

Contents

CHEMWATCH

(click on page numbers for links)

REGULATORY UPDATE

ASIA PACIFIC

Workplace exposure standards framework: Decision RIS now available.....	4
Proposed class action puts Australia's PFAS policies in the spotlight	4
Workplace exposure standards open for public comment – Release 7 – Dioxathion to n-ethylmorpholine	7
Japanese Authorities Issues Notice to Inform Implementation of Exemption System under CSCL.....	8

AMERICA

US EPA's science advisers split on tightening air pollution limit	9
EPA Denies Petition for TSCA Rule Prohibiting Oil Refineries from Using Hydrofluoric Acid in Manufacturing Processes.....	12
US EPA aims to crack down on chemical makers' ethylene oxide emissions.....	13
Announcement of Availability of a Second Public Review Draft Technical Support Document for Proposed Public Health Goals for Trihalomethanes in Drinking Water.....	14

EUROPE

Webinar: Testing the study appraisal methodology for the re- evaluation of BPA safety.....	15
"A policy from a parallel universe" Germany's draft coal phase-out law...	16
EC Committee Publishes Guidance on Safety Assessment of Nanomaterials in Cosmetics.....	17

REACH UPDATE

Inspectors in the EU to target REACH authorisation duties.....	19
Public consultations on applications for authorisation launched.....	20
Webinar: REACH information requirements for nanomaterials – material published.....	20
New substance evaluation conclusion published.....	21
Authorisation granted for one use of potassium dichromate	21
Want to keep using peroxyoctanoic acid?	21

CONTACT US

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

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

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

Contents

CHEMWATCH

New intention to harmonise classification and labelling	22
List of notifications updated	22

JANET'S CORNER

Concentration.....	23
--------------------	----

HAZARD ALERT

Lead.....	24
-----------	----

GOSSIP

Hydrogen boride nanosheets: A promising material for hydrogen carrier	33
Scientists bake gluten-free bread using a revolutionary technology	34
Scientists Have Made a Blueprint For a Quantum Battery That Never Loses Charge	36
This New Technology Can Fully Charge an Electric Car in Just 10 Minutes	36
Liquid-in-liquid printing method could put 3D-printed organs in reach...	38
Spiders inspire double-sided sticky tape to heal wounds.....	39
Micromotors push around single cells and particles	39
'Artificial leaf' successfully produces clean gas.....	41
The secret behind crystals that shrink when heated.....	42
Cage molecules act as molecular sieves for hydrogen isotope separation	46
New technique lets researchers map strain in next-gen solar cells	47
Oil and gas wastewater used for irrigation may suppress plant immune systems.....	49
Invention of shape-changing textiles powered only by body heat.....	51
Will lithium-air batteries ever take flight?.....	52
Promising discovery could lead to a better, cheaper solar cell.....	53
Using computational chemistry to produce cheaper infrared plastic lenses	54
An electronic signal expands a material by a factor of 100	55
Using renewable electricity for industrial hydrogenation reactions.....	56
Turning a dangerous toxin into a biosensor.....	57
Mimicking body's circulatory AC could keep airplanes, cars and computers cooler	59

Contents

CHEMWATCH

CURIOSITIES

PTSD tied to higher, earlier stroke risk.....	61
Why Do Some People Need Less Sleep Than Others?	62
Chemicals in consumer products during early pregnancy related to lower IQ, especially in boys.....	64
Exercise May Improve Arteries After Heart Failure.....	66
DEET 'Invisibility Cloak' May Keep Mosquitoes Away.....	67
Red is the most-risky ink colour, and other health issues from tattoos.....	69
Carbon Capture Might Not Be Such a Great Idea.....	72
Bacteria that can degrade pesticide linked to Bhopal Gas tragedy.....	75
Wait, There's Hope! Here's How Humans Might Save Antibiotics	76
Scientists Now Know How Sleep Cleans Toxins From the Brain.....	78
How Measles Leaves Kids Exposed to Other Diseases.....	80
Roundup weedkiller: 42,000 plaintiffs sue Bayer over glyphosate	83
Stress disorders tied to risk for life-threatening infections	84
Babies at higher risk for ADHD, autism if pregnant moms took acetaminophen.....	85

TECHNICAL NOTES

(Note: Open your Web Browser and click on Heading to link to section)...	87
ENVIRONMENTAL RESEARCH.....	87
MEDICAL RESEARCH.....	87
OCCUPATIONAL RESEARCH	87
PUBLIC HEALTH RESEARCH.....	88

Regulatory Update

CHEMWATCH

ASIA PACIFIC

Workplace exposure standards framework: Decision RIS now available

2019-11-15

Safe Work Australia has published the decision regulation impact statement (decision RIS) for the workplace exposure standards framework on its website. A majority of WHS ministers agreed to the preferred option in the decision RIS. This means:

- there is no change to the requirement to ensure exposure standards for substances and mixtures are not exceeded (Regulation 49)
- the Workplace exposure standards for airborne contaminants will be updated using the agreed methodology, and
- the name of workplace exposure standards will be changed to workplace exposure limits.

There will be a standard three-year transitional period for duty holders to comply with amendments to the workplace exposure standards. Educational and guidance materials will be developed to support implementation and compliance. Safe Work Australia will work closely with the Commonwealth, state and territory WHS regulators to implement the preferred option. Further information is available at: Decision regulation impact statement: Workplace exposure standards framework under the model Work Health and Safety laws.

To learn more about the workplace exposure standards, visit Safe Work Australia's workplace exposure standards for chemicals web page.

Safe Work Australia, 12 November 2019

<http://www.safeworkaustralia.gov.au>

Proposed class action puts Australia's PFAS policies in the spotlight

Up to 40,000 people living near defence sites affected

2019-11-15

The Australian government is coming under increasing pressure to deal with contamination from per- and polyfluorinated substances (PFASs), after lawyers announced plans for the country's biggest ever class action. Up to 40,000 people claiming to have been affected by PFAS pollution at

Safe Work Australia has published the decision regulation impact statement (decision RIS) for the workplace exposure standards framework on its website.

Regulatory Update

CHEMWATCH

and around defence sites plan to sue the government, saying that their property values have plummeted. Australia's Department of Defence (DoD) has used PFAS in firefighting foams at training facilities across the country since the 1970s and only began to phase out its legacy firefighting foams containing PFOS and PFOA in 2004. It now uses a "more environmentally safe" firefighting product called Ansulite. The DoD is carrying out environmental investigations at 27 of its sites across Australia. In some cases, it has put in place "management activities" to deal with contamination, including a soil treatment plant and water treatment facilities. It also provides bottled water to residents at four sites. In response to a journalist's question about residents living near RAAF Base Pearce, it stated that "based on the knowledge and evidence currently available, the government is not considering a land purchase programme as a result of PFAS contamination". In October 2017, the defence department admitted that it should have informed the public sooner about the potential danger of water supplies being contaminated by PFAS. Mariann Lloyd-Smith, senior adviser at NGO National Toxics Network (NTN), is hopeful that the class action may bring a move away from the government's "state of denial" regarding PFASs. "Until we see a real process of investigation, I have absolutely no confidence that things will change. There is no process by which NGOs or affected communities can be part of the discussion," she said. In 2018, Australia's Joint Standing Committee on Foreign Affairs, Defence and Trade established a PFAS sub-committee to look into contamination in and around defence bases. Andrew Laming MP, chair of the sub-committee, wrote that the issue has "driven many otherwise ordinary citizens to organise, conduct research and develop significant expertise in an effort to be heard. It should not take years of campaigning at this level of effort to adequately address the legitimate concerns of communities of people." The committee recommended that the Australian government review its existing advice on the human health effects of PFAS exposure and "acknowledge the potential links to certain medical conditions". Although Australia ratified the Stockholm Convention on persistent organic pollutants in 2004, it is yet to do so for the listing of PFOS. The government says that it "must first be able to meet the associated management obligations" as well as implement a national standard.

PFAS management plan

In February 2018, Australia's environment ministers endorsed the country's first PFAS National Environment Management Plan (NEMP), which was updated this year. NGOs have been broadly critical of the plan for being

Regulatory Update

CHEMWATCH

industry-focused and “developed behind closed doors, excluding NGOs but involving industry consultants working for Defence,” according to a statement from the NGO International POPs Elimination Network (Ipen). The plan outlines “general environmental obligations concerning PFAS”, including:

- taking “all reasonable and practicable measures” to prevent or minimise potential environmental harm from PFAS-related activities and contamination;
- checking the effectiveness of implemented management measures; and
- ensuring proper disposal of PFAS-contaminated waste.

The 2019 update also provides more detail about PFASs in soil. Australia’s Environmental Health Standing Committee (enHealth) first released PFAS guidance in June 2016, advising that “there is currently no consistent evidence that exposure to PFOS and PFOA causes adverse human health effects”. In June this year, the Department of Health published an updated version, reinforcing advice to avoid exposure but maintaining that “PFAS has not been shown to cause disease in humans”. “Some people who live or work in areas that have been contaminated with PFAS might have been exposed to higher levels through food or drinking water. They are advised to minimise their exposure until there is more known about possible impacts on health,” it said. The Department of Health is funding the Australian National University to conduct an epidemiological study into the potential health effects of PFAS exposure, which is expected to be completed by the end of 2020.

Victoria’s PFAS position

Although each state looks to the NEMP and federal government for guidance, they take separate PFAS positions. The Environment Protection Authority (EPA) in Victoria recently published a position statement. The EPA seeks to minimise PFAS in the environment wherever possible in accordance with the PFAS NEMP, which it took a leading role in developing. Victoria’s environmental protection laws will change in July 2020. They include a so-called general environmental duty (GED), requiring anyone conducting an activity that poses risks to human health and the environment to minimise them. Unlike similar laws in other states and territories, breaching the GED could lead to criminal or civil penalties. The EPA says that its ‘precautionary’ position on PFAS reflects the most up-to-date information from enHealth. At the time of publication, links to the

Regulatory Update

CHEMWATCH

PFAS NEMP, update and guidance appeared to have been removed from the Victoria EPA's webpages.

Chemical Watch, 6 November 2019

<http://chemicalwatch.com>

Workplace exposure standards open for public comment – Release 7 – Dioxathion to n-ethylmorpholine

2019-11-15

Safe Work Australia is evaluating the Workplace exposure standards for airborne contaminants to ensure they are based on the highest quality evidence and supported by a rigorous scientific approach. Release 7: Dioxathion to n-ethylmorpholine is now open for public comment. Please note that this Release includes chemicals that do not currently have an Australian workplace exposure standard. These are:

- 1,3-Dioxolane
- 2,6-Dimethylaniline (DMA)
- Ethylenediaminetetraacetic acid (EDTA)
- Ethyl Cyanoacrylate
- Ethylene
- Ethylene thiourea
- 2-Ethylhexanoic acid
- 2-Ethylhexanol

In particular, the agency is seeking comments of a technical nature regarding:

- the toxicological information and data that the value is based upon, and
- the measurement and analysis information provided.

Access our consultation platform, Engage to provide your comments on the draft evaluation reports and recommendations for Release 7. Please note some evaluation reports have been deferred to Release 8. Public comment will close on 6 December 2019. The feedback we receive will be considered when making final recommendations for workplace exposure standards. The draft evaluation reports and recommendations for the remaining chemicals will be released throughout 2019 and 2020. If you know someone who has an interest in workplace exposure standards,

Safe Work Australia are calling for comments on the recommendations for Release & - Dioxathion to n-ethylmorpholine.

Regulatory Update

CHEMWATCH

please forward this email and recommend they subscribe to the chemicals exposure standards mailing list to stay informed about the review and release dates.

Safe Work Australia, 8 November 2019

<http://www.safeworkaustralia.gov.au>

Japanese Authorities Issues Notice to Inform Implementation of Exemption System under CSCL

2019-11-15

On 1 November 2019, the Japanese Ministry of Health, Labor and Welfare (MHLW), Ministry of Economy, Trade and Industry (METI) and Ministry of the Environment (MoE) issued the revised Notice on Use Confirmations Required in Application for Exemptions under CSCL. In accordance with the Chemical Substance Control Law, for new chemical substances with a release volume less than 1 ton/year across Japan (small-amount new chemical substances) or those which are confirmed as non-biodegradable and non-bio-accumulative with a release volume less than 10 tons/year across Japan (low-volume new chemical substances), only a simplified new substance notification is needed. When applying for small-amount or low-volume exemptions, businesses are required to submit Use Confirmations as proof of the intended uses of their substances. The revised Notice provides a sample of Use Confirmations as well as information which should be specified therein. Additionally, starting from the beginning of this year, some changes have been in place for the numbering of Use Categories under CSCL. This Notice also includes explanations on the new numbering mode, Use Categories and release factor. Further information is available at: Notice on Use Confirmations Required in Application for Exemptions under CSCL

Japan MHLW, METI and MoE issued a revised notice concerning Use Confirmations which are required in the application for exemptions under CSCL.

Chemlinked, 13 November 2019

<http://chemlinked.com/en/news>

Regulatory Update

CHEMWATCH

AMERICA

US EPA's science advisers split on tightening air pollution limit

2019-11-15

As impeachment investigations hold the US public's attention, the Trump administration continues to push forward its deregulatory agenda, notably on pollution control. Part of that deregulation effort has involved modifying how the US Environmental Protection Agency gets science advice—a change that some say diminishes the role of such advice. Now, the committee of scientists that peer-reviews the agency's reasoning for tighter air pollution limits must do its job with less expertise than it has drawn on in past decades. Plus, EPA administrator Andrew Wheeler has overturned a longstanding practice with the advisers—he's given the committee only one chance to scrutinise key documents, even though the scientists asked for a second look after the EPA revises them. EPA staff and an independent review panel roughly agreed on reducing the limit for airborne fine particulate matter to protect public health, while a majority of the agency's official clean air advisory committee recommended no change. The EPA must finalise a new regulation or justify not changing it by the end of 2020. The first regulation affected by these moves is a limit for fine particulate matter, a type of pollution consisting of dust, dirt, soot, and droplets of liquids that are 2.5 μm or less in diameter. Exposure to fine particulates is linked to asthma attacks, heart attacks, and decreased lung function, as well as premature death in people with heart or lung disease. The current national limit for fine particulates is an annual average of 12 $\mu\text{g}/\text{m}^3$ of air, set in 2012. As required by the Clean Air Act, the EPA is reviewing the standard as well as the scientific evidence that has accrued since 2012 to decide whether to reduce the limit. If the agency opts to do so, the chemical industry and other sectors would likely have to control emissions of nitrogen oxides and sulfur oxides more tightly than they currently do. The agency's process for reviewing air-quality standards is scientific and deeply complex. It draws from mounds of data. It relies heavily on epidemiology studies that have repeatedly linked exposure to fine particulate matter with cardiovascular and respiratory problems that result in emergency room visits, hospitalisations, and deaths. Under a schedule set by former EPA administrator Scott Pruitt, who resigned amid scandal last year, the agency must determine in the coming months whether the 12 $\mu\text{g}/\text{m}^3$ limit protects public health. Wheeler is sticking to that schedule, meaning the agency must complete a new regulation

Regulatory Update

CHEMWATCH

or issue its reasons for not changing the current standard by the end of 2020. EPA staff is meeting the deadlines, releasing a draft assessment in September that suggested ratcheting down the standard. A level between 9 and 11 $\mu\text{g}/\text{m}^3$ could reduce health problems associated with fine particulate air pollution broadly across the US, the draft document says. The agency's Clean Air Scientific Advisory Committee (CASAC), a panel of experts from outside the agency, is reviewing and critiquing the assessment. For decades, the EPA has followed the advice of CASAC when determining what level to set air-quality standards. But CASAC is now bereft of the deep scientific insight it has had in the past. Last year, Wheeler summarily dismissed a review panel that provided CASAC with expertise specific to particulate matter. He also eliminated a similar panel on ground-level ozone. CASAC historically turned to these panels for input as it dug into the details of pollutant-specific health data. CASAC is currently chaired by Louis Anthony "Tony" Cox Jr., a business analytics consultant who is sceptical about the evidence associating fine particulates with health problems and deaths. The committee also includes four scientist-regulators from Alabama, Georgia, Texas, and Utah and an academic who is a pulmonologist. For the first time, no committee members have a background in epidemiology, the discipline that the EPA's draft report most relies on.

CASAC has recognised its scientific proficiency is limited. In April, the committee recommended Wheeler reappoint the previous review panel of particulate matter experts or a group with similar expertise. Wheeler didn't. Instead, in September, he tapped what the EPA called a "pool of subject matter experts": 12 scientists with whom CASAC can consult.

Related: U.S. EPA advisers want to give formal feedback on plan to restrict the science used by agency But the arrangement between CASAC and the pool of experts is markedly different than the relationship it had with the former review panels. CASAC members may consult with the pool only through CASAC's chair and only in writing. In the past, the panels did a deep dive into the EPA's analysis of the science on a pollutant and then reported to CASAC. Members of CASAC also consulted with panellists in oral deliberations, usually face to face. As CASAC has taken up the issue of whether to tighten the fine particulate matter standard, 20 scientists who were dismissed from the particulate matter review panel took the unprecedented step of forming what they call the Independent Particulate Matter Review Panel. Their aim: to review the EPA's draft document just as they would have done in the past. Members of the panel are researchers from academia, scientists for regulatory agencies, and consultants. Since

Regulatory Update

CHEMWATCH

the EPA released the draft fine particulate assessment in September, CASAC and the independent panel have pored over the document, each hewing to CASAC's review procedures. The EPA foots the bill for the CASAC members to meet. The Union of Concerned Scientists (UCS) reimbursed the independent panel members' travel costs for an in-person gathering open to the public. Panel members did not accept honoraria or other compensation for their review work, the UCS says. The independent panel crafted a 183-page report that it released 22 October. The panel concluded that the current $12 \mu\text{g}/\text{m}^3$ standard for fine particulates does not protect public health. Retaining it would require disregarding epidemiological evidence, a move that is not scientifically justified, the panel wrote. It recommended the agency revise the fine particulate matter standard to between 8 and $10 \mu\text{g}/\text{m}^3$. The independent panel provided its report to CASAC, which met 24-25 October to draft its own recommendations. CASAC can consider the panel's work, as it can any relevant scientific comment from the public. But at that public meeting, most committee members did not mention it. By the end of the CASAC meeting, committee members failed to reach consensus about the adequacy of the current fine particulate standard. And as the meeting drew to a close, their discussions came close to breaking down. "The review process is so dysfunctional that we need to stop," said CASAC member Mark Frampton, a pulmonologist and emeritus professor of medicine at the University of Rochester Medical Centre. He said the process is weakened because the pool of consultants that CASAC can draw on can't participate in the committee's discussions as the review panel used to, and the pool contains fewer epidemiology experts than the review panel did. He agreed to finish the discussions "under protest." CASAC member James Boylan, an environmental engineer with the Georgia Environmental Protection Division of the Georgia Department of Natural Resources, said he shared Frampton's frustrations. But Cox, the committee chair, said that by staying within their own scientific expertise, CASAC members "can deliver something useful" to the EPA. Cox concluded that the EPA had not convincingly laid out the extent to which health risks would be reduced by tightening the fine particulate matter standard, so there was no justification to change it. Concurring with his view were CASAC members Sabine Lange, a toxicologist at the Texas Commission on Environmental Quality; Corey Masuca, an environmental health scientist from Alabama's Jefferson County Department of Health; and Steven Packham, a toxicologist at the Utah Department of Environmental Quality. Though most specialists who study particulate matter conclude its risk is directly proportional to exposure, Packham said he believes there is a threshold for exposure to this pollutant below which "the human organism" experiences no effects. Frampton

Regulatory Update

CHEMWATCH

and Boylan disagreed with the CASAC majority. Citing evidence that has come to light since the EPA issued its 2012 standard, they supported a tighter standard. After CASAC issues an official version of its report to the EPA, which will likely happen in December, the agency will produce a final version of its assessment. Wheeler will take it and CASAC's divided advice into account as he decides next year whether to tighten or retain the 12 $\mu\text{g}/\text{m}^3$ standard to protect public health. "It is unusual for the CASAC to fail to reach consensus on its final advice regarding whether to retain, revise, or set" an air-quality standard, Christopher Frey, an environmental engineering professor at North Carolina State University, tells C&EN. "It is unusual for CASAC to offer advice that is less protective than supported by the scientific evidence," he says. Frey chaired CASAC from 2012 to 2015 and the independent review panel this year. The "EPA set them up to fail," Gretchen Goldman, research director of the UCS's Centre for Science and Democracy, says of CASAC. The changes affecting the committee's expertise weaken the role of science advice at the agency, she says. The outcome, Frey adds, could be dire. "Real people will die if EPA doesn't make this standard more stringent," he says.

Chemical & Engineering News, 10 November 2019

<http://pubs.acs.org/cen/news>

EPA Denies Petition for TSCA Rule Prohibiting Oil Refineries from Using Hydrofluoric Acid in Manufacturing Processes

2019-11-15

The United States Environmental Protection Agency (EPA) published a *Federal Register notice* on 12 November 2019, announcing the availability of its response to a petition it received under Section 21 of the Toxic Substances Control Act (TSCA) from Public Employees for Environmental Responsibility (PEER). 84 Fed. Reg. 60986. As reported in our August 23, 2019, [blog item](#), PEER petitioned EPA under TSCA Section 21 to prohibit the use of hydrofluoric acid in manufacturing processes at oil refineries under TSCA Section 6(a) and under the Administrative Procedure Act (APA) to take the same action pursuant to Section 112 of the Clean Air Act (CAA). PEER petitioned EPA to prohibit the use of hydrofluoric acid in manufacturing processes at oil refineries and require a phase-out of use at such facilities within two years. EPA states that after "careful consideration," it has denied the Section 21 petition. EPA notes that the *Federal Register* notice specifically addresses only the TSCA Section 21 petition, not the

The United States Environmental Protection Agency (EPA) published a Federal Register notice on 12 November 2019, announcing the availability of its response to a petition it received under Section 21 of the Toxic Substances Control Act (TSCA) from Public Employees for Environmental Responsibility (PEER).

Regulatory Update

CHEMWATCH

petition submitted under the APA. EPA is denying the petition “based on the petition’s lack of sufficient facts establishing that it is necessary for the Agency to issue a rule under TSCA section 6(a).” According to EPA, to grant a petition for a TSCA Section 6(a) rulemaking, a petition must provide facts establishing that the requested rulemaking is necessary. Those facts need to be “sufficiently clear and robust for EPA to be able to conclude, within 90 days of filing the petition, that the chemical presents an unreasonable risk of injury to health or the environment and that issuance of a TSCA section 6(a) rule is the appropriate response to the petition.” To make the threshold finding, EPA needs hazard and exposure data and other information to enable it to assess risk and conclude whether the risk is unreasonable. In this case, EPA states that PEER’s petition “refers to hazard databases and makes conclusory statements of toxicity but provides little further information that would support granting a TSCA section 6(a) rulemaking request.” According to EPA, the petition lacks the analysis that would be expected in a TSCA risk evaluation preceding a Section 6(a) rulemaking, such as “discussion of the appropriate hazard threshold, exposure estimates, assessment of risks, or how the facts presented allow EPA to comply with its duties under section 26 or other statutory requirements in making an unreasonable risk determination.” Absent such information, EPA “cannot make the threshold determinations necessary to substantively assess and grant a petition for a TSCA section 6(a) rulemaking.” EPA denies PEER’s petition request as facially incomplete.

National Law Review, 13 November 2019

<http://www.natlawreview.com>

US EPA aims to crack down on chemical makers’ ethylene oxide emissions

2019-11-15

Ethylene oxide emissions from chemical manufacturing plants would fall by about 9 metric tons (t) per year under the proposed regulation, the EPA says. The agency wants to require facilities to control emissions of the gas from storage tanks, vents, and leaky equipment. Chemical plants collectively reported emitting about 100 t of ethylene oxide in 2018, according to the EPA Toxics Release Inventory. Of this, about 42 t were fugitive emissions that leak from vents, pumps, and valves, the inventory data show. Ethylene oxide, which is made from petroleum or natural gas, is a chemical building block for making plastics, detergents, medicines, solvents, and a slew of other products. The substance is also used to sterilise medical devices. The proposed rule, which the EPA unveiled Nov.

Proposed regulation would require facilities to control leaks

Regulatory Update

CHEMWATCH

6, is aimed at trimming about 105 t of hazardous air pollutants, including toluene and methanol in addition to ethylene oxide, from manufacturers of miscellaneous organic chemicals. The agency says this sector's current releases of toxic pollutants pose unacceptable risks of cancer to the public. The EPA is under a federal court order to finalise the regulation by 13 March 2020. "EPA's actions underscore the Trump Administration's commitment to addressing and reducing hazardous air pollutants, including ethylene oxide emissions, across the country," says EPA administrator Andrew Wheeler. The Ethylene Oxide Panel of the American Chemistry Council, a trade association of chemical manufacturers, says it is reviewing the proposal. Companies that make and use this chemical are investing in research and product stewardship technologies to protect the health of communities around their plants, the panel says in a statement. In a related move, the EPA says it is studying the amount of airborne ethylene oxide in urban and rural areas that aren't near industrial facilities that make or use the chemical.

Chemical & Engineering News, 7 November 2019

<http://pubs.acs.org/cen/news>

Announcement of Availability of a Second Public Review Draft Technical Support Document for Proposed Public Health Goals for Trihalomethanes in Drinking Water

2019-11-15

The California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) is announcing the release of a draft document for a second public review describing proposed Public Health Goals (PHGs) for four trihalomethanes (THMs) found in drinking water as a result of disinfection methods: chloroform, bromodichloromethane (BDCM), dibromochloromethane (DBCM), and bromoform. A PHG is the level of a drinking water contaminant at which adverse health effects are not expected to occur from a lifetime of exposure. The California Safe Drinking Water Act of 1996 requires OEHHA to develop PHGs based exclusively on public health considerations. PHGs published by OEHHA are considered by the State Water Resources Control Board in setting drinking water standards (Maximum Contaminant Levels, or MCLs) for California. [The technical support document, available for download](#) below, presents the scientific information available on the toxicity of the THMs and the calculation of the proposed PHGs. The proposed PHGs of

Regulatory Update

CHEMWATCH

0.4 parts per billion (ppb) for chloroform, 0.06 ppb for BDCM, 0.1 ppb for DBCM, and 0.5 ppb for bromoform are based on carcinogenicity and are set at a level of risk of one additional cancer case per one million persons exposed over a 70-year lifetime. OEHHA also presents health-protective drinking water concentrations for noncancer health effects for the THMs. The draft technical support document was originally released for a 90-day public comment period in October 2018, and underwent an external scientific peer review in May 2019. The draft technical support document has been revised per public and peer review comments and is being released for a second public comment that begins 8 November 2019 and ends 9 December 2019. Following the second public comment period, OEHHA will evaluate all the comments received, and revise the document as appropriate. After any subsequent revisions, the final document will be posted on the OEHHA website along with responses to the external peer review comments and to major comments received during the two public comment periods.

Further information is available at:

- [Comment Submissions - Announcement of Availability of a Draft Technical Support Document for Proposed Public Health Goals for Trihalomethanes in Drinking Water](#)
- [Second Public Review Draft Trihalomethanes in Drinking Water: Chloroform Bromoform Bromodichloromethane Dibromochloromethane](#)
- [Bromodichloromethane](#)
- [Bromoform](#)
- [Chloroform](#)
- [Dibromochloromethane](#)

OEHHA, 8 November 2019

<http://www.oehha.ca.gov>

EUROPE

Webinar: Testing the study appraisal methodology for the re-evaluation of BPA safety

2019-11-15

On 19 September 2019, the European Food Safety Authority (EFSA) Panel on Food Contact Materials, Enzymes and Processing Aids (CEP

On 19 September 2019, the European Food Safety Authority (EFSA) Panel on Food Contact Materials, Enzymes and Processing Aids (CEP Panel) endorsed the technical report entitled "Testing the study appraisal methodology from the 2017 BPA hazard assessment protocol".

Regulatory Update

CHEMWATCH

Panel) endorsed the technical report entitled “Testing the study appraisal methodology from the 2017 BPA hazard assessment protocol”. This report focuses on the performance of the study appraisal methodology, as published in the 2017 protocol, when tested on a selection of studies that had been previously appraised by EFSA in the context of its 2015 and 2016 assessments of BPA. This testing was carried out to ensure the functioning of the 2017 methodology for appraising the internal validity of epidemiological and animal studies prior to applying it in the next BPA re-evaluation. In addition, it was deemed important to compare the outcome of the study appraisals when using the new 2017 methodology and the methodology applied in EFSA’s BPA safety assessments of 2015 and 2016, and to identify possible divergences. EFSA are holding a webinar: Testing the study appraisal methodology for the re-evaluation of BPA safety. The purpose of this webinar is to describe how the methodology was tested and discuss the outcome and the resulting refinement of the appraisal methodology. The full technical report will be publicly available on EFSA’s website in advance of the webinar. Participants will be guided through the main parts of the report and the tested methodology, and will be able to submit questions via the Q&A box that will be answered by EFSA scientists.

EFSA will publish a recording of the webinar on its website.

EFSA, November 2019

<http://www.efsa.europa.eu>

“A policy from a parallel universe” | Germany’s draft coal phase-out law

2019-11-15

A leak of Germany’s draft coal phase-out law as put together by the Ministry for Economic Affairs emerged recently. Environmental lawyers ClientEarth have criticised the text, calling it out of touch and piecemeal, and lambasting the failure to tie it to climate protection goals. Prof. Dr. Hermann Ott, Head of ClientEarth – Anwälte der Erde, said: “The long-awaited draft of Germany’s phase-out law is a shambles. The policy is riddled with unanswered questions, guarantees an unacceptably tardy coal exit and fails completely to acknowledge how urgently we need to decarbonise to address climate change. “Those writing the policy seem to be existing in a parallel universe where coal is still profitable, people aren’t being forced out of their homes for mining, and the climate catastrophe

A leak of Germany’s draft coal phase-out law as put together by the Ministry for Economic Affairs emerged recently.

Regulatory Update

CHEMWATCH

isn't unfolding around us. Further information is available at: <https://www.clientearth.org/>

Chemycal, 13 November 2019

<http://chemycal.com>

EC Committee Publishes Guidance on Safety Assessment of Nanomaterials in Cosmetics

2019-11-15

On 4 November 2019, the European Commission's (EC) Scientific Committee on Consumer Safety (SCCS) published an updated *Guidance on the Safety Assessment of Nanomaterials in Cosmetics*. The Guidance updates SCCS's 2012 Guidance (SCCS/1484/12) on the safety assessment of nanomaterials in cosmetic products. It covers the main elements of safety assessment — general considerations (Section 2), material characterization (Section 3), exposure assessment (Section 4), hazard identification and dose-response characterization (Section 5), and risk assessment (Section 6). The Guidance includes key recommendations for the safety assessment of nanomaterials intended for use in cosmetics on the following topics:

- **Definition:** The regulatory definition of nanomaterial is provided in the Cosmetic Regulation (EC) No. 1223/2009, under Article 2(1)(k). SCCS suggests that when assessing the safety of a material consisting of small particles, applicants should also take into account the EC's Recommendation (2011/696/EU). SCCS notes that "[w]here a new or an already-approved cosmetic ingredient fulfils the criteria for defining it as NM, it will be subject to safety assessment based on the data relevant to nano-scale properties."
- **Material characterisation:** At a minimum, applicants must provide characterization data on all the specified parameters that are relevant to a given nanomaterial. According to the Guidance, the nanomaterial characterization needs to be carried out at the raw material stage, in the cosmetic formulation, and during exposure for toxicological evaluations. The Guidance notes that SCCS may request a detailed description of the production processes, any surface modifications, and the preparatory steps carried out for integrating the nanomaterials in the final cosmetic products as input into the safety assessment process.
- **Exposure assessment:** Safety assessment of nanomaterials follows the same procedure as for non-nanoscale ingredients, but with special

On 4 November 2019, the European Commission's (EC) Scientific Committee on Consumer Safety (SCCS) published an updated Guidance on the Safety Assessment of Nanomaterials in Cosmetics.

Regulatory Update

CHEMWATCH

considerations of the nanoscale aspects. According to the Guidance, SCCS is of the view that the method for calculating dermal and oral exposure to nanomaterials will not be substantially different from the calculation of exposure to conventional cosmetic ingredients. The Guidance notes that calculation of exposure to aerosols containing nanomaterials may be more challenging, however.

- Hazard identification/dose-response characterisation: SCCS will require data from toxicological studies for local and — in case of systemic absorption — systemic effects. According to the Guidance, testing of nanomaterials for hazard identification/dose-response characterization must be carried out in consideration of the nano-related aspects.
- Safety assessment: The Guidance notes that historically, calculation of the margin of safety of a cosmetic ingredient has been based on a measured toxicological point of departure (POD), along with an estimate of internal exposure in terms of systemic exposure dose (SED). The Guidance acknowledges that with the European Union's ban on animal testing of cosmetic ingredients and/or products, derivation of POD_{sys} for systemic adverse effects of a new cosmetic ingredient may not be possible, or possible only in exceptional cases. Data obtained to comply with other non-cosmetic regulations should be used and submitted when available, however. For other cases, the applicant will need to assemble relevant information and data from different alternative (non-animal) methods and integrate the data to build an overall weight of evidence to support the safety of the cosmetic ingredient.

SCCS notes that due to the evolving nature of nanomaterials safety research, it may revise the Guidance in the future to take account of any new scientific knowledge.

Nano & Other Emerging Technologies Blog, 5 November 2019

<http://nanotech.lawbc.com>

REACH Update

CHEMWATCH

Inspectors in the EU to target REACH authorisation duties

2019-11-14

The Enforcement Forum decided that its next major enforcement project will focus on REACH authorisation. The Forum also initiated a pilot project on recovered substances and announced that its pilot project on classification of mixtures will focus on detergents and cleaning products. The Forum has agreed that its next major enforcement project, REF-9, will focus on provisions related to REACH authorisation meant to protect the safety and health of workers and the environment. Inspectors will check that substances of very high concern which are subject to authorisation, are not placed on the market without a valid authorisation and, where authorised, whether they are used in compliance with the conditions set in the authorisation decision. The enforcement project will be prepared in 2020, inspections will be conducted in 2021 and the report is expected to be published at the end of 2022. The Forum also started preparing the pilot project on substances recovered from waste, especially related to the exemption from the registration duty, but may also address other duties related to chemicals in waste. The scope and timelines of this project will be refined in early 2020. The pilot project on classification of mixtures will focus on the use of bridging principles in the classification of detergents and cleaning products. The preparation for this project will start near the end of 2020, with timelines for the project then being determined. The report of the pilot project on duties applicable to substances in articles was also adopted by the Forum. The results will be communicated shortly together with the publication of the report. Furthermore, the Forum reviewed the results of the REF-6 project on CLP mixtures. The report of this project will be published towards the end of 2019. The Forum has also started to work on the first update of its compendium of analytical methods recommended for enforcement of REACH restrictions. Third parties' input for this update cycle is welcome. In its annual open session, the Forum also concluded its joint action with stakeholders on the quality of safety data sheets (SDSs) where inspectors identified frequent non-compliances with SDSs and discussed with stakeholders how they could be addressed. The Forum offered to provide its feedback on standard phrases for the SDSs that industry uses when generating SDSs. ECHA's accredited stakeholders have committed to a number of actions such as identifying examples of best practice SDSs, training companies on the quality of SDSs or developing sector use maps and promoting their use. As part of a very active open session, 12 stakeholders and the Forum discussed a number of other issues ranging from industry initiatives for

The Enforcement Forum decided that its next major enforcement project will focus on REACH authorisation.

REACH Update

CHEMWATCH

updating registration dossiers, discussions on enforcement of dossier compliance and questions on enforcing REACH duties related to animal testing. The Forum for Exchange of Information on Enforcement met on 4-7 November 2019 and the Biocidal Products Regulation Subgroup (BPRS) met on 7-8 November 2019 in Helsinki. Further information is available at:

- [Enforcement Forum](#)
- [Compendium of analytical methods](#)

ECHA, 12 November 2019

<http://echa.europa.eu>

Public consultations on applications for authorisation launched

2019-11-14

The European Chemicals Agency (ECHA) is seeking comments on 19 applications for authorisation covering 30 uses of:

- 4-(1,1,3,3-tetramethylbutyl)phenol, ethoxylated (EC-, CAS-); and
- 4-nonylphenol, branched and linear, ethoxylated (EC-, CAS-).

The substances are used in the production of various medical devices (e.g. *in vitro* diagnostic kits and reagents) and medicinal, biopharmaceuticals and laboratory products (e.g. active pharmaceutical ingredients); also used in the manufacture of interlayer polymer films for laminated safety glass. Further information about the uses that authorisation is applied for, including the description of the function of the substance, exposure scenarios, possible alternatives identified by the applicants, together with socio-economic information, is available on ECHA's website. The deadline for comments is 8 January 2020.

ECHA News, 13 November 2019

<http://echa.europa.eu>

Webinar: REACH information requirements for nanomaterials – material published

2019-11-14

The European Chemicals Agency held a webinar recently titled: REACH information requirements for nanomaterials. The webinar explained what a nanoform is, how to build a set of similar nanoforms and how to fulfil data requirements for their characterisation. It also introduced new IUCLID

The European Chemicals Agency (ECHA) is seeking comments on 19 applications for authorisation for 30 uses of 4-(1,1,3,3-tetramethylbutyl) phenol, ethoxylated; and 4-nonylphenol, branched and linear, ethoxylated.

REACH Update

CHEMWATCH

fields for reporting nanoforms with practical examples. Presentations and recordings from the webinar are now available at: [Presentations and recording](#)

ECHA News, 13 November 2019

<http://echa.europa.eu>

New substance evaluation conclusion published

2019-11-14

A new substance evaluation conclusion document is now available on the European Chemicals Agency's (ECHA) website for [ethylene carbonate](#) (EC 202-510-0, CAS 96-49-1), added to the CoRAP list in 2018 and evaluated by Latvia. Further information is available at:

- [Community rolling action plan](#)
- [Substance evaluation](#)

ECHA News, 13 November 2019

<http://echa.europa.eu>

Authorisation granted for one use of potassium dichromate

2019-11-14

The European Commission has granted authorisation for one use of [potassium dichromate](#) (EC 231-906-6, CAS: 7778-50-9) to Wesco Aircraft EMEA, LTD., with a review period expiring on 21 September 2024. Further information is available at: [Summary in Official Journal](#)

ECHA News, 13 November 2019

<http://echa.europa.eu>

Want to keep using peroxyoctanoic acid?

2019-11-14

The identity of the substance [peroxyoctanoic acid](#) (EC -, CAS 33734-57-5), which is a substance in the Review Program for the use in disinfectants and algaecides not intended for direct application to humans or animals (product-type 2), veterinary hygiene (product-type 3), or the food and feed area (product-type 4) has been redefined to *reaction mass of peracetic acid and peroxyoctanoic acid*. The European Chemicals Agency (ECHA) has requested interested parties notify the agency by 8 November 2020 to

A new substance evaluation conclusion document is now available on the European Chemicals Agency's (ECHA) website for ethylene carbonate.

REACH Update

CHEMWATCH

keep peroxyoctanoic acid in the approval process. Further information is available at: [Upcoming deadlines](#)

ECHA News, 13 November 2019

<http://echa.europa.eu>

New intention to harmonise classification and labelling

2019-11-14

An intention has been received to harmonise the classification and labelling of 9-octadecenoic acid (Z)-, sulfonated, potassium salts (EC 271-843-1, CAS 68609-93-8). Further information is available at: [Registry of CLH intentions](#)

ECHA News, 13 November 2019

<http://echa.europa.eu>

List of notifications updated

2019-11-14

An updated list of those substance and product-type combinations for which a compliant notification for inclusion in the Review Program has been made is available. It also includes the names of the notifying companies to help you collaborate when submitting an application for approval of the active substance and to help avoid unnecessary testing on animals. Further information is available at: [List of compliant notifications](#)

ECHA News, 13 November 2019

<http://echa.europa.eu>

Janet's Corner

CHEMWATCH

Concentration

2019-11-10

**DON'T DRINK WATER WHILE
STUDYING. BECAUSE
CHEMISTRY SAYS THAT**



**CONCENTRATION DECREASES
ON ADDING WATER**

Pinterest

<https://www.pinterest.com.au>

Hazard Alert

CHEMWATCH

Lead

2019-11-03

Lead is a chemical element in the carbon group with symbol Pb and atomic number 82. Lead is a soft and malleable metal, which is regarded as a heavy metal. Metallic lead has a bluish-white colour after being freshly cut, but it soon tarnishes to a dull greyish colour when exposed to air. Lead has a shiny chrome-silver lustre when it is melted into a liquid. [1] Lead is found in the earth's crust. However, it is rarely found naturally as a metal. It is usually found combined with two or more other elements to form lead compounds. Metallic lead is resistant to corrosion (i.e., not easily attacked by air or water). When exposed to air or water, thin films of lead compounds are formed that protect the metal from further attack. Lead is easily moulded and shaped. Lead can be combined with other metals to form alloys. [2]

USES [2]

Lead and lead alloys are commonly found in pipes, storage batteries, weights, shot and ammunition, cable covers, and sheets used to shield us from radiation. The largest use for lead is in storage batteries in cars and other vehicles. Lead compounds are used as a pigment in paints, dyes, and ceramic glazes and in caulk. The amount of lead used in these products has been reduced in recent years to minimise lead's harmful effect on people and animals. Tetraethyl lead and tetramethyl lead were once used in the United States as gasoline additives to increase octane rating. However, their use was phased out in the United States in the 1980s, and lead was banned for use in gasoline for motor vehicles beginning January 1, 1996. Tetraethyl lead may still be used in gasoline for off-road vehicles and airplanes. It is also still used in a number of developing countries. Lead used in ammunition, which is the largest non-battery end-use, has remained fairly constant in recent years. However, even the use of lead in bullets and shot as well as in fishing sinkers is being reduced because of its harm to the environment.

SOURCES OF EMISSION & EXPOSURE

Sources of Emission [3]

- Industry sources: Mining and metal manufacturing are the largest sources of lead emissions in Australia. Water supply, sewerage and draining surfaces, oil and gas extraction and electricity supply can

Hazard Alert

CHEMWATCH

also emit lead. Lead is also emitted as a result of coal mining, cement, lime, plaster and concrete product manufacture, ceramic product manufacturing, transport equipment manufacturing, iron and steel manufacturing, petroleum and coal product manufacturing. Other manufacturing industries where lead may be used include: beverages and malt, paper and paper products, glass and glass products, fabricated and structural metal products, motor vehicles and parts, wood products, ceramic products, food and beverage products, textile, yarn and woven fabrics.

- Diffuse sources: Paved roads, windblown dust, burning fuels or wildfires, solid and liquid fuel combustion, lawn mowing and barbeques (from burning fuel) are all capable of causing emissions of lead.
- Natural sources: Lead and compounds occurs naturally in the earth's crust in rocks and soil.
- Transport sources: Lead emissions may be present from the vehicle exhaust of cars, aeroplanes, railway operations and from recreational and commercial shipping or boating.
- Consumer products: Lead and compounds are used in a range of applications. Lead is used in the production of batteries, ammunition, metal products (solder and pipes) and devices to shield X-rays. Lead was present in petroleum, paints and ceramic products, caulking and pipe solder, however due to health concerns, it is now prohibited to include lead in these products.

Sources of Exposure [4]

- Eating food or drinking water that contains lead;
- Water pipes in some older homes may contain lead solder;
- Lead can leach out into the water;
- Spending time in areas where lead-based paints have been used and are deteriorating;
- Deteriorating lead paint can contribute to lead dust;
- Working in a job where lead is used or engaging in certain hobbies in which lead is used, such as making stained glass;
- Using health-care products or folk remedies that contain lead

ROUTES OF EXPOSURE [5]

- Ingestion: Lead exposure in the general population occurs primarily through ingestion.

Hazard Alert

CHEMWATCH

- Inhalation may be the major contributor for workers in lead-related occupations. Almost all inhaled lead is absorbed into the body, whereas from 20% to 70% of ingested lead is absorbed. Since leaded gasoline additives were phased out beginning in the 1970s, and control measures were implemented in industries, which have reduced air emissions, inhalation is no longer the major exposure pathway for the general population.
- Dermal: Dermal exposure plays a role for exposure to organic lead among workers, but is not considered a significant pathway for the general population. Organic lead may be absorbed directly through the skin. Dermal exposure is most likely among people who work with lead.
- Endogenous Exposure: Endogenous exposure to lead may contribute significantly to an individual's current blood lead level, and of particular risk to the developing foetus. Once absorbed into the body, lead may be stored for long periods in mineralising tissue (i.e., teeth and bones). The stored lead may be released again into the bloodstream, especially in times of calcium stress (e.g., pregnancy, lactation, osteoporosis), or calcium deficiency.

HEALTH EFFECTS [6]

Noncancer Effects

- Studies of humans as well as laboratory animal studies have reported effects on the blood, kidneys, and nervous, immune, and cardiovascular systems.
- Ingestion of large amounts of lead can produce gastrointestinal symptoms, including colic, constipation, abdominal pain, anorexia and vomiting.
- Severe brain and kidney damage can occur in children after exposures resulting in blood lead levels between 70 and 100 $\mu\text{g}/\text{dL}$ and in adults at blood lead levels between 100 and 120 $\mu\text{g}/\text{dL}$.
- Anaemia has been reported after exposure resulting in blood lead levels of 40 to 70 $\mu\text{g}/\text{dL}$ in children and blood lead levels of 50 to 80 $\mu\text{g}/\text{dL}$ in adults.
- Other effects from chronic lead exposure in humans include effects on blood pressure and kidney function, immune system effects and interference with vitamin D metabolism.
- Lead also affects the nervous system in occupational-exposed adults. Neurological symptoms have been reported in workers with

Hazard Alert

CHEMWATCH

blood lead levels of 40 to 60 $\mu\text{g}/\text{dL}$, and slowed nerve conduction in peripheral nerves in adults occurs at blood lead levels of 30 to 40 $\mu\text{g}/\text{dL}$.

- Children are particularly vulnerable to the neurotoxic effects of lead. Exposure to low levels of lead early in life have been linked to effects on IQ, learning, memory, and behaviour.
- Exposure to lead during pregnancy has been associated with toxic effects on the human foetus, including increased risk of preterm delivery, low birthweight, and impaired mental development, including decreased IQ scores. These effects on mental development have been noted at maternal blood lead levels of 10 to 15 $\mu\text{g}/\text{dL}$ and somewhat lower.
- Studies on male lead workers have reported severe depression of sperm count and decreased function of the prostate and/or seminal vesicles and suggests an impact on male fertility at blood lead levels of above 40-45 $\mu\text{g}/\text{dL}$.
- Human studies are inconclusive regarding the association between lead exposure and other birth defects, while animal studies have shown a relationship between high lead exposure and birth defects.

Cancer Risk

- Human studies are inconclusive regarding lead exposure and an increased cancer risk. Animal studies have reported kidney tumours in rats and mice exposed to lead via the oral route.
- EPA has considered lead to be a probable human carcinogen, and, under more recent assessment guidelines, it would likely be classified as likely to be carcinogenic to humans.

SAFETY [7]

First Aid Measures

- Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.
- Skin Contact: Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
- Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person.

Hazard Alert

CHEMWATCH

If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Exposure Controls & Personal Protection

Engineering Controls

Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protective Equipment

The following personal protective equipment is recommended when handling lead:

- Safety glasses;
- Lab coat;
- Dust respirator (be sure to use an approved/certified respirator or equivalent);
- Gloves

Personal Protection in Case of a Large Spill:

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

Hazard Alert

CHEMWATCH

REGULATION [3,8]

United States

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA Permissible Exposure Limit (PEL) - General Industry See 29 CFR 1910.1025 Note: OSHA considers "lead" to mean elemental lead, all inorganic lead compounds, and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds. Note: Large nonferrous foundries (20+ employees) are required to achieve the PEL of 0.05 mg/m ³ by means of engineering and work practice controls. Small nonferrous foundries (<20 employees) are required to achieve an 8-hour TWA of 0.075 mg/m ³ by such controls.	0.05 mg/m ³ TWA 0.03 mg/m ³ Action Level	HE3	Nephrotoxicity
		HE5	Reproductive hazards
		HE7	Cumulative neurologic effects
		HE12	Cumulative blood effects

Hazard Alert

CHEMWATCH

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
OSHA PEL - Construction Industry See 29 CFR 1926.62	0.05 mg/m ³ TWA 0.03 mg/m ³ Action Level	HE3	Constipation, nausea, pallor
		HE5	Reproductive risks
		HE7	Nervous irritability, hyperactivity, anxiety, insomnia, headache, weakness, numbness, dizziness
OSHA PEL - Shipyard Employment See 29 CFR 1915.1025	0.05 mg/m ³ TWA 0.03 mg/m ³ Action Level	HE3	Nephropathy, loss of kidney function, increased blood pressure
		HE5	Reduced sperm count and male sterility
		HE7	Subclinical and clinical peripheral neuropathy (muscle weakness, pain, and paralysis of extremities)
		HE12	Disruption of hemesynthesis, anaemia

Hazard Alert

CHEMWATCH

Exposure Limit	Limit Values	HE Codes	Health Factors and Target Organs
National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) See Appendix C Note: NIOSH considers "lead" to mean metallic lead, lead oxides, and lead salts (including organic salts such as lead soaps but excluding lead arsenate).	0.05 mg/m ³ TWA Air concentrations should be maintained so that worker blood lead remains less than 0.06 mg Pb/100 g of whole blood	HE5	Reproductive toxicity, nephrotoxicity, cardiovascular toxicity, gastrointestinal toxicity
		HE7	Neurotoxicity
		HE12	Hematologic toxicity
American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (2001)	0.05 mg/m ³ TWA A3; BEI	HE3	Cardiovascular toxicity, hypertension, cerebrovascular disease, nephrotoxicity
		HE5	Reproductive toxicity
		HE7	Neurologic and neurobehavioral toxicity
		HE12	Blood dyscrasias
CAL/OSHA PELs (See also Section 5198)	0.05 mg/m ³ Lead (metallic and inorganic compounds), dust and fume, (as Pb)	HE3	Cardiovascular toxicity, hypertension, cerebrovascular disease, nephrotoxicity
		HE5	Reproductive toxicity
		HE7	Neurologic and neurobehavioral toxicity

[Australia](#)

Hazard Alert

CHEMWATCH

Safe Work Australia: Currently, the eight-hour time weighted average (TWA) exposure limits are 0.15 milligrams tetramethyl lead per cubic metre of air, 0.1 milligram tetraethyl lead per cubic metre of air, 0.15 milligrams lead arsenate per cubic metre of air, 0.15 milligrams of lead (inorganic dusts and fumes) per cubic metre of air and 0.05 milligrams of lead chromate per cubic metre of air. Consult your state or territory occupational health and safety agency for current sources of information.

Australian drinking water guidelines:

In 2004, the National Health and Medical Research Council (NHMRC) and the National Resource Management Ministerial Council (NRMMC) established the following guideline for acceptable water quality: Based on health considerations, the concentration should not exceed 0.01 milligrams of lead per litre of drinking water.

REFERENCES

1. <http://en.wikipedia.org/wiki/Lead>
2. <http://www.atsdr.cdc.gov/phs/phs.asp?id=92&tid=22>
3. <http://www.npi.gov.au/substances/lead/source.html>
4. <http://www.atsdr.cdc.gov/tfacts13.pdf>
5. <http://www.atsdr.cdc.gov/csem/csem.asp?csem=7&po=6>
6. <http://www.epa.gov/ttn/atw/hlthef/lead.html>
7. <http://www.sciencelab.com/msds.php?msdsId=9927204>
8. https://www.osha.gov/dts/chemicalsampling/data/CH_249110.html

Gossip

CHEMWATCH

Hydrogen boride nanosheets: A promising material for hydrogen carrier

2019-11-06

Researchers at Tokyo Institute of Technology, University of Tsukuba, and colleagues in Japan report a promising hydrogen carrier in the form of hydrogen boride nanosheets. This two-dimensional material, which has only recently begun to be explored, could go on to be used as safe, light-weight, high-capacity hydrogen storage materials. Innovative nanosheets made from equal parts of hydrogen and boron have a greater capacity to store and release hydrogen compared with conventional metal-based materials. This finding by researchers at Tokyo Institute of Technology (Tokyo Tech), the University of Tsukuba, Kochi University of Technology and the University of Tokyo reinforces the view that hydrogen boride nanosheets (HB sheets) could go beyond graphene as a nano-sized multifunctional material. Their study, published in Nature Communications, found that hydrogen can be released in significant amounts (up to eight weight percent) from HB sheets under ultraviolet light, even under mild conditions -- that is, at ambient room temperature and pressure. Such an easy-to-handle setup opens up possibilities for HB sheets to be utilised as highly efficient hydrogen carriers, which are expected to become increasingly in demand as a clean energy source in the coming decades. When HB sheets burst onto the scene in 2017, scientists recognized they could become an exciting new material for energy, catalysis and environmental applications. The breakthrough research garnered plaudits for its creative approach to materials design. A review article published in Chem in 2018 hailed the successful realization of HB sheets as "an exquisite example of human ingenuity at the pinnacle of innovative synthetic chemistry." HB sheets are expected to be applied for light-weight, light-responsive, and safe hydrogen carrier. Currently, HB sheets are only responsive to ultra-violet light, thus, the visible-light sensitivity is important for their industrial application. Also, refilling of hydrogen remains a key challenge in developing sustainable, viable hydrogen storage solutions. To address this issue, Miyauchi explains his team is investigating the visible-light sensitivity, rechargeability, and long-term durability of HB sheets. "Cost reduction of the starting materials -- magnesium diboride -- for HB sheets will be another important factor," he adds. The cross-institutional study showcases the predictive power

Researchers at Tokyo Institute of Technology, University of Tsukuba, and colleagues in Japan report a promising hydrogen carrier in the form of hydrogen boride nanosheets.

Gossip

CHEMWATCH

of first-principles calculations in materials science, namely as a way of investigating the mechanism of hydrogen release.

EurekaAlert, 25 October 2019

<http://www.eurekaalert.org>

Scientists bake gluten-free bread using a revolutionary technology

2019-11-06

A recent study from the Institute of Food Technology of the University of Natural Resources and Life Sciences (BOKU), Vienna, was just published in Food and Bioprocess Technology. The researchers used a technology called Ohmic heating and adapted it to the production of gluten-free bread. First results show superior quality of the Ohmic bread while saving energy and time during the manufacturing process. The principle is well known from the light bulb: An electrical current passing through a wire heats it up until it glows. This is due to its electrical resistance and the Ohmic law leading to the dissipation of electrical energy into heat. The resistance of bread dough results in the same effect—it doesn't glow like a wire, but heats up and bakes. The researchers used this smart solution to make gluten-free bread that is challenging to bake conventionally.

Hot flashes

"The heat is generated instantaneously within the complete dough," explains Prof. Henry Jäger. "This is the main advantage of the Ohmic heating technology. Conventional baking in the oven requires more time, since the heat needs to penetrate from the outside toward the centre of the dough." This slow heating is a major limitation for the manufacturing of gluten-free bread. Wheat protein, the gluten, which is usually responsible for the dough structure and its expansion, is missing in these products, so starch is substituted. Sufficient heating causes the starch to gelatinise and to contribute to the structure. However, a much larger portion of water is needed in the dough, which results in a lower viscosity and makes it thinner and more liquid. This is challenging for baking. The team around Prof. Jäger realised that the rapid and uniform heating of the whole dough mass is one of the major advantages obtained from Ohmic heating, particularly benefiting the production of gluten-free bread. "In order to really benefit from these advantages and obtain best results, the optimal process and product characteristics had to be identified," says Prof. Jäger.

Electric shocks are used to heat gluten-free bread from the inside, saving energy and time compared to conventional baking applying heat from the outside.

Gossip

CHEMWATCH

"Achieving such convincing results and improving the efficiency of the process at the same time was also surprising for us."

Quality

The Ohmic bread showed excellent quality characteristics compared to conventionally baked products. The volume of the bread was 10 to 30 percent higher. The crumb was softer and more elastic, and the pores were smaller and more evenly distributed. But the team did not just rely on the physical characteristics of the bread, and looked also into nutritional aspects and digestibility. "Taking into consideration the short baking time during Ohmic heating, a negative impact on starch digestibility might occur," says Prof. Regine Schönlechner, senior author of the study. However, tests performed by in-vitro methods did not reveal any differences. The superior quality of the gluten free Ohmic bread was accompanied by savings of energy and time. The first trials indicate savings of around two-thirds compared to the energy needed for conventional baking. Also, the Ohmic baking needs much less time compared to conventional baking. In just a few minutes, the dough is converted into a ready-to-eat, gluten-free bread. Browning and crust formation do not occur, so the bread can be used directly for applications such as toast or tramezzini bread. If a crust is desired, it can be formed afterward in a controlled manner by infrared heating. Special equipment from the BOKU Core Facility Food & Bio Processing was used by the team for the development and optimisation of this promising baking concept. In this study, it was used to identify the exact conditions that result in major benefits from the Ohmic heating to the baking of gluten-free bread. This was achieved by performing trials applying different combinations of electrical power input and duration of different baking steps. "At the end, the subsequent application of three different process intensities with different holding times proved to be the most suitable option," explains Prof. Jäger. "An initial baking step at two to six kiloWatts for 15 seconds followed by one kiloWatt for 10 seconds and a final baking at 0.3 kiloWatts for five minutes is the recipe for the successful production of gluten-free bread using Ohmic heating."

Phys.org, 24 October 2019

<http://phys.org>

Scientists Have Made a Blueprint For a Quantum Battery That Never Loses Charge

2019-11-06

A team of scientists from the universities of Alberta and Toronto have laid out the blueprints for a “quantum battery” that never loses its charge. To be clear, this battery doesn’t exist yet — but if they figure out how to build it, it could be a revolutionary breakthrough in energy storage. “The batteries that we are more familiar with — like the lithium-ion battery that powers your smartphone — rely on classical electrochemical principles, whereas quantum batteries rely solely on quantum mechanics,” University of Alberta chemist Gabriel Hanna said in a statement.

Dark State

A paper describing the research was published in the Journal of Physical Chemistry C. in July. The battery works by harnessing the power of “excitonic energy” — the state in which an electron absorbs sufficiently charged photons of light. The researchers found that their resulting battery model should be “highly robust to energy losses,” thanks to the fact that their battery is prepared inside a “dark state” where it cannot exchange energy — by absorbing or releasing photons — with its surroundings.

Large Charge

By breaking down this “dark state” quantum network, the researchers claim the battery could be able to discharge and release energy in the process. But the team has yet to come up with viable ways of doing so. They will also have to figure out a way to scale the technology for real-world applications as well.

Science Alert, 1 November 2019

<http://www.sciencealert.com.au>

This New Technology Can Fully Charge an Electric Car in Just 10 Minutes

2019-11-06

It’s called ‘range anxiety’, and it’s often pointed to as one of the key reasons why consumer uptake of battery-powered electric vehicles still hasn’t really taken off. In a nutshell, range anxiety is the fear that an electric car’s battery won’t hold enough juice to get you where you need to be going –

A team of scientists from the universities of Alberta and Toronto have laid out the blueprints for a “quantum battery” that never loses its charge.

Gossip

CHEMWATCH

and today's ultra-slow charging speeds (up to an hour or potentially much longer) don't really help the problem. What might alleviate the issue though is a new kind of battery technology developed by scientists at Penn State University, which overcomes existing bottlenecks to offer an EV battery that takes only minutes to get back to 100 percent charge. "We demonstrated that we can charge an electrical vehicle in 10 minutes for a 200 to 300-mile range," says chemical engineer Chao-Yang Wang. "And we can do this maintaining 2,500 charging cycles, or the equivalent of half a million miles of travel." That last part's important, because EV batteries – much like the ones in your smartphone or notebook – are lithium-ion batteries, which have a limited number of charge/discharge cycles before they degrade past the point of being useful. One of the factors that can hasten that degradation is heat (which is why companies always tell you not to let the batteries in your personal electric devices get too hot, as it can shorten their overall lifespan). That unfortunate reality is also an obstacle to something the US Department of Energy wants to achieve for EV batteries: a standard called extreme fast charging (XFC), which the body hopes will enable EV batteries that can be fully charged to a 200-mile range in less than 10 minutes. According to the Penn team, their new battery design - if scaled - could meet this ambitious technological goal, thanks to a workaround that sidesteps one of the biggest challenges to achieving XFC. "A critical barrier to XFC is Li plating, which usually occurs at high charge rates and drastically deteriorates battery life and safety," the researchers explain in their new paper. Li plating happens when lithium deposits form around the anode of the battery during charging. Even though high heat is bad for lithium-ion batteries, though, increasing temperatures for short periods seems to actually result in less Li plating, the team's research reveals. "In the past, it was universally believed that lithium ion batteries should avoid operating at high temperatures due to the concern of accelerated side reactions," says Wang. "This study suggests that the benefits of mitigated lithium plating at the elevated temperature with limited exposure time far outweigh the negative impact associated with exacerbated side reactions." Specifically, the researchers found that batteries temporarily heated to be 60 degrees Celsius (140 degrees Fahrenheit) for the ~10 minutes during which they were charged, could achieve the theoretical XFC standard, while lasting some 1,700 charge cycles. By contrast, a non-heated control battery in the experiment degraded after just 60 cycles. While heating a lithium-ion battery may seem unconventional (and definitely isn't something you should try at home), it delivered results here. "Taking this battery to the extreme of 60 degrees Celsius is forbidden in the battery arena," says Wang. "It is too high and considered a danger to the materials and would shorten battery

Gossip

CHEMWATCH

life drastically." In their controlled tests, though, the heating technique eliminated Li plating, but was short enough in duration to avoid the development of other harmful formations in the battery called solid-electrolyte-interphase (SEI) growths. But the team isn't done yet. Now that they've effectively achieved the XFC goal – or at least the battery component of it – they're looking at what kinds of materials they might need to fully charge an EV battery in just 5 minutes. So long, range anxiety. We hardly knew you. The findings are reported in *Joule*.

Science Alert, 1 November 2019

<http://www.sciencealert.com.au>

Liquid-in-liquid printing method could put 3D-printed organs in reach

2019-11-06

3D-printed tissues and organs could revolutionise transplants, drug screens, and lab models—but replicating complicated body parts such as gastric tracts, windpipes, and blood vessels is a major challenge. That's because these vascularized tissues are hard to build up in traditional solid layer-by-layer 3D printing without constructing supporting scaffolding that can later prove impossible to remove. One potential solution is replacing these support structures with liquid—a specially designed fluid matrix into which liquid designs could be injected before the "ink" is set and the matrix is drained away. But past attempts to make such aqueous structures have literally collapsed, as their surfaces shrink and their structures crumple into useless blobs. So, researchers from China turned to water-loving, or hydrophilic, liquid polymers that create a stable membrane where they meet, thanks to the attraction of their hydrogen bonds. The researchers say various polymer combinations could work; they used a polyethylene oxide matrix and an ink made of a long carbohydrate molecule called dextran. They pumped their ink into the matrix with an injection nozzle that can move through the liquid and even suck up and rewrite lines that have already been drawn. The resulting liquid structures can hold their shape for as long as 10 days before they begin to merge, the team reported last month in *Advanced Materials*. Using their new method, the researchers printed an assortment of complex shapes—including tornadoesque whirls, single and double helices, branched treelike shapes, and even one that resembles a goldfish. Once printing is finished, the shapes are set by adding polyvinyl alcohol to the inky portion of the

3D-printed tissues and organs could revolutionise transplants, drug screens, and lab models—but replicating complicated body parts such as gastric tracts, windpipes, and blood vessels is a major challenge.

Gossip

CHEMWATCH

structure. That means, the scientists say, that complex 3D-printed tissues made by including living cells in the ink could soon be within our grasp.

Science, 1 November 2019

<http://sciencemag.org/>

Spiders inspire double-sided sticky tape to heal wounds

2019-11-06

A double-sided tape designed to stick body tissue together after surgery has been inspired by the way spiders exude “glue” to catch their prey in the rain. Scientists at Massachusetts Institute of Technology noticed how the spiders’ secretion absorbed water, helping to secure their next meal. The sticky tape does the same and was found to work within seconds in tests on pig skin and lungs. The team said with more research, it could be used in place of sutures. But they are still several years away from trials in humans. Getting tissues in the body to form a tight seal is difficult because water on their surface makes them slippery. Sutures - stitches that hold a wound or cut together - don’t always work well and can cause infections and pain. And tissue glues, which already exist, can take several minutes to work and may drip on to other body parts. So, the scientists turned to nature for inspiration. Spiders secrete a sticky material containing charged polysaccharides that absorb water from the surface of an insect almost instantaneously, leaving a small dry patch the glue can then stick to. And, similarly, the researchers used polyacrylic acid on the tape to absorb water from wet body tissues, which then activated the glue to stick fast. Study author Hyunwoo Yuk said: “It’s very challenging to suture soft or fragile tissues such as the lung and trachea - but with our double-sided tape, within five seconds we can easily seal them.” It could potentially also be used to attach medical devices to organs such as the heart “without causing damage or secondary complications from puncturing tissue”. The researchers now plan to perform more tests on animals. The study is published in Nature.

BBC News, 31 October 2019

<http://news.bbc.co.uk>

Micromotors push around single cells and particles

2019-11-06

A new type of micromotor -- powered by ultrasound and steered by magnets -- can move around individual cells and microscopic particles in

A double-sided tape designed to stick body tissue together after surgery has been inspired by the way spiders exude “glue” to catch their prey in the rain.

Gossip

CHEMWATCH

crowded environments without damaging them. The technology could open up new possibilities for targeted drug delivery, nanomedicine, tissue engineering, regenerative medicine and other biomedical applications. "These microswimmers provide a new way to manipulate single particles with precise control and in three dimensions, without having to do special sample preparation, labelling, surface modification," said Joseph Wang, a professor of nanoengineering at the University of California San Diego. Wang, with Thomas Mallouk, a professor of chemistry at University of Pennsylvania, and Wei Wang, a professor of materials science and engineering at Harbin Institute of Technology in China, are senior authors of a paper describing the micromotors, published 25 October in *Science Advances*. Researchers used the micromotors to push around individual silica particles and HeLa cells in aqueous media without disturbing neighbouring particles and cells. In one demonstration, they pushed around particles to spell out letters. Researchers also controlled the micromotors to climb up micro-sized blocks and stairs, demonstrating their ability to move over three dimensional obstacles. The micromotors are hollow, half capsule-shaped polymer structures coated with gold. They contain a small piece of magnetic nickel in their bodies, which allows them to be steered with magnets. The inner surface is chemically treated to repel water so that when it is submerged in water, an air bubble spontaneously forms inside the micromotor. This trapped bubble allows the micromotor to respond to ultrasound. When ultrasound waves hit, the bubble oscillates inside the micromotor, creating forces that propel its initial movement. To keep the micromotor moving, researchers apply an external magnetic field. By changing the direction of the magnetic field, researchers can steer the micromotor in different directions and alter its speed. "We have a lot of control over the motion, unlike a chemically fuelled micromotor that relies on random motion to reach its target," said Fernando Soto, a nanoengineering Ph.D. student at UC San Diego. "Also, ultrasound and magnets are biocompatible, making this micromotor system attractive for use in biological applications." Future improvements to the micromotors include making them more biocompatible, such as building them from biodegradable polymers and replacing nickel with a less toxic magnetic material such as iron oxide, researchers said.

Science Daily, 25 October 2019

<http://www.sciencedaily.com>

A widely-used gas that is currently produced from fossil fuels can instead be made by an 'artificial leaf' that uses only sunlight, carbon dioxide and water, and which could eventually be used to develop a sustainable liquid fuel alternative to gasoline.

'Artificial leaf' successfully produces clean gas

2019-11-06

A widely-used gas that is currently produced from fossil fuels can instead be made by an 'artificial leaf' that uses only sunlight, carbon dioxide and water, and which could eventually be used to develop a sustainable liquid fuel alternative to petrol. The carbon-neutral device sets a new benchmark in the field of solar fuels, after researchers at the University of Cambridge demonstrated that it can directly produce the gas -- called syngas -- in a sustainable and simple way. Rather than running on fossil fuels, the artificial leaf is powered by sunlight, although it still works efficiently on cloudy and overcast days. And unlike the current industrial processes for producing syngas, the leaf does not release any additional carbon dioxide into the atmosphere. The results are reported in the journal *Nature Materials*. Syngas is currently made from a mixture of hydrogen and carbon monoxide, and is used to produce a range of commodities, such as fuels, pharmaceuticals, plastics and fertilisers. "You may not have heard of syngas itself but every day, you consume products that were created using it. Being able to produce it sustainably would be a critical step in closing the global carbon cycle and establishing a sustainable chemical and fuel industry," said senior author Professor Erwin Reisner from Cambridge's Department of Chemistry, who has spent seven years working towards this goal. The device Reisner and his colleagues produced is inspired by photosynthesis -- the natural process by which plants use the energy from sunlight to turn carbon dioxide into food. On the artificial leaf, two light absorbers, similar to the molecules in plants that harvest sunlight, are combined with a catalyst made from the naturally abundant element cobalt. When the device is immersed in water, one light absorber uses the catalyst to produce oxygen. The other carries out the chemical reaction that reduces carbon dioxide and water into carbon monoxide and hydrogen, forming the syngas mixture. As an added bonus, the researchers discovered that their light absorbers work even under the low levels of sunlight on a rainy or overcast day. "This means you are not limited to using this technology just in warm countries, or only operating the process during the summer months," said PhD student Virgil Andrei, first author of the paper. "You could use it from dawn until dusk, anywhere in the world." The research was carried out in the Christian Doppler Laboratory for Sustainable SynGas Chemistry in the University's Department of Chemistry. It was co-funded by the Austrian government and the Austrian petrochemical company OMV, which is looking for ways to make its business more sustainable. "OMV has been an avid supporter of the Christian Doppler Laboratory for the

Gossip

CHEMWATCH

past seven years. The team's fundamental research to produce syngas as the basis for liquid fuel in a carbon neutral way is ground-breaking," said Michael-Dieter Ulbrich, Senior Advisor at OMV. Other 'artificial leaf' devices have also been developed, but these usually only produce hydrogen. The Cambridge researchers say the reason they have been able to make theirs produce syngas sustainably is thanks the combination of materials and catalysts they used. These include state-of-the-art perovskite light absorbers, which provide a high photovoltage and electrical current to power the chemical reaction by which carbon dioxide is reduced to carbon monoxide, in comparison to light absorbers made from silicon or dye-sensitised materials. The researchers also used cobalt as their molecular catalyst, instead of platinum or silver. Cobalt is not only lower-cost, but it is better at producing carbon monoxide than other catalysts. The team is now looking at ways to use their technology to produce a sustainable liquid fuel alternative to petrol. Syngas is already used as a building block in the production of liquid fuels. "What we'd like to do next, instead of first making syngas and then converting it into liquid fuel, is to make the liquid fuel in one step from carbon dioxide and water," said Reisner, who is also a Fellow of St John's College. Although great advances are being made in generating electricity from renewable energy sources such as wind power and photovoltaics, Reisner says the development of synthetic petrol is vital, as electricity can currently only satisfy about 25% of our total global energy demand. "There is a major demand for liquid fuels to power heavy transport, shipping and aviation sustainably," he said. "We are aiming at sustainably creating products such as ethanol, which can readily be used as a fuel," said Andrei. "It's challenging to produce it in one step from sunlight using the carbon dioxide reduction reaction. But we are confident that we are going in the right direction, and that we have the right catalysts, so we believe we will be able to produce a device that can demonstrate this process in the near future." The research was also funded by the Winton Program for the Physics of Sustainability, the Biotechnology and Biological Sciences Research Council, and the Engineering and Physical Sciences Research Council.

Science Daily, 21 October 2019

<http://www.sciencedaily.com>

The secret behind crystals that shrink when heated

2019-11-06

Scientists at the United States Department of Energy's Brookhaven National Laboratory have new experimental evidence and a predictive

Scientists at the United States Department of Energy's Brookhaven National Laboratory have new experimental evidence and a predictive theory that solves a long-standing materials science mystery: why certain crystalline materials shrink when heated.

Gossip

CHEMWATCH

theory that solves a long-standing materials science mystery: why certain crystalline materials shrink when heated. Their work, just published in *Science Advances*, could have widespread application for matching material properties to specific applications in medicine, electronics, and other fields, and may even provide fresh insight into unconventional superconductors (materials that carry electric current with no energy loss). The evidence comes from precision measurements of the distances between atoms in crystals of scandium fluoride (ScF_3), a material known for its unusual contraction under elevated temperatures (also known as “negative thermal expansion”). What the scientists discovered is a new type of vibrational motion that causes the sides of these cube-shaped, seemingly solid crystals to buckle when heated, thus pulling the corners closer together. “Normally as something heats up, it expands,” said Brookhaven physicist Igor Zaliznyak, who led the project. “When you heat something up, atomic vibrations increase in magnitude, and the overall material size increases to accommodate the larger vibrations.” That relationship, however, doesn’t hold for certain flexible materials, including chainlike polymers such as plastics and rubber. In those materials, increasing heat increases vibrations only perpendicular to the length of the chains (picture the sideways vibrations of a plucked guitar string). Those transverse vibrations pull the ends of the chains closer together, resulting in overall shrinkage. But what about scandium fluoride? With a solid, cubic crystalline structure, it looks nothing like a polymer—at least at first glance. In addition, a widespread assumption that the atoms in a solid crystal have to maintain their relative orientations, no matter what the crystal size, left physicists confounded to explain how this material shrinks when heated.

Neutrons and a dedicated student to the rescue

A group from the California Institute of Technology (Caltech) was using one method to explore this mystery at the Spallation Neutron Source (SNS), a DOE Office of Science user facility at Oak Ridge National Laboratory. Measuring how beams of neutrons, a type of subatomic particle, scatter off the atoms in a crystal can give valuable information about their atomic-scale arrangement. It’s particularly useful for lightweight materials like fluorine that are invisible to x-rays, Zaliznyak said. Hearing about this work, Zaliznyak noted that his colleague, Emil Bozin, an expert in a different neutron-scattering analysis technique, could probably advance understanding of the problem. Bozin’s method, known as “pair distribution function,” describes the probability of finding two atoms separated by a certain distance in a material. Computational

Gossip

CHEMWATCH

algorithms then sort through the probabilities to find the structural model that best fits the data. Zaliznyak and Bozin paired up with the Caltech team to collect data at SNS using Caltech's ScF3 samples to track how the distances between neighbouring atoms changed with increasing temperature. David Wendt, a student who began a Brookhaven Lab High School Research Program internship in Zaliznyak's lab following his sophomore year in high school (now a freshman at Stanford University), handled much of the data analysis. He continued working on the project throughout his high-school days, earning the position of first author on the paper. "David basically reduced the data to the form that we could analyse using our algorithms, fitted the data, composed a model to model the positions of the fluorine atoms, and did the statistical analysis to compare our experimental results to the model. The amount of work he did is like what a good postdoc would do!" Zaliznyak said. "I am very grateful for the opportunity Brookhaven Lab provided me to contribute to original research through their High School Research Program," Wendt said.

Results: "soft" motion in a solid

The measurements showed that the bonds between scandium and fluorine don't really change with heating. "In fact, they expand slightly," Zaliznyak said, "which is consistent with why most solids expand." But the distances between adjacent fluorine atoms became highly variable with increasing temperature. "We were looking for evidence that the fluorine atoms were staying in a fixed configuration, as had always been assumed, and we found quite the opposite!" Zaliznyak said. Alexei Tkachenko, an expert in the theory of soft condensed matter at Brookhaven Lab's Centre for Functional Nanomaterials (another Office of Science user facility) made essential contributions to the explanation for this unexpected data. Since the fluorine atoms appeared not to be confined to rigid positions, the explanation could draw on a much older theory originally developed by Albert Einstein to explain atomic motions by considering each individual atom separately. And surprisingly, the final explanation shows that heat-induced shrinkage in ScF3 bears a remarkable resemblance to the behaviour of soft-matter polymers. "Since every scandium atom has a rigid bond with fluorine, the 'chains' of scandium-fluoride that form the sides of the crystalline cubes (with scandium at the corners) act similar to the rigid parts of a polymer," Zaliznyak explained. The fluorine atoms at the centre of each side of the cube, however, are unrestrained by any other bonds. So, as temperature increases, the "underconstrained" fluorine atoms are free to oscillate independently in directions perpendicular to the rigid Sc-F bonds.

Gossip

CHEMWATCH

Those transverse thermal oscillations pull the Sc atoms at the corners of the cubic lattice closer together, resulting in shrinkage similar to that observed in polymers.

Thermal matching for applications

This new understanding will improve scientists' ability to predict or strategically design a material's thermal response for applications where temperature changes are expected. For example, materials used in precision machining should ideally show little change in response to heating and cooling to maintain the same precision across all conditions. Materials used in medical applications, such as dental fillings or bone replacements, should have thermal expansion properties that closely match those of the biological structures in which they are embedded (think how painful it would be if your filling expanded while your tooth contracted when drinking hot coffee!). And in semiconductors or undersea fiberoptic transmission lines, the thermal expansion of insulating materials should match that of the functional materials to avoid impeding signal transmission. Zaliznyak notes that an underconstrained open framework architecture like that in ScF₃ is also present in copper-oxide and iron-based superconductors—where crystal lattice vibrations are thought to play a role in these materials' ability to carry electric current with no resistance. "The independent oscillation of atoms in these open-framework structures may contribute to these materials' properties in ways we can now calculate and understand," Zaliznyak said. "They might actually explain some of our own experimental observations that still remain a mystery in these superconductors," he added. "This work profoundly benefitted from the important advantages of the DOE national laboratories—including unique DOE facilities and our ability to have long-time-span projects where important contributions accumulate over time to culminate in a discovery," Zaliznyak said. "It represents the unique confluence of different expertise among the co-authors, including a dedicated high-school student intern, which we were able to integrate synergistically for this project. It would not have been possible to successfully carry out this research without the expertise provided by all the team members."

Phys.org, 1 November 2019

<http://phys.org>

A new hybrid material developed by scientists at the University of Liverpool may bring the dream of carbon-free nuclear fusion power a step closer.

Cage molecules act as molecular sieves for hydrogen isotope separation

2019-11-06

A new hybrid material developed by scientists at the University of Liverpool may bring the dream of carbon-free nuclear fusion power a step closer. The separation of hydrogen's three isotopes (hydrogen, deuterium, and tritium) is of key importance for fusion power technology, but current technologies are both energy intensive and inefficient. Nanoporous materials have the potential to separate hydrogen isotopes by a process known as kinetic quantum sieving (KQS), but poor performance levels currently prohibit scale up. In a new study published in *Science*, researchers at the University of Liverpool's Materials Innovation Factory have created hybrid porous organic cages capable of high-performance quantum sieving that could help advance the deuterium/hydrogen isotope separation technologies needed for fusion power. Deuterium, also called heavy hydrogen, has a number of commercial and scientific uses, including nuclear power, NMR spectroscopy and pharmacology. These applications need high-purity deuterium, which is expensive because of its low natural abundance. Deuterium enrichment from hydrogen-containing feedstocks, such as seawater, is an important industrial process, but it's costly and energy intensive. Porous organic cages are an emerging porous material, first reported by Professor Andrew Cooper's group at the University of Liverpool in 2009, which have been used previously for the separation of xylene isomers, noble gases, and chiral molecules. However, purifying deuterium from hydrogen/deuterium gas mixtures in this way is difficult because both isotopes have the same size and shape at normal conditions. By combining small-pore and large-pore cages together in a single solid, the group has now produced a material with high-quality separation performance that combines an excellent deuterium/hydrogen selectivity with a high deuterium uptake. The research was led by Professor Andrew Cooper FRS, whose team at the Materials Innovation Factory designed and synthesized the new cage systems. A separate team led by Dr. Michael Hirscher at the Max Planck Institute for Intelligent Systems tested the separation performance using cryogenic thermal desorption spectroscopy. Professor Cooper said: "The separation of hydrogen isotopes are some of the hardest molecular separations known today. The 'Holy Grail' for hydrogen / deuterium separation is to introduce precisely the right pore size to achieve high selectivity without compromising the gas uptake too much." "Our approach allows extremely delicate tuning of pore size—the entire tunability window for this series of cages spans the diameter a single nitrogen atom—and this ideally suits applications such

Gossip

CHEMWATCH

as KQS." Lead author Dr. Ming Liu added: "While the synthetic approach involves multistep organic synthesis, each step proceeds in close to 100% yield and there is no intermediate purification, so there is good potential to scale these materials up." Structural studies performed at the UK's Diamond Light Source and the Advanced Light Source in California enabled the Liverpool team to develop a site selective, solid state reaction, which enabled the pore size of the porous organic cages to be delicately tuned. These studies also enabled the team to design and understand the structure of their best performing material, which combined small-pore and large-pore cages. Co-author Dr. Marc Little added: "Data collected at these world-leading facilities underpinned our key structural findings and were an integral part of this study." The mechanistic understanding of the superior performance of these materials was supported by a joint computational effort, led by Dr. Linjiang Chen from the Leverhulme Research Centre for Functional Materials Design in the Materials Innovation Factory, also involving theoretical groups from Xi'an Jiaotong-Liverpool University (China) and École Polytechnique Fédérale de Lausanne (Switzerland). Although the reported material has excellent performance to separate deuterium from hydrogen, the ideal operation temperature is low (30 K). The group is now working on designing a new material that can separate hydrogen isotopes at higher temperatures. The paper, "Barely porous organic cages for hydrogen isotope separation," is published in Science.

Phys.org, 1 November 2019

<http://phys.org>

New technique lets researchers map strain in next-gen solar cells

2019-11-05

People can be good at hiding strain, and we're not alone. Solar cells have the same talent. For a solar cell, physical strain within its microscopic crystalline structure can interrupt its core function -- converting sunlight into electricity -- by essentially "losing" energy as heat. For an emerging type of solar cell, known as lead halide perovskites, reducing and taming this loss is key to improving efficiency and putting the perovskites on par with today's silicon solar cells. In order to understand where strain builds up within a solar cell and triggers the energy loss, scientists must visualize the underlying grain structure of perovskite crystals within the solar cell. But the best approach involves bombarding the solar cell with high-energy electrons, which essentially burns the solar cell and

People can be good at hiding strain, and we're not alone.

Gossip

CHEMWATCH

renders it useless. Researchers from the University of Washington and the FOM Institute for Atomic and Molecular Physics in the Netherlands have developed a way to illuminate strain in lead halide perovskite solar cells without harming them. Their approach, published online 10 September in *Joule*, succeeded in imaging the grain structure of a perovskite solar cell, showing that misorientation between microscopic perovskite crystals is the primary contributor to the build-up of strain within the solar cell. Crystal misorientation creates small-scale defects in the grain structure, which interrupt the transport of electrons within the solar cell and lead to heat loss through a process known as non-radiative recombination. "By combining our optical imaging with the new electron detector developed at FOM, we can actually see how the individual crystals are oriented and put together within a perovskite solar cell," said senior author David Ginger, a UW professor of chemistry and chief scientist at the UW-based Clean Energy Institute. "We can show that strain builds up due to the grain orientation, which is information researchers can use to improve perovskite synthesis and manufacturing processes to realise better solar cells with minimal strain -- and therefore minimal heat loss due to non-radiative recombination." Lead halide perovskites are cheap, printable crystalline compounds that show promise as low-cost, adaptable and efficient alternatives to the silicon or gallium arsenide solar cells that are widely used today. But even the best perovskite solar cells lose some electricity as heat at microscopic locations scattered across the cell, which dampens the efficiency. Scientists have long used fluorescence microscopy to identify the locations on perovskite solar cells' surface that reduce efficiency. But to identify the locations of defects causing the heat loss, researchers need to image the true grain structure of the film, according to first author Sarthak Jariwala, a UW doctoral student in materials science and engineering and a Clean Energy Institute Graduate Fellow. "Historically, imaging the solar cell's underlying true grain structure has not been possible to do without damaging the solar cell," said Jariwala. Typical approaches to view the internal structure utilise a form of electron microscopy called electron backscatter diffraction, which would normally burn the solar cell. But scientists at the FOM Institute for Atomic and Molecular Physics, led by co-authors Erik Garnett and Bruno Ehrler, developed an improved detector that can capture electron backscatter diffraction images at lower exposure times, preserving the solar cell structure. The images of perovskite solar cells from Ginger's lab reveal a grain structure that resembles a dry lakebed, with "cracks" representing the boundaries among thousands of individual perovskite grains. Using this imaging data, the researchers could for the first time map the 3D orientation of crystals within a functioning perovskite solar cell. They

Gossip

CHEMWATCH

could also determine where misalignment among crystals created strain. When the researchers overlaid images of the perovskite's grain structure with centres of non-radiative recombination, which Jariwala imaged using fluorescence microscopy, they discovered that non-radiative recombination could also occur away from visible boundaries. "We think that strain locally deforms the perovskite structure and causes defects," said Ginger. "These defects can then disrupt the transport of electrical current within the solar cell, causing non-radiative recombination -- even elsewhere on the surface." While Ginger's team has previously developed methods to "heal" some of these defects that serve as centres of non-radiative recombination in perovskite solar cells, ideally researchers would like to develop perovskite synthesis methods that would reduce or eliminate non-radiative recombination altogether. "Now we can explore strategies like controlling grain size and orientation spread during the perovskite synthesis process," said Ginger. "Those might be routes to reduce misorientation and strain -- and prevent defects from forming in the first place."

EurekAlert, 31 October 2019

<http://www.eurekalert.org>

Oil and gas wastewater used for irrigation may suppress plant immune systems

2019-11-06

The horizontal drilling method called hydraulic fracturing helps the United States produce close to 4 billion barrels of oil and natural gas per year, rocketing the U.S. to the top of oil-producing nations in the world. The highly profitable practice comes with a steep price: For every barrel of oil, oil and gas extraction also produces about seven barrels of wastewater, consisting mainly of naturally occurring subsurface water extracted along with the fossil fuels. That's about 2 billion gallons of wastewater a day. Companies, policymakers and scientists are on the lookout for new strategies for dealing with that wastewater. Among the most tantalising ideas is recycling it to irrigate food crops, given water scarcity issues in the West. A new Colorado State University study gives pause to that idea. The team led by Professor Thomas Borch of the Department of Soil and Crop Sciences conducted a greenhouse study using produced water from oil and gas extraction to irrigate common wheat crops. Their study, published in *Environmental Science and Technology Letters*, showed that these crops had weakened immune systems, leading to the question of whether using such wastewater for irrigation would leave crop systems

New study gives pause to the idea of using produced water for irrigation

Gossip

CHEMWATCH

more vulnerable to bacterial and fungal pathogens. "The big question is, is it safe?" said Borch, a biogeochemist who has joint academic appointments in the Department of Chemistry and Department of Civil and Environmental Engineering. "Have we considered every single thing we need to consider before we do this?" Typically, oil and gas wastewater, also known as produced water, is trucked away from drilling sites and reinjected into the Earth via deep disposal wells. Such practices have been documented to induce earthquakes and may lead to contamination of surface water and groundwater aquifers. The idea for using such water for irrigation has prompted studies testing things like crop yield, soil health, and contaminant uptake by plants, especially since produced water is often high in salts, and its chemistry varies greatly from region to region. Borch, who has conducted numerous oil and gas-related studies, including how soils fare during accidental spills, wondered if anyone had tried to determine whether irrigation water quality impacts crops' inherent ability to protect themselves from disease. The experiments were conducted in collaboration with plant microbiome expert Pankaj Trivedi, a CSU assistant professor in the Department of Bioagricultural Sciences and Pest Management, and researchers at Colorado School of Mines. The team irrigated wheat plants with tap water, two dilutions of produced water, and a salt water control. They exposed the plants to common bacterial and fungal pathogens and sampled the leaves after the pathogens were verified to have taken hold. Using state-of-the-art quantitative genetic sequencing, the scientists determined that the plants watered with the highest concentration of produced water had significant changes in expression of genes plants normally use to fight infections. Their study didn't determine exactly which substances in the produced water correlated with suppressed immunity. But they hypothesized that a combination of contaminants like boron, petroleum hydrocarbons and salt caused the plants to reallocate metabolic resources to fight stress, making it more challenging for them to produce disease-fighting genes. "Findings from this work suggest that plant immune response impacts must be assessed before reusing treated oil and gas wastewater for agricultural irrigation," the study authors wrote.

EurekAlert, 31 October 2019

<http://www.eurekalert.org>

A new study led by researchers at the University of Minnesota's Design of Active Materials and Structures Lab and Wearable Technology Lab details the development of a temperature-responsive textile that can be used to create self-fitting garments powered only by body heat.

Gossip

CHEMWATCH

Invention of shape-changing textiles powered only by body heat

2019-11-05

A new study led by researchers at the University of Minnesota's Design of Active Materials and Structures Lab (DAMSL) and Wearable Technology Lab (WTL) details the development of a temperature-responsive textile that can be used to create self-fitting garments powered only by body heat. The study, led by graduate students Kevin Eschen and Rachael Granberry and professors Julianna Abel and Brad Holschuh was recently published in *Advanced Materials Technologies*. "This is an important step forward in the creation of robotic textiles for on-body applications," said Holschuh. "It's particularly exciting because it solves two significant problems simultaneously: how to create usable actuation, or movement, without requiring significant power or heat, and how to conform a textile or garment to regions of the body that are irregularly shaped." The textiles resemble typical knits, except they are created using a special category of active materials—known as shape memory alloys (SMAs)—which change shape when heated. In partnership with NASA, U of M researchers studied the unique dimensions of a human leg. They then subsequently designed, manufactured and tested an SMA-based knitted garment that can precisely conform to a leg's topography. "This technology required advancements on multiple scales," said Abel. "At the material scale, we tuned it to respond to body temperature without added power. Structurally, we manufactured it to adapt to the complex shapes of the human body perfectly. At the system level, we created an operation that maps the mechanical performance of textiles to human anatomy. Each advancement is important, but, together, they create a functionality that didn't exist before." These knits can be used in custom garments that can easily transform from loose to tight-fitting, and even bend in unique ways to conform to irregularly shaped regions of the body (e.g., the back of the knee). Examples of future use could be to create compression garments that are initially loose fitting and easy to put on which could subsequently shrink to tightly squeeze the wearer. "This creates an exciting new opportunity to create garments that can physically transform over time, which has significant implications for medical, aerospace and commercial applications," Holschuh said. Next steps will be to integrate the textiles into full-sized garments, which could solve a variety of problems where

Amid growing climate concerns, many governments and scientists worldwide are trying to reduce air travel's environmental impact.

Gossip

CHEMWATCH

fit and conformance to the body are important, such as medical-grade compression stockings.

Phys.org, 30 October 2019

<http://phys.org>

Will lithium-air batteries ever take flight?

2019-11-06

Amid growing climate concerns, many governments and scientists worldwide are trying to reduce air travel's environmental impact. Electric planes are a possible solution, but better batteries are needed to power large aircraft for long distances. Lithium-air batteries, one of the most promising technologies, face challenges in taking flight from the lab bench to the friendly skies, according to an article in Chemical & Engineering News (C&EN). Small, short-distance electric aircraft can be powered by lithium-ion batteries, the rechargeable technology that powers cell phones, laptops and electric cars (and was recently recognised with a Nobel Prize). However, the best lithium-ion batteries have a specific energy of about 250 W h/kg—much less than the 800 W h/kg needed for a Boeing 737 to fly from Chicago to New York City, contributing editor Tien Nguyen writes. Lithium-air batteries theoretically offer a maximum specific energy of 3,460 W h/kg, and the oxygen required for the batteries' operation could be supplied by a plane's onboard air storage and filtration systems, experts say. But first, scientists need to overcome a spate of obstacles that limit the technology's practicality. Compared with lithium-ion technology, lithium-air batteries have a more complex chemistry that uses oxygen to oxidise a lithium-metal anode. As a result, the electrolyte solution, which conveys lithium ions from anode to cathode, decomposes quickly, limiting the batteries' rechargeability. Scientists are searching for more stable electrolytes, but so far, the best alternative allows only about 90 charging cycles (far short of the thousands of charging cycles possible for lithium-ion batteries). Another challenge is whether the batteries could run on air rather than pure oxygen, which is piped in for lab-scale batteries. Carbon dioxide or water in air could interfere with the chemistry. However, recent studies suggest that water might not be as problematic for the batteries as once thought, and scientists say that carbon-capture technology could be used to remove carbon dioxide from air.

Phys.org, 30 October 2019

<http://phys.org>

Researchers have gained tantalising new insights into the properties of perovskites, one of the world's most promising materials in the quest to produce a more efficient, robust and cheaper solar cell.

Gossip

CHEMWATCH

Promising discovery could lead to a better, cheaper solar cell

2019-11-06

McGill University researchers have gained tantalizing new insights into the properties of perovskites, one of the world's most promising materials in the quest to produce a more efficient, robust and cheaper solar cell. In a study published in *Nature Communications*, the researchers used a multi-dimensional electronic spectrometer (MDES) -- a unique instrument hand-built at McGill -- to observe the behaviour of electrons in caesium lead iodide perovskite nanocrystals. The MDES that made these observations possible is capable of measuring the behaviour of electrons over extraordinarily short periods of time -- down to 10 femtoseconds, or 10 millionths of a billionth of a second. Perovskites are seemingly solid crystals that first drew attention in 2014 for their unusual promise in future solar cells that might be cheaper or more defect tolerant.

A most exciting discovery

"It's the most exciting result that I have been a part of since starting in science in 1995," said senior author and McGill chemistry professor Patanjali Kambhampati of the discovery of perovskite's liquid-solid duality. "Instead of searching for perfection in defect-free silicon microelectronics, here we have a defective thing that's defect-tolerant. And now we know a bit more about why that is."

Solids acting like liquids

As the researchers looked more closely at the crystals using the MDES, what they saw was something that challenges our conventional understanding of the difference between liquids and solids. "Since childhood we have learned to discern solids from liquids based on intuition: we know solids have a fixed shape, whereas liquids take the shape of their container," said H el ene Seiler, lead author of the research and a former PhD student in the Department of Chemistry at McGill who is currently at the Department of Physical Chemistry, Fritz-Haber-Institut at the Max-Planck Institute. "But when we look at what the electrons in this material are actually doing in response to light, we see that they behave like they typically do in a liquid. Clearly, they are not in a liquid -- they are in a crystal -- but their response to light is really liquid-like. The main difference between a solid and a liquid is that a liquid has atoms or

A team created the next generation of long-wave infrared plastic lenses. The new lens material could make IR cameras and sensor devices more accessible to consumers.

Gossip

CHEMWATCH

molecules dancing about, whereas a solid has the atoms or molecules is more fixed in space as on a grid.”

Science Daily, 31 October 2019

<http://www.sciencedaily.com>

Using computational chemistry to produce cheaper infrared plastic lenses

2019-11-06

Five years ago, when University of Arizona materials scientist Jeffrey Pyun presented his first generation of orange-tinted plastic lens to optical scientist Robert Norwood, he responded, “This isn’t the ‘60s. No one wants orange glasses, man.” In the years since, a team led by Pyun has refined the material and created the next generation of lenses. The plastic, a sulfur-based polymer forged from waste generated by refining fossil fuels, is incredibly useful for lenses, window and other devices requiring transmission of infrared light, or IR, which makes heat visible. “IR imaging technology is already used extensively for military applications such as night vision and heat-seeking missiles,” said Pyun, a professor in the Department of Chemistry and Biochemistry who leads the lab that developed the polymer. “But for consumers and the transportation sector, cost limits high-volume production of this technology.” The new lens material could make IR cameras and sensor devices more accessible to consumers, according to Norwood, a professor in the James C. Wyant College of Optical Sciences. Potential consumer applications include economical autonomous vehicles and in-home thermal imaging for security or fire protection. The new polymers are stronger and more temperature resistant than the first-generation sulfur plastic developed in 2014 that was transparent to mid-IR wavelengths. The new lenses are transparent to a wider spectral window, extending into the long-wave IR, and are far less expensive than the current industry standard of metal-based lenses made of germanium, an expensive, heavy, rare and toxic material. Because of germanium’s many drawbacks, Tristan Kleine, a graduate student in Pyun’s lab and first author on the paper, identified a sulfur-based plastic as an attractive alternative. However, the ability to make IR-transparent plastics is a tricky business. The components that give rise to useful optical properties, such as sulfur-sulfur bonds, also compromise the strength and temperature resistance of the material. Moreover, the inclusion of additional organic molecules to give the material strength resulted in reduced transparency, since nearly all organic molecules absorb IR light, Kleine said. To overcome the challenge, Kleine

Gossip

CHEMWATCH

-- in collaboration with chemistry graduate student Meghan Talbot and chemistry and biochemistry professor Dennis Lichtenberger -- used computational simulations to design organic molecules that were not IR-absorbing and predicted transparency of candidate materials. "It could have taken years to test these materials in the laboratory, but we were able to greatly accelerate new materials design using this method," Kleine said. Germanium requires temperatures greater than 1,700 degrees Fahrenheit to melt and shape, but because of its chemical makeup, the sulfur polymer lenses can be shaped at a much lower temperature. "A major advantage of these new sulfur-based plastics is the ability to readily process these materials at much lower temperatures than germanium into useful optical elements for cameras or sensors, while still maintaining good thermomechanical properties to prevent cracking or scratches," Pyun said. "This new material has just checked so many boxes we couldn't before." "Its reliability is essentially equivalent to optical polymers that are routinely used for eyeglasses," Norwood added. The team is partnering with Tech Launch Arizona to translate the research into a viable technology. "Humans light up like a Christmas tree in IR," Pyun said. "So, as we think about the Internet of Things and human-machine interfaces, the use of IR sensors is going to be a really important way to detect human behaviour and activity."

Science Daily, 29 October 2019

<http://www.sciencedaily.com>

An electronic signal expands a material by a factor of 100

2019-11-06

Researchers at the Laboratory of Organic Electronics, Linköping University, have discovered a material that can both increase and reduce its volume when exposed to a weak electrical pulse. In a sponge, or filter, the researchers can control the size of particles that pass through. Materials, such as solids and gels, that change volume depending on temperature or pH have long been available. Such materials are used in control units (one example of which are windows in greenhouses that automatically open and close depending on the temperature). They are also used in robots and in other electromechanical systems and in applications in biomedicine. One property that researchers have, however, long sought is the change of a material from a solid form to a gel state with the aid of an electrical signal. It is particularly desirable that such electronic control of the phase transition is reversible. The goal is to be able to control the

Researchers have discovered a material that can both increase and reduce its volume when exposed to a weak electrical pulse. In a sponge, or filter, the researchers can control the size of particles that pass through.

Gossip

CHEMWATCH

volume by electrical means. This is possible in current materials, but researchers have only been able to achieve at most a doubling of the volume. Scientists at the Laboratory of Organic Electronics, Campus Norrköping, have now discovered a new material, a conducting polymer, that can increase its volume by a factor of more than 100. The material was synthesised in collaboration with researchers from Imperial College in London. The change takes place when the material is placed into an electrolyte and subjected to a weak electrical voltage of +0.8 V. If a negative voltage, -0.8 V, is instead applied, the material contracts, nearly the whole way back to its original volume. This is a significantly larger volume change than those previously reported, not only in conducting polymers but also in other materials controlled by an electrical signal. Experiments carried out by Johannes Gladisch and Eleni Stavrinidou have involved the conducting polymer being placed as a film with a thickness of a few micrometres around an electrically conducting carbon fibre. When electrical pulses with magnitudes of +0.5 V or +0.8 V are applied, the material changes its internal structure, then absorbs water and is finally converted to a gel that expands to 14 or 120 times the original volume. When pulses of magnitude +/- 0.5 V are repeatedly applied, the material expands by approximately 300%, or to three times, with respect to its previous contracted state. The change in volume is reversible. The scientists also describe an application in the article, published in *Advanced Science*. This is a smart sponge, or filter, in which they can control the expansion electronically, and in this way change the pore size by 85%. "We can control the pore size of a filter electronically, and potentially actively control the size of particles that pass through. This means that the properties of this smart filter can be dynamically changed to allow different types or different sizes of particle to pass through. This function can be used for sieving, filtration, purification, and in process chemistry. It may also have applications in medicine and biochemistry," says Magnus Berggren, professor in organic electronics and director of the Laboratory of Organic Electronics.

Science Daily, 29 October 2019

<http://www.sciencedaily.com>

Using renewable electricity for industrial hydrogenation reactions

2019-11-05

From the design of improved batteries to the use of solar and wind power for commodity chemical production, the University of Pittsburgh's

From the design of improved batteries to the use of solar and wind power for commodity chemical production, the University of Pittsburgh's James McKone ways that chemical engineering can make the world more sustainable.

Gossip

CHEMWATCH

James McKone ways that chemical engineering can make the world more sustainable. That's why his most recent work, investigating ways that the chemical industry can use renewable electricity as its energy source, is featured in the Journal of Materials Chemistry A Emerging Investigators special issue. The themed issue highlights the rising stars of materials chemistry research, from nanoparticle inks to next-generation solar cells. The featured investigators are early in their careers and were recommended by other experts in the field. Dr. McKone is an assistant professor of chemical engineering at Pitt's Swanson School of Engineering. "We're glad to have James on our faculty and know this honour is well-deserved," says Steven Little, Ph.D., chair of the Department of Chemical and Petroleum Engineering at the Swanson School. "It confirms what we already know: that his lab's work has the potential to influence the direction of future discoveries in energy production, energy storage and beyond." The paper, "Comparisons of WO₃ reduction to HxWO₃ under thermochemical and electrochemical control," features experiments and analysis completed by Evan V. Miu, a doctoral candidate in the McKone Lab. In this paper, McKone and Miu lay the groundwork for a new way to use renewable electricity as the primary energy input for industrial hydrogenation reactions, which are extremely important in the production of fuel and fertiliser. "The rapid growth in the electric vehicle market shows that it will be possible to replace fossil fuels with renewable electricity in the transportation sector" says McKone. "But the industrial sector also uses a lot of fossil resources, and we don't really know how to make, for example, plastic out of anything but petroleum. We're working to change that by inventing ways to convert the most abundant resources on the planet—air and seawater—into many of the fuels and chemicals that we use every day." Earlier this year, McKone was selected by the Oak Ridge Associated Universities (ORAU) as one of 36 recipients of this year's Ralph E. Powe Junior Faculty Enhancement Award. The award supports his project aimed at increasing the efficiency of redox flow batteries, making it easier for the electric grid to accommodate massive quantities of renewable power.

Phys.org, 29 October 2019

<http://phys.org>

Turning a dangerous toxin into a biosensor

2019-11-06

Some types of bacteria have the ability to punch holes into other cells and kill them. They do this by releasing specialised proteins called "pore-

Some types of bacteria have the ability to punch holes into other cells and kill them.

Gossip

CHEMWATCH

forming toxins" (PFTs) that latch onto the cell's membrane and form a tube-like channel that goes through it. This structure across the membrane is called a pore. Punctured by multiple PFTs, the target cell self-destructs. However, PFTs have garnered much interest beyond bacterial infections. The nano-sized pores that they form are used for sensing biomolecules: A biological molecule, e.g., DNA or RNA, passes through the nanopore like a string steered by a voltage, and its individual components (e.g., nucleic acids in DNA) give out distinct electrical signals that can be read out. In fact, nanopore sensing is already on the market as a major tool for DNA or RNA sequencing. Publishing in *Nature Communications*, scientists led by Matteo Dal Peraro at EPFL have studied another major PFT that can be used effectively for more complex sensing, such as protein sequencing. The toxin is aerolysin, which is produced by the bacterium *Aeromonas hydrophilia*, and is the "founding member" of a major family of PFTs found across many organisms. One of the main advantages of aerolysin is that it forms very narrow pores that can tell apart molecules with much higher resolution than other toxins. Previous studies have shown that aerolysin can be used to "sense" several biomolecules, but there have been few studies on the relationship between aerolysin's structure and its molecular sensing abilities. The researchers first used a structural model of aerolysin to study its structure with computer simulations. As a protein, aerolysin is made up of amino acids, and the model helped the scientists understand how those amino acids affect the function of aerolysin in general. Once they had a grasp of that relationship, the researchers strategically changed amino acids in the computer model. The model then predicted the possible impact of each change on the overall function of aerolysin. At the end of the computational process, Dr. Chan Cao, the leading author of this work, produced 16 genetically engineered, "mutant" aerolysin pores, embedded them in lipid bilayers to simulate their position in a cell membrane, and carried out various measurements (single-channel recording and molecular translocation experiments) to understand how ionic conductance, ion selectivity, and translocation properties of the aerolysin pore are regulated on a molecular level. And with this approach, the researchers finally found what drives the relationship between the structure and the function of aerolysin: its cap. The aerolysin pore isn't just a tube that goes through the membrane, but also has a cap-like structure that attracts and tethers the target molecule and "pulls" it through the pore's channel. And the study found that it is the electrostatics at this cap region that dictate this relationship. "By understanding the details of how the structure of the aerolysin pore connects to its function, we can now engineer custom pores for various sensing applications," says Dal Peraro. "These would open new, unexplored opportunities to sequence

Drexel researchers' program designs materials with human-like microvasculature

Gossip

CHEMWATCH

biomolecules as DNA, proteins and their post-translational modifications with promising applications in gene sequencing and biomarkers detection for diagnostics."The scientists have already filed a patent for their sequencing and characterisation of the genetically engineered aerolysin pores.

Phys.org, 29 October 2019

<http://phys.org>

Mimicking body's circulatory AC could keep airplanes, cars and computers cooler

2019-11-06

The complex network of veins that keeps us cool during the heat of summer has inspired engineers to create novel thermal management systems. But replicating the circulatory system, in form or function, has been no easy task. Recently, a team of researchers from Drexel University and North Carolina State University have created a computational platform that could be the key to mimicking the body's evolutionary optimised cooling system.

Microvasculature

In a study published in the International Journal of Heat and Mass Transfer, Ahmad Najafi, PhD, a professor in Drexel's College of Engineering, and his faculty collaborator, Jason Patrick, PhD, from North Carolina State University, report on how a computational technique they developed can quickly produce designs for 3D printing carbon-fibre composite materials with an internal vasculature optimised for active-cooling. "When you get hot, the body sends a signal to the circulatory system to pump more blood to the surface of the skin - this is why we sometimes get red in the face" Najafi said. "This is a natural method for dissipating heat that works so well, scientists and engineers have been trying for years to replicate in mechanical cooling systems, like the ones that keep cars and computers from overheating." Najafi and Patrick's latest paper describes an integrated platform to design and create bioinspired microvascular composites that can do just that. In minutes, their computer program, coined HyTopS, which is short for hybrid topology/shape optimization, can produce a schematic for a vascular network with the ideal shape, size and distribution of micro-vessels to actively cool a material via liquid circulation - a trick that took Mother Nature more than a few evolutionary cycles to perfect. Microvascular fibre-composites are currently being

Gossip

CHEMWATCH

developed to cool everything from electric vehicles to next generation aircraft, where increasingly higher performance is turning up the heat they generate. "These modern materials could revolutionise everything from hypersonic space vehicles to battery packaging in electric cars and even supercomputer cooling systems. As things move faster, and energy output and computing power continue to increase, an enormous amount of heat is generated that requires new approaches to cooling," Patrick said. "Inspired by circulatory systems in living organisms, internal microvasculature provides an effective means to thermal regulation in synthetic materials." This branch of bioinspired-based research has only been around for a decade or so, but the results it has generated are already quite promising, according to Najafi/Patrick who started their academic careers at the University of Illinois Urbana-Champaign developing microvascular materials for self-healing, active cooling and beyond. Part of their recent research thrust is to replace more traditional metallic systems that transfer heat via water or air. While it's been a reliable solution, anyone who has carried an air conditioner window unit will surely understand why a different cooling system would be an improvement for any vehicle or component that is trying to cut weight. "Microvascular composites offer many advantages over existing liquid and air-cooling systems, primarily, they are much lighter with comparable strength, but they are also very durable - which is important if you consider the widespread effect of corrosion on metallic components," Najafi said. "And if you consider these among other factors, it's easy to see why they are being sought in aerospace, automotive and energy sectors." To put their optimisation method to the test, the researchers designed and built a microvascular carbon-fibre composite using 3D printing and tested its cooling abilities against a reference design from prior studies. After heating the carbon-composites to a maximum temperature, liquid coolant (similar to the one in your car) was pumped through each vascular network to begin the cooling process. The HyTopS-optimised carbon-composite was not only cooler, but more uniform in terms of surface temperature distribution, and was able to cool down faster than the reference design. In addition to superior performance of the optimised material, the advantage the HyTopS method is that it automatically calculates the impact of changes to the diameter and arrangement of the channels, as well as how they are connected to one another. It takes into consideration the material makeup and overall geometry of the system being cooled and corresponding heat transfer characteristics. And it factors in parameters related to the manufacturing process, so the final design is a realistic microvascular material that can be made by 3D printing or other accessible fabrication approaches. "It's nearly impossible to reproduce the entire complexity

Curiosities

CHEMWATCH

PTSD tied to higher, earlier stroke risk

2019-11-07

Young adults who develop PTSD may be more likely to have a stroke by the time they are middle aged, a study of veterans in the United States has suggests. Researchers followed almost one million young and middle-aged veterans of the conflicts in Iraq and Afghanistan for more than a decade, starting when they were 30 years old, on average, and had no history of stroke. Overall, 29% had been diagnosed with PTSD. During the study, 766 people had a transient ischemic attack, or brief "mini-stroke," and another 1,877 people had a stroke. Veterans with PTSD were 61% more likely than others to have a mini-stroke and 36% more likely to have a stroke, the study found. "This trend is very concerning given the devastating impact stroke has on young patients and their families, many of whom struggle to cope with long-term disability, depression, and economic loss during their most productive years," said study leader Lindsey Rosman of the University of North Carolina School of Medicine in Chapel Hill. "Because PTSD is a potentially treatable psychological condition, understanding the relationship between the two conditions may have important implications for improving stroke prevention and treatment in young and middle-aged adults," Rosman said by email. While PTSD has been shown to increase the risk of heart disease and stroke in older adults, this is the first study to show a link between trauma-induced stress disorders and the risk of stroke and mini-strokes in young and middle-aged adults, researchers note in the journal *Stroke*. Most strokes occur when a clot blocks an artery carrying blood to the brain, known as an ischemic stroke. About 10% to 14% of ischemic strokes occur in adults ages 18 to 45, the study team notes. Most of the veterans in the current study were men, and the majority were white. There was a stronger link between PTSD and stroke in men than in women. Even after accounting for behaviours that can raise stroke risk, like smoking, getting little exercise and substance abuse, researchers still found an increased stroke risk associated with PTSD. While the study focused on PTSD among military veterans, it's possible that people with PTSD from other experiences like natural disasters, gun violence or sexual assault might also have an increased stroke risk, the study authors conclude. "We don't fully understand how PTSD in young adults increases their risk of developing stroke at an early age, but multiple biological and behavioural pathways are likely involved," Rosman said. For example, prolonged exposure to intense psychological stress may lead to chronic inflammation that eventually contributes to stroke. Stress is also associated with unhealthy lifestyle behaviours such as smoking, physical inactivity, poor

Young adults who develop PTSD may be more likely to have a stroke by the time they are middle aged, a study of veterans in the United States has suggests.

Curiosities

CHEMWATCH

diet and substance abuse, which may increase risk for early stroke. With PTSD, people may develop long-lasting symptoms of anxiety, avoidance, hypervigilance, anger, irritability, flashbacks and nightmares. This can happen just as easily for non-combat traumas and may lead to unhealthy behaviours that raise the risk of stroke among civilians, Rosman said. The study focused on younger veterans, and results might be different for older veterans or other older adults with more traditional risk factors for stroke like heart rhythm disorders or heart failure, the research team notes. "The causes, characteristics and consequences of stroke for young patients will likely differ from those for the 'typical' stroke patient who is much older and more likely to have other medical conditions," Rosman said. "We can't just apply a one-size fits all strategy to address this problem."

Reuters Health, 24 October 2019

<http://www.reuters.com>

Why Do Some People Need Less Sleep Than Others?

2019-11-07

We all wish we could get by on less sleep, but one father and son actually can—without suffering any health consequences and while actually performing on memory tests as well as, or better than, most people. To understand this rare ability, researchers at the University of California, San Francisco, first identified a genetic mutation—in both individuals—that they thought might deserve the credit. Then the scientists intentionally made the same small genetic spelling mistake in mice. The mice also needed less sleep, remembered better and suffered no other ill effects, according to a study published in *Science Translational Medicine*. Although a medication with the same benefits will not be available anytime soon—and might never materialise—the idea is incredibly appealing: take a pill that replicates whatever the father and son's body does and sleep less, with no negative repercussions. "I find the concept of a gene product that might potentially provide protection against comorbid disorders of restricted sleep tantalising," says Patrick Fuller, an associate professor of neurology at Harvard Medical School and Beth Israel Deaconess Medical Centre in Boston, who was not involved with the work. "If true, this would indeed have 'potential therapeutic implications,' as well as provide another point of entry for exploring and answering the question 'Why do we sleep?' which remains [one] of the greatest mysteries in neuroscience." But as Jamie Zeitzer, an associate professor in the department of psychiatry and behavioural sciences at Stanford University, notes, "There often are trade-offs." Zeitzer says he worries that

We all wish we could get by on less sleep, but one father and son actually can—without suffering any health consequences and while actually performing on memory tests as well as, or better than, most people.

Curiosities

CHEMWATCH

even if a drug like this could be produced without causing significant side effects, it would still have social consequences. Some individuals might be forced or pressured to take medication so they could work more hours. Even if people will not need as much sleep, they will still need downtime, he insists. The study's senior author, Ying-Hui Fu, a professor of neurology at U.C.S.F., says it is far too early for such fantasies. Instead she is interested in better understanding the mechanisms of healthy sleep to help prevent diseases ranging from cancer to Alzheimer's. "These people sleep more efficiently," she says of the father-son pair. "Whatever function sleep is doing for us, it takes us eight [hours to feel rested], but it takes them six or four hours. If we can figure out why they are more efficient, we can use that knowledge to help everybody to be more efficient." The subjects, who live on the East Coast, reached out to Fu's team after hearing about a previous publication of its work. She would not reveal any more information about them to protect their privacy, except that they are fully rested after four to six hours of sleep instead of the more typical seven to nine. Also, Fu says, the duo and others with similar mutations are more optimistic, more active and better at multitasking than the average person. "They like to keep busy. They don't sit around wasting time," she says. If most people sleep less than their body needs, that deficit that will affect memory and performance, in addition to measures of health, Fu notes. Many think they can get away with five hours of sleep on weeknights and compensate for the loss on weekends—but few actually can. "Your perception is skewed, so you don't really know your performance is not as good," she says. "That's why people think [adequate sleep] doesn't matter. But actually, it does. If you test them, it's obvious." Joking about her own academic experience, Fu adds, "All those nights that I stayed up to study, it would have been better to go to sleep." That's not true of the father and son, who genuinely needed just 5.5 and 4.3 hours of sleep each night, respectively, the new paper showed. Stanford's Zeitzer praises the study's design, saying, "Starting with humans and going to rodents and then back is great." Mice, he adds, are not ideal role models because they regulate sleep differently than humans. And many individuals believe they are short sleepers but, when put in a lab, turn out to slumber the typical seven to nine hours. People are naturally short sleepers if they rest a relatively brief time even when given the chance to sleep in on weekends or vacations. "If you get extra sleep when you have the opportunity, it's generally a good sign that you need more sleep," Zeitzer says. Jerome Siegel, a professor of psychiatry at the University of California, Los Angeles, Centre for Sleep Research, says he is comfortable with Fu's group's main finding: that the neuropeptide S receptor 1 (NPSR1) gene is important in regulating sleep. But it is likely only one small piece

Curiosities

CHEMWATCH

in a very complex process, he adds. And he is not convinced by the connection between sleep and memory the group claims. Sleep may have many functions, but there is no indication, he says, that needing less of it somehow boosts memory or cognition. "We consolidate memory while we sleep and while we're awake, even when we're anesthetised," he says. "It's not something that just occurs during sleep." The mechanism of action of the newly discovered mutation is not entirely clear. Fu and her team used a molecular probe to explore how the protein made by the father and son's mutant NPSR1 gene differs from that made by a normal gene. The mutation, they found, makes the receptor more sensitive and active. The specifics of that process, Fu says, still have to be worked out. Fu and her collaborators previously discovered two other genes involved in sleep. They are continuing to explore the mechanisms behind these genes, she says, adding that the speed of their work would be faster if they had more financial support. Fu says once she and her colleagues can find about 10 pieces of the genetic puzzle, "each piece can serve as a point to build upon. And hopefully, someday we can know the whole picture."

Live Science, 23 October 2019

<http://www.livescience.com>

Chemicals in consumer products during early pregnancy related to lower IQ, especially in boys

2019-11-07

Exposure during the first trimester of pregnancy to mixtures of suspected endocrine-disrupting chemicals found in consumer products is related to lower IQ in children by age 7, according to a study by researchers at the Icahn School of Medicine at Mount Sinai and Karlstad University, Sweden, published in *Environment International* in October. This study is among the first to look at prenatal suspected endocrine-disrupting chemical mixtures in relation to neurodevelopment. Scientists measured 26 chemicals in the blood and urine of 718 mothers during the first trimester of their pregnancies in the study of Swedish mothers and children, known as SELMA. These chemicals included bisphenol A (BPA), which is found in plastic food and drink containers, as well as pesticides, phthalates, and other chemicals found in consumer products. Some of the 26 are known to disrupt endocrine (hormone) activity in humans; others have been shown to do so only in animals, or are suspected of endocrine disruption because they share chemical features with known disruptors. Researchers later followed up with the children at age 7 and found that those whose mothers had higher levels of the chemicals in

Exposure during the first trimester of pregnancy to mixtures of suspected endocrine-disrupting chemicals found in consumer products is related to lower IQ in children by age 7, according to a new study.

Curiosities

CHEMWATCH

their system during pregnancy had lower IQ scores -- particularly boys, whose scores were lower by two points. Within the mixture, bisphenol F (BPF), a BPA-replacement compound, made the highest contribution to lowering children's IQ, suggesting that BPF is not any safer for children than BPA. The study found that other chemicals of concern in the mixture were the pesticide chlorpyrifos; polyfluoroalkyl substances, which are found in cleaning products; triclosan, a chemical found in antibacterial soaps; and phthalates, which are found in soft polyvinyl chloride plastics and cosmetics. Many of the chemicals only stay in the body a short time, meaning that even a short-term exposure may be detrimental, so researchers believe this indicates that preventing exposures to pregnant women or women trying to become pregnant is critical to preventing neurological harm to children. "This study is significant because most studies evaluate one chemical at a time; however, humans are exposed to many chemicals at the same time, and multiple exposures may be harmful even when each individual chemical is at a low level," said Eva Tanner, PhD, MPH, postdoctoral researcher in the Department of Environmental Medicine and Public Health at the Icahn School of Medicine at Mount Sinai. Carl-Gustaf Bornehag, PhD, Professor at Karlstad University, says it shows that exposure to mixtures of chemicals in ordinary consumer products may affect child brain development and that some chemicals believed to be safer, like BPF, may not be any safer for children. The chemicals interfere with hormone activity, even at low levels. Previous studies link numerous suspected endocrine disruptors, including phthalates and BPA, to neurodevelopmental difficulties in children. Some of these chemicals cross the placenta during pregnancy, exposing the foetus and potentially causing irreversible developmental damage. While ending exposure to a short-lived pollutant may eliminate adverse effects in adults, exposure during critical periods of foetal development may be permanent, with subtle endocrine changes potentially influencing health outcomes into adulthood, Dr. Tanner said. Dr. Tanner says this study only assessed exposure at a single time during early pregnancy, so more research needs to be done to understand how exposures throughout later pregnancy and childhood may influence the results. The researchers note that several of the chemicals studied only stay in the body for a short amount of time, so the mothers in the study may have had additional exposures before or after their blood and urine samples were taken.

Curiosities

CHEMWATCH

Researchers note the study was observational, and further studies are needed to confirm these findings.

Science Daily, 24 October 2019

<http://www.sciencedaily.com>

Exercise May Improve Arteries After Heart Failure

2019-11-07

Exercise may improve the health of blood vessels in the heart for people with heart failure, according to new research. The finding is based on a study with swine, which have very similar blood vessels and heart muscles—both structurally and functionally—as humans. Generally, exercise is considered good for you. However, doctors used to prescribe bedrest to people with heart failure, fearing exercise could potentially lead to additional health problems. Craig Emter, associate professor in the College of Veterinary Medicine at the University of Missouri, studied three different groups of swine with heart failure: one group was inactive; a second group exercised using intervals with a higher level of intensity for short periods of time intermixed with periods of lower intensity; and the third group exercised with a constant lower level of intensity. Emter found that regardless of exercise intensity or duration, any level of exercise resulted in improved health of blood vessels in the heart. “People with heart failure cannot do everything that a healthy individual can, so the question becomes how much exercise can they handle and what type of impact will it have on their health,” Emter says. “We found that regardless of intensity level, some type of physical activity was good for heart health compared to no exercise at all.” Emter explains stiff blood vessels can block or impair blood flow to the heart and can lead to a variety of cardiovascular issues. The research findings could be useful for human medicine as well. “We now have a better understanding of how blood flows in the heart, the stiffness of blood vessels and the impact that exercise has on heart health,” Emter says. “Understanding the underlying science of the heart allows us to help improve the health of people with heart failure.” The study appears in the *Journal of Applied Physiology*. Additional authors came from the University of Saskatchewan and Ball State University. Funding came from the National Institutes of Health. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

Exercise may improve the health of blood vessels in the heart for people with heart failure, according to new research.

Futurity, 23 October 2019

<http://www.futurity.org>

Curiosities

CHEMWATCH

DEET 'Invisibility Cloak' May Keep Mosquitoes Away

2019-11-07

DEET may chemically "cloak" humans from malaria-carrying mosquitoes, rather than repel them, researchers report. Since its invention during the Second World War for soldiers stationed in countries with high malaria transmission rates, researchers have worked to pinpoint precisely how DEET actually affects mosquitoes. Past studies have analysed the chemical structure of the repellent, studied the response in easier insects to work with, such as fruit flies, and experimented with genetically engineered mosquito scent receptors grown inside frog eggs. However, the Anopheles mosquito's neurological response to DEET and other repellents remained largely unknown because directly studying the scent-responsive neurons in the mosquito itself proved technically challenging and labour-intensive work.

Hidden Skin Odours

For the new study, published in *Current Biology*, researchers applied a genetic engineering technique to the malaria-transmitting Anopheles mosquito, which allowed them to peer at the inner workings of the insect's nose. "Repellents are an amazing group of odours that can prevent mosquito bites, but it's been unclear as to how they actually work. Using our new, engineered strains of Anopheles mosquitoes, we can finally ask the question, 'How do the smell neurons of a mosquito respond to repellent odours?'" says Christopher Potter, associate professor of neuroscience at Johns Hopkins University School of Medicine. "Our results from Anopheles mosquitoes took us by surprise. We found that Anopheles mosquitoes 'smell' neurons did not directly respond to DEET or other synthetic repellents, but instead these repellents prevented human-skin odours from being able to be detected by the mosquito. In other words, these repellents were masking, or hiding, our skin odours from Anopheles." "We found that DEET interacts with and masks the chemicals on our skin rather than directly repelling mosquitoes. This will help us develop new repellents that work the same way," says first author Ali Afify, a postdoctoral fellow.

DEET Scent Trap

When researchers then puffed a scent that the mosquitoes could detect—such as the chemicals that make up the scent of human skin—onto the insects' antennae, fluorescent molecules engineered to be expressed in the antenna would light the neurons up and a camera would record them, showing that the mosquito's nose detected the signal. Using

DEET may chemically "cloak" humans from malaria-carrying mosquitoes, rather than repel them, researchers report.

Curiosities

CHEMWATCH

this odour-detecting setup, the researchers found that different scents, including chemical bug repellents such as DEET, natural repellents such as lemongrass, and chemicals found in human scent had different effects on the neurons. When the researchers puffed the scent of DEET alone onto the mosquitoes' antennae, the fluorescent molecules in the mosquitoes' neurons did not light up, a sign that the mosquitoes could not directly "smell" the chemical. When exposed to the chemicals known to make up human scent, the neurons "lit up like a Christmas tree," Potter says. And notably, when researchers mixed human scent with DEET, simulating the effect of applying the repellent to the skin, it tempered the neuronal response to the mixture, resulting in a much lower response—about 20% the power of the response to human scent alone. Looking to gain insight into why this happened, the researchers measured the number of scent molecules in the air reaching the antenna to find out how much "smell" was present for the insects to respond. They found that when combined with DEET, the number of human scent molecules in the air decreased to 15% of their previous amounts. "We therefore think that DEET traps human scents and prevents them from reaching the mosquitoes," says Afify. The researchers say they suspect that this effect is enough to mask the human scent and keep it from ever reaching the mosquito's odour detectors.

Varied Senses of Smell

The investigators caution that their study did not address the possibility that DEET and similar chemicals likely also act as contact repellents, possibly deterring *Anopheles* through taste or touch. The group also did not look at DEET's effect on other species of mosquito—issues they say they plan to tackle in future experiments. "The sense of smell in insects is quite remarkable in its variety, and it is certainly possible that other types of mosquitoes such as *Aedes* mosquitoes, which can transmit Zika or dengue, might actually be able to detect DEET. A key question to address would be if this detection is linked to repulsion, or if it's perceived as just another odour by the mosquito," Potter says. The researchers say they also plan to study the specific chemical receptors in the brain responsible for detecting natural odours like lemongrass. *Anopheles* mosquitoes are the most prevalent carrier of the malaria-causing parasite *Plasmodium*, which spreads from person to person through infected bites. Malaria killed an estimated 435,000 people in 2017, according to the World Health Organization (WHO). Additional researchers are from Durham University, Virginia Polytechnic Institute and State University, and Johns Hopkins. The Department of Defence, the National Institute of Allergy and Infectious

Curiosities

CHEMWATCH

Diseases, and Johns Hopkins funded the work. The authors declare no competing interests.

Futurity, 21 October 2019

<http://www.futurity.org>

Red is the most-risky ink colour, and other health issues from tattoos

2019-11-07

If you clicked on this story, you likely either have or are thinking about getting some ink. It might be your first embellishment (in tattoo-speak, you're a tenderfoot), or maybe it's your sixth (on your way to being a showcase). And you're part of a massive trend. Nearly four in 10 millennials ages 18 to 29 have a tattoo; half of those have two to five tats, the vast majority hidden under clothing, according to a 2010 Pew Research Centre report. Previous generations have about the same amount of ink: 40% of Gen Xers -- who are now between 40 and 54 years old -- sport a tattoo. Body art has become a form of self-expression. When visible, they tell the world something about you and what you like, about what you believe and value. Tattoos also pay homage to loved ones, permanently enshrining the names of lovers, precious children or dates of special significance. But are they safe? While the popularity of tattoos has grown, regulation of the industry has not. Tattoo ink is not regulated by the federal government. And oversight of tattoo parlours and artists on the state and local level is spotty. Many states and some cities have ordinances restricting tattoos on minors, but not all require cosmetic artists to be certified or tattoos shops to be licensed. Even when they are, inspectors are scarce, and shops may not be monitored to assure they always use clean, fresh needles. And even in the best of circumstances, there are real dangers in both the inking process and the self-care of the wounds. "We see people come into our clinic with some bad tattoo reactions," said Dr. Crystal Aguh, an assistant professor of dermatology at Johns Hopkins University School of Medicine. "You're introducing a foreign body via the skin and there are risks," said Dr. Shawn Kwatra, also an assistant professor of dermatology at Johns Hopkins. "Sometimes your body can react in many ways you may have never thought about."

Allergic reactions

Tattoos can trigger allergic reactions; the most common is to ink. The reaction can be to any colour, but the most typical are yellow and red.

If you clicked on this story, you likely either have or are thinking about getting some ink.

Curiosities

CHEMWATCH

According to the American Academy of Dermatology, the allergic response can occur immediately, weeks later, and surprisingly, even years and decades later. The academy says joint-replacement surgery or the beginning of antiviral treatment for HIV can activate a later reaction. Yellow ink is associated with sun sensitivity, which can be irritating because you have to cover up your tat to protect it. But the photosensitivity typically fades after a few years, Aguh said. A reaction to red ink, however, is most common. For many, the response is mild: a bit of redness, swelling or an itch that can be treated with a steroid cream.

For some, red ink can spark a potentially serious allergic reaction, turning the tattoo experience into a nightmare. Pimple-like bumps, blisters, and raised, scaly patches that flake off can appear. There could also be a watery discharge from the site. If those signs are paired with troubled breathing, or you experience a racing heart, dizziness, stomach ache, serious pain, flushing or hives, seek medical care immediately. In rare cases, people can get neurodermatitis, also known as lichen simplex chronicus. "It's a persistent, almost chronic-like inflammation, which causes your whole tattoo to bubble up where the pigment is and become like thick, leathery skin," Aguh said. Treatment is usually effective, she said. But for some it fails and leads to disfigurement. How do you know if you'll have an allergic reaction or how serious it might be? Unfortunately, you won't, which is why dermatologists recommend first getting a tiny test tattoo in a spot that isn't visible. "You may be completely normal, completely healthy, but there could be something about the red pigment that your body just does not like," Aguh said. "If you've never been exposed to it before there would be no way for you to know before getting the tattoo."

Lymph nodes

A 32-year-old woman with 14 lower body tattoos was being treated for cervical cancer when doctors noticed two swollen lymph glands. Thinking her cancer had spread, they removed the nodes and discovered they were full of tattoo ink particles. In this situation, doctors said they would have operated anyway, but warned that might not always be the case. In Australia, doctors were treating a woman for a type of cancer called lymphoma. She had lumps under her arms, as well as enlarged lymph nodes near the roots of her lungs, all classic signs of the cancer. But when they put those nodes under a microscope, they found out it was black tattoo ink placed there 15 years ago. She didn't have cancer; her immune system was reacting to the tattoo on her back. Another group of researchers studied cadavers with tattoos. In their lymph nodes they found carbon black ink, which breaks down easily into microscopically

Curiosities

CHEMWATCH

tiny bits called nanoparticles. They also found larger particles of titanium dioxide, a common ingredient in white ink. White ink is often used to mix tattoo colours. Their most disturbing discovery, however, was toxic heavy metals in the lymph nodes, including cobalt, nickel and chromium. Heavy metals are sometimes added to tattoo pigment as preservatives. "There are reports in the published scientific literature of tattoo inks that contain everything from pigments used in printer toner to pigments used in car paint," said Dr. Linda Katz, director of the Food and Drug Administration's Office of Cosmetics and Colours, in a published Q&A. The FDA considers tattooing to be a cosmetic procedure, so it doesn't regulate the industry. But it does look into adverse reactions. Katz said the agency is analysing tattoo inks and pigments for "heavy metals, degradants, potentially toxic chemicals — including pH stabilisers, microbicides and coating agents — and other materials that are not intended to be placed into the body."

Skin diseases

If you carry the gene for psoriasis, dermatologists warn, a tattoo might activate the disease for the first time, or cause a flare if you already have it. Other skin diseases can appear too: eczema (inflamed, itchy, irritated skin); vitiligo (a loss of skin pigment in blotches); sarcoidosis (an inflammatory disease); lichen planus (flat, itchy, purple bumps); even skin cancer. If you are prone to scarring or have ever had a keloid, which is a scar that grew bigger than the wound, the American Academy of Dermatology suggests you should "rethink getting a tattoo." "Keloids are very exaggerated scars in areas of trauma," Aguh said. "Depending on which colour of ink the body's most sensitive to, a person could develop a large scar that can be difficult to treat. It also permanently changes the appearance of the tattoo as well."

Self-care

Be sure you know exactly how to care for your new tattoo before you let the artist sling that ink. Few states have any regulations requiring tattoo salons to provide after-care instructions. You don't want to repeat the tragic mistake of a 31-year-old man in Texas. Five days after getting a tattoo on his leg of a cross and hands in prayer, with the words "Jesus is my life" written in cursive below, he went swimming in the Gulf of Mexico. Within days he was in the hospital, infected with *vibrio vulnificus*, a bacterium commonly found in coastal ocean water. The US Centres for Disease Control and Prevention estimates the bacteria causes 80,000 illnesses and 100 deaths every year in the United States. The man went into septic shock, kidneys failing, and despite aggressive care died within a

Curiosities

CHEMWATCH

month. Do your own thorough research before you get your tat; and in the meantime, here are a few key tips from dermatologists and tattoo artists:

- A thin layer of petroleum jelly and a bandage or plastic wrap should be applied by the artist before you leave the salon. Keep that on for 6 to 24 hours -- ask your artist for recommendations -- then remove carefully.
- With clean hands, gently wash the tattoo with antimicrobial soap and water and pat dry with a clean, soft cloth. Apply a very thin layer of antibiotic ointment and leave the tattoo open to breathe. Over the next few weeks you'll want to wash the tattoo twice a day and apply moisturiser.
- For the first few days your skin may feel warm, appear reddish and even ooze plasma and ink. That's a normal part of the process. If you see any sort of skin reaction after the first few days, however, visit a dermatologist. Infected skin could be redder, warmer and more painful, and could leak pus.
- Don't go swimming or otherwise immerse yourself in water for at least two weeks. Quick showers are fine.
- Don't pick at the scab or try to rub flakes off. Let them come off naturally to keep the ink in the skin and avoid scarring.
- The tattoo is likely to itch as it heals -- don't scratch, and apply moisturiser to help relieve the sensation.
- Wear protective, loose clothing to keep your tat out of the sun, but don't apply sunblock until after it looks healed, which is around three weeks.

According to dermatologists, your tattoo may appear dull and cloudy as it heals, but should be to its full vibrant colours within four months, about the time that all layers of the tattooed skin have healed.

CNN Health, 29 October 2019

<http://www.cnn.com/health>

Carbon Capture Might Not Be Such a Great Idea

2019-11-07

Carbon capture technologies can cause more harm than good, according to new research. Capturing carbon from the air is one proposed method for reducing carbon dioxide (CO₂) levels in the atmosphere—and reducing the risk of climate change. "All sorts of scenarios have been developed under the assumption that carbon capture actually reduces

Carbon capture technologies can cause more harm than good, according to new research.

Curiosities

CHEMWATCH

substantial amounts of carbon. However, this research finds that it reduces only a small fraction of carbon emissions, and it usually increases air pollution,” says Mark Z. Jacobson, a professor of civil and environmental engineering and a senior fellow at Stanford University’s Woods Institute for the Environment. “Even if you have 100% capture from the capture equipment, it is still worse, from a social cost perspective, than replacing a coal or gas plant with a wind farm because carbon capture never reduces air pollution and always has a capture equipment cost. Wind replacing fossil fuels always reduces air pollution and never has a capture equipment cost.” Jacobson examined public data from a coal with carbon capture electric power plant and a plant that removes carbon from the air directly. In both cases, electricity to run the capture technology came from natural gas. He calculated the net CO₂ reduction and total cost of the carbon capture process in each case, accounting for the electricity needed to run the carbon capture equipment, the combustion and upstream emissions resulting from that electricity, and, in the case of the coal plant, its upstream emissions. (Upstream emissions are emissions, including from leaks and combustion, from mining and transporting a fuel such as coal or natural gas.) Common estimates of carbon capture technologies—which only look at the carbon captured from energy production at a fossil fuel plant itself and not upstream emissions—say they can remediate 85-90% of carbon emissions. Once Jacobson calculated all the emissions associated with these plants that could contribute to global warming, he converted them to the equivalent amount of carbon dioxide in order to compare his data with the standard estimate. He found that in both cases the equipment captured the equivalent of only 10-11% of the emissions they produced, averaged over 20 years. The researchers also looked at the social cost of carbon capture—including air pollution, potential health problems, economic costs, and overall contributions to climate change—and concluded that those are always similar to or higher than operating a fossil fuel plant without carbon capture and higher than not capturing carbon from the air at all. Even when renewable electricity powers the capture equipment, Jacobson concludes that it is always better to use the renewable electricity instead to replace coal or natural gas electricity or to do nothing, from a social cost perspective. Given this analysis, Jacobson argues that the best solution is to instead focus on renewable options, such as wind or solar, replacing fossil fuels. This research is based on data from two real carbon capture plants, which both run on natural gas. The first is a coal plant with carbon capture equipment. The second plant is not attached to any energy-producing counterpart. Instead, it pulls existing carbon dioxide from the air using a chemical process. Jacobson examined several scenarios to determine the actual and possible efficiencies of these

Curiosities

CHEMWATCH

two kinds of plants, including what would happen if the carbon capture technologies ran with renewable electricity rather than natural gas, and if the same amount of renewable electricity required to run the equipment were instead used to replace coal plant electricity. While the standard estimate for the efficiency of carbon capture technologies is 85-90%, neither of these plants met that expectation. Even without accounting for upstream emissions, the equipment associated with the coal plant was only 55.4% efficient over 6 months, on average. With the upstream emissions included, Jacobson found that, on average over 20 years, the equipment captured only 10-11% of the total carbon dioxide equivalent emissions that it and the coal plant contributed. The air capture plant was also only 10-11% efficient, on average over 20 years, once Jacobson took into consideration its upstream emissions and the uncaptured and upstream emissions that came from operating the plant on natural gas. Due to the high energy needs of carbon capture equipment, Jacobson concludes that the social cost of coal with carbon capture powered by natural gas was about 24% higher, over 20 years, than the coal without carbon capture. If the natural gas at that same plant were replaced with wind power, the social cost would still exceed that of doing nothing. Only when wind replaced coal itself did social costs decrease. For both types of plants this suggests that, even if carbon capture equipment is able to capture 100% of the carbon it is designed to offset, the cost of manufacturing and running the equipment plus the cost of the air pollution it continues to allow or increases makes it less efficient than using those same resources to create renewable energy plants replacing coal or gas directly. "Not only does carbon capture hardly work at existing plants, but there's no way it can actually improve to be better than replacing coal or gas with wind or solar directly," says Jacobson. "The latter will always be better, no matter what, in terms of the social cost. You can't just ignore health costs or climate costs." This study did not consider what happens to carbon dioxide after capture but Jacobson suggests that most applications today, which are for industrial use, result in additional leakage of carbon dioxide back into the air. People propose that carbon capture could be useful in the future, even after we have stopped burning fossil fuels, to lower atmospheric carbon levels. Even assuming these technologies run on renewables, Jacobson maintains that the smarter investment is in options that are currently disconnected from the fossil fuel industry, such as reforestation—a natural version of air capture—and other forms of climate change solutions focused on eliminating other sources of emissions and pollution. These include reducing biomass burning, and reducing halogen, nitrous oxide, and methane emissions. "There is a lot of reliance on carbon capture in theoretical modelling,

Curiosities

CHEMWATCH

and by focusing on that as even a possibility, that diverts resources away from real solutions,” says Jacobson. “It gives people hope that you can keep fossil fuel power plants alive. It delays action. In fact, carbon capture and direct air capture are always opportunity costs.” The study appears in *Energy and Environmental Science*.

Futurity, 28 October 2019

<http://www.futurity.org>

Bacteria that can degrade pesticide linked to Bhopal Gas tragedy

2019-11-07

Researchers from the Indian Institute of Technology, Bombay have identified bacteria can reduce the amount of the pesticide carbaryl in soil, which was used in India for several years until it was banned last year. During the 1984 Bhopal gas tragedy, the gases that escaped and caused several thousand deaths and many lakh injuries was used to manufacture carbaryl. Carbaryl is known to be toxic to humans and has been banned in United Kingdom, Austria, Denmark, Sweden, Iran, Germany, and Angola. Prashant Phale and his team from IITB, along with Rakesh Sharma from Institute of Genomics Integrative Biology (CSIR-IGIB), Delhi, have identified a bacteria which can clean up this pesticide. The scientists found that three strains of the bacteria *Pseudomonas* can get rid of carbaryl. These bacteria can break down the pesticide three times faster than other similar bacteria which are known to break down carbaryl. “Carbaryl may stay back for years after the crop is harvested because it degrades slowly in the acidic soil as compared to alkaline soil. Also, repeated application of carbaryl in the fields increases its concentration to a level lethal for living beings”, said Phale in a release issued by the institute. The bacteria essentially uses the pesticide as food. The researchers speculate that the genes that allow the bacteria to breaking down carbaryl may have been acquired from other species of bacteria, through a process known as ‘horizontal gene transfer’, which is the transfer of genetic material between different organisms. Typically, genes are transferred within a species – from parent to offspring, during reproduction. The researchers have also understood how exactly the breakdown occurs. The researchers found that bacteria breaks down the pesticide into an intermediate product called 1-naphthol, which itself is highly toxic. To survive the 1-naphthol, the bacteria keeps it in a chamber outside the main body, and then slow slowly lets it in so that it can be broken down. An advantage of the bacteria is that they are not genetically modified organisms, and so there are no restrictions on their

Researchers from the Indian Institute of Technology, Bombay have identified bacteria can reduce the amount of the pesticide carbaryl in soil, which was used in India for several years until it was banned last year.

Curiosities

CHEMWATCH

use. The bacteria can also be used to treat waste water and effluents from industries using or producing carbaryl or 1-naphthol. The findings were published in the journal Applied and Environmental Biology.

The Economic Times, November 2019

<http://economictimes.indiatimes.com>

Wait, There's Hope! Here's How Humans Might Save Antibiotics

2019-11-07

People have a poor track record of preventing global disasters. But for antimicrobial resistance, an unlikely group of allies is making big promises. Last month, a massive group of business leaders and health officials gathered for one of the biggest events in the fight against antimicrobial resistance. Almost 350 parties showed up to pledge support for the AMR Challenge, a program whose goal is to make countries and corporations get serious about a major threat facing humanity: the gradual but catastrophic loss of drugs that can treat life-threatening infections, which leads to an estimated 700,000 deaths each year. By the standards of the public policy world, the New York event was an enormous success. Those executives and officials didn't just state their support, they made surprisingly detailed commitments. And the boldest moves came from a perhaps unlikely source: the business world. Dozens of hospital networks, both giant and small, pledged to reduce the prescriptions they write in-house, to keep from encouraging resistance. Huge retailers committed to tracking animal antibiotic use; Walmart, for instance, agreed to set guidelines for the suppliers that funnel meat to its more than 5,000 stores. Pharmaceutical manufacturers including Merck, one of the few US-based companies still making antibiotics, laid out a plan to invest more in basic research on new compounds. Fifty-five pharma and biotech companies promised to develop better rapid tests, which prevent unnecessary prescriptions, including Accelerate Diagnostics, based in Arizona, which committed a \$100 million program. Two manufacturers of veterinary vaccines announced they would educate veterinarians on alternatives to using antibiotics in farm animals. At a time when global challenges can seem paralyzing in their complexity, the New York convocation offers a ray of hope, an indication of how worldwide alliances can in fact take root. The AMR Challenge is the brainchild of staff at the US Centres for Disease Control and Prevention, who worked for 18 months to wrangle all those companies and entities into one room. In other settings, many of them might have considered each other competitors. But at least on this topic,

Curiosities

CHEMWATCH

they aligned themselves with a higher priority than profits at all costs. It should have happened a lot sooner. Three years ago, the United Nations held a landmark meeting to discuss antibiotic resistance. It was only the fourth time the UN had ever assembled to consider a health problem; the last such meeting had been over the international epidemic of Ebola in 2014. At the gathering, the UN's secretary general called antimicrobial resistance "a fundamental long-term threat to human health, sustainable food production, and development," and the director-general of the World Health Organization urged that "we are running out of time." At the end, representatives of all 193 states that make up the UN signed a resolution that committed their governments to developing national plans for reducing antibiotic overuse and misuse. But those words did not yield much action. So, officials at the CDC decided to step things up. Under the Obama administration, they had masterminded a meeting of health care and business leaders at the White House that produced hard commitments, along with a national action plan and an executive order. They figured that event could perhaps serve as a model for the rest of the world, says Michael Craig, the CDC's senior adviser for antibiotic resistance. "We thought we'd try to revisit the framework of the White House summit, in which people came ready to make commitments, but do it on a bigger scale." They got what they asked for. The commitments made at the September gathering reached across the spectrum of what causes antibiotic resistance, from cleaning dirty drinking water that transmits pathogens in communities, to preventing the infections occurring in long-term care facilities that prevent patients from going home and restricting the overmedication of the pets. The commitments also stretched across the planet, including a New York City operator of urgent care clinics and medical groups in India, Australia, and Tanzania. The range of the entities and companies underscores how complex a problem antibiotic resistance is. "Its complexity is second only to climate change," says Dame Sally Davies, who spoke at the New York event and who has worked for years to draw attention to resistance as the outspoken chief medical officer of the United Kingdom. (Davies stepped down from that post on September 30 to become the first female master of Trinity College, Cambridge.) "But that means there's room for every country to find a different way of tackling this." The challenge of course is the follow-through. "The key thing is, what are the next steps; what will be the measures of accountability?" says Matt Wellington, the antibiotics program director of US PIRG, a coalition of public-interest research groups, which committed to getting the six largest US restaurant chains to forgo meat raised with routine antibiotic use. "To make this mean something, every one of them is going to have to commit to hard goals." Accountability is difficult when there are no

Curiosities

CHEMWATCH

regulations on the horizon and no hints of enforcement to come. In the US, the Trump administration is unlikely to crack down on antibiotic use. And looking globally, the countries that use antibiotics the most are in the developing world and have other priorities for national action. But there's a positive spin too. Overwhelmingly, the commitments made in the CDC's challenge represented commercial interests taking responsibility for their own actions: using antibiotics more conservatively, making them more carefully, relying more on vaccines to make them less necessary. Attacking antibiotic overuse through commerce has already produced results: The year after the Obama administration tightened its rules, sales of antibiotics for use in farm animals dropped significantly. The reason it worked is that consumers made it clear to those companies they were ready for change. After all, administrations come and go; farming, pharma and health care are here for the long haul. If they can choose to change practices—and even, as they did in New York, be eager to show off what they've done—they may be more likely to stick with the changes for good.

Wired, 31 October 2019

<http://www.wired.com/news>

Scientists Now Know How Sleep Cleans Toxins From the Brain

2019-11-07

Laura Lewis and her team of researchers have been putting in late nights in their Boston University lab. Lewis ran tests until around 3:00 in the morning, then ended up sleeping in the next day. It was like she had jet lag, she says, without changing time zones. It's not that Lewis doesn't appreciate the merits of a good night's sleep. She does. But when you're trying to map what's happening in a slumbering human's brain, you end up making some sacrifices. "It's this great irony of sleep research," she says. "You're constrained by when people sleep." Her results, published in the journal *Science*, show how our bodies clear toxins out of our brains while we sleep and could open new avenues for treating and preventing neurodegenerative diseases like Alzheimer's. When we sleep our brains travel through several phases, from a light slumber to a deep sleep that feels like we've fallen unconscious, to rapid eye movement (REM) sleep, when we're more likely to have dreams. Lewis' work looks at non-REM sleep, that deep phase which generally happens earlier in the night and which has already been associated with memory retention. One important 2013 study on mice showed that while the rodents slept, toxins like beta amyloid, which can contribute to Alzheimer's disease, got swept away.

The synchronized brain waves of non-REM sleep may play a key role in preventing toxins from accumulating in a person's brain.

Curiosities

CHEMWATCH

Lewis was curious how those toxins were cleared out and why that process only happened during sleep. She suspected that cerebrospinal fluid, a clear, water-like liquid that flows around the brain, might be involved. But she wasn't sure what was unique about sleep. So, her lab designed a study that measured several different variables at the same time. Study participants had to lie down and fall asleep inside an MRI machine. To get realistic sleep cycles, the researchers had to run the tests at midnight, and they even asked subjects to stay up late the night before so people would be primed to drift off once the test began. Lewis outfitted the participants with an EEG cap so she could look at the electrical currents flowing through their brains. Those currents showed her which stage of sleep the person was in. Meanwhile, the MRI measured the blood oxygen levels in their brains and showed how much cerebrospinal fluid was flowing in and out of the brain. "We had a sense each of these metrics was important, but how they change during sleep and how they relate to each other during sleep was uncharted territory for us," she says. What she discovered was that during non-REM sleep, large, slow waves of cerebrospinal fluid were washing over the brain. The EEG readings helped show why. During non-REM sleep, neurons start to synchronize, turning on and off at the same time. "First you would see this electrical wave where all the neurons would go quiet," says Lewis. Because the neurons had all momentarily stopped firing, they didn't need as much oxygen. That meant less blood would flow to the brain. But Lewis's team also observed that cerebrospinal fluid would then rush in, filling in the space left behind. "It's a fantastic paper," says Maiken Nedergaard, a neuroscientist at the University of Rochester who led the 2013 study that first described how sleep can clear out toxins in mice. "I don't think anybody in their wildest fantasy has really shown that the brain's electrical activity is moving fluid. So that's really exciting." One big contribution of the paper is it helps show that the systems Nedergaard has been studying in mice are present and hugely important for humans too. "It's telling you sleep is not just to relax," says Nedergaard. "Sleep is actually a very distinct function." Neurons don't all turn off at the same time when we're awake. So, brain blood levels don't drop enough to allow substantial waves of cerebrospinal fluid to circulate around the brain and clear out all the metabolic by-products that accumulate, like beta amyloid.

The study also could have clinical applications for treating Alzheimer's. Recent attempts at developing medications have targeted beta amyloid. But drugs that looked promising at first all failed once they got into clinical trials. "This opens a new avenue," says Nedergaard. Instead of trying to act on one particular molecule, new interventions might instead focus on increasing the amount of cerebrospinal fluid that washes over

Curiosities

CHEMWATCH

the brain. That would help clear out beta amyloid but also could help with other molecules like tau, a protein that gets tangled in Alzheimer's patients' brains and harms the connections between neurons. Finding a way to clear out all of that garbage could be much more powerful than just focusing on one piece of the problem. "Aging is not just about one molecule," says Nedergaard. "Everything fails." These discoveries bring along their own set of questions. Lewis didn't study what happens during other stages of sleep, and she only looked at healthy young adults. But the methods she used were entirely non-invasive or as non-invasive as having people sleep in an MRI while hooked up to lots of machines can be. She didn't even inject any dye. That will make it easier to start studying older participants who may be developing neurodegenerative diseases.

Wired, 31 October 2019

<http://www.wired.com/news>

How Measles Leaves Kids Exposed to Other Diseases

2019-11-07

In the summer of 1907, a German doctor named Clemens von Pirquet noticed something strange with one of his patients. The five-year-old boy had previously tested positive for tuberculosis. The test involved injecting a tiny bit of TB protein just under the skin. His antibodies recognised it, activating immune cells which formed a little bump at the injection site. This happens to anyone who has ever been infected with TB. But when Pirquet performed the same test on the boy a second time, no bump. Puzzled, he looked through the boy's medical history. The only thing different was that the boy had come down with a case of measles between the two tests. Curious, Pirquet rummaged through his case file, where he found dozens of other patients who'd previously tested positive for TB only to have their immune response disappear either during or shortly after a bout with measles. His report on this strange phenomenon was the first clue that the measles virus didn't just cause a high fever and a nasty rash. Something more insidious was going on. Since then, advances in modern science have helped fit together the puzzle of how the virus simultaneously induces, among its survivors, lifelong protection from measles itself, while crippling victims' immune systems against other infectious agents, sometimes for years. Now two papers, published in the journals *Science* and *Science Immunology*, drop some of the final pieces of this so-called measles paradox into place. The new research shows exactly how the measles virus devastates the cells that produce antibodies, damaging the body's ability to remember the

New techniques allow researchers to get definitive numbers on how the virus depletes its victims' antibodies and the memory cells that make them.

Curiosities

CHEMWATCH

pathogens it's already been exposed to and inducing a profound "immune amnesia." With measles surging globally once again, understanding the virus' long-lasting effects could have sweeping implications for public health. After the measles vaccine was first introduced in the 1960s, global vaccination campaigns didn't just slow its spread. It also caused all forms of childhood deaths to plummet by up to 50 percent in resource-poor countries, and up to 90 percent in the most impoverished corners of the world. While obviously a boon for public health, these massive improvements mystified epidemiologists. Measles may be the planet's most contagious human pathogen, but on its own is not a very lethal disease. Some pointed to the fact that children who tend to get vaccines likely have better health care, and access to clean water and food. Others hypothesized that the measles vaccine must be protecting kids against other kinds of deadly infectious diseases too. But that notion never really sat well with evolutionary biologist Michael Mina. "Every single day, kids are putting dirt in their mouth and inhaling rhinovirus particles, so how could one vaccine be boosting their immune system so much for years?" he says. "It just didn't make sense." In 2015, he published a more plausible explanation for the 50-year-old mystery. He and his collaborators pulled population-level epidemiological data from the US, UK, and Denmark, and compared mortality rates in children between the pre- and post-vaccine eras. They found that for two to three years after measles epidemics spiked, non-measles deaths also increased. They argued that the virus was predisposing children to other infectious diseases. No one had noticed before because in the pre-vaccine era, virtually everyone got measles. Earlier clues had suggested something like this was going on. As far back as the 1940s, doctors observed that patients with auto-immune-related disorders went into remission following a measles infection. In 2000, scientists discovered that measles preferentially went after cells in the bone marrow responsible for storing immune memories. One study, from 2007, showed just how ravenous its tastes were—in just a few weeks, the measles virus could infect and destroy half a person's population of these so-called memory B cells. Another, from 2012, proposed that this depletion might lead to a long-term erasure, or immune amnesia. So, after an infection a child's immune system has to start over, rebuilding its protections against pathogens it's already seen. Mina's study provided compelling real-world evidence for the theory of immune amnesia. But critically, it didn't show a mechanism of how it worked. It wasn't enough to convince public health officials and policymakers that it was a real thing. That's when technology and a little bit of luck stepped in.

Curiosities

CHEMWATCH

About a week after Mina published his paper in *Science*, researchers at Harvard Medical School unveiled a new, powerful way to probe people's immune systems. At the time, scientists could only fish inside a person's bloodstream for one antibody at a time, at a cost of about \$30 each. The new technique, called VirScan, made it possible to simultaneously scoop up hundreds of thousands of antibodies—to all the pathogens someone's ever been exposed to—in a single drop of blood. Mina wanted to try it. And he knew just who to talk to about getting the perfect sample. Years before, one of his collaborators, a Dutch immunopathologist named Rik de Swart, had stumbled upon a scientific goldmine in the Netherlands' Bible Belt. Fundamentalist Protestant families there are vehemently opposed to vaccines on religious grounds. But they were open to participating in one of de Swart's studies. As a measles epidemic swept through the tight-knit community in 2013, his team collected blood samples from 90 children ages 4 to 17 who had no clinical signs of measles. They returned again months later, after 77 of them had fallen ill to the virus. This second blood sample collection provided a rare opportunity to examine the effects of the measles virus on the kids' immune systems. At the time de Swart had plans to team up with a group of scientists from the Wellcome Sanger Institute and Cambridge University who wanted to sequence the antibody-making genes in memory B cells before and after a measles infection. Using the Dutch samples, they discovered that the virus actually resets the immune system to an immature state, limiting how well it can respond to new infections, as they report today in *Science Immunology*. While that work was going on in the UK, Mina connected de Swart with the Harvard team, whom he joined in 2016 for a medical residency. At first, they planned to just run a small test pilot of a few of the Dutch samples through VirScan. But Mina still remembers getting the email with the first results. "It said 'We see this curious reduction in overall antibodies, which fit perfectly with the immune amnesia hypothesis,'" he says. "It was a first glimpse. But none of us had any idea the effect would be so massive." To make sure what they were seeing was real, they tested the full cohort and added in controls—children who had never been exposed to measles, as well as those who'd received the MMR vaccine, to get a general baseline for antibody fluctuations. The effect was still startling. Two months after measles infection, between 11 and 73 percent of individuals' antibody repertoires remained wiped out by the virus. On average, kids lost about 20 percent of the antibody diversity they'd had, including protection to all the major childhood diseases—influenzas, pneumonia, and common cold and stomach bugs. They reported these findings in *Science*. Together, the new research makes the immune amnesia hypothesis indisputable, says Roberto Cattaneo, a measles researcher at the Mayo Clinic, who was one of

Curiosities

CHEMWATCH

the first to show the virus decimated immune cells and was not involved in either study. "This demonstrates with experimental data hard proof of what we think has been happening," he says. "If somebody had doubts before, those are all gone."

But Mina, who started his own epidemiology lab at Harvard earlier this year, says there's still more work to be done. The biggest outstanding question is just how long the amnesia lasts. His study was performed in healthy kids from a high-income nation with only two time points. No one knows yet what the effect looks like in malnourished populations, where most measles outbreaks actually strike. He's in the midst of setting up clinical studies in Nigeria and Romania to better understand the disease's dynamics in different environmental settings. The answers will have important public health implications, including how long after a measles infection, children should undergo increased monitoring, or even additional vaccinations. "The effects we've found might just be the tip of the iceberg," says Mina. That work could be crucial to convincing governments to improve vaccine access in parts of the world where resources are strained. As for Europe and the US, which saw large outbreaks this year in enclaves of vaccine hesitancy, it remains to be seen if today's scientific revelations prove a useful tool for public health officials and pro-vaccine advocates in the fight against vaccine misinformation. The more complicated immunological picture makes one thing for sure though—measles is more than just skin deep.

Wired, 31 October 2019

<http://www.wired.com/news>

Roundup weedkiller: 42,000 plaintiffs sue Bayer over glyphosate

2019-11-07

More than 42,000 plaintiffs have joined lawsuits against German chemical giant Bayer, blaming the company's glyphosate-based weedkiller for their cancer. The number of plaintiffs, largely brought by US citizens, is now at 42,700 — more than double the 18,400 reported in the middle of July, Bayer has announced. The legal cases all concern Roundup, a weedkiller with controversial active ingredient glyphosate. "This significant increase is clearly driven by the plaintiff-side television advertising spend which is estimated to have roughly doubled in the third quarter compared with the entire first half of the year," Bayer said in a statement. "However, the number of lawsuits says nothing about their merits," it added. Claims

Lawsuits against Bayer are on the rise over claims that the company's weedkiller causes cancer. The legal cases have taken a toll on Bayer's share price and reputation.

Curiosities

CHEMWATCH

against the company gathered momentum following a lawsuit in August 2018 that found Monsanto, a Bayer subsidiary, should have warned of alleged cancer risks associated with its glyphosate-based weedkillers. Bayer's shares have dropped 30% since then. The company said it was engaged in a mediation process ordered by a federal judge in California. In 2015, the World Health Organization's International Agency for Research on Cancer (IARC) said glyphosate, the world's most commonly used herbicide, was "probably carcinogenic to humans."

DW, 30 October 2019

<http://www.dw.com>

Stress disorders tied to risk for life-threatening infections

2019-11-07

People who have stress disorders like PTSD may be more vulnerable to potentially life-threatening infections, especially if they are diagnosed at younger ages or dealing with other psychiatric issues, a recent study suggests. Researchers examined data on 144,919 people diagnosed with post-traumatic stress disorder (PTSD), adjustment disorders common after a major life change like a death or move, and other stress-related conditions. They also looked at data for 184,612 siblings of these subjects who didn't have a stress disorder, along with more than 1.4 million unrelated individuals without these disorders. After an average follow-up of eight years, the annual incidence of life-threatening infections – including infections of the nervous system or heart – was 2.9 in every 1,000 people with stress disorders, compared with 1.7 in every 1,000 siblings and 1.3 in every 1,000 unrelated individuals. "Severe or prolonged emotional stress causes alterations in multiple bodily functions through dysregulation in the release of stress hormones," said Dr. Huan Song, lead author of the study and a researcher at the Karolinska Institute in Stockholm. "The hypothesis behind our research is that a severe reaction to trauma or other life stressors, through these pathways, leads to impaired immune function and thereby susceptibility to infection," Song said by email. Previous research has linked stress to an increased risk of acute and respiratory infections, the study authors note in *The BMJ*. The current analysis, however, focused only on life-threatening infections, including endocarditis caused by infections of the lining of the heart chambers and heart valves, meningitis and other nervous system infections, and infections that lead to sepsis. During the study, a total of 2,197 people with a history of stress disorders developed life-threatening

People who have stress disorders like PTSD may be more vulnerable to potentially life-threatening infections, especially if they are diagnosed at younger ages or dealing with other psychiatric issues, a recent study suggests.

Curiosities

CHEMWATCH

infections, as did 2,646 of their siblings. People with stress disorders were 47% more likely to develop infections than those without any history of stress-disorders. When people with stress disorders took certain antidepressant medications over the first year after their diagnosis, they were 19% less likely to develop life-threatening infections later on, the study also found. The study wasn't a controlled experiment designed to prove whether or how stress disorders might increase risk of infections, or to what extent any treatment for stress might alter the infection risk. One limitation of the analysis is that it relied on outpatient clinic records to identify people with stress disorders, and it's possible this might have omitted patients with milder cases, the study authors note. Researchers also lacked data on certain lifestyle habits that can also impact infection risk, like smoking, drinking and illegal drug use. Even so, the findings add to a large body of evidence linking PTSD and other stress-related mental health problems to an increased risk of poor physical health, Jonathan Bisson of Cardiff University School of Medicine in the UK writes in an editorial accompanying the study. "The main message to patients suffering from severe emotional reactions after trauma or other life stressors is it is important to seek treatment or timely medical care," Song said.

Reuters Health, 1 November 2019

<http://www.reuters.com/news/health>

Babies at higher risk for ADHD, autism if pregnant moms took acetaminophen

2019-11-07

Babies born to women who used acetaminophen late in pregnancy may be at increased risk of ADHD and autism spectrum disorder, a new study suggests. After examining stored blood samples from babies' umbilical cords, researchers determined that the risks of ADHD and autism were significantly increased in children whose blood had high levels of acetaminophen breakdown products, according to a report in *JAMA Psychiatry*. "Our findings corroborate previous studies that were based on maternal self-report of acetaminophen use and they warrant additional investigations," said Dr. Xiaobin Wang, a professor of paediatrics at the Johns Hopkins School of Medicine in Baltimore and director of the Centre on Early Life Origins of Disease at the Johns Hopkins Bloomberg School of Public Health. This study, "provides objective evidence of foetal exposure to acetaminophen in utero." Earlier research showed that acetaminophen can cross through the placenta, Wang noted. Because the metabolites, or breakdown products, of the drug appear to linger

Babies born to women who used acetaminophen late in pregnancy may be at increased risk of ADHD and autism spectrum disorder, a new study suggests.

Curiosities

CHEMWATCH

for nearly two days, researchers are able to get an estimate of maternal acetaminophen use in the hours before delivery. For a window on the possible impact of acetaminophen exposure on babies' risks of developing certain neurodevelopmental disorders, the researchers turned to data from the Boston Birth Cohort. That database includes only births that produced a single child. It excludes babies conceived with the help of IVF and those born with major birth defects. Wang and her colleagues focused on 996 mother-infant pairs, for whom there was sufficient cord blood in the samples for an analysis of acetaminophen metabolites. At the time of the study, the children's average age was 9.8 years, with 257 having been diagnosed only with ADHD, 66 with autism spectrum disorder (ASD) only, 42 with both ADHD and ASD, 304 with other developmental disabilities and 327 who were developing typically. All of the cord samples contained some detectable acetaminophen, the researchers note. When they compared children with cord blood containing the highest levels of acetaminophen metabolites to those with the lowest levels, they found a significant association between acetaminophen metabolite levels and neurodevelopmental disorders. Those at the highest levels were 2.86 times more likely than those at the lowest to have been diagnosed with ADHD and 3.62 times more likely to have an ASD diagnosis. Because metabolite levels were measured only around the time of birth, the researchers can't say anything about how often the mothers took the drug or at which points during pregnancy, Wang said. "Our study opened inquiry for further investigation," she added. Dr. Hyagriv Simhan isn't ready to tell his pregnant patients to stop using acetaminophen. "There are some limitations to the study," said Simhan, executive vice chair, obstetrical services at UPMC Magee-Womens Hospital in Pittsburgh, Pennsylvania. "First, the acetaminophen metabolite levels in the cord blood only reflects acetaminophen use around the time of delivery and doesn't reflect exposure to acetaminophen during other points in the pregnancy," he said. "Also, although the authors tried to account for the reason that acetaminophen was used, this process was fairly limited in this study," Simhan noted in an email. "Thus, this makes it harder to separate the effect of acetaminophen itself from the underlying reason for the use of acetaminophen." Beyond that, Simhan said, "in the grand scheme, the effect described in this study is not a large one."

Reuters Health, 31 October 2019

<http://www.reuters.com/news/health>

Technical Notes

CHEMWATCH

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

ENVIRONMENTAL RESEARCH

Characteristics of growth and microcystin production of *Microcystis aeruginosa* exposed to low concentrations of naphthalene and phenanthrene under different pH values

Development and use of interspecies correlation estimation models in China for potential application in water quality criteria

Suspect screening of plastic-related chemicals in northern pike (*Esox lucius*) from the St. Lawrence River, Canada.

The dataset for antifeedant activity of eugenol derived compounds against red palm weevil (*Rhynchophorus ferrugineus*, Olivier) larvae

Green kiwifruit extracts protect motor neurons from death in a spinal muscular atrophy model in *Caenorhabditis elegans*

MEDICAL RESEARCH

Oestrogen-related receptor γ is a novel target for Lower-Chlorinated Polychlorinated Biphenyls and their hydroxylated and sulfated metabolites

Developmental Exposure to a Mixture of Unconventional Oil and Gas Chemicals Increased Risk-Taking Behaviour, Activity and Energy Expenditure in Aged Female Mice After a Metabolic Challenge

Mono-2-ethylhexyl phthalate (MEHP) promoted lipid accumulation via JAK2/STAT5 and aggravated oxidative stress in BRL-3A cells

Characterisation of rat glutathione transferases in olfactory epithelium and mucus

Toxicogenomic analyses of the effects of BDE-47/209, TBBPA/S and TCBCPA on early neural development with a human embryonic stem cell in vitro differentiation system

OCCUPATIONAL RESEARCH

EXPO-S.T.O.P. 2016 and 2017 blood exposure surveys: An alarming rise

Declining blood lead levels among small-scale miners participating in a safer mining pilot programme in Nigeria

Technical Notes

CHEMWATCH

Antifibrotic treatment response and prognostic predictors in patients with idiopathic pulmonary fibrosis and exposed to occupational dust

Setting up a collaborative European human biological monitoring study on occupational exposure to hexavalent chromium

An atypical Bacillus anthracis infection in a bull-A potential occupational health hazard

PUBLIC HEALTH RESEARCH

Biomonitoring of populations in Western New York at risk for exposure to Great Lakes contaminants

German Environmental Specimen Bank: 24-hour urine samples from 1999 to 2017 reveal rapid increase in exposure to the para-phthalate plasticiser di(2-ethylhexyl) terephthalate (DEHTP).

Do stressful life events during pregnancy modify associations between phthalates and anogenital distance in newborns?

Oxidative Stress Markers, Trace Elements and Endocrine Disrupting Chemicals in Children with Hashimoto's Thyroiditis

Chemical characterisation and bioactivity of phenolics from Tieguanyin oolong tea