CHEMWATCH

Bulletin Board

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CONTACT US

subscribers@chemwatch.net
tel +61 3 9572 4700
fax +61 3 9572 4777

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

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ASIA PACIFIC

Approved active constituents

2024-03-19

Table 7: Approved active constituents

Application no.	140801
Active constituent	Saflufenacil
Applicant name	Zhejiang Xinan Chemical Industrial Group Co., Ltd
Applicant ACN	N/A
Date of approval	26 February 2024
Approval no.	93891
Description of the application and its purpose, including the intended use of the active constituent	Approval of the active constituent saflufenacil for use in agricultural chemical products

Application no.	140817
Active constituent	Bentazone
Applicant name	Shandong Rainbow International Co Ltd
Applicant ACN	N/A
Date of approval	26 February 2024
Approval no.	93902
Description of the application and its purpose, including the intended use of the active constituent	Approval of the active constituent bentazone for use in agricultural chemical products

Read More

APVMA, 19-03-24

https://www.apvma.gov.au/news-and-publications/publications/gazette/gazette-6-19-Mar-24

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

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Chemicals added to the Inventory 5 years after issue of assessment certificate - 26 March 2024

2024-03-26

CAS number	2009242-07-1	
Chemical name	Phenol, 4,4′ -(1-methylethylidene)bis-, reaction products with 3-chloro-2-methyl-1-propene, brominated	
Molecular formula	Unspecified	
Specific information requirements	Obligations to provide information apply. You must tell us within 28 days if the circumstances of your importation or manufacture (introduction) are different to those in our assessment.	
Listing date	7 March 2024	
CAS number	849230-52-0	
Chemical name	Decanedioic acid, polymer with 12-hydroxyoctadecanoic acid and 1,2,3-propanetriol, isooctadecanoate	
Molecular formula	(C18H36O3.C10H18O4.C3H8O3)x.xC18H36O2	
Specific information requirements	Obligations to provide information apply. You must tell us within 28 days if the circumstances of your importation or manufacture (introduction) are different to those in our assessment.	
Listing date	7 March 2024	
CAS number	53192-18-0	
Chemical name	2-Propenoic acid, polymer with 2-ethyl-2-(hydroxymethyl)-1,3-propanediol and 3a,4,7,7a-tetrahydro-1,3-isobenzofurandione	
Molecular formula	(C8H8O3.C6H14O3.C3H4O2)x	

CAS number	2009242-07-1	
Specific information requirements	Obligations to provide information apply. You must tell us within 28 days if the circumstances of your importation or manufacture (introduction) are different to those in our assessment.	
Listing date	7 March 2024	

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AICIS, 26-03-24

https://www.industrialchemicals.gov.au/news-and-notices/chemicals-added-inventory-5-years-after-issue-assessment-certificate-26-march-2024

India holds public consultation on revised standard for iron oxide pigments for paints

2024-03-12

The draft standard proposed by BIS aims to address health and safety concerns and restrictions related to lead and toxic heavy metals in paint ingredients.

Changes to the revised standard:

The aim of this third revision is to improve the acceptability and relevance of the product by bringing it into compliance with current market requirements. Notable changes include:

1. The material classification has been reorganized into color-based groups, categories (represented as iron (III) oxide), grades based on sieve residue, types based on water soluble matter content and total water soluble chlorides and sulfates (represented as Cl– and SO42– ions), and classes based on the origin of the material. By replacing the previous seven classes, this change brought the criteria into line with current market practice.
2. Furthermore, requirements of each classification and associated test procedures have been revised. For example, new standards have been added to the colour measurement, staining power, and undertone test methods.
3. Restrictions have been introduced for lead and toxic heavy metals to address health and safety concerns.
4. Finally, several revisions and updates to references have been made to make the updated standard more accurate and relevant.

The Bureau of Indian Standards (BIS) is seeking comments until 20 April 2024 on the third revision of the standard for iron oxide pigments used in paints. The standard (IS 44) was first released in 1950.

Read More

Indian Chemical Regulation, 12-03-24

https://indianchemicalregulation.com/india-holds-public-consultation-on-revised-standard-for-iron-oxide-pigments-for-paints/

AMERICA

EPA Publishes Draft Risk Evaluation For Formaldehyde

2024-03-15

EPA announced on March 15, 2024, the availability of and solicited public comment on the 2024 draft risk evaluation for formaldehyde prepared under TSCA. 89 Fed. Reg. 18933. EPA will submit the draft risk evaluation to SACC for peer review. EPA also announced that there will be two virtual public meetings of SACC. SACC will consider and review the draft risk evaluation at a four-day virtual peer review public meeting that will be held May 20-23, 2024. A virtual preparatory public meeting will be held May 7, 2024, for SACC to consider the scope and clarity of the draft charge questions for the peer review. EPA will make online registration available for the May 7, 2024, meeting in April 2024. According to EPA, to request time to present oral comments during the virtual preparatory public meeting, registration must be completed by 12:00 p.m. (EDT) on May 3, 2024. For those not making oral comments during the virtual preparatory public meeting, registration will remain open through the end of the meeting. Online registration for the virtual peer review public meeting will be available beginning in April 2024. To make oral comments during the virtual peer review public meeting and be included on the meeting agenda, registration must be completed by 12:00 p.m. (EDT) on May 13, 2024. For those not making oral comments, registration for this meeting will remain open through the last day of the meeting. Written comments on the draft risk evaluation are due May 14, 2024. More information on the draft risk evaluation will be available in a forthcoming memorandum.

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B&C, 15-03-24

https://www.lawbc.com/recent-federal-developments-for-march-2024/

EPA Enforcement Alert States That Violations At Petroleum Refineries And Ethylene Plants Cause Excess Benzene And Other VOC Emissions In Nearby Communities

2024-03-15

EPA's Office of Enforcement and Compliance Assurance (OECA) published a February 2024 Enforcement Alert entitled "Violations at Petroleum Refineries and Ethylene Plants Cause Excess Benzene and Other VOC Emissions in Nearby Communities." According to the Enforcement Alert, EPA and state environmental agencies "continue to identify common noncompliance of Clean Air Act regulations that are causing excess emissions of benzene and other volatile organic compounds (VOCs) from petroleum refineries, chemical plants, including ethylene plants, and coke byproduct recovery plants." EPA notes that these facilities are required to comply with "longstanding requirements," including the National Emission Standard for Benzene Waste Operations at 40 C.F.R. Part 61, Subpart FF (BWON) and, in addition for refineries, New Source Performance Standards for VOCs from Petroleum Wastewater Systems at 40 C.F.R. Part 60, Subpart QQQ (NSPS QQQ). The BWON regulation also applies to hazardous waste treatment, storage, and disposal facilities that treat, store, or dispose of hazardous waste generated by these three types of facilities. According to the Enforcement Alert, EPA investigations of petroleum refineries have identified BWON and NSPS QQQ requirements as areas of common noncompliance, and EPA investigations of ethylene plants are also identifying noncompliance with BWON requirements. EPA published the Enforcement Alert to remind owners and operators of these facilities of the importance of compliance with these requirements. EPA states that "[f]ailure to comply could result in excess emissions of benzene and other VOCs and could result in an enforcement action assessing significant penalties for noncompliance."

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B&C, 15-03-24

https://www.lawbc.com/recent-federal-developments-for-march-2024/

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PHMSA Amends HMR To "Update, Clarify, Improve The Safety Of, Or Streamline" Various Regulatory Requirements

2024-03-15

On March 4, 2024, the Pipeline and Hazardous Materials Safety Administration (PHMSA) amended the Hazardous Materials Regulations (HMR), to update, clarify, improve the safety of, or streamline various regulatory requirements. 89 Fed. Reg. 15636. Specifically, according to PHMSA, the rulemaking responds to 18 petitions for rulemaking submitted by the regulated community between May 2018 and October 2020 that request PHMSA address a variety of provisions, including but not limited to those addressing packaging, hazard communication, and the incorporation by reference of certain documents. PHMSA states that the revisions "maintain or enhance the existing high level of safety under the HMR while providing clarity and appropriate regulatory flexibility in the transport of hazardous materials." The final rule will be effective April 3, 2024. The delayed compliance date is March 4, 2025. The incorporation by reference of certain publications listed in the final rule is approved by the Director of the Federal Register as of April 3, 2024.

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B&C, 15-03-24

https://www.lawbc.com/recent-federal-developments-for-march-2024/

EPA Seeks Input on Lead Exposure from Lead Wheel Weights

2024-03-28

The U.S. Environmental Protection Agency (EPA) is asking the public for information on the potential ways in which people might be exposed to lead through the use of wheel weights. Lead exposure can have devastating impacts to human health and can be especially harmful to developing children. The Advance Notice of Proposed Rulemaking (ANPRM) issued today requests information that could be used in a future rulemaking to consider potential human health concerns, including those for children, associated with lead wheel weights. This information will help EPA determine if the use of lead wheel weights poses unreasonable risk to human health and the environment. If unreasonable risk is found, EPA will initiate a proposed rulemaking under the Toxic Substances Control Act (TSCA) to address the unreasonable risk. This action also furthers EPA's

commitment to protect all people from lead with an emphasis on high-risk communities as outlined in the EPA Strategy to Reduce Lead Exposures and Disparities in U.S. Communities.

Wheel weights are used to correct imbalances in the weight distribution of motor vehicle wheels. Lead is the primary component of many wheel weights, though alternatives such as steel, zinc alloy and plastic-metal composite are now widely available. Workers and other people, including children, may be exposed to lead released through the manufacturing, processing, distribution, use or disposal of these wheel weights. Additionally, people may be exposed when lead dust from these products is tracked into homes and other indoor places. Lead exposure can cause irreversible and life-long health effects.

In May 2009, the Ecology Center, Sierra Club and others raised concerns about lead exposure to children from lead wheel weights in a TSCA section 21 petition, which EPA granted, requesting that EPA "establish regulations prohibiting the manufacture, processing, and distribution in commerce" of lead wheel weights. In August 2023, these petitioners sought a writ of mandamus the United States Court of Appeals for the Ninth Circuit to direct EPA to conclude a rulemaking regulating lead wheel weights.

Read More

US EPA, 28-03-24

www.regulations.gov

EPA Revises PM NAAQS

2024-03-15

On March 6, 2024, based on its reconsideration of the air quality criteria and the national ambient air quality standards (NAAQS) for particulate matter (PM), EPA revised the primary annual PM2.5 standard by lowering the level from 12.0 micrograms per cubic meter (µg/m3) to 9.0 µg/m3. 89 Fed. Reg. 16202. EPA retained the current primary 24-hour PM2.5 standard and the primary 24-hour PM10 standard. EPA notes that it also is not changing the secondary 24-hour PM2.5 standard, secondary annual PM2.5 standard, and secondary 24-hour PM10 standard at this time. EPA amended other key aspects related to the PM NAAQS, including revisions to the Air Quality Index (AQI) and monitoring requirements for the PM NAAQS. The final rule will be effective May 6, 2024.

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B&C, 15-03-24

https://www.lawbc.com/recent-federal-developments-for-march-2024/

EPA Announces Final Amendments To NESHAP For Ethylene Oxide Commercial Sterilizers

2024-03-15

EPA announced on March 14, 2024, final amendments to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Ethylene Oxide Commercial Sterilizers. According to EPA's fact sheet, the final rule requires facilities to install available and proven technologies, practices, and procedures that have been demonstrated to reduce significantly ethylene oxide emissions. The amendments to the NESHAP will:

- Establish standards for currently unregulated emissions, such as building leaks ("room air emissions") and chamber exhaust vents, to reduce risk and account for technological developments;
- Strengthen standards that are on the books for sources such as sterilization chamber vents and aeration room vents;
- Strengthen compliance by requiring the use of continuous emissions monitoring systems that will provide much-needed assurance to nearby communities;
- Include definitions for affected sources;
- Ensure that sterilizers are subject to emission standards during periods of startup, shutdown, and malfunction; and
- Clarify other items, including electronic reporting and technical revisions.

According to EPA, the final rule will address emissions at nearly 90 commercial sterilization facilities that are owned and operated by approximately 50 companies. In the final rule, EPA is addressing the second Risk and Technology Review for the ethylene oxide NESHAP, which was initially promulgated in 1994 and last amended in 2001. EPA last reviewed the rule in 2006. The final rule will take effect upon publication in the Federal Register.

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B&C, 15-03-24

https://www.lawbc.com/recent-federal-developments-for-march-2024/

EUROPE

Strengthening the Chemical Weapons Convention by updating Germany's legislation

2024-03-19

The Chemical Weapons Convention is one of the most successful multilateral disarmament treaties for the worldwide prohibition of chemical weapons. Germany's legislation regarding the CWC has recently been revised.

By revising Germany's legislation related to the Chemical Weapons Convention (CWC), the German Government is further reducing proliferation risks and at the same time setting a good example for the international community with regard to the national implementation of the Convention.

The German Government is thereby also carrying out the task it set itself in its National Security Strategy, namely to increase its endeavours to contain chemical, biological, radiological and nuclear risks.

In early March 2024, the changes to national legislation related to the CWC, specifically to the Implementing Act and to the Implementing Regulation, took effect. The amendments were informed by nearly 30 years of experience with implementation of the CWC, specifically industry inspections, trade in listed chemicals and the discovery of old chemical weapons.

A number of important changes have been made:

For example, a notification requirement has been established for when chemical weapons or chemicals listed under the CWC (referred to as scheduled chemicals) are found or stolen. This aims to better protect the population. Also, an appropriate legal basis has been created for the previously voluntary procedure that aims to investigate transfer discrepancies, or differences between the declarations of import and export of scheduled chemicals.

Read More

German Federal Foreign Office, 19-03-24

https://www.auswaertiges-amt.de/en/aussenpolitik/chemical-weapons-convention/2649628

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UK'S DIVERGENCE FROM EU'S POLLUTION STANDARDS RAISES CONCERNS

2024-04-25

THE WHAT? The European Union has revised its urban waste water treatment directive to include a "polluter pays" principle, requiring pharmaceutical and cosmetic companies to fund the cleanup of pollutants they release into waterways. This update aims to tighten pollution controls and introduce standards for micropollutants, with industries responsible for significant pollution covering at least 80% of cleanup costs.

THE DETAILS: England has opted out of adopting these new EU pollution regulations, leading to concerns that it is falling behind in environmental protection efforts, especially in managing chemical pollution. While Northern Ireland and Scotland are moving to align their regulations with the EU to maintain environmental standards, England and Wales's reluctance highlights a growing divide in environmental policies within the UK.

Read More

Global Cosmetic News, 25-04-24

https://www.globalcosmeticsnews.com/uks-divergence-from-eus-pollution-standards-raises-concerns/

INTERNATIONAL

Toxic metal particles can be present in cannabis vapes even before the first use

2024-03-19

Vapes have often been heralded as a "safer" way to consume either nicotine or cannabis, where legal to do so. But the devices present their own suite of risks that are slowly being revealed as they undergo increasing research and regulation. Now, researchers have discovered that nano-sized toxic metal particles may be present in cannabis vaping liquids even before the vaping device is heated, and the effect is worse in unregulated products.

The researchers will present their results today at the spring meeting of the American Chemical Society (ACS). ACS Spring 2024 is a hybrid meeting

being held virtually and in person March 17-21; it features nearly 12,000 presentations on a range of science topics.

While cannabis regulation and legalization are still growing in the U.S., it was made federally legal in Canada under its Cannabis Act in 2018. "Cannabis vapes are newly regulated products in Canada, so we don't yet have much scientific data about them," says Andrew Waye, who will present the work at the meeting. "This is an opportunity for us to look at some of the questions concerning the risks and unknowns of cannabis vapes." Waye manages the research program at the Office of Cannabis Science and Surveillance at Health Canada.

Unlike smoking, vaping does not involve a combustion reaction, which produces harmful byproducts. Instead, a vaping device heats a liquid until it evaporates into an inhalable vapor. As a result, it is often seen as a safer method to consume cannabis or nicotine. But research on nicotine vapes has shown that the metal compnents that heat the vape liquid may release harmful elemental metals, including nickel, chromium and lead, which can then be transported into the aerosol and deposited into the user's body.

Waye's team wanted to investigate whether this was also true for cannabis vapes. To do so, the group collaborated with Zuzana Gajdosechova, who is a scientist at the Metrology Research Centre of the National Research Council of Canada, which has been involved in cannabis testing and standardization for several years.

The team gathered 41 samples of cannabis vape liquids — 20 legal, regulated samples from the Ontario Cannabis Store and 21 samples from the illicit market provided by the Ontario ProvincialPolice. The liquids were analyzed by mass spectrometry to look for the presence of 12 metals. Regulated cannabis products are routinely tested for some of the analyzed metals, as well as other contaminants.

To verify the team's findings, Gajdosechova collaborated with imaging experts and used techniques such as scanning electron microscopy to provide a visual confirmation of the metal particles. While some metals, such as arsenic, mercury and cadmium, were within the generally accepted tolerance limits for cannabis products, others were detected in concentrations considered to be very high. The most striking example proved to be lead: Some unregulated samples contained 100 times more lead than the regulated samples, far exceeding the generally accepted tolerance limit.

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AMERICAN CHEMICAL SOCIETY, 19-03-24

https://www.eurekalert.org/news-releases/1037096

Study Uncovers Hidden Ingredients in 83% of Tattoo Inks, Raising Concerns

2024-03-25

Kelli Moseman, a chemistry researcher at Binghamton University in New York, and colleagues, analyzed more than 50 tattoo inks from nine different brands used in the US after noticing that some inks they had used in previous studies contained substances that weren't listed on the label, the journal Analytical Chemistry reported.

Testing inks made by global companies and smaller producers, the researchers found in their new analysis that 45 of the 54 inks they ran through chemical analyses contained substances that weren't on the label, like unlisted pigments or additives. Some ink labels also listed additives that weren't present: 36 listed glycerol but it was only detected in 29 of the inks.

Only one brand's labels accurately listed the ingredients its ink contained. Fifteen inks contained propylene glycol, the American Contact Dermatitis Society's 2018 allergen of the year, while other tested samples contained potentially harmful or simply strange substances, such as antibiotics.

It's not yet known if these are accidental contaminations of tattoo inks, errors in labelling, or intentional but undisclosed additions; that would require further investigation.

But given how long tattoo inks stay in the skin, their summons of immune cells, and evidence suggesting small amounts of pigment can leak into lymph nodes, the findings are concerning enough to warrant attention.

A 2021 study of tattoo inks used in the European Union also uncovered major issues with mislabelling and unlisted additives in a similar proportion of products (around 90 percent) while also detecting metal impurities at concentrations exceeding regulated limits.
Read More

ANA, 25-03-24

https://ana.ir/en/news/5461/study-uncovers-hidden-ingredients-in-83-of-tattoo-inks-raising-concerns

~5th Annual Chocolate Scorecard Paints Bittersweet Picture of the Industry

2024-03-22

The Scorecard — which evaluates global chocolate manufacturers, brands and retailers on social and environmental criteria in seven areas — helps consumers make ethical purchasing decisions and incentivizes companies to improve their performance in these areas.

The fifth edition of the Chocolate Scorecard, released Wednesday, reveals that — while the industry is undergoing significant improvement — key, systemic issues such as farmer poverty remain a challenge. However, the chocolate industry — which is expected to generate around US$254 billion in 2024 and whose forecasted revenue growth stands at 5.6 percent, surpassing global economic growth estimates of 2.6 percent — has ample resources to address these challenges.

"Chocolate is a sweet treat that we often share with people we love to celebrate a special occasion or indulge in a sweet moment. But usually, the conditions in which it's made are far from sweet," Be Slavery Free said in a statement. "When cocoa farmers and their communities live in poverty, they deforest to clear more land to grow more cocoa. They rely on family and unpaid labor (child labor and forced labor) to make ends meet. As a result, our environment is harmed and children's future opportunities are squandered to survive."

The Chocolate Scorecard initiative, coordinated by Be Slavery Free in collaboration with an international team of over 40 collaborators — including NGOs EcoCare Ghana and Mighty Earth; along with Macquarie University, Open University and University of Wollongong — aims to promote transparency, accountability and responsible practices within the industry. By evaluating companies on social and environmental criteria, the Chocolate Scorecard provides valuable information for consumers to make ethical purchasing decisions and incentivizes companies to improve their performance in these areas.

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Read More

Sustainable Brands, 22-03-24

https://sustainablebrands.com/read/supply-chain/5th-chocolate-scorecard-bittersweet-picture

Climate Inaction is More Expensive Than Climate Action: WMO Report

2024-03-27

The World Meteorological Organization (WMO) has released its annual assessment of the state of the global climate. The report shows that 2023 broke records for greenhouse gas (GHG) levels, surface temperatures, ocean heat and acidification, sea level rise, Antarctic sea ice cover, and glacier retreat. It highlights the potential of renewable energy to help achieve decarbonization targets, warning that the cost of inaction is higher than the cost of action.

The 'State of the Global Climate 2023' report confirms that 2023 was the warmest year on record, with the global average near-surface temperature at 1.45°C (with a margin of uncertainty of ± 0.12°C) above pre-industrial levels. It was also the warmest ten-year period on record.

"Never have we been so close – albeit on a temporary basis at the moment – to the 1.5°C lower limit of the Paris Agreement on climate change," said WMO Secretary-General Celeste Saulo.

The report shows that on an average day in 2023, almost one-third of the global ocean was affected by a "marine heatwave," damaging vital ecosystems. Towards the end of 2023, more than 90% of the ocean had undergone heatwave conditions at some point during the year.

Read More

SDG, 27-03-24

https://sdg.iisd.org/news/climate-inaction-is-more-expensive-than-climate-action-wmo-report/

Enforcement authorities will check poison centre notifications

2024-03-25

Helsinki, 25 March 2024 – The objective of the checks is to protect human health by enforcing the requirement that suppliers of chemicals notify information about hazardous mixtures to the national authorities. The national authorities make that information available to poison centres so that they can give advice to citizens or medical personnel in the event of an emergency. Poison centres must have correct information about hazardous mixtures to ensure that the emergency response is well informed and appropriate.

The inspectors will check that the notification has been submitted and verify labels of mixtures and – where needed – Safety Data Sheets. The exact scope of the checks will be defined in the coming months.

Inspections in this project will begin in January 2025 and continue for six months, with the project report to be published at the end of 2025.

New Online Sales Project in 2025

The Forum also agreed on the specific scope of the next harmonised enforcement project (REF-13) on online sales, for which inspections will start in 2025. Inspectors will check products sold online, if they contain substances restricted for use under the REACH and POPs regulations. These controls will also verify that mixtures are classified, labelled and packaged in line with the Classification, Labelling and Packaging (CLP) Regulation and will verify that the related information is provided online. Checks may also address compliance with restrictions defined in the Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive.

During the March meeting, the Forum and its biocidal products regulation subgroup (BPRS) members gave steer to other ongoing projects and exchanged information about enforcement initiatives on the national level.

The Forum and the BPRS met remotely on 14-22 March 2024. The next meeting will take place in June 2024.

Background

The Enforcement Forum including its biocides subgroup (BPRS) is a network of enforcement authorities from the EU and EEA. They are

ECHA's Enforcement Forum prepares a project to check if suppliers have notified hazardous chemical mixtures to the poison centres. The poison centre notifications allow appropriate emergency response.

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responsible for coordinating the enforcement of the REACH, CLP, PIC, POPs and the Biocidal Product regulations with the aim of protecting our health and the environment while ensuring a level playing field for companies across the EU market.

Read More

ECHA, 25-03-24

https://echa.europa.eu/-/enforcement-authorities-will-check-poison-centre-notifications

Janet's Corner

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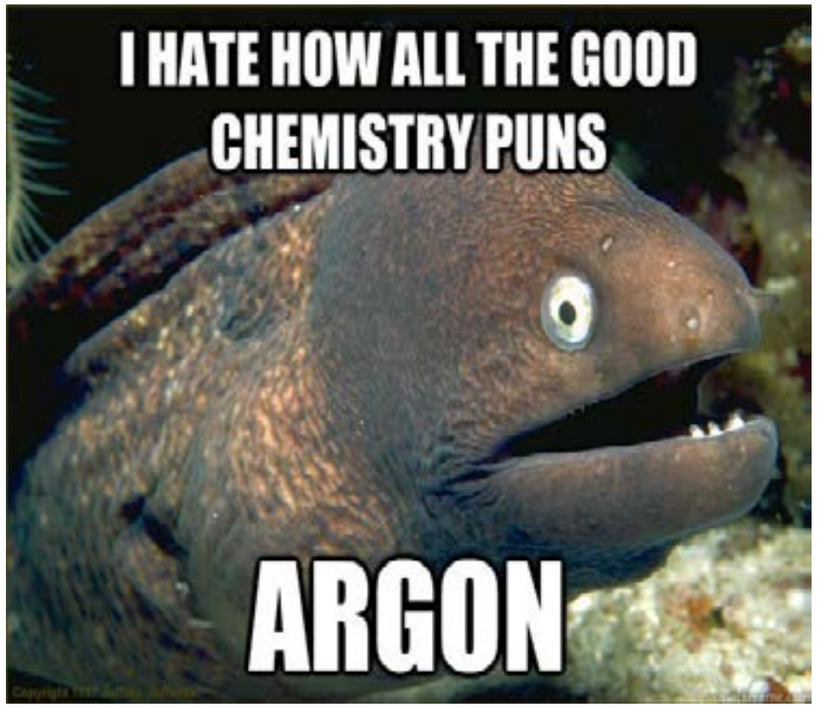
Science Puns

2024-04-05



https://cheezburger.com/2424325/nerd-out-23-mostly-painful-science-puns

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Hazard Alert

APR. 05, 2024

Sulfuric acid

2024-04-05

USES [2,3]

The main use of sulfuric acid is in the production of phosphate fertilisers. It is also used to manufacture explosives, other acids, dyes, glue, wood preservatives, and automobile batteries. It is used in the purification of petroleum, the pickling of metal, copper smelting, electroplating, metal work, and the production of rayon and film.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

The primary sources of sulfuric acid emissions are the industries that manufacture it or use it in production. Some of the industries that use it in production are the metal smelters, phosphate fertiliser producers, oil refiners, the chemical industry, battery manufacturers, manufacturers or fabricated metal products, manufacturers of electronic components, and manufacturers of measuring and controlling devices. These are emissions to the air unless there is a spill to water or land. Sulfuric acid spilt to land or water may result in emissions of the acid to air. Other possible emitters of sulfuric acid are home and larger pool treatment, the disposal of automobile batteries, electroplating facilities, electronics, semiconductor and circuit board production, potato growers, and water and waste water treatment. These emissions may be to the soil, water, or air. Sulfuric acid may be also produced as a result of sulphur dioxide reacting with other chemicals in the air.

Routes of Exposure

The major routes of exposure to sulfuric acid are via inhalation of contaminated air, dermal or ocular exposure and ingestion. While it is not absorbed through the skin, contact of the skin and eyes with strong concentrations may cause serious burns.

HEALTH EFFECTS [4]

Acute Health Effects

Sulfuric acid causes irritation to the eyes, skin, nose, throat; pulmonary oedema, bronchitis; emphysema; conjunctivitis; stomatis; dental erosion;

Sulfuric acid is a highly corrosive strong mineral acid with the molecular formula H2SO4. It is a colourless to slightly yellow viscous liquid which is soluble in water at all concentrations. [1,2]

eye, skin burns; dermatitis. The substance is very corrosive to the eyes, the skin, and the respiratory tract and attacks the enamel of the teeth. Inhalation may result in a burning sensation, sore throat, cough, laboured breathing, shortness of breath and lung oedema. Symptoms may be delayed. Skin contact may result in redness, pain, blisters, serious skin burns. Eye contact may result in redness, pain and severe deep burns. Corrosive on ingestion and may result in abdominal pain, burning sensation, shock or collapse.

Carcinogenicity

The International Agency for Research on Cancer has classified 'occupational exposures to strong-inorganic-acid mists containing sulfuric acid' as carcinogenic to humans.

Other Effects

Lungs may be affected by repeated or prolonged exposure to an aerosol of sulfuric acid. There is a risk of tooth erosion upon repeated or prolonged exposure to an aerosol of this substance.

SAFETY

First Aid Measures [5]

Ingestion:

- If swallowed do NOT induce vomiting.
- If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.
- Avoid giving milk or oils.
- Avoid giving alcohol.
- If spontaneous vomiting appears imminent or occurs, hold patient's head down, lower than their hips to help avoid possible aspiration of vomitus.

Eye Contact:

- Immediately hold eyelids apart and flush the eye continuously with running water.
- Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.

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Dermal Contact:

- Immediately remove all contaminated clothing, including footwear.
- Flush skin and hair with running water (and soap if available).

Inhalation:

- If fumes or combustion products are inhaled remove from contaminated area.
- Lay patient down. Keep warm and rested.

Personal Protective Equipment [4]

- **Eyes:** Safety glasses with side shields and chemical goggles.
- **Hands:** Chemical protective gloves, such as PVC should be worn. Suitability and durability of glove type is dependent on usage. Factors such as frequency and duration of contact and chemical resistance of glove material should be considered.
- **Feet:** Safety footwear or safety gumboots should be worn.
- Other safety equipment advised include overalls and PVC Apron.
- Some plastic personal protective equipment (PPE) (e.g. gloves, aprons, overshoes) are not recommended as they may produce static electricity.
- For large scale or continuous use wear tight-weave non-static clothing (no metallic fasteners, cuffs or pockets), non sparking safety footwear.

REGULATION

United States

Exposure Limit	Limit Values	HE Code	Health Factors and Target Organs
OSHA Permissible Exposure Limit (PEL) - General Industry See 29 CFR 1910.1000 Table Z-1	1 mg/m^3 TWA	HE10	Lung changes
		HE11	Cough

Exposure Limit	Limit Values	HE Code	Health Factors and Target Organs
OSHA PEL - Construction Industry See 29 CFR 1926.55 Appendix A	1 mg/m³ TWA	HE10	Lung changes
		HE11	Cough
OSHA PEL - Shipyard Employment See 29 CFR 1915.1000 Table Z-Shipyards	1 mg/m³ TWA	HE10	Lung changes
		HE11	Cough
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)	1 mg/m³ TWA	HE3	Dental erosion
		HE10	Pulmonary fibrosis, bronchiectasis, and emphysema
		HE11	Pulmonary oedema
		HE14	Respiratory irritation, cough
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2004)	0.2 mg/m³ TWA (thoracic particulate mass) A2 (when contained in strong inorganic acid mists)	HE3	Dental erosion
		HE10	Pulmonary fibrosis, bronchiectasis, and emphysema
		HE14	Marked eye, nose, throat, bronchial, and skin irritation
CAL/OSHA PELs	0.1 mg/m³ TWA 3 mg/m³ STEL		Irritation of the upper and lower respiratory tract

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Air conditioners may help catch criminals, by snagging their DNA

2024-04-03

Throughout their lives, animals disperse DNA into the environment via their feces, sloughed skin, and other genetic material. Therefore, by seeing what types of this "environmental DNA" (eDNA) are present in water, soil or air samples, scientists can determine which species are present in the region.

Among many other applications, we've recently seen eDNA analysis used to check for great white sharks near beaches, document a frozen prehistoric ecosystem, and even search for the Loch Ness monster.

Being members of the animal kingdom ourselves, us humans also leave eDNA wherever we go. The substance can even stay airborne for a while, in the form of tiny exhaled saliva droplets or minuscule flakes of skin. What's more, before that eDNA has a chance to settle and get wiped up by a careful alcohol-cloth-wielding culprit, it may get sucked up by a room's air conditioning system.

With this fact in mind, scientists from Australia's Flinders University set out to see if human eDNA could be obtained from a room's air conditioner. It's important to note that air conditioners work by recirculating the air in a room, not by drawing air in from outside.

After cleaning the air conditioners in four offices and four homes – thus removing any existing DNA – the researchers left the occupants to live their regular lives for four weeks. When samples were then taken from the inside of those air conditioners, eDNA that could be matched to the occupants was found in all but one sample.

In fact, in a separate batch of experiments, it was found that airborne eDNA could even be filtered directly from the air – no air conditioner required. That said, this technique is limited to detecting the eDNA of people who have been in the room recently. By contrast, the air conditioner eDNA can identify people who have been in the room some time ago.

Further studies will now focus on the pros and cons of different eDNA collection methods.

"It is very unlikely that an average offender, even with forensic awareness, could totally prevent their DNA from being released into the environment," says the lead scientist, Dr. Mariya Goray.

Even if a criminal wears gloves, their cast-off DNA may still be present in a room's air after they leave. A new study suggests that if such telltale material gets sucked up by an air conditioner, it could let forensic investigators know if a suspect has or has not been in a certain room.

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A paper on the research was recently published in the journal Electrophoresis.

New Atlas, 03 April 2024

https://newatlas.com

More Broadly Protective Potential Coronavirus Vaccine Developed

2024-04-02

Researchers at the Georgia Institute of Technology and the University of Wisconsin-Madison have developed a new vaccine that offers broad protection against not only SARS-CoV-2 variants, but also other bat sarbecoviruses. The groundbreaking trivalent vaccine has shown complete protection with no trace of virus in the lungs, marking a significant step toward a universal vaccine for coronaviruses.

"We had been working on strategies to make a broadly protective vaccine for a while," said Ravi Kane, professor in the School of Chemical and Biomolecular Engineering. "This vaccine may protect not just against the current strain circulating that year, but also future variants."

They presented their findings in "Broad protection against clade 1 sarbecoviruses after a single immunization with cocktail spike-protein-nanoparticle vaccine," published in the February edition of Nature Communications.

Kane and his research group have been working on the technologies to develop more widely protective vaccines for viruses since he joined Georgia Tech in 2015. Although the team didn't specifically foresee Covid-19 arising when it did, pandemics have regularly occurred throughout human history. While the team pivoted their vaccine research to address coronaviruses, they were surprised by how rapidly each new variant arose, making their broader vaccine even more necessary.

Once they realized the challenge inherent in how fast SARS-CoV-2 mutates, they had two options for how to build a vaccine: design one to be widely preventative against the virus, or use the influenza vaccine, which updates annually for the anticipated prevalent variant, as a model.

Making a broad vaccine is more appealing because it enables patients to get one shot and be protected for years. To create their general vaccine, Kane's team capitalized on the key to the original mRNA vaccines — the spike protein, which binds the virus to healthy cells. Their vaccine uses

Scientists have been searching for the optimal coronavirus vaccine since the Covid-19 pandemic started.

three prominent spike proteins, or a trivalent vaccine, to elicit a broad enough antibody response to make the vaccine effective against SARS-CoV-2 variants as well as other sarbecoviruses that have been identified as having pandemic potential.

"If you know which variant is circulating, you can immunize with the spike protein of that variant," Ph.D. student and co-author Kathryn Loeffler said. "But a broad vaccine is more difficult to develop because you're protecting against many different antigens versus just one."

Collaborators in the Kawaoka group at the University of Wisconsin tested their vaccine in hamsters, which they had previously identified as an appropriate animal model to evaluate vaccines and immunotherapies against SARS-CoV-2. The vaccine was able to neutralize all SARS-CoV-2 omicron variants tested, as well as non-SARS-CoV-2 coronaviruses circulating in bats. Even better, the vaccine provided complete protection with no detectable virus in the lungs.

Kane hopes that the vaccine strategy his team identified can be applied to other viruses — other coronavirus subfamilies as well as other viruses such as influenza viruses. They also expect that some of the specific antigens they describe in this paper can be moved toward preclinical trials. Someday, a trivalent vaccine could comprise a routine part of people's medical treatment.

Technology Networks, 02 April 2024

https://technologynetworks.com

Model explains why water can freeze at different temperatures

2024-03-28

Using molecular simulations, nucleation theory, mathematical modelling and thermodynamics, which they integrated with experimental results, the team from the University of Utah identified a mathematical expression showing that specific angles between surface features facilitate water molecules gathering and crystallising at relatively warmer temperatures. Their model demonstrates that the ice-nucleating ability of ice-binding surfaces not only depends on the chemistry of the surface but also its topographical characteristics.

The question of how water forms ice might appear trivial but it is critical to understand the formation of clouds and precipitation, as well as for

A new theoretical model has been created that shows how certain features on a surface affect the freezing point of water.

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cryopreservation, according to Valeria Molinero, a physical and materials chemist at the University of Utah who led the work.

It is generally accepted that the freezing point of water is 0°C, but impurities in water like bacteria or certain proteins often mean ice crystals can form more easily on the surfaces. In completely pure liquid water, ice may not form until -46°C, a phenomenon known as supercooling.

Ice-nucleating bacteria contribute to ice crystal formation in clouds and they are routinely used to produce snow. These bacteria have proteins in their outer membrane that helps ice form at temperatures as high as -1°C.

Previous research by Molinero's team determined that the distances between groups of proteins could affect the temperature at which ice is formed. 'Topographical features, such as cracks, cavities and steps, have been reported to be preferred active sites that transform the mineral dust into an effective nucleant that is comparable with ice-nucleating proteins (INPs),' explains Yuqing Qiu, a postdoc who carried out this latest research as part of a PhD with Molinero. 'This understanding, together with the molecular basis and mechanisms of ice-nucleating proteins in nature identified in our previous work, can guide the design of effective artificial INPs that outcompete those produced in nature.'

Christoph Salzmann, a physical and materials chemist at University College London who was not involved in this research, says that it is very hard, from the experimentalist's perspective, to figure out what goes on at the molecular scale when ice forms. 'This computational study is therefore like gold dust which will enable us to be more focused and efficient in developing new high-performance ice-nucleating materials,' states Salzmann, who was part of a team last year that discovered a new type of amorphous ice that more closely resembles liquid water than other known ices.

He predicts that the impact of this research will be 'far-reaching', from cryopreservation of biological materials and cloud science to food processing and snowmaking for winter sports.

Will Cantrell, an associate provost at Michigan Technological University whose research focuses on atmospheric science, as well as cloud and aerosol physics and chemistry, is excited. 'There has been a lot of work on ice nucleation, but this puts many of the old pieces together and adds new elements in a way that makes the theory more predictive,' he says. 'That's

a critical first step in engineering materials to be better (or worse!) ice nucleators, depending on the application.'

Chemistry World, 28 March 2024

https://chemistryworld.com

Researchers determine structure of new metal tellurate material with potential uses in solar energy and more

2024-04-03

The physical properties and crystal structures of most tellurate materials were only discovered during the last two decades, but they have tantalizing properties. For example, they respond to light in a way very similar to current solar materials.

"This could be one material for all applications," says University of Oulu scientist Dr. Harishchandra Singh. "But they are new, and very little is known in the literature. We are trying to explore all its unexplored and hidden properties."

Identifying the structure of new materials is often the first step to unlocking their potential for applications. The international team, led by Matthias Weil (Vienna University of Technology) and Dr. Singh, successfully created a single crystal of a metal tellurate compound, making it possible to define its structure with better accuracy than ever before.

The pair used the Canadian Light Source (CLS) at the University of Saskatchewan to understand how the material works under real-world conditions. A longtime user of the facility, Singh knew that the Brockhouse beamline could help confirm the structural details they had uncovered.

Their results, published in the journal Materials Advances, overturn what was previously thought to be the structure of metal compounds.

"With the results that we are publishing here, one can think of using these metal tellurate compounds for a practical application in the future in a solar cell and also in water splitting to produce hydrogen."

Singh hopes to keep working on and discovering new uses for these fascinating materials. "I feel really excited to be part of discovering a new material that is useful for our current scenario, especially solving global issues like climate change," says Singh.

Scientists have determined the structure of a new material with the potential to be used in solar energy, batteries, and splitting water to produce hydrogen.

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Lead author Weil shares that excitement. "I am always amazed that a closer look at a material can explain special properties and thus enables practical applications, which is particularly true for the family of metal tellurate," he says.

Phys Org, 03 April 2024

https://phys.org

Revolutionizing Plastics: How Sugar-Based Polyamides Could Save Our Planet

2024-03-18

Now, a study led by Jeremy Luterbacher's team at EPFL unveils a pioneering approach to producing high-performance plastics from renewable resources. The research, published in Nature Sustainability, introduces a novel method for creating polyamides – a class of plastics known for their strength and durability, the most famous of which are nylons – using a sugar core derived from agricultural waste.

The new method leverages a renewable resource, and also achieves this transformation efficiently and with minimal environmental impact.

Environmental Benefits and Efficiency

"Typical, fossil-based plastics need aromatic groups to give rigidity to their plastics – this gives them performance properties like hardness, strength, and high-temperature resistance," says Luterbacher. "Here, we get similar results but use a sugar structure, which is ubiquitous in nature and generally completely non-toxic, to provide rigidity and performance properties."

Lorenz Manker, the study's lead author, and his colleagues developed a catalyst-free process to convert dimethyl glyoxylate xylose, a stabilized carbohydrate made directly from biomass such as wood or corn cobs, into high-quality polyamides. The process achieves an impressive atom efficiency of 97%, meaning almost all the starting material is used in the final product, which drastically reduces waste.

The bio-based polyamides exhibit properties that can compete with their fossil counterparts, offering a promising alternative for various applications. What's more, the materials demonstrated significant resilience through multiple cycles of mechanical recycling, maintaining their integrity and performance, which is a crucial factor for managing the lifecycle of sustainable materials.

In today's fast-paced industrial society, the search for eco-friendly materials is more pressing than ever. Plastics, which are a common part of everyday life, present major environmental issues, primarily due to their fossil fuel origins and problematic disposal.

The potential applications for these innovative polyamides are vast, ranging from automotive parts to consumer goods, all with a significantly reduced carbon footprint. The team's techno-economic analysis and life-cycle assessment suggest these materials could be competitively priced against traditional polyamides including nylons (e.g. nylon 66), with a global warming potential reduction of up to 75%.

Sci Tech Daily, 18 March 2024

https://scitechdaily.com

Scientists Supercharge Fuel Cells Using Caffeine

2024-03-16

Amidst worldwide efforts to shift away from fossil fuels, fuel cells emerge as a notable source of energy without carbon emissions. These cells are made up of an anode and a cathode, divided by an electrolyte, and they directly transform the chemical energy of the fuel into electrical power. The fuel is fed to the anode, and an oxidizing agent, usually oxygen from the air, is supplied to the cathode.

In a hydrogen fuel cell, hydrogen undergoes oxidation at the anode, producing hydrogen ions and electrons. The ions move through the electrolyte to the cathode, and electrons flow through an external circuit, generating electricity. At the cathode, oxygen combines with the hydrogen ions and electrons, resulting in water as the sole byproduct.

However, the presence of water affects the performance of the fuel cell. It reacts with the platinum (Pt) catalyst, forming a layer of platinum hydroxide (PtOH) on the electrode, which obstructs the efficient catalysis of the oxygen reduction reaction (ORR), leading to energy losses. To maintain efficient operation, fuel cells require a high Pt loading, which significantly increases the costs of fuel cells.

Breakthrough in Fuel Cell Catalyst Efficiency

Now, in a study recently published in the journal Communications Chemistry, Professor Nagahiro Hoshi, along with Masashi Nakamura, Ryuta Kubo, and Rui Suzuki, all from the Graduate School of Engineering at Chiba University, Japan, have found that adding caffeine to certain platinum electrodes can increase the activity of the ORR. This discovery has the potential to reduce platinum requirements, making fuel cells more affordable and efficient.

Caffeine improves fuel cell performance by boosting the activity of the oxygen reduction reaction.

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"Caffeine, one of the chemicals contained in coffee, enhances the activity of a fuel cell reaction 11-fold on a well-defined Pt electrode of which atomic arrangement has a hexagonal structure," says Prof. Hoshi.

The Impact of Caffeine on Platinum Electrodes

To assess caffeine's impact on the ORR, researchers measured current flow through platinum electrodes immersed in an electrolyte containing caffeine. These platinum electrodes had surface atoms arranged in specific directions, namely (111), (110), and (100). There was a notable improvement in the electrode's ORR activity with an increase in caffeine concentration in the electrolyte. Caffeine, when present, adsorbs onto the electrode's surface, effectively preventing hydrogen adsorption and the formation of Pt oxide on the electrode. However, the effect of the caffeine depended on the orientation of the platinum atoms on the electrode's surface.

At a caffeine molar concentration of $1 \times 10{-}6$, the ORR activity on Pt(111) and Pt(110) increased by 11 and 2.5 times, respectively, with no noticeable effect on Pt(100). To understand this difference, the researchers investigated the molecular orientation of caffeine on the electrode surface using Infrared Reflection Absorption Spectroscopy. They found that caffeine gets absorbed on Pt(111) and Pt(110) surfaces with its molecular plane perpendicular to the surface. However, on Pt(100), steric hindrances cause it to be attached with its molecular plane tilted relative to the surface of the electrode.

"The increased ORR activity of Pt(111) and Pt(110) was attributed to the decreased PtOH coverage and lower steric hindrance of the adsorbed caffeine. Conversely, for Pt(100), the effect of decreasing PtOH was counteracted by the steric hindrance of the adsorbed caffeine, and thus caffeine did not affect the ORR activity," explains Prof. Hoshi.

Unlike batteries with limited lifespans, fuel cells can generate power as long as fuel is supplied, making them suitable for various applications, including vehicles, buildings, and space missions. The proposed method has the potential to improve the designs of fuel cells and lead to their widespread use.

Sci Tech Daily, 16 March 2024

https://scitechdaily.com

Liquid metals research breaks ground in sustainable chemical manufacturing with metal-enhanced catalysts

2024-04-03

"A remarkable 14-fold increase in the catalyst's lifetime was achieved by employing liquid gallium as a promoter, which molecular-level effects on the working catalyst were uncovered through meticulous in situ spectroscopic studies conducted at Charles University," said one of the authors of the study Mariya Shamzhy from Charles University Center of Advanced Materials, Faculty of Science.

In a significant advancement for the field of chemical engineering, scientists have unveiled a novel approach to enhancing the efficiency and sustainability of the MTH process, a key method for converting methanol into valuable chemicals and fuels. This research demonstrates the use of low-melting-point metals, such as gallium (Ga), to significantly improve the performance and lifespan of the catalysts involved in the MTH process. The research is published in the journal Nature Communications.

Traditionally, the MTH process has relied on zeolite catalysts. While effective, these catalysts suffer from rapid deactivation caused by coke deposition, necessitating frequent and costly regeneration treatments. The innovative approach introduced by the research team leverages the unique properties of gallium to slow the deposition of coke and enhance the desorption of carbonaceous species from the zeolite catalysts. This not only extends the catalysts' operational life but also increases the process's overall efficiency and sustainability.

A key finding of the research was that physically mixing ZSM-5 zeolite with liquid gallium resulted in a catalyst that demonstrated an enhanced lifetime in the MTH reaction, increasing by a factor of up to approximately 14 times compared to the traditional ZSM-5 zeolite catalysts. This remarkable improvement opens the door to more cost-effective and environmentally friendly chemical manufacturing processes.

The implications of this research are profound, offering an alternative route to the design and preparation of deactivation-resistant zeolite catalysts. By reducing the need for regular regeneration treatments, this method not only lowers production costs but also decreases the environmental footprint associated with chemical manufacturing.

This breakthrough represents a pivotal step forward in the quest for more sustainable and efficient chemical production methods. It underscores

A team of co-authors from five different countries, has uncovered a new design concept for catalysts used in the industrially crucial methanol-to-hydrocarbon (MTH) process, enabling the production of high-demand chemical commodities from source-abundant methanol.

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the potential of integrating novel materials and innovative techniques to overcome longstanding challenges in the industry.

The research team's findings offer a promising path forward for the development of next-generation catalysts that will play a crucial role in the sustainable manufacture of valuable chemical products from methanol.

"The new concept of the utilization of liquid metals as promoters of zeolite catalysts introduces exciting possibilities for the development of more efficient and robust catalytic systems for a wide range of industrial processes," concluded one of the corresponding authors, Vitaly V. Ordomsky from Université de Lille, Unité de Catalyse et Chimie du Solide.

Phys Org, 03 March 2024

https://phys.org

Casimir Funk: The scientist who gave us the word 'vitamin'

2024-02-23

There have been theories of how food affects health for millennia. In ancient Greece and Rome, early physicians invented "humoral" theory, which stated that foods must have the right balance of wet, dry, hot and cold to keep the body's four essential humours – fire, earth, blood and phlegm – in check. Much later, physicians made more distinct associations, such as the observation that consuming citrus fruits like lemons helped to prevent the disease scurvy in sailors on long voyages.

In the late 19th century, scientists were trying to figure out the cause of beriberi disease, which can affect a person's nervous or cardiovascular system and is today known as a vitamin B1 deficiency. In 1897, Christiaan Eijkman published a study based on experiments in chickens, proposing that diets containing brown rice were protective against beriberi, compared with those consisting of only white rice.

Casimir Funk read Eijkman's paper and set himself the task of finding the chemical compound that gave brown rice its protective properties. In 1912, Funk managed to isolate a chemical that he thought was responsible and found it contained a characteristic nitrogen compound called an amine, so he named it a vital amine, or vitamine. When scientists eventually realised that vitamins didn't necessarily need to contain an amine group, they dropped the final "e".

Casimir Funk, the Polish biochemist who coined the term "vitamins" for the vital class of molecules that help keep us alive, is the subject of today's Google doodle.

Funk suggested that similar compounds might exist for many other "deficiency diseases", as he called them, writing: "We will speak of a beriberi and scurvy vitamine, which means a substance preventing that special disease." Funk also correctly suggested that vitamins existed that prevented the diseases pellagra and rickets.

The compound that Funk isolated and dubbed an "anti beriberi factor" was what we now call vitamin B3, or niacin, which doesn't actually prevent beriberi. Two years earlier, Japanese scientist Umetaro Suzuki isolated vitamin B1 from brown rice and correctly identified its role in preventing beriberi. However, his work was published in a Japanese journal and the first Western translation, in German, failed to note that it was a new discovery.

In the 35 years after Funk's initial finding, scientists discovered the rest of the vitamins, which number 13 in total, including eight kinds of vitamin B and vitamins A, C, D, E and K. Funk continued working with vitamins, and for pharmaceutical companies, for the rest of his career. He produced the first widely used vitamin concentrate in the US, called OSCODAL, which contains liquid vitamin A and D.

While vitamins are recognised as helping to prevent certain diseases, their use as supplements is still debated by scientists. A recent meta-analysis found there isn't good evidence that supplements and vitamins protect against cancer or heart disease for most people.

New Scientist, 23 February 2024

https://newscientist.com

New approach to monitoring freshwater quality can identify sources of pollution, and predict their effects

2024-03-28

Microparticles from car tyres, pesticides from farmers' fields, and toxins from harmful algal blooms are just some of the organic chemicals that can be detected using the new approach, which also indicates the impact these chemicals are likely to have in a particular river or lake.

Importantly, the approach can also point to the origin of specific organic matter dissolved in the water, because it has a distinct composition depending on its source.

It uses a technique called high-resolution mass spectrometry to analyse water samples: within an hour this provides a comprehensive overview of all the organic molecules present.

Water quality is strongly determined by the diversity of organic matter dissolved in it -- termed 'chemodiversity.' The scientists say that the thousands of different dissolved organic compounds can keep freshwater ecosystems healthy, or contribute to their decline, depending on the mixture present.

The paper is published today in the journal Science.

"Traditional approaches to monitoring water quality involve taking lots of different measurements with many devices, which takes a lot of time. Our technique is a very simple way to get a comprehensive overview of what's going on in a particular river or lake," said Jérémy Fonvielle, a researcher in the University of Cambridge's Department of Biochemistry and co-author of the paper.

To understand what drives this chemodiversity, the team reviewed studies of dissolved organic matter in freshwater samples from rivers and lakes across Europe and northern Canada.

For example, water analysis of Lake Erie in Canada revealed high levels of phosphorus pollution. By looking at the composition of individual molecules in the water sample, researchers identified agricultural activities as the source of this pollution, rather than wastewater effluent.

"Whereas before, we could measure the amount of organic nitrogen or phosphorus pollution in a river, we couldn't really identify where pollution was coming from. With our new approach we can use the unique molecular fingerprint of different sources of pollution in freshwater to identify their source," said Dr Andrew Tanentzap at Trent University School of the Environment, co-author of the report.

Traditional approaches involve separately measuring many indicators of ecosystem health, such as the level of organic nutrients or particular pollutants like nitrogen. These can indicate the condition of the water, but not why this state has arisen.

Dissolved organic matter is one of the most complex mixtures on Earth. It consists of thousands of individual molecules, each with their own unique properties. This matter influences many processes in rivers and lakes, including nutrient cycling, carbon storage, light absorption, and food web interactions -- which together determine ecosystem function.

Sources of dissolved organic matter in freshwater include urban runoff, agricultural runoff, aerosols and wildfires.

"It's possible to monitor the health of freshwater through the diversity of compounds that are present. Our approach can, and is, being rolled out across the UK," said Tanentzap.

Fonvielle will now apply this technique to analysing water samples from farmland drainage ditches in the Fens, as part of a project run by the University of Cambridge's Centre for Landscape Regeneration to understand freshwater health in this agricultural landscape.

Science Daily, 28 March 2024

https://sciencedaily.com

Water-based paints: Less stinky, but some still contain potentially hazardous chemicals

2024-04-03

Paint consists of four ingredients: pigments, binders, additives and a liquid. If the liquid is water—as in latex and some acrylic paints—it's classified as a water-based paint, rather than solvent-based.

Historically, solvent-based paints were easy to apply and durable, though they released foul-smelling VOCs into the air both during and after application, stinking up a newly painted room. These airborne VOCs can cause respiratory irritation and headaches, among other potential health problems, especially in high concentrations or over long periods of time.

Despite water-based paints sporting labels with "zero-" or "low-VOC," their formulations could contain potentially dangerous chemicals of their own. So, Ying Xu and colleagues wanted to understand more about these paints' formulations. The team notes that there are differing definitions of what constitutes a VOC, some of which are stricter than others, including the World Health Organization's definition used in this research.

The team collected 40 water-based paints from around the world, all ranked among the top 70 most-sold brands, and many labeled as zero- or low-VOC. Both dry and wet samples were analyzed by gas chromatography-mass spectrometry to determine their composition.

- Twenty semi-volatile organic compounds were identified in concentrations ranging from 10 to 35,000 parts per million. While less likely to be in a gaseous form, these can still persist indoors for years, often incorporated into dust.
- Endocrine-disrupting phthalates, which act as binders, were largely absent in the tested paints. However, several phthalate-replacement chemicals were detected—their toxicities are still being assessed.

Choosing paint for your home brings a lot of options: What kind of paint, what type of finish and what color? Water-based paints have emerged as "greener" and less smelly than solvent-based options. And they are often advertised as containing little-to-no volatile organic compounds (VOCs).

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- Nearly half the analyzed samples contained measurable amounts of isothiazolinones—preservatives that have been linked to skin irritation and asthmatic symptoms.
- In 24 of the wet paint samples advertised as either zero- or low-VOC, 11 different VOCs were detected at concentrations up to 20,000 parts per million.

These concentrations represent the chemical composition within the paint, not the air. Further studies are required to understand how much of these potentially hazardous compounds become airborne as painted surfaces are drying. The researchers say that this work could allow for the design of safer paint products in the future.

Phys Org, 03 April 2024

https://phys.org

Cross-coupling technique cracks open alcohols for chemical synthesis

2024-03-27

Alcohols are inexpensive and abundant with a lot of structural diversity. However, harnessing them for carbon–carbon bond-forming reactions – the core of organic synthesis – has remained a long-standing challenge. This is largely due to their strong carbon–oxygen bond, which is hard to break and thus makes activating alcohols particularly difficult, often requiring time- and resource-consuming pre-activation steps.

However, in 2021, David MacMillan's lab at Princeton University in New Jersey, US, discovered a quick way to activate a single alcohol building block and break its C–O bond. This involved using N-heterocyclic carbene (NHC) salts and a light-triggered catalyst, which ultimately converted the alcohol unit into a transient carbon-centred alkyl radical that could then form new bonds with other functional groups.

Now, MacMillan's team has applied this concept to simultaneously activate two distinct alcohol units in the same flask and shown how their respective radicals can be cross-coupled to form a new C–C bond. 'Once we had identified the optimal conditions and began pushing the limits on scope, we knew we had something special,' explains study co-author Nick Intermaggio. 'The reaction setup is surprisingly easy and amenable to practitioners. We just have to mix necessary reagents one by one and then we get productive results within an hour upon shining blue light.'

Key to the success of the C–C bond forming reaction was preventing the alkyl radicals from the two distinct alcohols coupling with their own kind and creating a chaotic and hard-to-control mixture of products. The researchers overcame this by incorporating a 'radical sorting' mechanism that they first described in 2022. This involved adding a nickel catalyst to the reaction, which forms metal–carbon bonds of different strength and reactivity with the two types of radical, ultimately ensuring that each kind of radical selectively reacts and forms a C–C bond with the other.

'The concept of taking two different alcohols, clipping the oxygen atoms off and joining the carbon skeletons together is so simple on paper, but so incredibly hard to achieve in practice,' comments Liam Ball, a synthetic chemist at the University of Nottingham, UK. 'What the team has achieved is phenomenal and promises to radically change the way that organic chemists approach the construction of complex aliphatic architectures.'

A new cross-coupling technique promises to unlock the unexplored chemical space of alcohols by expanding their use as building blocks in the synthesis of new and complex chemicals.

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Stephen Newman who researches alcohol cross-coupling at the University of Ottowa, Canada, is similarly impressed. 'While the reaction is not perfectly selective and the yields throughout are usually modest, there's no doubt that this is an incredibly efficient and exciting way of combining two attractive starting materials,' he says. 'Coupling two alcohols to make a new C(sp3)–C(sp3) bond should be very high on any synthetic chemist's wish list, in particular for medicinal chemists who want to take abundant building blocks and rapidly make useful, complex, and structurally novel products.'

'We hope that people will use this reaction to make complex structures that would otherwise be very difficult or take a long time to make. We already have folks from the pharmaceutical industry and total synthesis groups contacting us and wanting to use this technology to simplify their routes, which makes us very excited,' says MacMillan. 'All the reagents are commercially available and the reaction set up is very robust so once someone wants to use it, there should be little barrier to entry.'

Chemistry World, 27 March 2024

https://chemistryworld.com

Thousands of Previously Unknown Bile Acids Discovered

2024-03-12

"Bile acids are a key component of the language of the gut microbiome, and finding this many new types radically expands our vocabulary for understanding what our gut microbes do and how they do it," said senior author Pieter Dorrestein, Ph.D., professor at Skaggs School of Pharmacy and Pharmaceutical Sciences and professor of pharmacology and pediatrics at UC San Diego School of Medicine. "It's like going from 'See Spot Run' to Shakespeare."

The results, as described by study co-author and bile acids expert Lee Hagey, Ph.D, are akin to a molecular Rosetta stone, providing previously unknown insight into the biochemical language microbes use to influence distant organ systems.

Bile acids originate in the liver, are stored in the gallbladder and ultimately released into the intestine, where they are deployed to aid in digestion following the consumption of a meal. The microbes in our gut metabolize the bile acids produced by the liver, changing them into a vast array of different molecules called secondary bile acids, which tend to be easier for

Researchers from Skaggs School of Pharmacy and Pharmaceutical Sciences at the University of California San Diego have uncovered thousands of previously unknown bile acids, a type of molecule used by our gut microbiome to communicate with the rest of the body.

the body to absorb. Until now, the rich diversity and range of functions of secondary bile acids have been underappreciated by scientists.

"When I started working in the lab, there were about a few hundred known bile acids," said study co-author Ipsita Mohanty, Ph.D., a postdoctoral researcher in the Dorrestein lab. "Now we've discovered thousands more, and we're also working toward realizing that these bile acids do so much more than just help with digestion."

In addition to aiding digestion, bile acids are also important signaling molecules that help regulate the immune system and serve important metabolic functions, such as controlling lipid and glucose metabolism. These molecules also help explain how microbes in the gut are able to influence distant organ systems.

"Because of their interaction with our microbiome, the influence of bile acids spreads far beyond the digestive system, and so could the diseases we treat with them – the list of diseases related to bile acids is a mile long, and there are several FDA approvals for these kinds of acids as treatments," said co-author Helena Mannochio-Russo, Ph.D., also a postdoctoral researcher in the Dorrestein lab.

In order to discover these molecules, the researchers leveraged the unique resources of UC San Diego. Dorrestein is director of the Collaborative Microbial Metabolite Center (CMMC), a first-of-its-kind collaboration between UC San Diego and UC Riverside that seeks to gather and centralize information about the metabolites that microbes produce to help researchers learn more about their impact on human health and the environment.

"In other areas of biology like genomics, sharing data is common, but there hasn't been an infrastructure in place for microbial metabolomics researchers to share data until now," said Dorrestein "Ultimately these breakthroughs are the result of a convergence of collaboration and computing power, and we expect many more breakthroughs to come out of the CMMC."

Earlier this year, the team debuted a new tool that can instantly match microbes to the metabolites they produce. The present study is the first of potentially many studies to utilize the tool for specific types of molecules. The researchers next hope to explore the specific functions of their newly-discovered bile acids as well as use their approach on other types of biomolecules, such as lipids or other kinds of acids.

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"We're rewriting the textbook of human metabolism," said Dorrestein. "If you'd have spoken to me a few years ago, I would have said we were decades away from solving this puzzle, but now, it could happen within five years. It's really a remarkable change in our capabilities, and we believe it's going to revolutionize the way we approach disease."

Technology Networks, 12 March 2024

https://technologynetworks.com

Researchers investigate the surface extraction of platinum catalysts in alkaline media

2024-04-02

To address this, researchers investigated the mechanisms of surface oxidation on Pt surface in alkaline media, a previously unexplored avenue of research. Their experiments revealed crucial insights that can aid in the development of next-generation catalysts, paving the way for a carbon-neutral society. The findings are published in the Journal of the American Chemical Society.

Platinum (Pt) electrodes are crucial for clean power technologies like hydrogen fuel cells and electrolysis. However, the surface oxidation that occurs during such processes degrades catalyst performance and stability.

The pursuit of carbon neutrality drives the exploration of clean energy sources, with hydrogen fuel cells emerging as a promising avenue. In these cells, hydrogen undergoes an electrochemical reaction with oxygen to produce electricity and water. Also, the reverse of this process, called electrolysis, can be used to split the abundantly available water to produce hydrogen and oxygen.

These two technologies can work in tandem to provide a clean and renewable source of energy. A pivotal element in these two technologies is the platinum (Pt) electrode.

Hydrogen fuel cells consist of two electrodes: an anode and a cathode, with an electrolyte between them. Pt serves as a fundamental catalyst in low-temperature fuel cells, such as alkaline fuel cells and polymer electrolyte fuel cells (PEFCs). Pt has a high activity for the oxygen reduction reaction (ORR), which is crucial for fuel cells, in alkaline and acidic conditions at the operating voltage of PEFC cathodes.

However, this also leads to oxide formation on the surface, which roughens and dissolves the Pt layer, ultimately degrading the cathodes and affecting performance and stability. Understanding surface oxide formation mechanisms is thus crucial for developing Pt cathode catalysts that work well in alkaline conditions.

Studies have shown that the oxide formation on the Pt surface depends on the electrode potential, the electrolyte, and the electrical double layer (EDL). While studies have investigated the oxide formation and reduction on the Pt surface in acidic media, few of them have addressed the same in alkaline media, present in fuel cells and electrolyzers with anion exchange membranes.

To address this gap, a team of researchers led by Professor Masashi Nakamura from the Graduate School of Engineering, Chiba University, Japan, dug deep into the oxide formation mechanisms on Pt surfaces in alkaline media.

"In a previous study, we reported that interfacial hydrophobic ions with long alkyl chains can enhance ORR. This suggests that it is possible to construct an interfacial reaction field that not only activates the ORR but also improves the durability of Pt electrodes by using optimal interfacial ions," explains Prof. Nakamura.

The study also included contributions from Dr. Tomoaki Kumeda and Professor Nagahiro Hoshi, both from the Graduate School of Engineering at Chiba University, along with Dr. Osami Sakata from the Center for Synchrotron Radiation Research at Japan Synchrotron Radiation Research Institute.

The team investigated the oxide formation on the Pt (111) surface in alkaline aqueous solutions containing different cations, namely Lithium cation (Li+), Potassium (K+) cation and Tetramethylammonium cation (TMA+), using advanced methods like X-ray crystal truncation rod (CTR) scattering, gold nanoparticle-based surface-enhanced Raman spectroscopy (GNP-SERS), and infrared reflection absorption spectroscopy (IRAS).

"Studies have shown that a combination of vibrational spectroscopy and X-ray diffraction is effective for elucidating surface oxidation processes," adds Prof. Nakamura.

X-ray CTR revealed that oxide formation results in surface buckling and Pt extraction. SERS and IRAS measurements revealed the potential and cation-dependent formation of three oxide species, namely infrared (IR)-active adsorbed hydroxide OH (OHad), Raman active adsorbed water (H2O)ad, and Raman-active oxygen (Oad).

The team found that hydrophilic cations like Li+ stabilize IR-active OHad, thus preventing harmful oxide formation, while moderate hydrophilicity

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of K+ has no protective effect. Interestingly, bulky hydrophobic cations such as TMA+ also reduce irreversible oxidation, similar to Li+. Notably, the team also found that the electrostatic repulsion between Raman-active (H2O)ad and neighboring Raman-active Oad facilitates Pt extraction.

These results suggest that interfacial cations play an essential role in oxide formation on Pt surfaces, which can be controlled by selecting appropriate cations. Elaborating on these results, Prof. Nakamura remarks, "These insights are crucial for understanding the surface oxidation mechanisms and the EDL structure, which can be beneficial for achieving high-performance and stable Pt electrocatalysts for use in next-generation electrochemical devices."

Overall, this study takes us a step further in achieving a zero-carbon future powered by abundant and clean hydrogen.

Phys Org, 04 April 2024

https://phys.org

Pregnancy advances your 'biological' age — but giving birth turns it back

2024-03-22

It's not surprising that pregnancy takes a toll, but the reversal was "somewhat unexpected", says perinatal-health specialist Kieran O'Donnell at Yale University in New Haven, Connecticut, a co-author of the study. It was published on 22 March in Cell Metabolism.

Aged DNA

The chemical tags analysed in the study are called methyl groups, and they are added to DNA in a process called methylation. They are one example of the 'epigenome', features of DNA that change gene activity without altering the genetic code.

DNA-methylation patterns can be used to estimate a person's 'biological age', which reflects the physiological stresses that a person's body has accrued over time. Some research has found that biological age is a better predictor of health problems such as cardiovascular disease3 and dementia4 than a person's chronological age.

But unlike chronological age, "biological age is quite flexible; it's a fluid parameter. It can go up and down", says biomedical scientist Vadim Gladyshev at Harvard Medical School in Boston, Massachusetts. Last year,

Aches and pains aren't all that pregnancy shares with ageing. Brewing a baby leads to changes in the distribution of certain chemical markers on a pregnant person's DNA — changes similar to those that are a hallmark of getting older.

his team published a study in Cell Metabolism2 that noted a decrease in biological age after pregnancy in mice and suggested that there could be a similar effect in humans. Cessation of several other stressful conditions also reversed biological age.

Obesity's effect

The latest study confirmed Gladyshev and colleagues' results in humans and also showed that not everyone bounces back from pregnancy to the same degree. People who were at the cusp of obesity before pregnancy shed fewer years of biological age in the three months after birth than did people who had a body weight classified as 'normal', O'Donnell and his colleagues found. Meanwhile, people who breastfed exclusively experienced a greater reduction in biological age than did those who used formula or a mix of formula and breast milk.

Some participants' biological ages were a few years younger postpartum than in early pregnancy. That's "one thing that caught my eye", says ageing-biologist Yousin Suh at Columbia University in New York City, who was not involved in the work.

The researchers didn't measure the biological age of participants before pregnancy, so "we can't claim that this is a rejuvenation effect", O'Donnell says. But the data are suggestive, and he'd like to follow up with the participants in the future.

Not to worry

Interpreting Gladyshev and O'Donnell's findings is tricky, some researchers say. Methylation clearly changes during pregnancy, but "we would be wrong to assume pregnancy is a state of accelerated ageing", says Dena Dubal, a physician-scientist and specialist in ageing at the University of California, San Francisco. Dubal thinks that methylation might not be a hallmark of ageing in the case of pregnancy but could instead underlie some of the sweeping changes that the body must undergo to support a growing fetus, such as altered gene expression.

Suh isn't so sure. "Methylation is, thus far, one of the most robust markers of biological age," she says.

Whether a reversible state can truly be called "age" is "a really important point", O'Donnell says. "Perhaps as we begin to focus on pregnancy as a new area for ageing research, maybe there's new terms and terminology that will need to be developed."

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In the end, people shouldn't worry about any pregnancy-related increase in their biological age, scientists say. "We are talking about, you know, changes of about two, three years," Gladyshev says.

And Dubal points out that pregnancy should not be conceptualized as a biological problem, even for people who don't maximize recovery by breastfeeding. "While the benefits of breast feeding are many, its absence is not a dangerous predicament," she says.

Nature, 22 March 2024

https://nature.com

Melanoma Vaccine Offers Improved Survival for Men

2024-04-02

A second-generation melanoma vaccine developed at UVA Cancer Center improves long-term survival for melanoma patients compared with the first-generation vaccine, new research shows.

The vaccine developers, led by Craig L. Slingluff Jr., MD, found that they could enhance the effectiveness of their melanoma vaccine by simultaneously stimulating important immune cells known as "helper T cells" to recognize melanoma proteins, in addition to stimulating killer T cells against melanoma. This boosted patient survival and helped prevent reoccurrences of the cancer.

The researchers are not sure why the approach was more effective in men, but biologic sex is emerging as an important factor in outcomes of patients with melanoma, in particular with immune therapies. The findings support the importance of understanding how best to benefit women and well as men with effective immunotherapies.

"These findings support the promise of this second-generation melanoma vaccine for prolonging survival of patients after surgery for high-risk melanoma," said Slingluff, a surgical oncologist and translational immunologist at UVA Health and the University of Virginia School of Medicine. "We hope that we can make this available to patients in addition to other effective immune therapies so that they may have even greater benefit than either treatment alone."

MORE EFFECTIVE MELANOMA VACCINE

People commonly think of vaccines as something you take to avoid getting sick from viruses. Most cancers do not have a known viral cause, but melanoma vaccines can induce immune responses against human melanoma cells, and Slingluff and others have been working to make them effective for treatment of melanoma. (There are cancers that are caused by viruses, and some vaccines against those viruses have been

very effective at preventing cancers they cause — for example, there are vaccines against human papillomavirus and hepatitis B).

Slingluff's melanoma vaccine targets a form of skin cancer that kills thousands of Americans every year. In seeking to make the vaccine more effective, he and his team tested two different approaches to stimulating both CD4+ helper T cells and CD8+ killer T cells in patients with high-risk melanoma. More than 160 clinical trial volunteers were given, at random, one of two vaccine preparations of purified peptides to stimulate their helper T cells.

Fifteen years after the last participant was enrolled in the trial, overall survival rates were encouraging with both vaccine approaches, but overall survival was better for those with the second-generation vaccine. Those who benefitted most appeared to be younger men with earlier-stage melanoma. The researchers characterize the benefit as "meaningful and durable" in a new scientific paper outlining their findings.

"We were very excited by these findings and for the promise to improve survival with these vaccines," Slingluff said. "Combination of the second-generation vaccine with other immune therapies may further increase the benefit for patients."

The multicenter trial's findings suggest that both age and sex may play important roles in determining immune therapy outcomes. That is important information for doctors and researchers developing these treatments, Slingluff says.

"The differences in benefit based on age and biologic sex highlight the need to understand reasons for those differences so that we can provide the same benefit for all patients," Slingluff said. "We are excited to build on these exciting findings."

Slingluff's pioneering research is part of UVA Cancer Center's ongoing mission to develop new ways to treat cancer and improve patients' cancer treatment options. In recognition of those efforts, the National Cancer Center has named UVA Cancer Center one of only 56 "comprehensive cancer centers" in the country. The designation recognizes elite cancer centers with the most outstanding patient care and research programs in the nation.

Advancing the field of immunotherapy is also a key pillar of UVA's upcoming Paul and Diane Manning Institute of Biotechnology, now under construction at Fontaine Research Park. The institute is poised to fast

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track the development of new treatments and cures and transform how healthcare is delivered across the state and beyond.

FINDINGS PUBLISHED

Slingluff and his team have published their findings in the scientific journal Nature Communications. In addition to Slingluff, the multi-institutional team included Emily K. Ninmer, Hong Zhu, Kimberly A. Chianese-Bullock, Margaret von Mehren, Naomi B. Haas, Merrick I. Ross and Lynn T. Dengel.

The research was supported by the National Cancer Institute, grants R01CA118386 and P30CA044579; gifts from Alice and Bill Goodwin; and the Commonwealth Foundation for Cancer Research.

Slingluff disclosed that he receives licensing fees for patents for peptides used in cancer vaccines; his work has been supported by Celldex, Glaxo-Smith Kline, Merck, 3M and other companies. A full list of the authors' disclosures is included in the paper.

Technology Networks, 2 April 2024

https://technologynetworks.com

New polymers show interaction with cells

2024-04-03

The study, which was published in the journal ACS Polymers Au, may help to transport active substances into cells in a more targeted manner.

A team of researchers led by Prof. Dr. Meike Leiske, Junior Professor of Macromolecular Chemistry at the University of Bayreuth, has investigated how polymers can be used to deliver active ingredients of drugs exactly to the place in the body where they are needed.

To this end, they have produced a new type of amino acid-functionalized polymer. Amino acids—organic compounds that make up proteins or hormones, for example—were attached to polymers. These novel polymers can bind slowly to cells and accumulate in the cell membrane. This opens up exciting possibilities for the development of new medical applications.

In the current study by Prof. Dr. Meike Leiske, Junior Professor of Macromolecular Chemistry at the University of Bayreuth, polyanions were produced that are derived from amino acids and have different alkyl side chains. These polyanions were produced using a special chemical synthesis method to obtain defined properties.

A new development in biomedical research could open the door to a variety of new applications: Scientists at the University of Bayreuth have found that certain polymers, called polyanions, can penetrate cells in a unique way without causing damage.

The researchers were able to show that these polymers have a similar ionic charge to the well-known polyacrylic acids, while they are hydrophobic, i.e., water-soluble, in different ways.

The interactions between these polyanions and cells were examined in detail, and it was found that the polymers bind slowly to the cells and can accumulate in the cell membrane. In particular, the polyanions with a higher hydrophobicity showed stronger binding to the cells.

"Normally, polyanions interact very slowly or not at all with our cells because, like our cell membrane, they also have a negative charge. By using slightly more hydrophobic amino acids, we were able to design the polymers in such a way that they embed themselves in the cell membrane—which does not normally happen—before they are finally taken up," explains Leiske.

This groundbreaking research shows the potential of polymers derived from natural amino acids. The diversity of these materials opens up new ways of adapting their properties for different medical purposes.

"The discovery that polyanions can enter cells in a gentle way without damaging them opens up new possibilities for biomedical research. This finding underlines that customized polymers, e.g., based on amino acids, could contribute to the development of innovative approaches for biomedical applications," says Leiske.

Phys Org, 03 March 2024

https://phys.org

Researchers synthesize new compounds within living cells using light

2024-04-02

Now, scientists at the Center for Research in Biological Chemistry and Molecular Materials (CiQUS) have achieved a breakthrough by integrating non-native photosensitizers into mammalian cells. This revelation showcases the capability of these substances to also absorb green or blue light, thus instigating artificial chemical reactions within cellular environments. Notably, this innovative approach has been employed for synthesizing indoles, chemical compounds boasting significant biological activities.

Such findings underscore the feasibility of leveraging light to fabricate functional molecular products, including fluorescent variants, within

Plants harness chlorophyll to capture sunlight and kickstart photosynthesis, a crucial process on our planet that converts luminous energy into chemical fuel while producing oxygen. This pivotal chemical energy is subsequently utilized by plants, algae, and select bacteria to metabolize carbon dioxide and water into sugars.

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biological settings. Published in the Journal of the American Chemical Society (JACS), this study marks the pioneering demonstration of forging synthetic chemical bonds within cells through photocatalysis.

Photocatalysis emerges as a transformative chemical technology with vast socioeconomic implications. It empowers the utilization of light as an energy source to activate catalysts and instigate chemical transformations, thereby facilitating sustainable synthetic endeavors.

"The evidence of employing these synthetic photocatalysis technologies within biological milieus, we believe, heralds a new frontier at the frontier of chemistry and biology," remarks Professor José Luis Mascareñas, co-leading the research alongside Dr. María Tomás Gamasa. "Moreover, we anticipate that in the foreseeable future, these technologies will unveil novel strategies for precisely manipulating human cells, thus fostering the development of innovative therapeutic interventions."

Dr. Sara Gutiérrez and Ph.D. student Cinzia D'Avino spearheaded the experimental work, conducted entirely at CiQUS.

Phys Org, 02 April 2024

https://phys.org

Chemistry researchers modify solar technology to produce a less harmful greenhouse gas

2024-04-02

"One challenge with solar energy is that it's not always available when we have the highest need for it," said Gabriella Bein, the paper's first author and a Ph.D. student in chemistry. "Another challenge is that renewable electricity, like that from solar panels, doesn't directly provide the raw materials needed for making chemicals. Our goal is to store solar power in the form of liquid fuels that can be used later."

The researchers used a ruthenium molecular catalyst with a piece of chemically modified silicon, called a photoelectrode, that facilitated the conversion of carbon dioxide to carbon monoxide using light energy without producing unwanted byproducts, such as hydrogen gas, making the process more efficient for converting carbon dioxide into other substances.

Jillian Dempsey, a co-author of the paper and Bowman and Gordon Gray Distinguished Term Professor, said that when they ran experiments in a solution filled with carbon dioxide, they found that they could produce

The research was supported by the Center for Hybrid Approaches in Solar Energy to Liquid Fuels (CHASE), an Energy Innovation Hub funded by the DOE Office of Science, and informed by a process called artificial photosynthesis, which mimics how plants use sunlight to convert carbon dioxide into energy-rich molecules.

carbon monoxide at 87% efficiency, meaning the system using the modified silicon photoelectrodes is comparable or better than systems using traditional metal electrodes, such as gold or platinum.

In addition, the silicon photoelectrode used 460 millivolts less electrical energy to produce a reaction than one would have using only electricity. Dempsey called this significant, because the process uses direct light harvesting to supplement or offset the energy required to drive the chemical reaction that converts carbon dioxide into carbon monoxide.

"What's interesting is normally silicon surfaces make hydrogen gas instead of carbon monoxide, which makes it harder to produce it from carbon dioxide," said Dempsey, who is also deputy director of CHASE. "By using this special methyl-terminated silicon surface, we were able to avoid this problem. Modifying the silicon surface makes the process of converting CO2 into carbon monoxide more efficient and selective, which could be really useful for making liquid fuels from sunlight in the future."

Bein and Dempsey collaborated on the research with Professor Alexander Miller; Eric Assaf, a former graduate student in the department; Senior Research Scientist Renato Sampaio; Madison Stewart, an undergraduate chemistry major; and Senior Research Scientist Stephen Tereniak.

CHASE is made up of seven different institutions, headquartered at UNC-Chapel Hill, and received $40 million in funding from the Department of Energy in 2020 to accelerate fundamental research on ways to produce fuels from sunlight.

Science Daily, 02 April 2024

https://sciencedaily.com

Cheaper, Cleaner, Greener: Scientists Develop New Way To Produce Ammonia

2024-04-03

Among the many chemicals we use every day, ammonia is one of the worst for the atmosphere. The nitrogen-based chemical used in fertilizer, dyes, explosives, and many other products ranks second only to cement in terms of carbon emissions, due to the high temperatures and energy needed to manufacture it.

But by improving on a well-known electrochemical reaction and orchestrating a "symphony" of lithium, nitrogen, and hydrogen atoms, the University of Illinois Chicago engineers led by Meenesh Singh have

Low temperature, regenerative method conserves energy and effectively generates common chemical.

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developed a new ammonia production process that meets several green targets.

The process, called lithium-mediated ammonia synthesis, combines nitrogen gas and a hydrogen-donating fluid such as ethanol with a charged lithium electrode. Instead of cracking apart nitrogen gas molecules with high temperature and pressure, nitrogen atoms stick to the lithium, then combine with hydrogen to make the ammonia molecule.

The reaction works at low temperatures, and it's also regenerative, restoring the original materials with each cycle of ammonia production.

The Science Behind the Process

"There are two loops that happen. One is the regeneration of the hydrogen source and the second is the regeneration of the lithium," said Singh, associate professor of chemical engineering at UIC. "There is a symphony in this reaction, due to the cyclic process. What we did was understand this symphony in a better way and try to modulate it in a very efficient way, so that we can create a resonance and make it move faster."

The process, described in a paper published and featured on the cover of ACS Applied Materials & Interfaces, is the latest innovation from Singh's lab in the quest for cleaner ammonia. Previously, his group developed methods to synthesize the chemical using sunlight and wastewater and created an electrified copper mesh screen that reduces the amount of energy needed to make ammonia.

Their latest advance is built on a reaction that is hardly new. Scientists have known about it for nearly a century.

"The lithium-based approach can actually be found in any organic chemistry textbook. It's very well-known" Singh said. "But making this cycle run efficiently and selectively enough to meet economically feasible targets was our contribution."

Those targets include high energy efficiency and low cost. If scaled up, the process would produce ammonia at roughly $450 per ton, which is 60% cheaper than prior lithium-based approaches and other proposed green methods, according to Singh.

But selectivity is also important, as many attempts to make ammonia production cleaner have ended up creating large quantities of unwanted hydrogen gas instead.

Environmental Benefits and Hydrogen Fuel Potential

The Singh group's results are among the first to achieve levels of selectivity and energy use that could meet Department of Energy standards for industrial-scale production of ammonia. Singh also said the process, which can be performed in a modular reactor, can be made even greener by powering it with electricity from solar panels or other renewable sources and feeding the reaction with air and water.

The process also could help meet another energy goal — the use of hydrogen as fuel. Reaching that goal has been stymied by the difficulties of transporting the highly combustible liquid.

"You want hydrogen to be generated, transported, and delivered to hydrogen pumping stations, where hydrogen can be fed to the cars. But it's very dangerous," Singh said. "Ammonia could function as a carrier of hydrogen. It's very cheap and safe to transport, and at the destination, you can convert ammonia back to hydrogen."

Currently, the scientists are partnering with the General Ammonia Co. to pilot and scale up their lithium-mediated ammonia synthesis process at a plant in the Chicago area. UIC's Office of Technology Management has filed a patent for the process.

Scie Tech Daily, 03 April 2024

https://scitechdaily.com

Magnetic particles turn water droplets into tightrope-walking acrobats

2024-02-28

Shilin Huang at Sun Yat-sen University in China and his colleagues made a surface with tiny grooves and covered it in a varnish that is superhydrophobic, or nearly impossible to wet. They knew water droplets sitting on top of such grooves can spontaneously jump up because of the pressure difference between a droplet's bottom, which is deformed by the small channel, and its rounder and less restrained top.

The researchers wanted to create this pressure difference on demand. They added a tiny magnetic particle into each droplet and placed an electromagnet underneath the groove. When they turned on the electromagnet, it pulled the particle – and therefore some of the droplet – into the groove. When they switched it off, the droplet's shape rebounded and it flew upwards as if flying from a slingshot.

Putting tiny magnetic particles inside ordinary water droplets can turn them into liquid acrobats – the droplets can climb steps, leap over obstacles and jump-start chemical reactions. This level of control could be useful in drug delivery or to make more complex lab-on-a-chip technologies.

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With this technique, the team made liquid droplets hop up millimetre-scale stairs and over miniature obstacles. The researchers even steered a droplet into a narrow space between two wires, thus connecting a circuit and lighting a light bulb.

Xiao Yan at Chongqing University in China says this is a creative way to take control of pressure-based droplet jumping, and it could be a valuable tool for precisely transporting droplets of chemicals.

In one experiment, researchers caused a droplet to jump into and mix with a liquid chemical sample under a microscope lens, enabling them to watch the resulting chemical reaction from start to finish. In another, they made two droplets mix with a third inside a closed box, remotely starting a reaction that would have been ruined if a researcher had needed to open the box and let air in.

Such precise chemical control has applications for drug delivery. Huang hopes the technique will also advance "lab-on-a-chip" technologies, efforts to miniaturise complex biochemistry experiments that usually require lots of space and glassware. He proposes "lab-on-stacked-chips", where droplets vertically jump between levels to allow many reactions to happen in parallel.

New Scientist, 28 February 2024

https://newscientist.com

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