as a reward, causing the neurons to release serotonin, which makes the larvae feel good and keep eating. Given that it's a mechanism that is fundamentally important to survival, the researchers think it probably exists in humans, too.

"Despite the differences in the number of cell types as compared with the fly, it would be interesting to see if serotonin also monitors the completion of a biologically meaningful action such as swallowing or other vital activities in mammals," said the researchers.

If the esophagus-brain circuit does exist in humans, it could be a way of treating eating disorders such as anorexia or binge eating. That's a way off, though.

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"[W]e don't know enough at this stage about how the control circuit in humans actually works," said Pankratz. "There is still years of research required in this area."

The study was published in the journal *Current Biology*.

New Atlas, 16 September 2024

<https://newatlas.com>

Tea tree oil faces ban in UK and EU over reprotoxicity

2024-09-11

Tea tree oil is under threat of being banned in the UK and EU after assessments by regulators have found that it is toxic to reproduction. Industry representatives are challenging the proposals, claiming the animal data showing tea tree oil's health effects does not apply to humans.

With its distinct fragrance and antimicrobial properties, the essential oil extracted from the leaves of the Australian tea tree, *Melaleuca alternifolia*, is used in a range of cosmetic products, traditional medicines, and as a natural fungicide for crops such as grapes and coffee.

Classification as reprotoxic category 1B (presumed human reproductive toxicant), as proposed by the British Health and Safety Executive (HSE) in August, would result in a default ban in cosmetics and pesticides. The HSE's conclusion is based on data collected by its EU equivalent, the European Chemicals Agency (Echa), whose risk assessment committee (RAC) adopted an opinion last November to classify tea tree oil as a category 1B reproductive toxicant under the EU classification, labelling and packaging (CLP) regulation.

Both classifications are primarily based on studies that involved force-feeding tea tree oil to rats, rabbits and dogs. They showed adverse effects on male reproductive systems, including sperm formation, with the strongest effects in rats.

Industry representatives say the data is inappropriate for evaluating potential human impacts, because the effects shown are species-specific. In the studies, rabbits recovered once dosing was complete; rats and dogs did not. 'Rats are not a good model for human reproductive fertility studies. [They] can't metabolise terpenes like humans can,' says Lauren Hamilton, chief executive of the Australian Tea Tree Industry Association (Attia).

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Defenders also question whether the force-feeding process is appropriate for identifying risks in humans, who use tea tree oil topically, and at much lower doses.

‘From the evidence that I’ve seen, I have very few concerns that there are human safety issues with the reasonable use of tea tree oil,’ says Christine Carson, a microbiologist without industry affiliation who studied tea tree oil at the University of Western Australia for 20 years. ‘It’s hard to reconcile this data with what we’re seeing in humans.’

The RAC and HSE commonly use animal data to assess toxicity effects in humans, however, and the studies in themselves are solid, says Geraldine Garrs, an independent cosmetics safety assessor.

‘I would absolutely trust that set of data,’ Garrs says, but adds that an automatic ban on the oil would be a shame. ‘Reprotoxicity is highly impactful, so you don’t want to take any chances. But we’ve been using tea tree oil under a safe dose rule for a long time, and if the industry wanted to defend that, I would support it.’

Echa said the RAC considered whether there were any reasons that would support a different classification outcome, but the evidence on mode of action and human relevance considerations ‘was not sufficient’.

New data in progress

In the UK, the HSE technical report is only the first step of the classification process, and companies have another year to submit data to defend the substance.

The recommended EU classification will become law when the CLP is updated through an ‘adaptation to technical progress (ATP)’, which is issued yearly by the European Commission.

Attia has asked the authorities to delay the next ATP update while it gathers data to dispute the classification. The trade body has commissioned contract research organisation Charles River Labs to carry out cell line tests in rats, humans and rabbits, which it hopes will show that tea tree oil has a different mode of action in humans.

Knock-on effects

Garrs and Carson think it’s unlikely that industry will overturn the classification proposals. ‘But at least new data might help to get other essential oils assessed differently,’ Carson said.

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She and Attia share concerns that the classification will have a knock-on effect on other essential oils, which share many of the constituents that may be implicated in tea tree oil’s reprotoxic effects. p-Cymene, a monoterpene derivative found in many essential oils, is currently being evaluated for reprotoxic properties under the EU CLP regulations.

‘This isn’t a question of doing more tests until the desired results are achieved. [The industry is] genuinely trying to understand what tests are relevant and what the data mean. And this quibbling over the data is not going to be unique to tea tree oil,’ Carson says.

Chemistry World, 11 September 2024

<https://chemistryworld.com>

World’s Strongest Battery Paves Way for Light, Energy-Efficient Vehicles

2024-09-12

When cars, planes, ships or computers are built from a material that functions as both a battery and a load-bearing structure, the weight and energy consumption are radically reduced. A research group at Chalmers University of Technology in Sweden is now presenting a world-leading advance in so-called massless energy storage – a structural battery that could halve the weight of a laptop, make the mobile phone as thin as a credit card or increase the driving range of an electric car by up to 70 percent on a single charge.

‘We have succeeded in creating a battery made of carbon fibre composite that is as stiff as aluminium and energy-dense enough to be used commercially. Just like a human skeleton, the battery has several functions at the same time,’ says Chalmers researcher Richa Chaudhary, who is the first author of a scientific article recently published in *Advanced Materials*.

Research on structural batteries has been going on for many years at Chalmers, and in some stages also together with researchers at the KTH Royal Institute of Technology in Stockholm, Sweden. When Professor Leif Asp and colleagues published their first results in 2018 on how stiff, strong carbon fibres could store electrical energy chemically, the advance attracted massive attention. The news that carbon fibre can function as electrodes in lithium-ion batteries was widely spread and the achievement was ranked as one of the year’s ten biggest breakthroughs by the prestigious *Physics World*.

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Lower weight requires less energy

Since then, the research group has further developed its concept to increase both stiffness and energy density. The previous milestone was reached in 2021 when the battery had an energy density of 24 watt-hours per kilogramme (Wh/kg), which means roughly 20 percent capacity of a comparable lithium-ion battery. Now it's up to 30 Wh/kg. While this is still lower than today's batteries, the conditions are quite different. When the battery is part of the construction and can also be made of a lightweight material, the overall weight of the vehicle is greatly reduced. Then not nearly as much energy is required to run an electric car, for example.

"Investing in light and energy-efficient vehicles is a matter of course if we are to economise on energy and think about future generations. We have made calculations on electric cars that show that they could drive for up to 70 percent longer than today if they had competitive structural batteries," says research leader Leif Asp, who is a professor at the Department of Industrial and Materials Science at Chalmers.

When it comes to vehicles, of course, there are high demands on the design to be sufficiently strong to meet safety requirements. There, the research team's structural battery cell has significantly increased its stiffness, or more specifically, the elastic modulus, which is measured in gigapascal (GPa), from 25 to 70. This means that the material can carry loads just as well as aluminium, but with a lower weight.

"In terms of multifunctional properties, the new battery is twice as good as its predecessor – and actually the best ever made in the world," says Leif Asp, who has been researching structural batteries since 2007.

Several steps towards commercialisation

From the start, the goal was to achieve a performance that makes it possible to commercialise the technology. In parallel with the fact that the research is now continuing, the link to the market has been strengthened – through the newly started Chalmers Venture company Sinonus AB, based in Borås, Sweden.

However, there is still a lot of engineering work to be done before the battery cells have taken the step from lab manufacturing on a small scale to being produced on a large scale for our technology gadgets or vehicles.

"One can imagine that credit card-thin mobile phones or laptops that weigh half as much as today, are the closest in time. It could also be that components such as electronics in cars or planes are powered by

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structural batteries. It will require large investments to meet the transport industry's challenging energy needs, but this is also where the technology could make the most difference," says Leif Asp, who has noticed a great deal of interest from the automotive and aerospace industries.

More about: Research and structural batteries

Structural batteries are materials that, in addition to storing energy, can carry loads. In this way, the battery material can become part of the actual construction material of a product, which means that much lower weight can be achieved on, for example, electric cars, drones, handheld tools, laptops and mobile phones.

The latest advances in this area have been published in the article Unveiling the Multifunctional Carbon Fibre Structural Battery in the journal *Advanced Materials*. The authors are Richa Chaudhary, Johanna Xu, Zhenyuan Xia and Leif Asp at Chalmers University of Technology.

The developed battery concept is based on a composite material and has carbon fibre as both the positive and negative electrodes – where the positive electrode is coated with lithium iron phosphate. When the previous battery concept was presented, the core of the positive electrode was made of an aluminium foil.

The carbon fibre used in the electrode material is multifunctional. In the anode it acts as a reinforcement, as well as an electrical collector and active material. In the cathode it acts as a reinforcement, current collector, and as a scaffolding for the lithium to build on. Since the carbon fibre conducts the electron current, the need for current collectors made of copper or aluminium (for example), is reduced, which reduces the overall weight even further. Nor are any so-called conflict metals such as cobalt or manganese required in the chosen electrode design.

In the battery, the lithium ions are transported between the battery terminals through a semi-solid electrolyte, instead of a liquid one, which is challenging when it comes to getting high power and for this more research is needed. At the same time, the d

Technology Networks, 12 September 2024

<https://technologynetworks.com>

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When ions go hiking: New insights into solvation kinetics at electrocatalyst surfaces

2024-09-19

The ion's pathway is strongly influenced by a process that is ubiquitous across bio- and electrochemistry: ions need to reorganize their solvation shell before they can intercalate into battery cathodes, enter ion channels across biochemical membranes or adsorb and convert to chemicals, such as green hydrogen, on electrocatalyst surfaces.

Previously, researchers from the Interface Science Department of the Fritz-Haber Institute discovered that the kinetics of interfacial ion solvation are governed by so-called compensation effects between the activation entropy and enthalpy. In other words, as the elevation of the mountain in front of the ion is raised, the number of available hiking trails increases, making it more likely for the ion to go on the hike.

To come to these conclusions, the team interpreted the kinetics according to statistical physics and the Eyring-Evans-Polanyi equation, the center piece of transition state theory from 1935, which was codeveloped by Michael Polanyi, head of the Physical Chemistry Department of FHI until 1933.

Now, almost 90 years later, the researchers of the Interface Science Department are able to track the two key parameters of transition state theory, the activation enthalpy and activation entropy with a millisecond time resolution. The study is published in the journal *Nature Communications*.

"Our findings are really substantial on many fundamental levels," says Francisco Sarabia, first author of the study and Marie Curie Postdoctoral Fellow.

"Using this technique, we can directly access the electrosorption kinetics of hydroxide ions that occur at specific structural surface motifs, e.g., step-edges or defects, and show how they are linked to electrocatalyst kinetics. Further, we studied the dynamic poisoning behavior of the Pt surface during the ammonia oxidation reaction and how it impacts the solvation kinetics. This level of insight has remained completely hidden, so far."

Overall, the work further supports the notion that activation entropy changes at the catalyst surface and in the interfacial solvent are critical to understanding electrocatalyst activity. For example, the team discovered that the pH can directly impact the activation entropy and induce non-

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Nernstian activity changes with pH. Currently, it is widely assumed, that the activation energy plays the primary role in the bias dependence of electrocatalytic reactions.

Dr. Sebastian Öner, Group leader at the Interface Science Department and corresponding author of the study, says, "Abundant operando spectroscopy and microscopy evidence, including from my colleagues here at the Inorganic Chemistry and Interface Science Departments, show that catalyst surfaces are highly dynamic. Beyond studying solvation kinetics, we now have a tool, that we can apply to capture true kinetic information in real-time and overlay it with spectroscopic and microscopic information."

The research of the team highlights the importance of bias dependent changes in the local environment of catalysts, showing how the solid structure and liquid electrolyte are closely interconnected and can influence each other. This comprehensive understanding is crucial for developing catalysts with improved activity, selectivity, and stability.

The Interface Science Department, led by Prof. Dr. Beatriz Roldán Cuenya, is committed to further exploring these insights, with the potential to significantly impact the fields of energy and chemical conversion technology.

Phys Org, 19 September 2024

<https://phys.org>

Old books can have unsafe levels of chromium, but readers' risk is low

2024-08-18

Old books can be beautiful to look at. But handle with care — they just might be toxic.

The covers of Victorian-era books are already known to sometimes have pigments that contain toxic heavy metals such as lead, chromium and arsenic. But when researchers recently assessed a collection at their university's main library, they found toxic metal concentrations on some tomes that exceeded safe levels.

"I think it's very important for librarians to be aware of those risks," says Leila Ais, an undergraduate student studying biochemistry at Lipscomb University in Nashville who presented the team's findings August 18 at the American Chemical Society meeting in Denver.

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Librarians approached the team about testing old, brightly colored books in the university's collection. The researchers used a handheld machine called an X-ray fluorescence spectrometer to detect metals in the covers of 26 books. Additional laboratory studies helped the team determine the amount of each metal compound present in the cover.

In the golden-yellow covers of some books, Ais and colleagues found crocoite — a compound containing the toxic metals lead and chromium — and lead sulfate, two compounds that make up a pigment called chrome yellow. Post-Impressionist painter Vincent van Gogh notably used chrome yellow pigments in his sunflowers series (SN: 3/23/16).

"[One] thing that surprised me is how concentrated [the metals in] some of the books are," Ais says. In the most metal-rich book cover, the chromium concentration was around 50 parts per million, well above the 4–25 ppm that can cause skin reactions, according to the U.S. Centers for Disease Control and Prevention.

But that doesn't necessarily mean library patrons are in danger. Chrome yellow doesn't flake off the covers easily, so the risk of inhaling particles or transferring those heavy metals to your hands is low, says Rosie Grayburn, an analytical materials scientist at Winterthur Museum in Delaware and with the Poison Book Project, a research initiative at Winterthur and the University of Delaware to identify toxic pigments in book covers. Other pigments, such as arsenic-based emerald green, flake more easily and carry a greater risk for exposure, she says.

Lipscomb's team plans to contribute its findings to the Poison Book Project after running a few more tests. In the meantime, library staff have sealed books that might contain harmful compounds in plastic bags and removed ones known to contain toxins from circulation.

Science News, 18 August 2024

<https://sciencenews.org>

Revealing the Invisible: Living Cells Can Be Seen With Infrared Light

2024-09-19

IST's new infrared microscopy technique allows for the detailed imaging of biomolecules in cells, supporting advancements in biotechnology and cellular therapies.

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In an effort to advance biotechnology innovations, scientists are working to develop faster, more quantitative, and more accessible ways to observe biomolecules in living cells.

Now, researchers at the National Institute of Standards and Technology (NIST) have developed a new method that allows the use of infrared (IR) light to capture clear images of biomolecules inside cells, something that was previously not possible due to the tendency of the water in cells to absorb infrared radiation.

NIST's new method removes the obscuring effects of water in IR-based measurements and allows researchers to determine the amounts of key biomolecules in cells, such as the proteins that direct cell function. The ability to measure changes in living cells could speed up advances in biomanufacturing, cell therapy development, drug development, and more.

Their findings have been published in *Analytical Chemistry*.

Understanding Infrared Microscopy and Its Challenges

Infrared radiation is light that is just beyond what is visible to the human eye. Although we cannot see IR light, we can feel it as heat. In IR microscopy, a material of interest absorbs radiation from a range of wavelengths in the IR spectrum. Scientists measure and analyze the IR absorption spectrum of a sample, producing a set of "fingerprints" to identify molecules and other chemical structures. However, water, the most abundant molecule both inside and outside cells, absorbs infrared strongly and masks the infrared absorption from other biomolecules in cells.

One way to understand this optical masking effect is to compare it to when an airplane passes overhead next to the Sun. With the naked eye, it's hard to see the airplane because of the Sun, but if you use a special Sun-blocking filter, then you can easily see the airplane in the sky.

"In the spectrum, water absorbs infrared so strongly, and we want to see the absorption spectrum of proteins through the thick water background, so we designed the optical system to uncloak the water contribution and reveal the protein signals," said NIST chemist Young Jong Lee.

Advancing Cellular Analysis with SAC-IR

Lee developed a patented technique that uses an optical element to compensate for water absorption from IR. Called solvent absorption

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compensation (SAC), the technique was used with a hand-built IR laser microscope to image cells that support the formation of connective tissue, called fibroblast cells. Over a 12-hour observation period, researchers were able to identify groups of biomolecules (proteins, lipids, and nucleic acids) during stages of the cell cycle, such as cell division. While this may seem like a long time, the method is ultimately faster than current alternatives, which require beam time at a large synchrotron facility.

This new method, called SAC-IR, is label-free, meaning it does not require any dyes or fluorescent markers, which can harm cells and also produce less consistent results across labs.

The SAC-IR method enabled NIST researchers to measure the absolute mass of proteins in a cell, in addition to nucleic acids, lipids, and carbohydrates. The technique could help establish a foundation for standardizing methods for measuring biomolecules in cells, which could prove useful in biology, medicine, and biotechnology.

“In cancer cell therapy, for example, when cells from a patient’s immune system are modified to better recognize and kill cancer cells before being reintroduced back to the patient, one must ask, ‘Are these cells safe and effective?’ Our method can be helpful by providing additional insight with respect to biomolecular changes in the cells to assess cell health,” said Lee.

Other potential applications include using cells for drug screening, either in the discovery of new drugs or in understanding the safety and efficacy of a drug candidate. For example, this method could help to assess the potency of new drugs by measuring absolute concentrations of various biomolecules in a large number of individual cells or to analyze how different types of cells react to the drugs.

Future Applications and Improvements

The researchers hope to develop the technique further so it can measure other key biomolecules, such as DNA and RNA, with greater accuracy. The technique could also help provide detailed answers to fundamental questions in cell biology, such as what biomolecule signatures correspond with cell viability — in other words if the cell is alive, dying, or dead.

“Some cells are preserved in a frozen state for months or years, then thawed for later use. We don’t yet fully understand how best to thaw the cells while maintaining maximum viability. With our new measurement

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capabilities, we may be able to develop better processes for cell freezing and thawing by looking at their infrared spectra,” said Lee.

Sci Tech Daily, 19 September 2024

<https://scitechdaily.com>

Mussel-inspired adhesive comes unglued on command

2024-09-19

Modern integrated microelectronic devices are often poorly repairable and difficult to recycle. Debondable adhesives play a key role in the transition to a circular economy with sustainable resources, less waste, and intelligent repair/recycling strategies. In the journal *Angewandte Chemie*, a research team has now introduced a method for making adhesives that can be deactivated “on command.”

Their inspiration came from the masters of underwater adhesion: mussels. Mussel-inspired adhesives have been developed before. These new versions are based on thiol-catechol polyaddition, which forms polymers with adhesive thiol-catechol connectivities (TCC, thiol-substituted six-membered aromatic rings with two neighboring OH groups which are responsible for the strong adhesive properties).

The trick is that when the catechol groups in the adhesive polymers are oxidized to quinones (six-membered rings with two oxygen atoms bound by double bonds), the strength of adhesion decreases dramatically.

Changing the basic framework of the monomers allows for control over the properties of the polymers. Kannan Balasubramanian, Hans Börner, and their team at Humboldt University zu Berlin, the Leibniz Institute for Analytical Sciences (ISAS, Berlin, Germany), Universidad Nacional de General San Martín (Buenos Aires, Argentina), the Fraunhofer Institute for Applied Polymer Research (Potsdam-Golm, Germany), and the company Henkel (Düsseldorf, Germany) have now produced two different types of TCC adhesives with strong adhesion and shear strength.

Biobased, peptidic biscatechol precursors of DiDOPA, which is similarly found in mussels, were compared with their fossil-based analog. Both adhesives also function under water and are insensitive to atmospheric oxygen and weak oxidizing agents. However, they lose their stickiness through oxidation with the strongly oxidizing sodium periodate (NaIO₄), so that the adhesive residues can be easily peeled or wiped off the substrate in one piece.

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While the oxidation of the fossil adhesive inactivates the catechols, but at the same time makes the adhesive more hydrophobic, the biobased type shows the deactivation without becoming dramatically more hydrophobic due to a variety of other peptide functionalities.

Börner explains, "The multifunctionality is typical of biomaterials, in which often only the key functionalities are switched off and not much else changes in the material. This circumstance enables a dramatically more efficient de-adhesion mechanism, which reduces the adhesive strength of the bio-based type by 99%."

The reason for the poorer deactivation (60%) of the fossil-based adhesive lies in the composition, as hydrophobic polymers are also very good adhesives.

In the longer term, the consortium is working on replacing chemical oxidation with direct electrochemical oxidation, which could be interesting for the repair of cell phones, for example.

Phys Org, 19 September 2024

<https://phys.org>

Low-carbon ammonia offers green alternative for agriculture and hydrogen transport

2024-09-19

A new way of making ammonia by harnessing the unique power of liquid metal could lead to significant cuts in carbon emissions caused by production of the widely-used chemical.

Ammonia is used in fertiliser to grow much of our food, but also plays a role in clean energy as a carrier to safely transport hydrogen.

The global production of ammonia, however, comes at a high environmental cost: it consumes over 2% of global energy and produces up to 2% of global carbon emissions.

RMIT Research Fellow and study lead author, Dr Karma Zuraiqi, said their greener alternative used 20% less heat and 98% less pressure than the century-old Haber-Bosch process used today for splitting nitrogen and hydrogen into ammonia.

"Ammonia production worldwide is currently responsible for twice the emissions of Australia. If we can improve this process and make it less

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energy intensive, we can make a large dent in carbon emissions," said Zuraiqi, from the School of Engineering.

Results of the RMIT-led study published in Nature Catalysis show their low-energy approach to be as effective at producing ammonia as the current gold standard by relying more on effective liquid metal catalysts and less on the force of pressure.

"The copper and gallium we use is also much cheaper and more abundant than the precious metal ruthenium used as a catalyst in current approaches," Zuraiqi said. "These advantages all make it an exciting new development that we're keen to take further and test outside the lab."

Liquid metal to the rescue

The team including RMIT's Professor Torben Daeneke is at the forefront of harnessing the special properties of liquid metal catalysts for ammonia production, carbon capture and energy production.

A catalyst is a substance that makes chemical reactions occur faster and more easily without being consumed.

This latest study showcased their new technique by creating tiny liquid metal droplets containing copper and gallium -- named 'nano planets' for their hard crust, liquid outer core and solid inner core structure -- as the catalyst to break apart the raw ingredients of nitrogen and hydrogen.

"Liquid metals allow us to move the chemical elements around in a more dynamic way that gets everything to the interface and enables more efficient reactions, ideal for catalysis," Daeneke said.

"Copper and gallium separately had both been discounted as famously bad catalysts for ammonia production, yet together they do the job extremely well."

Tests revealed gallium broke apart the nitrogen, while the presence of copper helped the splitting of hydrogen, combining to work as effectively as current approaches at a fraction of the cost.

"We essentially found a way to take advantage of the synergy between the two metals, lifting their individual activity," Daeneke said.

RMIT is now leading commercialisation of the technology, which is co-owned by RMIT and QUT.

Upscaling for industry

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While ammonia produced via the traditional Haber-Bosch process is only viable at huge facilities, the team's alternative approach could suit both large-scale and smaller, decentralised production, where small amounts are made cheaply at solar farms, which in turn would slash transport costs and emissions.

As well as obvious applications in producing ammonia for fertiliser, the technology could be a key enabler for the hydrogen industry and support the move away from fossil fuels.

"One good way to make hydrogen safer and easier to transport is to turn it into ammonia," Daeneke explained.

"But if we use ammonia produced through current techniques as a hydrogen carrier, then emissions from the hydrogen industry could significantly increase global emissions."

"Our vision is to combine our green ammonia production technology with hydrogen technologies allowing green energy to be shipped safely around the world without huge losses on the way," he said.

The next challenges are to upscale the technology -- which has so far been proven in lab conditions -- and to design the system to operate at even lower pressures, making it more practical as a decentralised tool for a broader range of industries.

"At this stage, we are really excited by the results and are keen to speak with potential partners interested in scaling this up for their industry," he said.

This research was supported by the Australian Research Council and the Australian Synchrotron (ANSTO). Analysis of molecular interactions was carried out at RMIT's cutting-edge Microscopy and Microanalysis Facility, as well as QUT's Central Analytical Research Facility, the Australian Synchrotron and via the NCI Australia supercomputing facility.

Science Daily, 19 September 2024

<https://sciencedaily.com>

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Some Diabetes Drugs Tied to Lower Dementia and Parkinson's Risk

2024-09-19

A class of drugs for diabetes may be associated with a lower risk of dementia and Parkinson's disease, according to a study published in the September 18, 2024, online issue of *Neurology*[®], the medical journal of the American Academy of Neurology.

The study looked at sodium-glucose cotransporter-2 (SGLT2) inhibitors, which are also known as gliflozins. They lower blood sugar by causing the kidneys to remove sugar from the body through urine.

"We know that these neurodegenerative diseases like dementia and Parkinson's disease are common and the number of cases is growing as the population ages, and people with diabetes are at increased risk of cognitive impairment, so it's encouraging to see that this class of drugs may provide some protection against dementia and Parkinson's disease," said study author Minyoung Lee, MD, PhD, of Yonsei University College of Medicine in Seoul, South Korea.

The retrospective study looked at people with type 2 diabetes who started diabetes medication from 2014 to 2019 in South Korea. People taking SGLT2 inhibitors were matched with people taking other oral diabetes drugs, so the two groups had people with similar ages, other health conditions and complications from diabetes. Then researchers followed the participants to see whether they developed dementia or Parkinson's disease. Those taking the SGLT2 inhibitors were followed for an average of two years and those taking the other drugs were followed for an average of four years.

Among the 358,862 participants with an average age of 58, a total of 6,837 people developed dementia or Parkinson's disease during the study.

For Alzheimer's disease, the incidence rate for people taking SGLT2 inhibitors was 39.7 cases per 10,000 person-years, compared to 63.7 cases for those taking other diabetes drugs. Person-years represent both the number of people in the study and the amount of time each person spends in the study.

For vascular dementia, which is dementia caused by vascular disease, the incidence rate for people taking the SGLT2 drugs was 10.6 cases per 10,000, compared to 18.7 for those taking the other drugs.

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For Parkinson's disease, the incidence rate for those taking the SGLT2 drugs was 9.3 cases per 10,000, compared to 13.7 for those taking the other drugs.

After researchers adjusted for other factors that could affect the risk of dementia or Parkinson's disease, such as complications from diabetes and medications, they found that SGLT2 inhibitor use was associated with a 20% reduced risk of Alzheimer's disease and a 20% reduced risk of Parkinson's disease. Those taking the drugs had a 30% reduced risk of developing vascular dementia.

"The results are generally consistent even after adjusting for factors like blood pressure, glucose, cholesterol and kidney function," Lee said. "More research is needed to validate the long-term validity of these findings."

Lee said that since participants were followed for less than five years at the most, it's possible that some participants would later develop dementia or Parkinson's disease.

Technology Networks, 19 September 2024

<https://technologynetworks.com>

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Technical Notes

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