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CONTACT US

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

1227 Glen Huntly Rd
Glen Huntly
Victoria 3163 Australia

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

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ASIA PACIFIC

Key information about the new scheme

2019-12-05

There is now a new Australian industrial chemicals law – the Industrial Chemicals Act 2019. This law creates a new regulatory scheme for the importation and manufacture of industrial chemicals in Australia (to replace NICNAS) from 1 July 2020. This law also gives effect to the ban on the use of new animal test data for ingredients solely used in cosmetics.

Industrial Chemicals General Rules, Categorisation Guidelines and Transitional Rules — now final

On 2 December 2019, after extensive consultation with stakeholders, NICNAS announced that key documents are now final. These documents are as follows:

- Industrial Chemicals (General) Rules 2019
- Industrial Chemicals Categorisation Guidelines (final draft)
- Industrial Chemicals (Consequential Amendments and Transitional Provisions) Rules 2019

NINCAS will soon release stakeholder submissions following the public consultations on the General Rules and Categorisation Guidelines summary of submissions and our responses to issues raised

General Rules

The General Rules set out the details for the regulation of the importation and manufacture of industrial chemicals in Australia under AICIS.

- [View the General Rules](#)
- [View the Explanatory Statement to the General Rules](#)
- [Read our summary of key changes we've made to the General Rules](#)

Categorisation Guidelines (final draft)

The final draft Categorisation Guidelines set out technical details and requirements of the importation and manufacture of industrial chemicals in Australia. The Executive Director of AICIS will sign-off on these Guidelines so they take effect from 1 July 2020. Further information is available at:

- [Download the Categorisation Guidelines \[PDF 728 KB\]](#)
- [Download the Categorisation Guidelines \[Word 141 KB\]](#)

There is now a new Australian industrial chemicals law – the Industrial Chemicals Act 2019.

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- [List of chemicals with high hazard for categorisation \[Excel 797 KB\]](#)
- [Read our summary of key changes we've made to Categorisation Guidelines](#)

Transitional Rules

The Transitional Rules cover matters relating to the changeover from NICNAS to AICIS. They will work together with the Industrial Chemicals (Consequential Amendments and Transitional Provisions) Act 2019.

- [View the Transitional Rules](#)
- [View the Explanatory Statement to the Transitional Rules](#)

Transitional highlights

NICNAS exemption categories will continue to be available until 31 August 2022 for introduction of chemicals not listed on the AICIS Inventory. NICNAS low volume and controlled use permits will remain in force until at least 30 June 2022. Further information is available at:

- [Go to our transitions section to find answers to your most asked questions](#)
- [View the Transitional Provisions Act](#)

Other legislation

There is also 3 Industrial Chemicals Charges Acts authorising the imposition of charges on importers and manufacturers of industrial chemicals.

- [View the Industrial Chemicals Charges \(Customs\) Act 2019](#)
- [View the Industrial Chemicals Charges \(Excise\) Act 2019](#)
- [View the Industrial Chemicals Charges \(General\) Act 2019](#)

NICNAS, 3 December 2019

http://www.nicnas.gov.au/Publications/Chemical_Gazette

Request for information on industrial uses of certain chemicals on the Inventory

2019-12-05

The National Industrial Chemicals Notification and Assessment Scheme's (NICNAS) new scheme, the Australian Industrial Chemicals Introduction Scheme (AICIS), starts on 1 July 2020. It will be governed by a new law — the Industrial Chemicals Act 2019 (IC Act). The Australian Inventory of Industrial Chemicals (the new Inventory) will replace the Australian

The Australian Inventory of Industrial Chemicals (the new Inventory) will replace the Australian Inventory of Chemical Substances (the current Inventory)

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Inventory of Chemical Substances (the current Inventory). Section 80 of the IC Act mandates that the new Inventory must only contain industrial chemicals. At the moment, NICNAS believe that the current Inventory lists more than 1600 chemicals that are not — and are not likely to ever have been — industrial chemicals, and are (or have been) used solely as:

- an agricultural chemical
- a veterinary chemical
- a medicine or therapeutic, or
- a food or food additive

Chemicals used in this way are not industrial chemicals and are regulated by other agencies. Under the Industrial Chemicals (Notification and Assessment) Act 1989, these are called 'excluded use' chemicals.

Removal of non-industrial chemicals from the Inventory before the new scheme starts

NICNAS have prepared a list of chemicals on the current inventory that we believe do not have (and have not had) an industrial use and need to be removed. A list of the excluded chemicals is available at: [View the list of excluded use chemicals](#). The agency intends to remove from the current Inventory all chemicals on the list that have no industrial use before the new scheme starts. The new Inventory will then contain chemicals used only for industrial purposes.

Relevant legislation informing this action

Do you know of any chemical on this list that has an industrial use?

If you are aware of any chemicals on this list that have an industrial use, NICNAS need to know:

- the chemical name
- the CAS number
- the industrial use of the chemical

You can let us know by submitting this form

Please note that it is an offence under the Criminal Code Act 1995 to provide false or misleading information.

Due date

You must submit the information by 31 March 2020. If the information is submitted after this date, NICNAS will:

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- consider the information received
- remove any chemical without an industrial use from the Inventory, and
- publish a list of these chemicals on the NICNAS website

Any chemical that has an industrial use as well as an excluded use will not be removed.

Relevant legislation

Section 50 of the Industrial Chemicals (Consequential Amendments and Transitional Provisions) Act 2019, and Associated requirements set out in section 66 of the Industrial Chemicals (Consequential Amendments and Transitional Provisions) Rules 2018 (Transitional Rules)

Section 66 Transitional Rules excerpt: 66 Removing chemicals that have been wrongly listed on the Inventory

(1) This section applies if:

(a) immediately before the commencement day, a chemical was listed in the non-confidential section of the old Inventory*; and
(b) the chemical is not an industrial chemical under the old law or the new law.

(2) For the purposes of the new law and the transitional Act, the chemical is taken to have never been listed in the old Inventory.

(3) The Executive Director must publish on the NICNAS website a list of the chemicals to which this section applies.

Previous consultations on this issue

This is the third round of consultation. It follows our previous consultations on these chemicals, which we did under the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework.

Background information on the current Inventory

The current Inventory was developed over 4 phases from the late 1970s until 1990. During these development phases (most of which occurred prior to the establishment of NICNAS), industry was encouraged to nominate any chemicals (not only industrial chemicals) that were in use in Australia. This resulted in the inclusion of a number of chemicals on the current Inventory that are not, and never have been, industrial chemicals.

*the old inventory is the current Inventory under the Industrial Chemicals (Notification and Assessment) Act, 1989

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Further information is available at:

- [Learn more about how the IC Act defines an industrial chemical](#)
- [Learn more about excluded use chemicals](#)

NICNAS Chemical Gazette, 3 December 2019

http://www.nicnas.gov.au/Publications/Chemical_Gazette

Proposal to change the classification system for hazardous substances in New Zealand

2019-12-05

New Zealand's Environmental Protection's (EPA) has proposed to update the current classification framework for hazardous substances to the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Revision 7 (2017). The GHS is an internationally agreed system developed by the United Nations to classify chemicals and communicate their hazards through labels and safety data sheets. If adopted, it will ensure an internationally-aligned classification system for hazardous substances that facilitates trade, increases efficiency in chemicals management, and enhances the effectiveness of the Hazardous Substances and New Organisms Act 1996. If GHS 7 is adopted, a new EPA Classification Notice will be issued that incorporates GHS 7 by reference. This Notice would align with the EPA Labelling and Safety Data Sheet Notices, which already require compliance with the GHS. Having the classification system and compliance requirements aligned will reduce complexity for everyone. We see a lot of benefits to adopting GHS, but are also mindful that there are costs and resource implications for others in doing this, and this is one of the areas we are hoping to get feedback on. There are also a range of technical proposals we are seeking input on, for example which particular parts of the GHS we should adopt in New Zealand. The agency believe that this consultation document will be of specific interest to applicants for new hazardous substances approvals, producers of safety data sheets, importers and manufacturers, industry organisations, relevant health sector bodies, Non-Governmental Organisations, and other regulators especially those that administer legislation that refers to the current HSNO classification system. Further information on the proposal is available at: [Read the consultation document \(pdf 1.27MB\)](#)

[Make a submission](#)

New Zealand's Environmental Protection's (EPA) has proposed to update the current classification framework for hazardous substances to the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Revision 7 (2017).

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A submission can be made by completing the [online form](#). Submissions close on 9 January 2020.

NZ EPA, 29 October 2019

<http://www.epa.govt.nz>

South Korea Completes Domestic Approval Process for the Minamata Convention on Mercury

2019-12-05

On 21 November, South Korea MoE issued a [Notice](#) that the Minamata Convention on Mercury had been approved internally. The approval document was submitted to the United Nations on 22 November. The approval document, which sets requirements on the safety management of mercury manufacturing, importation, exportation, and disposal, is scheduled to take effect 90 days after being received and deposited by the UN. The Minamata Convention was agreed to, signed in October 2013, and entered into force in August 2017 in accordance with the United Nations Environment Programme. After signing the Minamata Convention in September 2014, South Korea made proper legal preparations to meet the obligations in the agreement and completed all preparations recently. As mentioned above, the Convention specifies the safety management for the entire life of mercury and mercury compounds. In the Notice, MoE showed major control measures and corresponding regulation basis, which were gradually completed since the Convention had been signed. Here are the major management measures:

- Mercury mining is prohibited, and existing mercury mining must close within 15 years.
- Since 2020, the manufacture and import-export agreement of eight mercury-added products shall be banned, and the use of dental amalgam shall decrease.
- From 2025, Chlorine-alkali production using mercury will stop.
- Mercury can be exported when it meets the use permitted in the agreement, or it is environmentally-friendly temporary storage, while the written consent of the importing country is required.
- Grasp discharge facilities that can release mercury into the atmosphere, rivers, and soil, and conduct discharge surveys and set discharge permit standards to reduce emissions.
- The temporary storage of non-waste mercury and the treatment of mercury waste need to adopt environmentally sound methods.

The South Korea approval document on the Minamata Convention was completed and submitted to the United Nations on 22 November. The requirements in the approval document are scheduled to enter into effect 90 days after deposition.

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- Carry out surveys on the health effects of mercury exposure and reviews on pollution standards in the environment, etc.

As so far, South Korea completed the implementation of the above measures in domestic management regulations. However, there are still new control measures that are newly added in the approval document, which is worth noting for stakeholders. Further information is available at: [MoE Notice](#)

Chemlinked, 26 November 2019

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

AMERICA

US EPA rescinds chemical industry safety provisions

2019-12-05

The United States Environmental Protection Agency has finalised an overhaul to its industry Risk Management Program (RMP), weakening provisions intended to protect communities and workers from industrial accidents at some 12,500 plants that use, make, or store some of the world's most dangerous chemicals. The RMP rule goes back to 1990 but was revised after a deadly ammonium nitrate fertiliser explosion in West, Texas, in 2013. Fifteen people were killed, mostly emergency responders. Nearby, a school, a nursing home, and an apartment building and other homes suffered damage. With some fanfare, then-president Barack Obama ordered a sweeping examination of federal industrial safety regulations. The EPA at that time reported that some 1,500 accidents occurred over a recent 10-year period at RMP-covered facilities. Those accidents led to nearly 60 deaths, 17,000 injuries, the evacuation of 500,000 people, and property damage of more than \$2 billion. The RMP modification was the only significant regulatory change to emerge from the review, and it was issued in the last days of Obama administration. The Trump administration's first EPA head, Scott Pruitt, attempted to withdraw the regulation but was challenged by community groups and labor unions and eventually blocked by a court order. The EPA then began the process to re-propose and finalise a replacement regulation. Among changes announced by the EPA on 21 November, the new RMP regulation removes earlier provisions calling for independent, third-party audits of companies after an accident or a near-accident. It also eliminates requirements for root-cause accident investigations and for companies with poor safety records to consider inherently safer manufacturing approaches. Because

Risk Management Program update reverts changes made in response to West, Texas, fertiliser explosion

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of security concerns, the new rule also rescinds provisions allowing the public to obtain facilities' hazard information and for community emergency planning. The updated rule "maintains important public safety measures while saving Americans roughly \$88 million per year," current EPA administrator Andrew Wheeler says in a statement. Overall, Wheeler says that under the Trump administration, the EPA has finalised 48 deregulatory actions, saving industry more than \$5 billion in regulatory costs. The American Chemistry Council, a chemical industry trade association, applauds the changes and the EPA's willingness to consider public input. "Most importantly, EPA's changes to RMP will provide a strong regulatory framework for our industry to continue our work to safeguard chemical facilities and to work with our state and local partners to plan for a potential emergency," Mike Walls, the ACC's vice president of regulatory and technical affairs, says in a statement. However, Michele Roberts, head of the Environmental Justice Health Alliance for Chemical Policy Reform, a network of grassroots environmental justice organisations, says that 177 million people live next to RMP-covered sites. Many of those people are low-income communities and communities of colour, she notes. "EPA's own analysis demonstrated that our communities are at disproportionate risk of chemical disasters, on top of the many other toxic hazards we experience daily," she says in a statement. "This is environmental racism."

Chemical & Engineering News, 22 November 2019

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

EPA Moves Forward on Key Drinking Water Priority Under PFAS Action Plan

2019-12-05

The United States Environmental Protection Agency (EPA) sent the proposed regulatory determination for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in drinking water to the Office of Management and Budget for interagency review. This step is an important part of EPA's extensive efforts under the PFAS Action Plan to help communities address per- and polyfluoroalkyl substances (PFAS) nationwide. "Under President Trump, EPA is continuing to aggressively implement our PFAS Action Plan – the most comprehensive cross-agency plan ever to address an emerging chemical," said EPA Administrator Andrew Wheeler. "With today's action, EPA is following through on its commitment in the Action Plan to evaluate PFOA and PFOS under the Safe Drinking Water Act." The action will provide proposed determinations for at least five contaminants listed on the fourth Contaminant Candidate List

The United States Environmental Protection Agency (EPA) sent the proposed regulatory determination for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in drinking water to the Office of Management and Budget for interagency review.

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(CCL4), including PFOA and PFOS, in compliance with Safe Drinking Water Act requirements.

Background

The Safe Drinking Water Act establishes robust scientific and public participation processes that guide EPA's development of regulations for unregulated contaminants that may present a risk to public health. Every five years, EPA must publish a list of contaminants, known as the Contaminant Candidate List or CCL, that are known or anticipated to occur in public water systems and are not currently subject to EPA drinking water regulations. EPA publishes draft CCLs for public comment and considers those prior to issuing final lists. After issuing the final CCL, EPA determines whether or not to regulate five or more contaminants on the CCL through a process known as a Regulatory Determination. EPA publishes preliminary regulatory determinations for public comment and considers those comments prior to making final regulatory determinations. If EPA makes a positive regulatory determination for any contaminant, it will begin the process to establish a national primary drinking water regulation for that contaminant. For more information: www.epa.gov/ccl

Background on the PFAS Action Plan

PFAS are a large group of man-made chemicals used in consumer products and industrial processes. In use since the 1940s, PFAS are resistant to heat, oils, stains, grease, and water—properties which contribute to their persistence in the environment. The agency's PFAS Action Plan is the first multi-media, multi-program, national research, management and risk communication plan to address a challenge like PFAS. The plan responds to the extensive public input the agency received during the PFAS National Leadership Summit, multiple community engagements, and through the public docket. The PFAS Action Plan outlines the tools EPA is developing to assist states, tribes, and communities in addressing PFAS. EPA is taking the following highlighted actions:

Highlighted Action: Drinking Water

EPA is committed to following the national primary drinking water regulation rulemaking process as established by the Safe Drinking Water Act (SDWA). EPA has sent the proposed regulatory determination for PFOA and PFOS to the Office of Management and Budget for interagency review. The agency is also gathering and evaluating information to determine if regulation is appropriate for other chemicals in the PFAS family.

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Highlighted Action: Clean-up

On 10 June 2019, EPA concluded public comment on the draft *Interim Recommendations for Addressing Groundwater Contaminated with PFOA and PFOS*, when finalised it will provide clean-up guidance for federal clean-up programs (e.g., CERCLA and RCRA) that will be helpful to states and tribes. EPA is initiating the regulatory development process for listing certain PFAS as hazardous substances under CERCLA.

Highlighted Action: Monitoring

EPA will propose nationwide drinking water monitoring for PFAS under the next UCMR monitoring cycle.

Highlighted Action: Toxics

EPA has issued an advanced notice of proposed rulemaking that would allow the public to provide input on adding PFAS to the Toxics Release Inventory toxic chemical list. A supplemental proposal to ensure that certain persistent long-chain PFAS chemicals cannot be manufactured in or imported into the United States without notification and review under the TSCA is currently undergoing interagency review at the Office of Management and Budget.

Highlighted Action: Surface Water Protection

EPA plans to develop national Clean Water Act human health and aquatic life criteria for PFAS, as data allows. EPA is examining available information about PFAS released into surface waters by industrial sources to determine if additional study is needed for potential regulation.

Highlighted Action: Biosolids

EPA will be developing risk assessments for PFOA and PFOS to understand any potential health impacts.

Highlighted Action: Research

On 22 November 2019, EPA announced availability of \$4.8 million in funding for new research on managing PFAS in agriculture. EPA continues to compile and assess human and ecological toxicity information on PFAS to support risk management decisions. EPA continues to develop new methods to test for additional PFAS in drinking water. The agency is also validating analytical methods for surface water, ground water, wastewater, soils, sediments and biosolids; developing new methods to test for PFAS in air and emissions; and improving laboratory methods to discover

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unknown PFAS. EPA is developing exposure models to understand how PFAS moves through the environment to impact people and ecosystems. EPA continues to assess and review treatment methods for removing PFAS in drinking water. EPA is working to develop tools to assist officials with the clean-up of contaminated sites.

Highlighted Action: Enforcement

EPA uses enforcement tools, when appropriate, to address PFAS exposure in the environment and assists states in enforcement activities.

Highlighted Action: Risk Communications

EPA will work collaboratively to develop a risk communication toolbox that includes multi-media materials and messaging for federal, state, tribal, and local partners to use with the public. A full summary of EPA's action to address PFAS can be found in the PFAS Action Plan: <https://www.epa.gov/pfas/epas-pfas-action-plan>

U.S EPA, 4 December 2019

<http://www.epa.gov>

Lawmaker subpoenas US EPA over formaldehyde review

2019-12-05

House Democrats claim that the EPA completed a draft IRIS assessment in the fall of 2017, showing a link between formaldehyde exposure and leukemia. The EPA, however, did not release that assessment. Johnson requested information from the EPA several times this year about its decision to halt the formaldehyde assessment. The agency provided insufficient responses every time, she claims. "These subpoenas come after eight months of EPA delays and obfuscation in providing the Committee with information necessary for the oversight of the IRIS program and its review of the chemical formaldehyde," Johnson writes in a letter to EPA Administrator Andrew Wheeler sent with the subpoenas. In a 15 November statement, the EPA calls the committee's action "reckless and unjustified." The agency claims that it has complied with all of the committee's requests related to the IRIS program.

Chemical & Engineering News, 22 November 2019

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

**House Democrat
claims agency provided
useless information
to multiple request**

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Monsanto Agrees to Plead Guilty to Illegal Use of Methyl Parathion and to Pay \$10.2M in Penalties and Restitution, Thereby Avoiding Felony Convictions for Related Hazardous Waste Violations

2019-12-05

On 21 November 2019, the United States Department of Justice announced a settlement with Monsanto Company (Monsanto) in which Monsanto agreed to plead guilty to a misdemeanour count of illegally using the pesticide Pennacap-M, a methyl parathion product that was cancelled by the U.S. Environmental Protection Agency (EPA) on 27 July 2010. This settlement of several criminal counts by Monsanto followed an investigation by the EPA Criminal Investigation Division. Under the existing stocks provision in the EPA cancellation order, continued use of Pennacap-M became unlawful after 31 December 2013. In the settlement documents, Monsanto admits that its employees knowingly violated this order by using Pennacap-M on 15 July 2014, to treat corn seed research crops at Monsanto's Valley Farm research facility in Maui, Hawaii. Monsanto also admits that Monsanto employees directed other employees to re-enter the treated site seven days after the 15 July 2014, application, although the re-entry period established for this pesticide prior to its cancellation was 31 days. Monsanto further admits that it stored stocks of Pennacap-M after 31 December 2013, when unused stocks of this product became an acute hazardous waste under the Resource Conservation and Recovery Act (RCRA), at several locations in Hawaii without obtaining the required permits. As part of the settlement, Monsanto agreed to pay a total of \$10.2 million in fines and penalties, which includes a maximum fine of \$200,000 for illegal use of a cancelled pesticide, \$6 million in fines for the hazardous waste violations, and \$4 million in community service payments to Hawaii governmental entities for various environmental remediation programs. Monsanto also agreed to be sentenced to two years of probation. If Monsanto adheres to all of its obligations under this settlement, at the end of the two-year period of probation, the criminal felony counts for the RCRA hazardous waste violations will be dismissed with prejudice.

Commentary

Although the agreement reached with Monsanto will allow Monsanto to escape any felony convictions, it is clear from the stiff penalties imposed (which include the maximum fine permissible for the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) violation) that EPA considers the

On 21 November 2019, the United States Department of Justice announced a settlement with Monsanto Company (Monsanto) in which Monsanto agreed to plead guilty to a misdemeanour count of illegally using the pesticide Pennacap-M, a methyl parathion product that was cancelled by the U.S.

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violations at issue to be very serious. Pesticide research facilities often handle dangerous pesticides, and EPA typically affords such research facilities wide latitude to use unregistered active ingredients in small-scale research projects, but Monsanto has admitted that its personnel deliberately violated a FIFRA cancellation order, and did not comply with the restrictions on re-entry that were in place before the product in question was cancelled. Monsanto also has admitted that it stored stocks of a cancelled pesticide at several sites after they became acute hazardous waste without obtaining the required permits. The substantial penalties imposed may not seem surprising to some given those admissions.

National Law Review, 27 November 2019

<http://www.natlawreview.com>

EUROPE

ECHA Releases New, Updated Guidance Documents for Registering Nanoform Substances

2019-12-05

On 3 December, the European Chemicals Agency (ECHA) announced that it has developed a new Appendix for nanoforms applicable to the Guidance on Registration and Substance Identification. According to ECHA, it aligns ECHA's guidance with the amended annexes of the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation that will apply to nanomaterials and enter into force on 1 January 2020. The new guidance document explains the term *nanoform*, provides advice on how to build and justify sets of nanoforms, and explains what characterisation information needs to be reported. ECHA updated the Appendix for nanoforms applicable to the Guidance on QSARs and Grouping of Chemicals to reflect the advice of the new guidance document. ECHA states that the update also clarifies the differences between creating a set of nanoforms and read-across for justifying the use of hazard data between different (sets of) nanoforms of a substance. ECHA notes that it will keep updating the existing guidance for human health and environmental information requirements during 2020. To support potential registrants in meeting the new information requirements, an updated overview of available test guidelines and other recognised

On 3 December, the European Chemicals Agency (ECHA) announced that it has developed a new Appendix for nanoforms applicable to the Guidance on Registration and Substance Identification.

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methods and standards is available on the [European Union Observatory for Nanomaterials \(EUON\)](#)

National Law Review, 3 December 2019

<http://www.natlawreview.com>

Public consultation: Ochratoxin A

2019-12-05

The European Food Safety Authority (EFSA) is seeking feedback from interested parties on its scientific opinion about public health risks related to the presence of Ochratoxin A (OTA) in food – a mycotoxin naturally produced by fungi such as the *Penicillium* and *Aspergillus* species. The deadline for submitting comments is 24 January 2020. OTA is found in a variety of foods including grains and grain products, preserved meats, fresh and dried fruits. It is also found in breast milk. EFSA previously assessed public health risks related to OTA in food in 2006. Experts concluded that OTA accumulates in the kidney and is particularly toxic to this organ. At high doses OTA also causes kidney tumours in rats. EFSA set a tolerable weekly intake (TWI) of 120 nanograms per kilogram of body weight. More information has since become available suggesting that OTA may be genotoxic and carcinogenic. In such cases, EFSA experts calculate a margin of exposure (MOE) for consumers. In general, the higher the MOE, the lower the level of concern for consumers. The estimated MOE for OTA is below 10,000 across most consumer groups, suggesting a possible health concern.

What is the MOE?

The MOE is a tool used by risk assessors to characterise the risk from exposure to genotoxic and carcinogenic substances, which may be found in food or feed. It provides an indication of the level of safety concern about a substance's presence in food but does not quantify the risk. The MOE is a ratio of two factors: the dose at which a small but measurable adverse effect is observed and the level of exposure to the substance.

Further information is available at: [Public consultation: Scientific Opinion on the risks to public health related to the presence of ochratoxin A in food](#)

EFSA, 4 December 2019

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

The European Food Safety Authority (EFSA) is seeking feedback from interested parties on its scientific opinion about public health risks related to the presence of Ochratoxin A (OTA) in food – a mycotoxin naturally produced by fungi such as the *Penicillium* and *Aspergillus* species.

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EU Commission set to vote on ban of controversial organophosphate pesticides

2019-12-05

On 6 November, the European Commission voted at the PAFF standing committee on not renewing the approval of two pesticides, chlorpyrifos and chlorpyrifos-methyl, which the EU's food safety agency says may have serious effects on foetuses and children – a claim industry strongly rejects. The two insecticides, which belong to a category of pesticides known as 'organophosphates' and are used on a number of crops, have faced staunch opposition from environmental and health groups, who say the agrochemicals cause major developmental issues in children. As it currently stands, the EU authorisation of the two pesticides is due to expire on 31 January 2020. If passed, the vote would effectively ban the pesticides from the EU. However, the vote is being heavily contested, with manufacturers lobbying authorities to extend its legal existence. The vote comes after the European Food Safety Authority (EFSA) was mandated by the European Commission in July 2019 to provide a statement on the available outcomes of the human health assessment in the peer review of chlorpyrifos, which was still in process at the time. A peer review is when work is evaluated by several qualified members of a profession within a relevant field. It is used to maintain quality standards, improve performance, and provide credibility. Accordingly, EFSA provided a summary of the main findings of the assessment related to human health following the pesticides peer review expert discussions in mammalian toxicology. EFSA identified concerns that the pesticides cause "possible genotoxic effects as well as neurological effects during development", a finding which they say is corroborated by available epidemiological evidence related to developmental neurological outcomes in children. As such, EFSA concluded that the pesticide chlorpyrifos "does not meet the criteria required by legislation for the renewal of its approval in the European Union". No pesticide should be authorised if it is found to have harmful effects on humans, animals, the environment, and the ecosystem, the new coalition "Citizens for Science in Pesticide Regulation" said in a manifesto launched on 31 October. In a letter management consultancy EPPA sent to the Commission on behalf of industry, it states that NGOs have "pressured the European Commission and some member states to suddenly over-react".

They added that a "rushed scientific assessment of an active substance could lead to an unreliable and non-transparent regulatory process". However, Angeliki Lysimachou, environmental toxicologist and science

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policy officer at the Pesticide Action Network (PAN) EU, told EURACTIV there have been two studies, as well as “numerous epidemiological studies” that clearly demonstrate the link between chlorpyrifos and significant developmental and neurological issues in children, which includes memory loss, hyperactivity and lower IQ levels. This is corroborated by a 2016 study published in *The Lancet Diabetes and Endocrinology*, which estimated that each year, exposure to organophosphate pesticides, including both pesticides in question, causes 59,300 cases of intellectual disability and the loss of 13 million IQ points in Europe. While Lysimachou acknowledged that there are less conclusive studies on chlorpyrifos-methyl, she maintained that as the two pesticides have the same mode of action, it should be assumed they carry the same neurotoxicity risks. József Máté, communications leader for the agricultural company Corteva, told EURACTIV that Corteva “fundamentally disagrees with the conclusions from EFSA and the non-renewal proposals from the European Commission”. He stated that “no active ingredient had been more thoroughly researched than chlorpyrifos and the EFSA conclusions do not match the conclusions of other major regulatory bodies, including the US Environmental Protection Agency, the Australian Pesticides and Veterinary Medicines Authority or the World Health Organisation”. Máté added that chlorpyrifos is approved in approximately 80 countries, including 18 EU member states, and used on more than 100 crops. In order to block the renewal of the pesticides, the vote requires a qualified majority, meaning support from 16 out of the 28 member states representing at least 65% of the total EU population. Lysimachou said it was “highly likely” that, in the event of the vote not gaining the necessary support, the Commission may appeal the vote. The vote comes against the backdrop of the controversial decision of the Trump administration to reject the scientific conclusions of its own government experts, the Environmental Protection Agency (EPA).

Euractiv, 4 December 2019

<http://www.euractiv.com/>

Novichok and carbamate compounds are the first added to the treaty since it came into force

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INTERNATIONAL

New nerve agents added to Chemical Weapons Convention

2019-12-05

Canada, the Netherlands, and the US submitted the first proposal in January 2019. It includes two large families of novichok organophosphorus nerve agents. The Russian Federation moved to expand the list to add an additional novichok agent and a family of carbamates that are chemically unrelated but have a similar biochemical basis for their toxicity. The OPCW Secretariat will now prepare a merged text of the proposals and send it to all members of the CWC, says the organization's director-general, Fernando Arias. The changes will enter into force 180 days after the date of that notification. The decisions don't mean that the CWC suddenly bans Novichoks. These compounds already meet the definition of a chemical weapon if they are used to cause intentional death or harm, as they were in Salisbury in 2018. However, adding the chemicals to the convention means they are now subject to the most stringent controls described by the treaty. The Conference of the States Parties, where the decision was made, happens annually to oversee implementation of the convention. Earlier at the conference, the OPCW rewarded the efforts of two leading chemical arms control experts and the International Union of Pure and Applied Chemistry (IUPAC) with the OPCW–The Hague Award. Robert Mikulak and Cheng Tang were both involved in negotiating the CWC in the 1990s, while IUPAC was recognized for having provided objective scientific evidence. Mikulak, Tang, and IUPAC will share the €90,000 (\$99,109) prize. The conference also passed the OPCW's 2020 budget by a large majority vote. The budget includes continued funding for the Investigation and Identification Team (IIT) charged with identifying who used chemical weapons in the Syrian Arab Republic. The IIT is currently investigating seven attacks, including the chlorine assault at Douma near Damascus that killed 43 people in April 2018. The team will complete its first reports in a few months, Arias says. "It is essential for all of us to continue to work together, to push for accountability for chemical weapons use," said Thomas DiNanno, US deputy assistant secretary of state for defence policy, emerging threats, and outreach, in a statement read to the conference. "The United States is proud of what States Parties and the OPCW together have accomplished."

REACH Update

CHEMWATCH

Mapping the chemical universe: List of substances by regulatory action published

2019-12-05

The European Chemicals Agency (ECHA) has published a list of over 21,000 REACH registered substances mapped in its 'chemical universe'. The substances have been divided into five pools based on the regulatory actions in place, initiated or considered for them. It also highlights that there are still thousands of substances for which possible actions have not yet been determined. The mapping of registered substances, also called the *chemical universe*, is a planning and monitoring tool that helps Member States and EU authorities focus on substances of (potential) concern and identify appropriate regulatory actions, where needed. For companies and other stakeholders, publishing the mapping provides additional transparency on the work of authorities and the progress made in regulating chemicals. Each substance in the universe has been assigned to a pool that indicates the regulatory actions in place, initiated, ongoing or under consideration. The five pools are:

- Regulatory risk management ongoing: substances with confirmed hazards for human health and the environment.
- Regulatory risk management under consideration: substances that are currently being considered for regulatory risk management.
- Data generation: substances that require additional information to conclude whether further regulatory action is needed.
- Currently no further actions proposed: substances for which authorities have not proposed further regulatory action at the moment.
- Not yet assigned: substances currently registered under REACH but not yet assigned to any of the other pools.

Jack de Bruijn, Director for Prioritisation and Integration says: "We are currently focusing mostly on the substances registered for volumes greater than 100 tonnes per year, where we aim to assign each substance to one of the pools by the end of 2020. For all registered substances, the work should be concluded by 2027. For many substances, further hazard data will need to be generated as non-compliant registrations are hampering progress. To that end, we have a joint action plan with the Commission to improve compliance of registrations to ensure they contain the necessary information to establish safe use." The chemical universe does not indicate whether a substance's use is safe or not – it is mainly to help authorities focus their actions. The assignment to a pool

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is also not permanent – substances will move from one pool to another over time when new information becomes available or priorities change. Furthermore, the assignment is largely calculated by algorithms and is based on a snapshot of the data from August 2019. It is, therefore, not flawless and we encourage people to check the substances' infocards for the latest information. The links to the infocards are available in the list of substances. The initial numerical mapping of REACH registered substances on the EU/EEA market was published in April 2019 with the publication of ECHA's first report on the implementation of its integrated regulatory strategy. An update of the substance list is foreseen in early 2021. Further information is available at:

- [Universe of registered substances](#) – download the Excel list of substances
- [How does the chemical universe mapping work?](#) Includes descriptions of the pools
- [Addressing substances of concern – ECHA's integrated regulatory strategy](#)
- [Report: Mapping the universe of registered substances to address substances of concern](#)

ECHA, 4 December 2019

<http://echa.europa.eu>

EU exported more than 700 000 tonnes of PIC chemicals in 2018

2019-12-05

The European Chemicals Agency's (ECHA) report on the exports and imports that took place in 2018 under the Prior Informed Consent (PIC) Regulation shows benzene as the most traded PIC chemical, both for exports and imports. The latest annual report on exports and imports under PIC lists benzene as the EU's most exported and imported chemical in 2018, with approximately 228 000 tonnes exported and 445 000 tonnes imported. The amount of benzene being exported has increased by more than 80 000 tonnes compared to the 2017 figures. Benzene is predominantly used to make plastics, resins, synthetic fibres, rubber lubricants, dyes, detergents, drugs and pesticides. The quantity of the next most exported PIC chemical, ethylene dichloride decreased significantly by more than 200 000 tonnes, with the numbers for the third most exported chemical, chlorate, remaining steady compared to exports in 2017. Overall, the total amount of exported PIC chemicals has dropped

The European Chemicals Agency's (ECHA) report on the exports and imports that took place in 2018 under the Prior Informed Consent (PIC) Regulation shows benzene as the most traded PIC chemical, both for exports and imports.

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significantly by around 120 000 tonnes compared to 2017 figures, from approximately 829 000 tonnes in 2017 to less than 708 000 tonnes in 2018.

Three most exported PIC chemicals:

Substance	Quantity in 2018 (tonnes)
Benzene	228 084
Ethylene dichloride (1,2-dichloroethane)	136 171
Chlorate	118 730

More than 445 000 tonnes of benzene were also imported into the EU in 2018, making it the most imported chemical that year, too (representing more than 80% of all PIC chemicals imports into the EU). This was a significant increase of around 200 000 compared to 2017 (+82 %). Benzene was imported to Belgium, France, Germany, Italy, Poland, Spain and the United Kingdom. After a decrease of approximately 30 % between 2016 and 2017, the total amount of PIC chemicals imported into the EU has risen by more than 246 000 tonnes compared to the figures for 2017 (mainly due to the imports of benzene), to reach approximately 547 500 tonnes in 2018.

Four most imported PIC chemicals:

Substance	Quantity in 2018 (tonnes)
Benzene	445 333
Ethylene dichloride (1,2-dichloroethane)	62 872
Arsenic compounds; Ethylene oxide ¹	17 616

¹ The data on some chemicals is merged to ensure data confidentiality for companies involved or to ensure compliance with competition law.

Article 10 of the PIC Regulation requires exporters and importers to give information about annual trade of Annex I chemicals to their designated national authorities (DNAs) by 31 March of the following year. Each EU Member State then has to provide the aggregated information to ECHA so that it can be summarised at Union level and non-confidential information can be made publicly available. The report is available as a PDF, accompanied by searchable lists of the exported and imported chemicals.

Background

467 exporters from 22 Member States provided data to ECHA on exports of PIC chemicals from the EU in 2018; six Member States declared that they had not exported PIC chemicals.

153 importers from 20 Member States provided data on imports of PIC chemicals into the EU in 2018; eight Member States declared that they had not imported PIC chemicals.

Further information is available at:

- [Report on exports and imports in 2018 of chemicals listed in Annex I to the Prior Informed Consent \(PIC\) Regulation](#)
- [Annual reports on PIC exports and imports](#)
- [Annex I chemicals](#)
- [Understanding PIC](#)

ECHA, 2 December 2019

<http://echa.europa.eu>

Reminder: Call for evidence on possible restriction of lead in ammunition and fishing tackle

2019-12-05

The European Chemicals Agency will continue to receive scientific evidence and information on the impacts of a possible restriction on the placing on the market and use of lead in ammunition (gunshot and bullets) and fishing tackle until 16 December 2019. To provide information, go to: Give comments

ECHA News, 4 December 2019

<http://echa.europa.eu>

New substance evaluation conclusions published

2019-12-05

New substance evaluation conclusion documents are now available on the European Chemicals Agency's (ECHA) website for:

- 2-methylpropan-2-ol (EC 200-889-7; CAS 75-65-0), added to the CoRAP list in 2013 and evaluated by United Kingdom;

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- m-phenylenediamine (EC 203-584-7; CAS 108-45-2), added to the CoRAP list in 2018 and evaluated by Latvia;
- 2-[methyl[(nonafluorobutyl) sulphonyl]amino]ethyl acrylate (EC 266-733-5; CAS 67584-55-8), added to the CoRAP list in 2018 and evaluated by Germany.

Further information is available at:

- Community rolling action plan
- Substance evaluation

ECHA News, 4 December 2019

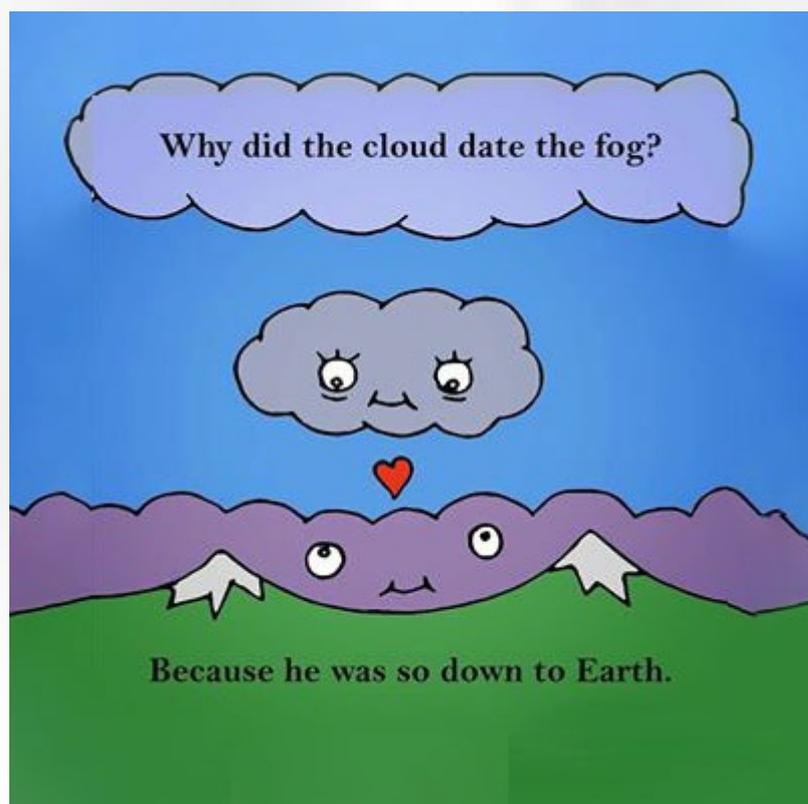
<http://echa.europa.eu>

Janet's Corner

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Down to Earth

2019-12-05



<https://www.calpaclab.com/science-jokes/#>

Hazard Alert

CHEMWATCH

Bromine

2019-11-25

Bromine is a chemical element with the symbol Br, an atomic number of 35, and an atomic mass of 79.904. It is in the halogen element group.

[1] At ambient temperature bromine is a brownish-red liquid. It has a similarly coloured vapour with an offensive and suffocating odour. It is the only non-metallic element that is liquid under ordinary conditions, it evaporates easily at standard temperature and pressures in a red vapour that has a strong disagreeable odour resembling that of chlorine. Bromine is less active chemically than chlorine and fluorine but is more active than iodine; its compounds are similar to those of the other halogens. Bromine is soluble in organic solvents and in water. [2]

USES [2]

Bromine is used in industry to make organobromo compounds. A major one was dibromoethane an agent for leaded gasoline, before they were largely phased out due to environmental considerations. Other organobromines are used as insecticides, in fire extinguishers and to make pharmaceuticals. Bromine is used in making fumigants, dyes, flameproofing agents, water purification compounds, sanitises, medicinals, agents for photography and in brominates vegetable oil, used as emulsifier in many citrus-flavoured soft drinks.

ROUTES OF EXPOSURE

- Following the release of bromine into water, you could be exposed by drinking the contaminated water.
- If food becomes contaminated with bromine, you could be exposed by eating the contaminated food.
- Following release of bromine gas into the air, you could be exposed by breathing the fumes.
- Skin exposure to bromine could occur through direct contact with bromine liquid or gas.
- Bromine gas is heavier than air, so it would settle in low-lying areas.

HEALTH EFFECTS

Bromine is corrosive to human tissue in a liquid state and its vapours irritate eyes and throat. Bromine vapours are very toxic with inhalation. [2]

Bromine is a chemical element with the symbol Br, an atomic number of 35, and an atomic mass of 79.904.

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Acute Effects [3]

- Breathing bromine gas could cause you to cough, have trouble breathing, get a headache, have irritation of your mucous membranes (inside your mouth, nose, etc.), be dizzy, or have watery eyes.
- Getting bromine liquid or gas on your skin could cause skin irritation and burns. Liquid bromine that touches your skin may first cause a cooling sensation that is closely followed by a burning feeling.
- Swallowing bromine-containing compounds (combinations of bromine with other chemicals) would cause different effects depending on the compound. Swallowing a large amount of bromine in a short period of time would be likely to cause symptoms such as nausea and vomiting (gastrointestinal symptoms).
- Showing these signs and symptoms does not necessarily mean that a person has been exposed to bromine.

Chronic Effects [4]

Bromine is toxic to mucous membranes. The substance may be toxic to kidneys, liver, cardiovascular system, central nervous system (CNS) and thyroid. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many

human organs.

SAFETY

First Aid Measures [4]

- 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. WARM water MUST be used. Get medical attention immediately.
- Skin Contact: In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

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- **Serious Skin Contact:** Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- **Inhalation:** If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
- **Serious Inhalation:** Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. **WARNING:** It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.
- **Ingestion:** Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Exposure Controls/Personal Protection [4]

- **Engineering Controls:** Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.
- **Personal Protection:** Face shield, full suit, vapour respirator (be sure to use an approved/certified respirator or equivalent), gloves and boots.
- **Personal Protection in Case of a Large Spill:** Splash goggles, full suit, vapour respirator, boots and gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

REGULATION

United States [5]

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

- **General Industry:** 29 CFR 1910.1000 Z-1 Table -- 0.1 ppm, 0.7 mg/m³ TWA

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- Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 0.1 ppm, 0.7 mg/m³ TWA

ACGIH: American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for bromine of 0.1 ppm, 0.66 mg/m³ TWA; 0.2 ppm, 1.3 mg/m³ STEL

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for bromine of 0.1 ppm TWA; 0.3 ppm STEL

Australia [6]

Safe Work Australia: Safe Work Australia has set an 8-hour time weighted average concentration for bromine of 0.1 ppm or 0.66 mg/m³. In addition, the following 15-minute short-term exposure limit (STEL) has been set 0.3 ppm or 2 mg/m³.

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4. <http://www.sciencelab.com/msds.php?msdsId=9927659>
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Gossip

CHEMWATCH

Spray painting fibre bandages onto wounds

2019-11-27

With newly developed technology, medical personnel can manufacture a bandage with drug-delivery capabilities directly onto a wound. Electrospinning is a well-developed method for developing polymer fibres for a wide variety of applications. If biocompatible materials are used, the fibres produced can be used for biomedical applications. But electrospinning requires very high voltages, making direct deposition of the fibres onto biological material dangerous due to the shock hazard it creates. A group of researchers at Montana Technological University has developed a portable electrospinning device with a confined electric field that can safely deposit bandages and drugs directly onto biological surfaces. The group describes the instrument—which they call the electrostatic and air driven device—in the *Journal of Vacuum Science & Technology B*. Instead of using the voltage difference between the tool and a surface to deposit the fibres, the new device uses air to spray the fibres out onto the surface, like a can of spray paint. “In spray painting, pressurised gas forces direct particles toward a surface, creating a sort of deposited material,” said author Lane Huston, a mechanical engineering graduate student at Montana Tech. “Like spray painting, the EStAD device is used by directing its nozzle at the desired surface during operation, causing a fibre mat to be deposited onto that surface.” By applying this spray paint-like mechanism, this device can be used to cover wounds and provide controlled drug release over time. The deposited fibres adhere to materials containing internal moisture, such as human skin. Though use of electrospun fibres for effective drug delivery has been established in the past, previous methods have required a wound to be placed directly into the electric field path. In that configuration, the only safe option is predepositing fibres onto a surface, such as parchment paper, to collect and store for later use. The device has been tested on a porcine skin incision as well as a gloved human hand and is the first demonstration of depositing the drug-delivering fibres directly onto a wound site safely. The authors hope this new technology will be used to aid doctors, first responders and other medical personnel with wound treatment in rural areas, where immediate medical care may not be readily available. “The bandage material, as well as the drug used, can be chosen on demand as the situation warrants, making modular and adaptable drug delivery accessible in remote locations,” Huston said. Though the direct deposition

With newly developed technology, medical personnel can manufacture a bandage with drug-delivery capabilities directly onto a wound.

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method is its most unique application, the researchers' new device can also be used as a traditional tabletop electrospinning device.

Phys.org, 12 November 2019

<http://phys.org>

Researchers generate terahertz laser with laughing gas

2019-11-27

Within the electromagnetic middle ground between microwaves and visible light lies terahertz radiation, and the promise of "T-ray vision." Terahertz waves have frequencies higher than microwaves and lower than infrared and visible light. Where optical light is blocked by most materials, terahertz waves can pass straight through, similar to microwaves. If they were fashioned into lasers, terahertz waves might enable "T-ray vision," with the ability to see through clothing, book covers, and other thin materials. Such technology could produce crisp, higher-resolution images than microwaves, and be far safer than X-rays. The reason we don't see T-ray machines in, for instance, airport security lines and medical imaging facilities is that producing terahertz radiation requires very large, bulky setups or devices that produce terahertz radiation at a single frequency -- not very useful, given that a wide range of frequencies is required to penetrate various materials. Now researchers from MIT, Harvard University, and the U.S. Army have built a compact device, the size of a shoebox, that produces a terahertz laser whose frequency they can tune over a wide range. The device is built from commercial, off-the-shelf parts and is designed to generate terahertz waves by spinning up the energy of molecules in nitrous oxide, or, as it's more commonly known, laughing gas. Steven Johnson, professor of mathematics at MIT, says that in addition to T-ray vision, terahertz waves can be used as a form of wireless communication, carrying information at a higher bandwidth than radar, for instance, and doing so across distances that scientists can now tune using the group's device. "By tuning the terahertz frequency, you can choose how far the waves can travel through air before they are absorbed, from meters to kilometres, which gives precise control over who can 'hear' your terahertz communications or 'see' your terahertz radar," Johnson says. "Much like changing the dial on your radio, the ability to easily tune a terahertz source is crucial to opening up new applications in wireless communications, radar, and spectroscopy." Johnson and his colleagues have published their results in the journal *Science*. Co-authors include MIT postdoc Fan Wang, along with Paul Chevalier, Arman Armizhan, Marco Piccardo, and Federico Capasso of Harvard University, and Henry Everitt of

**Device may enable
"T-ray vision" and
better wireless
communication**

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the U.S. Army Combat Capabilities Development Command Aviation and Missile Centre.

Molecular breathing room

Since the 1970s, scientists have experimented with generating terahertz waves using molecular gas lasers -- setups in which a high-powered infrared laser is shot into a large tube filled with gas (typically methyl fluoride) whose molecules react by vibrating and eventually rotating. The rotating molecules can jump from one energy level to the next, the difference of which is emitted as a sort of leftover energy, in the form of a photon in the terahertz range. As more photons build up in the cavity, they produce a terahertz laser. Improving the design of these gas lasers has been hampered by unreliable theoretical models, the researchers say. In small cavities at high gas pressures, the models predicted that, beyond a certain pressure, the molecules would be too "cramped" to spin and emit terahertz waves. Partly for this reason, terahertz gas lasers typically used meters-long cavities and large infrared lasers. However, in the 1980s, Everitt found that he was able to produce terahertz waves in his laboratory using a gas laser that was much smaller than traditional devices, at pressures far higher than the models said was possible. This discrepancy was never fully explained, and work on terahertz gas lasers fell by the wayside in favour of other approaches. A few years ago, Everitt mentioned this theoretical mystery to Johnson when the two were collaborating on other work as part of MIT's Institute for Soldier Nanotechnologies. Together with Everitt, Johnson and Wang took up the challenge, and ultimately formulated a new mathematical theory to describe the behaviour of a gas in a molecular gas laser cavity. The theory also successfully explained how terahertz waves could be emitted, even from very small, high-pressure cavities. Johnson says that while gas molecules can vibrate at multiple frequencies and rotational rates in response to an infrared pump, previous theories discounted many of these vibrational states and assumed instead that a handful of vibrations were what ultimately mattered in producing a terahertz wave. If a cavity were too small, previous theories suggested that molecules vibrating in response to an incoming infrared laser would collide more often with each other, releasing their energy rather than building it up further to spin and produce terahertz. Instead, the new model tracked thousands of relevant vibrational and rotational states among millions of groups of molecules within a single cavity, using new computational tricks to make such a large problem tractable on a laptop computer. It then analysed how those molecules would react to incoming infrared light, depending on their

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position and direction within the cavity. "We found that when you include all these other vibrational states that people had been throwing out, they give you a buffer," Johnson says. "In simpler models, the molecules are rotating, but when they bang into other molecules, they lose everything. Once you include all these other states, that doesn't happen anymore. These collisions can transfer energy to other vibrational states, and sort of give you more breathing room to keep rotating and keep making terahertz waves."

Laughing, dialled up

Once the team found that their new model accurately predicted what Everitt observed decades ago, they collaborated with Capasso's group at Harvard to design a new type of compact terahertz generator by combining the model with new gases and a new type of infrared laser. For the infrared source, the researchers used a quantum cascade laser, or QCL -- a more recent type of laser that is compact and also tunable. "You can turn a dial, and it changes the frequency of the input laser, and the hope was that we could use that to change the frequency of the terahertz coming out," Johnson says. The researchers teamed up with Capasso, a pioneer in the development of QCLs, who provided a laser that produced a range of power that their theory predicted would work with a cavity the size of a pen (about 1/1,000 the size of a conventional cavity). The researchers then looked for a gas to spin up. The team searched through libraries of gases to identify those that were known to rotate in a certain way in response to infrared light, eventually landing on nitrous oxide, or laughing gas, as an ideal and accessible candidate for their experiment. They ordered laboratory-grade nitrous oxide, which they pumped into a pen-sized cavity. When they sent infrared light from the QCL into the cavity, they found they could produce a terahertz laser. As they tuned the QCL, the frequency of terahertz waves also shifted, across a wide range. "These demonstrations confirm the universal concept of a terahertz molecular laser source which can be broadly tunable across its entire rotational states when pumped by a continuously tunable QCL," Wang says. Since these initial experiments, the researchers have extended their mathematical model to include a variety of other gas molecules, such as carbon monoxide and ammonia, providing scientists with a menu of different terahertz generation options with different frequencies and tuning ranges, paired with a QCL matched to each gas. The group's theoretical tools also enable scientists to tailor the cavity design to different applications. They are now pushing toward more focused beams and higher powers, with commercial development on the horizon.

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Johnson says scientists can refer to the group's mathematical model to design new, compact and tunable terahertz lasers, using other gases and experimental parameters. "These gas lasers were for a long time seen as old technology, and people assumed these were huge, low-power, non-tunable things, so they looked to other terahertz sources," Johnson says. "Now we're saying they can be small, tunable, and much more efficient. You could fit this in your backpack, or in your vehicle for wireless communication or high-resolution imaging. Because you don't want a cyclotron in your car."

EurekAlert, 14 November 2019

<http://www.eurekalert.org>

Iron-based solar cells on track to becoming more efficient

2019-11-27

An international study led from Lund University in Sweden shows that 30 percent of the energy in a certain type of light-absorbing iron molecule disappears in a previously unknown manner. By closing this loophole, the researchers hope to contribute to the development of more efficient solar cells using this iron-based solar cell. The sun is an unlimited source of pure and renewable energy. However, manufacturing the components in today's silicon-based solar cell solutions requires a lot of energy, and many new solar cell use rare or toxic elements. Researchers at Lund University have therefore started to develop alternative solar cell solutions based on iron. As a part of this research, an international research team recently carried out a free electron laser experiment at Stanford in the US to investigate how light-absorbing iron molecules transfer electrons into a state from which the energy can be extracted. "It was shown that in one-third of cases, the electron is not held in position long enough for us to extract the energy. Instead the energy disappeared very rapidly over a previously unknown channel," says Jens Uhlig, chemistry researcher at Lund University and leader of the study. More studies at large scale facilities like Stanford or MAX IV in Lund will now be conducted with the aim to find methods for avoiding this energy loss. "If we can find a way to extract energy from all the molecules, the efficiency of these iron-based solar cells or light activated catalysts would increase considerably," says Jens Uhlig. According to the research team, it is of the utmost importance that we find sustainable, scalable materials that can replace or complement today's silicon-based solar cell solutions. Jens Uhlig is convinced that iron, which is a plentiful resource in the Earth's crust, could

An international study led from Lund University in Sweden shows that 30 percent of the energy in a certain type of light-absorbing iron molecule disappears in a previously unknown manner.

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be a solution to the problem. "Through our discovery linked to these new iron-based solar cells, we hope to contribute important knowledge about how we are to meet the global energy challenge we are facing," he concludes.

Phys.org, 12 November 2019

<http://phys.org>

Chinese EV start-up Byton is bringing an electric SUV to the U.S

2019-11-27

United States car buyers who want to switch to electric but who still want the heft of an SUV will soon be spared that tough choice, as Chinese electric-vehicle start-up Byton is bringing its M-Byte e-SUV Stateside. Byton announced recently that it received both a dealer license and a distributor license from the State of California, kicking off what the company touts as its "innovative hybrid retail model" in the U.S. The hybrid element there doesn't refer to the EVs but to "the sale and service of vehicles using Byton's own infrastructure" as well as through automotive retail and aftersales service partners, the company said in a statement. The M-Byte electric SUV is Byton's first model and is expected to launch in China in 2020 before becoming available in the U.S. and Europe in 2021. Byton—which was founded in Hong Kong in 2017 and unveiled its first concept car the following year—opened a North American headquarters in Santa Clara in 2017. The company initially said its SUV would launch in the fourth quarter of 2019, to be followed by a sedan and an MPV in 2021 and 2022. Those timelines have clearly changed, but the company is still moving forward with even more electric vehicle designs. Along with being electric, Byton has said its vehicles are "smart" as well, with a 49-by-10-inch screen, a touch steering wheel, gesture recognition, and facial recognition. The M-Byte is a midsize electric SUV that can seat up to five and go 250 miles or more on a single battery charge. It promises "state-of-the-art" quick charging from zero to 80% in roughly 30 minutes. It's expected to sell in the States for around \$45,000. The Byton electric SUV is just one of a few bigger EVs coming to the market. Ford unveiled its Mustang Mach-E electric SUV—to be delivered to customers in 2020—and both Ford and GM previously announced they were in the process of designing electric pickup trucks. SUVs are becoming increasingly popular around the world, and not a lot of drivers have been willing so far to swap out their internal-combustion-engine SUVs and trucks for the types of electric vehicles currently available. (Besides, an electric SUV does not mitigate all

The M-Byte electric SUV will cost around \$45,000 and will be available in 2021.

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the problems with such vehicles.) A recent report from the International Energy Agency found that the still-growing demand for SUVs in the U.S, China, Europe, and beyond could actually negate all the environmental benefits of the increased use of electric cars, but maybe once these are on the market, that outlook will change.

Fast Company, 20 November 2019

<http://www.fastcompany.com/>

The mystery of the mass of the neutrino could soon be solved

2019-11-27

We are one step closer to unravelling the mystery of the mass of the neutrino. It has been revealed that the particle, which was once thought to weigh nothing, probably has a mass no more than 500,000 times that of an electron. The new upper limit of the neutrino's mass, 1.1 electronvolts, is almost half of the previous known upper limit of 2 electronvolts and brings us nearer to pinning down the exact mass of this elusive particle. "Neutrinos are a billion times more abundant in the universe than atoms, so even tiny neutrino masses would make a big contribution to the mass in the universe," says Christian Weinheimer at the University of Münster, Germany. Identifying the mass of the neutrino will not only help us discern the structure of the early universe but may also help scientists better understand the physics of the smallest things, he says. To estimate the upper limit of the neutrino's mass, an international team of researchers analysed the decay of a radioactive form of hydrogen called tritium – a process that emits an electron and a neutrino simultaneously. By measuring the energy of the released electrons, they were able to estimate the mass of the neutrino with greater precision than was previously possible. "We are extremely happy and proud," says Weinheimer. He was part of the international collaboration of scientists behind the Karlsruhe Tritium Neutrino experiment. Weinheimer and his colleagues were able to measure the precise energy of the electrons by using an enormous, purpose-built electron spectrometer that is 24 metres tall and 10 metres across. "It's very, very exciting," says Melissa Uchida at the University of Cambridge, UK. "This is just the most precise measurement we've ever had," she says. Uchida thinks the project gives us real hope of pinpointing the mass of the neutrino in the coming years. "We may finally be able to

We are one step closer to unravelling the mystery of the mass of the neutrino.

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put together the puzzle of how the formation of the universe happened," says Uchida.

New Scientist, 22 November 2019

<http://www.newscientist.com/>

Swarms of golf ball-sized robots could detect leaks in the sewers

2019-11-27

Swarms of floating robots could help map underground pipe networks and detect leaks and blockages in plumbing. Peter Baltus at Eindhoven University of Technology in the Netherlands and his colleagues have developed golf ball-sized sensors that can collect information as they float through pipes. Each robot contains a microprocessor, sensor, memory boards and a battery. They can be programmed to detect sound, temperature, pressure, acceleration, rotation and magnetic fields. To save power, a sensor can be activated by a sudden change in conditions, such as hissing sounds associated with water escaping, or increased rotation, which could be a sign of turbulent water flow. The robot would then increase the rate at which it takes measurements. "If you have a leak, you want to be fairly precise because then ultimately you will have to start digging," says Baltus. The researchers would like to use the floating sensors to map water distribution networks below cities, many of which aren't well documented. "They are sometimes quite old, like 50 or 100 years old," says Baltus. "The documentation is spotty and incorrect, or least very approximate." The advantage of these sensors is that they can collect measurements without having to shut down the networks they travel through. "It makes many people unhappy if you have to switch off drinking water to inspect pipelines," says Baltus. Similarly, the robots could be used to inspect piping in chemical plants without the need to shut the plant down entirely, which can be both costly and risky.

New Scientist, 22 November 2019

<http://www.newscientist.com/>

A Promising Solar Energy Breakthrough Just Achieved 1,000-Degree Heat From Sunlight

2019-11-27

A new start-up backed by Bill Gates says it has managed to harness solar energy to greater effect than ever before, generating enough heat from

Swarms of floating robots could help map underground pipe networks and detect leaks and blockages in plumbing.

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a field of mirrored panels to drive the production of cement, steel and glass – processes that are usually reliant on fossil fuels. In keeping with our modern age, this extra heat and efficiency has been made possible through artificial intelligence: computer software that can perfectly position the mirrors to concentrate sunlight in the most intense way. The company, called Heliogen, claims that its focussed beams of light are able to create a solar oven reaching 1,000 degrees Celsius (1,832 degrees Fahrenheit), something that hasn't been done before in a commercial setting. That means solar power could replace fossil fuels for a host of industrial jobs, not just providing electricity. "The world has a limited window to dramatically reduce greenhouse gas emissions," says Bill Gross, CEO and founder of Heliogen. "We've made great strides in deploying clean energy in our electricity system. But electricity accounts for less than a quarter of global energy demand. "Heliogen represents a technological leap forward in addressing the other 75 percent of energy demand: the use of fossil fuels for industrial processes and transportation. With low-cost, ultra-high temperature process heat, we have an opportunity to make meaningful contributions to solving the climate crisis." Energy production through these concentrated solar power plants isn't a new idea, but Heliogen has been able to get its systems to reach temperatures close to double what's currently possible, which opens up a host of new opportunities. In terms of the AI used, we're mainly talking about computer vision here: the use of high-resolution cameras to work out the position of each mirror, backed by complex algorithms that can optimise the angle they're set at. Further down the line, Heliogen is confident that it can use its systems to generate temperatures of up to 1,500 degrees Celsius (2,732 degrees Fahrenheit). That's enough to create 100 percent fossil-free fuels like hydrogen or syngas, through CO₂-splitting and water-splitting processes. Hydrogen fuel has long been talked about as a clean, eco-friendly way of meeting our transportation needs, while syngas (synthesis gas) can be used for heating or converted into biofuel. The problem with both is being able to produce them practically and affordably at scale. With heat-generating fossil fuel processes responsible for around 10 percent of global CO₂ emissions, the system that Heliogen has put together promises to make a big dent in the amount of carbon dioxide we're putting into the atmosphere. All of this needs scaling up though, which means plenty more investment is going to be required – as well as solutions for storing the generated energy on days when the Sun isn't shining (not every industrial firm operates in the California desert like Heliogen does). With that in mind, we're not going to be able to ditch fossil fuels in the short term, but Heliogen's AI tech might just have got us a big step closer. "[Heliogen's] capacity to achieve the high temperatures

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required for these processes is a promising development in the quest to one day replace fossil fuel," says Bill Gates, the ex-Microsoft boss who is one of the early backers of the solar start-up. "If we're going to get to zero carbon emissions overall, we have a lot of inventing to do."

Science Alert, 21 November 2019

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

Old newspapers can be used to grow carbon nanotubes

2019-11-27

A research collaboration between Rice University and the Energy Safety Research Institute (ESRI) at Swansea University has found that old newspapers can be used as a low cost, eco-friendly material on which to grow single walled carbon nanotubes on a large scale. Carbon nanotubes are tiny molecules with incredible physical properties that can be used in a huge range of things, such as conductive films for touchscreen displays, flexible electronics, fabrics that create energy and antennas for 5G networks. The new study, published in the MDPI Journal C, details the research experiments carried out in producing carbon nanotubes which could have the potential to solve some of the problems associated with their large scale production such as:- The high cost of preparing a suitable surface for chemical growth. The difficulties in scaling up the process, as only single surface growth processes have been previously available. The research team discovered that the large surface area of newspapers provided an unlikely but ideal way to chemically grow carbon nanotubes. Lead researcher Bruce Brinson said: "Newspapers have the benefit of being used in a roll-to-roll process in a stacked form making it an ideal candidate as a low-cost stackable 2D surface to grow carbon nanotubes." However, not all newspaper is equally good -- only newspaper produced with sizing made from kaolin, which is china clay, resulted in carbon nanotube growth. Co-author Varun Shenoy Gangoli said: "Many substances including talc, calcium carbonate, and titanium dioxide can be used in sizing in papers which act as a filler to help with their levels of absorption and wear. However, it was our observation that kaolin sizing, and not calcium carbonate sizing, showed us how the growth catalyst, which in our case was iron, is affected by the chemical nature of the substrate." ESRI Director Andrew Barron, also a professor at Rice University in the USA, said: "While there have been previous research that shows that graphene, carbon nanotubes and carbon dots can be been synthesised on a variety of materials, such as food waste, vegetation waste, animal, bird or insect waste and chemically grown on natural materials, to date, this research

New research has found that old newspaper provides a cheap and green solution for the bulk production of single walled carbon nanotubes.

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has been limited. "With our new research, we have found a continuous flow system that dramatically reduces the cost of both substrate and post synthesis process which could impact on the future mass manufacture of single walled carbon nanotubes."

Science Daily, 22 November 2019

<http://www.sciencedaily.com>

Efficient bottom-up synthesis of new perovskite material for the production of ammonia

2019-11-27

Perovskites are a class of synthetic materials that have a crystalline structure similar to that of the naturally occurring mineral calcium titanate. They have been the subject of many studies because they exhibit exciting and unique properties that can be tuned according to their composition. One of their potential applications is as catalysts for the synthesis of ammonia. In other words, specific perovskites can be placed inside a reaction chamber with nitrogen and hydrogen to promote the reaction of these gases to form ammonia. Ammonia is a useful substance that can be employed in the production of fertilisers and artificial chemicals, and even as a clean-energy carrier (in the form of hydrogen), which may be key in eco-friendly technologies. However, there are various challenges associated with the synthesis of ammonia and perovskites themselves. The synthesis rate for ammonia is generally limited by the high energy required to dissociate nitrogen molecules. Some researchers have had some success using precious metals, such as ruthenium. Recently, perovskites with some of their oxygen atoms replaced by hydrogen and nitrogen ions have been developed as efficient catalysts for ammonia synthesis. However, the traditional synthesis of perovskites with such substitutions usually has to be carried out at high temperatures (more than 800°C) and over long periods of time (weeks). To address these issues, in a recent study carried out at Tokyo Tech, a group of researchers led by Prof. Masaaki Kitano devised a novel method for the low-temperature synthesis of one of such oxygen-substituted perovskites with the chemical name $BaCeO_{3-x}NyHz$ and tested its performance as a catalyst to produce ammonia. To achieve this, they made an innovative alteration to the perovskite synthesis process. The use of Barium carbonate and Cerium dioxide as precursors (or "ingredients") involves a very high temperature would be required to have them combine into the base perovskite, or $BaCeO_3$, because Barium carbonate is very stable. In addition, one would then have to substitute the oxygen atoms with nitrogen and hydrogen

Scientists found a way to synthesise a special type of perovskite that promotes the production of ammonia, which has key applications in fertiliser production and hydrogen energy.

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ions. On the other hand, the team found that the compound Barium amide reacts easily with Cerium dioxide under ammonia gas flow to directly form $BaCeO_{3-x}NyHz$ at low temperatures and in less time. "This is the first demonstration of a bottom-up synthesis of such a material, referred to as perovskite-type oxynitride-hydride," explains Prof. Kitano. The researchers first analysed the structure of the perovskite obtained through the proposed process and then tested its catalytic properties for the low-temperature synthesis of ammonia under various conditions. Not only did the proposed material outperform most of the state-of-the-art competitors when combined with ruthenium, but it also vastly surpassed all of them when combined with cheaper metals, such as cobalt and iron. This represents tremendous advantages in terms of both performance and associated cost. Finally, the researchers attempted to elucidate the mechanisms behind the improved synthesis rate for ammonia. Overall, the insight provided in this study serves as a protocol for the synthesis of other types of materials with nitrogen and hydrogen ion substitutions and for the intelligent design of catalysts. "Our results will pave the way in new catalyst design strategies for low-temperature ammonia synthesis," concludes Prof. Kitano. These findings will hopefully make the synthesis of useful materials cleaner and more energy efficient.

Science Daily, 22 November 2019

<http://www.sciencedaily.com>

Niobium used as catalyst in fuel cell

2019-11-27

Brazil is the world's largest producer of niobium and holds about 98 percent of the active reserves on the planet. This chemical element is used in metal alloys, especially high-strength steel, and in an almost unlimited array of high-tech applications from cell phones to aircraft engines. Brazil exports most of the niobium it produces in the form of commodities such as ferroniobium. Another substance Brazil also has in copious quantities but underuses is glycerol, a by-product of oil and fat saponification in the soap and detergent industry, and of transesterification reactions in the biodiesel industry. In this case the situation is even worse because glycerol is often discarded as waste, and proper disposal of large volumes is complex. A study performed at the Federal University of the ABC (UFABC) in São Paulo State, Brazil, combined niobium and glycerol in a promising technological solution to the production of fuel cells. An article describing the study, entitled "Niobium enhances electrocatalytic Pd activity in alkaline direct glycerol fuel cells," is published in ChemElectroChem and

Glycerol fuel cell can replace batteries in cell phones and laptops, and could be used in future to run electric cars and supply power to homes

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featured on the cover of the journal. "In principle, the cell will work like a glycerol-fuelled battery to recharge small electronic devices such as cell phones or laptops. It can be used in areas not covered by the electricity grid. Later the technology can be adapted to run electric vehicles and even to supply power to homes. There are unlimited potential applications in the long run," chemist Felipe de Moura Souza, first author of the article told. Souza has a direct doctorate scholarship from São Paulo Research Foundation—FAPESP. In the cell, chemical energy from the glycerol oxidation reaction in the anode and air oxygen reduction in the cathode is converted into electricity, leaving only carbon gas and water as residues. The complete reaction is $C_3H_8O_3$ (liquid glycerol) + $7/2 O_2$ (oxygen gas)

$3 CO_2$ (carbon gas) + $4 H_2O$ (liquid water). "Niobium [Nb] participates in the process as a co-catalyst, assisting the action of the palladium [Pd] used as the fuel cell anode. The addition of niobium enables the amount of palladium to be halved, lowering the cost of the cell. At the same time, it significantly increases the power of the cell. But its main contribution is a reduction in the electrolytic poisoning of the palladium that results from the oxidation of intermediates that are strongly adsorbed in long-term operation of the cell, such as carbon monoxide," said Mauro Coelho dos Santos, a professor at UFABC, thesis adviser for Souza's direct doctorate, and principal investigator for the study. From the environmental standpoint, which more than ever should be a decisive criterion for technological choices, the glycerol fuel cell is considered a virtuous solution because it can replace combustion engines powered by fossil fuels.

Phys.org, 22 November 2019

<http://phys.org>

Clear, conductive coating could protect advanced solar cells, touch screens

2019-11-27

MIT researchers have improved on a transparent, conductive coating material, producing a tenfold gain in its electrical conductivity. When incorporated into a type of high-efficiency solar cell, the material increased the cell's efficiency and stability. The new findings are reported in the journal *Science Advances*, in a paper by MIT postdoc Meysam Heydari Gharahcheshmeh, professors Karen Gleason and Jing Kong, and three others. "The goal is to find a material that is electrically conductive as well as transparent," Gleason explains, which would be "useful in a range of applications, including touch screens and solar cells." The material most

MIT researchers have improved on a transparent, conductive coating material, producing a tenfold gain in its electrical conductivity.

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widely used today for such purposes is known as ITO, for indium titanium oxide, but that material is quite brittle and can crack after a period of use, she says. Gleason and her co-researchers improved a flexible version of a transparent, conductive material two years ago and published their findings, but this material still fell well short of matching ITO's combination of high optical transparency and electrical conductivity. The new, more ordered material, she says, is more than 10 times better than the previous version. The combined transparency and conductivity is measured in units of Siemens per centimetre. ITO ranges from 6,000 to 10,000, and though nobody expected a new material to match those numbers, the goal of the research was to find a material that could reach at least a value of 35. The earlier publication exceeded that by demonstrating a value of 50, and the new material has leapfrogged that result, now clocking in at 3,000; the team is still working on fine-tuning the process to raise that further. The high-performing flexible material, an organic polymer known as PEDOT, is deposited in an ultrathin layer just a few nanometres thick, using a process called oxidative chemical vapor deposition (oCVD). This process results in a layer where the structure of the tiny crystals that form the polymer are all perfectly aligned horizontally, giving the material its high conductivity. Additionally, the oCVD method can decrease the stacking distance between polymer chains within the crystallites, which also enhances electrical conductivity. To demonstrate the material's potential usefulness, the team incorporated a layer of the highly aligned PEDOT into a perovskite-based solar cell. Such cells are considered a very promising alternative to silicon because of their high efficiency and ease of manufacture, but their lack of durability has been a major drawback. With the new oCVD aligned PEDOT, the perovskite's efficiency improved and its stability doubled. In the initial tests, the oCVD layer was applied to substrates that were 6 inches in diameter, but the process could be applied directly to a large-scale, roll-to-roll industrial scale manufacturing process, Heydari Gharahcheshmeh says. "It's now easy to adapt for industrial scale-up," he says. That's facilitated by the fact that the coating can be processed at 140 degrees Celsius—a much lower temperature than alternative materials require. The oCVD PEDOT is a mild, single-step process, enabling direct deposition onto plastic substrates, as desired for flexible solar cells and displays. In contrast, the aggressive growth conditions of many other transparent conductive materials require an initial deposition on a different, more robust substrate, followed by complex processes to lift off the layer and transfer it to plastic. Because the material is made by a dry vapor deposition process, the thin layers produced can follow even the finest contours of a surface, coating them all evenly, which could be useful in some applications. For example, it could be coated onto fabric and

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cover each fibre but still allow the fabric to breathe. The team still needs to demonstrate the system at larger scales and prove its stability over longer periods and under different conditions, so the research is ongoing. But “there’s no technical barrier to moving this forward. It’s really just a matter of who will invest to take it to market,” Gleason says.

Phys.org, 22 November 2019

<http://phys.org>

New material captures and converts toxic air pollutant into industrial chemical

2019-11-27

An international team of scientists, led by the University of Manchester, has developed a metal-organic framework, or MOF, material that provides a selective, fully reversible and repeatable capability to capture a toxic air pollutant, nitrogen dioxide, produced by combusting diesel and other fossil fuels. The material then requires only water and air to convert the captured gas into nitric acid for industrial use. The mechanism for the record-breaking gas uptake by the MOF, characterised by researchers using neutron scattering at the Department of Energy’s Oak Ridge National Laboratory, could lead to air pollution control and remediation technologies that cost-effectively remove the pollutant from the air and convert it into nitric acid for use in producing fertiliser, rocket propellant, nylon and other products. As reported in *Nature Chemistry*, the material, denoted as MFM-520, can capture atmospheric nitrogen dioxide at ambient pressures and temperatures—even at low concentrations and during flow—in the presence of moisture, sulfur dioxide and carbon dioxide. Despite the highly reactive nature of the pollutant, MFM-520 proved capable of being fully regenerated multiple times by degassing or by treatment with water from the air—a process that also converts the nitrogen dioxide into nitric acid. “To our knowledge, this is the first MOF to both capture and convert a toxic, gaseous air pollutant into a useful industrial commodity,” said Sihai Yang, one of the study’s lead authors and a senior lecturer at Manchester’s Department of Chemistry. “It is also interesting that the highest rate of NO₂ uptake by this material occurs at around 113 degrees Fahrenheit (45 degrees Centigrade), which is about the temperature of automobile exhausts.” Martin Schröder, a lead author of the study, professor of chemistry and vice-president of the University of Manchester, said, “The global market for nitric acid in 2016 was USD \$2.5 billion, so there is a lot of potential for manufacturers of this MOF technology to recoup their costs and profit from the resulting nitric acid

An international team of scientists, led by the University of Manchester, has developed a metal-organic framework, or MOF, material that provides a selective, fully reversible and repeatable capability to capture a toxic air pollutant, nitrogen dioxide, produced by combusting diesel and other fossil fuels.

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production. Especially since the only additives required are water and air." As part of the research, the scientists used neutron spectroscopy and computational techniques at ORNL to precisely characterize how MFM-520 captures nitrogen dioxide molecules. "This project is an excellent example of using neutron science to study the structure and activity of molecules inside porous materials," said Timmy Ramirez-Cuesta, co-author and coordinator for the chemistry and catalysis initiative at ORNL's Neutron Sciences Directorate. "Thanks to the penetrating power of neutrons, we tracked how the nitrogen dioxide molecules arranged and moved inside the pores of the material, and studied the effects they had on the entire MOF structure. What made these observations possible is the VISION vibrational spectrometer at ORNL's Spallation Neutron Source, which has the highest sensitivity and resolution of its kind in the world." The ability of neutrons to penetrate solid metal to probe the interactions between the nitrogen dioxide molecules and MFM-520 is helping the researchers validate a computer model of MOF gas separation and conversion processes. Such a model could help predict how to produce and tailor other materials to capture a variety of different gases. "Neutron vibrational spectroscopy is a unique tool to study adsorption and reaction mechanisms and guest-host interactions at the molecular level, especially when combined with computer simulation," said Yongqiang Cheng, an ORNL neutron scattering scientist and co-author. "The interaction between the nitrogen dioxide molecules and MOF causes extremely small changes in their vibrational behaviour. Such changes can only be recognized when the computer model accurately predicts them." "The characterisation of the mechanism responsible for the high, rapid uptake of NO₂ will inform future designs of improved materials to capture air pollutants," said Jiangnan Li, first author and doctoral student at the University of Manchester. "The post-treatment of the captured nitrogen dioxide avoids the need to sequester or process the gas and provides future direction for clean air technologies." Capturing greenhouse and toxic gases from the atmosphere has been a challenge because of their relatively low concentrations and because water in the air competes with and can often negatively affect the separation of targeted gas molecules from other gases. Another issue was finding a practical way to filter out and convert captured gases into useful, value-added products. The MFM-520 MOF material offers solutions to many of these challenges.

Phys.org, 23 November 2019

<http://phys.org>

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T-shirt generates electricity from temperature difference between body and surroundings

2019-11-27

Researchers of the Faculty of Science of the University of Malaga (UMA) have designed a low-cost T-shirt that generates electricity from the temperature difference between the human body and the surroundings. We are talking about the “e-textile” prototype, developed in collaboration with the Italian Institute of Technology in Genoa (IIT) based on sustainable methods and low-cost materials like tomato skin. “So far, metals have been the chemical elements commonly used in the fabrication of electronic devices. This project took a step forward, and we have been able to generate electricity by using light and more affordable and less toxic materials”, explains José Alejandro Heredia, one of the authors of this project. The formula is very simple: water and ethanol -a type of ecological alcohol- derived from tomato skin and carbon nanoparticles. A solution that, according to experts, when heated, penetrates and adheres to cotton, thus obtaining electrical properties, like those generated by tellurium, germanium or lead, but from biodegradable materials. “When someone walks or runs, warms up. If such person wore a T-shirt designed with these characteristics, the difference between his/her body and the colder temperature of the surroundings could generate electricity”, says Susana Guzmán, another author from the UMA.

“Iron Man” made in UMA

The results of this project, in which the Italian researcher Pietro Cataldi has participated, were published in the journal *Advanced Functional Materials*. At present, this group of scientists continues their work on the development of devices that can be incorporated into textile to be able to, for example, generate light to make this T-shirt reflective or even charge a mobile phone without a charger. Other possible applications include biomedicine, thanks to the monitoring of signals of each user, or robotics, because the use of these lighter and more flexible materials enables improvement of robot features. “In a previous study, we were able to create a Wi-Fi antenna from tomato skin and graphene. We are also studying the possibility of incorporating this invention into the “e-textile” T-shirt, which would enable us to be like the superhero Iron Man, who wears a suit with all types of technological devices, and even fly”, jokes Guzmán. José Alejandro Heredia and Susana Guzmán are members of the Department of Molecular Biology and Biochemistry of the University of Málaga. They are part of the Institute for Mediterranean and Subtropical Horticulture (IHSM) and their main R+D+i lines include the fabrication of

The ‘e-textile’ prototype uses sustainable and low-cost materials like tomato skin

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electronic devices with biodegradable materials. José Alejandro Heredia and Susana Guzmán are members of the Department of Molecular Biology and Biochemistry of the University of Málaga. They are part of the Institute for Mediterranean and Subtropical Horticulture (IHSM) and their main R+D+i lines include the fabrication of electronic devices with biodegradable materials.

EurekAlert, 22 November 2019

<http://www.eurekalert.org>

Stabilising sulfur cathode by single Li-ion channel polymer binder

2019-11-27

The growing demands on the high-performance energy-storage system for emerging technologies such as electric vehicles and artificial intelligence drive the development of high-performance batteries. As a promising candidate of next-generation batteries, Li-S batteries have been drawn much attention carrying a high specific capacity (1675 mAh g⁻¹) and energy density (2600 Wh kg⁻¹). However, the diffusion of polysulfide in electrolyte cause changes in the structure of the sulfur cathode during discharge-charge cycles, which greatly limits the commercial applications of Li-S batteries. Polymer binder, as an essential component of electrode, acts to bond the active material and are related to the performance of batteries. Unfortunately, the conventional binder has failed to meet the requirements of emerging batteries. For example, the PVDF binder exhibits low ionic conductivity of Li-ions, poor mechanical stability, and almost none inhibition on the shuttle of polysulfide, these factors limit the applications of Li-S batteries. Therefore, an ideal polymer binder which overcomes the drawback of conventional binders is urgently needed for Li-S batteries. In a new research published in the Beijing-based National Science Review, scientists at the Soochow Institute for Energy and Materials Innovations for Lithium-sulfur battery in Suzhou, China present the latest advances in Single Lithium-ion Channel Polymer Binder for Li-S battery. Co-authors Chaoqun Niu, Jie Liu, Xiaowei Shen, Jinqiu Zhou, Tao Qian and Chenglin Yan report a novel polymer binder with single lithium-ions channels allowing fast lithium-ions transport while blocking the shuttle of polysulfide anions. This study reports a new avenue to assemble a polymer binder with single lithium-ion channel for solving the serious problem of energy attenuation of Li-S batteries. These scientists confirmed the effect of the prepared polymer binder on Li-S batteries by monitoring polysulfide concentration in the electrolyte and device capacity retention

The growing demands on the high-performance energy-storage system for emerging technologies such as electric vehicles and artificial intelligence drive the development of high-performance batteries.

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in real time during the cycle. "The polymer binder is confirmed to effectively immobilise the shuttle effect of polysulfide intermediates by the in-situ UV-vis measurement." "Moreover, the excellent adhesion and mechanical stability of prepared binder maintain the structure integrity of sulfide cathode after discharge-charge cycles. These results demonstrate that the promising improvement of Li-S battery by the prepared binder and we believe the reported polymer binder with single Li-ion channels is one of the most effective strategies for the high-energy Li-S batteries."

EurekAlert, 22 November 2019

<http://www.eurekalert.org>

Small, fast, and highly energy-efficient memory device inspired by lithium-ion batteries

2019-11-27

Virtually all digital devices that perform any sort of processing of information require not only a processing unit, but also a quick memory that can temporarily hold the inputs, partial results, and outputs of the operations performed. In computers, this memory is referred to as dynamic random-access memory, or DRAM. The speed of DRAM is very important and can have a significant impact in the overall speed of the system. In addition, lowering the energy consumption of memory devices has recently become a hot topic to achieve highly energy-efficient computing. Therefore, many studies have focused on testing out new memory technologies to surpass the performance of conventional DRAM. The most basic unit in a memory chip are its memory cells. Each cell typically stores a single bit by adopting and holding one of two possible voltage values, which correspond to a stored value of either "0" or "1". The characteristics of the individual cell largely determine the performance of the overall memory chip. Simpler and smaller cells with high speed and low energy consumption would be ideal to take highly efficient computing to the next level. A research team from Tokyo Tech led by Prof. Taro Hitosugi and student Yuki Watanabe recently reached a new milestone in this area. These researchers had previously developed a novel memory device inspired by the design of solid lithium-ion batteries. It consisted of a stack of three solid layers made of lithium, lithium phosphate, and gold. This stack is essentially a miniature low-capacity battery that functions as a memory cell; it can be quickly switched between charged and discharged states that represent the two possible values of a bit. However, gold combines with lithium to form a thick alloy layer, which increases the amount of energy required to switch from one

Virtually all digital devices that perform any sort of processing of information require not only a processing unit, but also a quick memory that can temporarily hold the inputs, partial results, and outputs of the operations performed.

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state to the other. In their latest study, the researchers created a similar three-layer memory cell using nickel instead of gold. They expected better results using nickel because it does not easily form alloys with lithium, which would lead to lower energy consumption when switching. The memory device they produced was much better than the previous one; it could actually hold three different voltage states instead of two, meaning that it is a three-valued memory device. "This system can be viewed as an extremely low-capacity thin-film lithium battery with three charged states," explains Prof. Hitosugi. This is a very interesting feature that has potential advantages for three-valued memory implementations, which may be more area efficient. The researchers also found that nickel forms a very thin nickel oxide layer between the Ni and the lithium phosphate layers (see Fig. 1), and this oxide layer is essential for the low-energy switching of the device. The oxide layer is much thinner than that of the gold-lithium alloys that formed in their previous device, which means that this new "mini-battery" cell has a very low capacity and is therefore quickly and easily switched between states by applying minuscule currents. "The potential for extremely low energy consumption is the most noteworthy advantage of this device," remarks Prof. Hitosugi. Increased speed, lower energy consumption, and smaller size are all highly demanded features in future memory devices. The memory cell developed by this research team is a very promising stepping stone toward much more energy-efficient and faster computing.

EurekAlert, 22 November 2019

<http://www.eurekalert.org>

Chemists create new route to PHAs: Naturally degradable bioplastics

2019-11-27

A tide of public momentum is swelling against the crisis of petroleum-based plastics, which are sitting in our landfills, floating in our oceans, and showing up in our air and even our food. Meanwhile, in a Colorado State University chemistry laboratory, polymer scientists are toiling toward what they think is a viable solution. Every day, they are working on new chemistry for sustainable materials that could compete with, and eventually even replace, the hard-to-recycle, non-degradable commodity plastics that have overwhelmed our environment for decades. Eugene Chen, professor in the Department of Chemistry, has led a new study demonstrating a chemical catalysis path for making an existing class of biomaterials -- already gaining momentum in industrial settings --

A new study demonstrates a chemical catalysis path for making an existing class of biomaterials called PHAs -- already gaining momentum in industrial settings -- even more commercially viable and structurally diverse.

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even more commercially viable and structurally diverse. The results are published in the journal *Science*, and the paper includes first author Xiaoyan Tang and graduate student co-authors Andrea Westlie and Eli Watson. In recent years, Chen has focused some of his lab's efforts on a set of biomaterials called PHAs, or polyhydroxyalkanoates. They're a class of polyesters, produced by bacteria, that are biodegradable to a degree not seen in commercial plastics. They beat out "compostable" bioplastics made out of polylactic acid (PLA) by degrading naturally in oceans and landfills, whereas PLA needs to be composted industrially. Some see PHAs as a beacon in a dark, plastics-filled world, with companies already trying to create an industry around such bio-based materials. But PHAs have their limitations. They are made in bioreactors where communities of bacteria convert biorenewable carbon feedstocks, such as sugars, into the simplest form of PHA, called poly(3-hydroxybutyrate), or P3HB. Different carbon sources and bacteria can also make other PHA derivatives. These biosynthesis setups are currently expensive, relatively slow and hampered by their limited scalability and productivity. In their *Science* paper, Chen and colleagues attack those limitations one by one, offering a novel, chemical synthetic pathway for making conventional and new PHAs with enhanced, tunable, mechanical and physical properties. These are the very characteristics that made petroleum plastics so ubiquitous in our world. The CSU polymer chemists report that their new polymerisation methodology is enabled by catalysts that directly polymerise a bio-sourced monomer called 8DL that exists in a form called stereo-isomers. The catalysed polymerisation produces orderly, crystalline, so-called "stereosequenced" PHAs. In the lab, the researchers showed their materials' ductility and toughness, and their ability to tune the structure and function of their materials. "We wanted to solve the bottleneck issue," Chen said. "How can we develop the chemical catalysis pathway to this fantastic class of biodegradable plastics so that you have, basically, scalability, fast production and tunability to make different PHAs? ... That was the motivation." This work built on previously published research that appeared in *Nature Communications*. Then, the researchers used their chemical synthesis pathway to make P3HB, one of 150 PHA biomaterials. But P3HB is relatively brittle, making it impractical for many petroleum plastics applications of today. Chen stresses that he is not an expert in biosynthetic pathways for making PHAs. However, his lab is offering the technologically advantageous chemical catalysis approach to both

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existing and new PHA materials -- which could play a big role in solving the plastics crisis of our generation.

Science Daily, 21 November 2019

<http://www.sciencedaily.com>

Researchers design an improved pathway to carbon-neutral plastics

2019-11-27

Researchers from U of T Engineering and Caltech have designed a new and improved system for efficiently converting CO₂, water, and renewable energy into ethylene -- the precursor to a wide range of plastic products, from medical devices to synthetic fabrics -- under neutral conditions. The device has the potential to offer a carbon-neutral pathway to a commonly used chemical while enhancing storage of waste carbon and excess renewable energy. "CO₂ has low economic value, which reduces the incentive to capture it before it enters the atmosphere," says Professor Ted Sargent, the U of T Engineering lead on the project. "Converting it into ethylene, one of the most widely-used industrial chemicals in the world, transforms the economics. Renewable ethylene provides a route to displacing the fossil fuels that are currently the primary feedstock for this chemical." Last year, Sargent and his team published a paper in Science describing how they used an electrolyser -- a device that uses electricity to drive a chemical reaction -- to convert CO₂ into ethylene with record efficiency. In this system, the three reactants, CO₂ gas, water and electricity, all come together on the surface of a copper-based catalyst. Though the device was a breakthrough for the team, there was still room for improvement. The latest version, described in a paper published today in Nature, further modifies the catalyst in order to enhance the system's performance and lower its operating cost. "One of the challenges with this reaction is that while some of the CO₂ is converted into ethylene, most of it turns into side products, especially carbonate, which dissolves on the liquid side of the electrolyser," says post-doctoral fellow Fengwang Li, lead author of the new paper. "This undesired loss increases the cost of ensuing product separation and purification." In the latest work, Sargent's team partnered with Caltech chemistry professors Jonas C. Peters and Theodor Agapie. Their published research on a class of molecules known as arylpyridiniums suggested that adding them to the catalyst could favour the production of ethylene over other side products. Using theoretical calculations and experiments, the two teams sifted through more than a dozen different kinds of arylpyridiniums before selecting one.

Researchers have designed a new and improved system for efficiently converting CO₂, water, and renewable energy into ethylene -- the precursor to a wide range of plastic products -- under neutral conditions.

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Sure enough, adding a thin layer of this molecule to the copper catalyst surface significantly increased the selectivity of the reaction for ethylene. It also led to another benefit: lowering the working reaction pH from basic to neutral. "The previous system required the water side of the reaction to be at high pH, very basic conditions," says Li. "But the reaction of the CO₂ with caustic soda in the water lowers the pH, so we would've had to continuously add chemicals to keep the pH up. The new system works just as well under neutral conditions, so we can eliminate that additional cost, as well as loss of CO₂ in the form of carbonate." The improved catalyst also lasted longer than the previous version, remaining stable for nearly 200 hours of operation. Another enhancement -- increasing the area of the catalyst surface by a factor of five -- gave the teams a taste of the challenges that will need to be overcome in order to scale production up to industrial levels. While the prototype is still a long way from commercialization, the overall concept offers a promising way to address several key challenges in sustainability. It eliminates the need to extract more oil to make plastics and other consumer goods based on ethylene, and it turns waste CO₂ into a feedstock, adding a new incentive to invest in carbon capture. Li also points out that such a system could be powered by intermittent renewable sources, such as wind or solar power. Currently, there is often a mismatch between the amount of electricity produced by these systems and consumer demand. By storing excess electricity in the form of ethylene, the system offers a way to smooth out those peaks and valleys. "What's great about this CO₂-to-ethylene conversion system is that you don't need to choose between capturing and recycling CO₂ emissions versus trying to prevent them from occurring in the first place by displacing the used fossil fuels," says Li. "We can do both at the same time."

Science Daily, 20 November 2019

<http://www.sciencedaily.com>

Scientists engineer 'Venus flytrap' bio-sensors to snare pollutants

2019-11-27

Scientists from Trinity College Dublin have created a suite of new biological sensors by chemically re-engineering pigments to act like tiny Venus flytraps. The sensors are able to detect and grab specific molecules, such as pollutants, and will soon have a host of important environmental, medical and security applications. Porphyrins, a unique class of intensely coloured pigments -- also known as the "pigments of life" -- provide the

The biological sensors change colour once they have successfully snared a target molecule, and will soon have a host of important environmental, medical and security applications.

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key to this ground-breaking innovation. The word porphyrin is derived from the Greek word porphura, meaning purple, and the first chapter detailing the medical-chemical history of porphyrins goes back to the days of Herodotus (circa 484 to 425 BC). This tale has been progressing ever since and is at the heart of Professor Mathias O. Senge's work at Trinity. In living organisms, porphyrins play an important role in metabolism, with the most prominent examples being heme (the red blood cell pigment responsible for transporting oxygen) and chlorophyll (the green plant pigment responsible for harvesting light and driving photosynthesis). In nature, the active versions of these molecules contain a variety of metals in their core, which gives rise to a set of unique properties. The researchers at Trinity, under the supervision of Professor Mathias O. Senge, Chair of Organic Chemistry, chose a disruptive approach of exploring the metal-free version of porphyrins. Their work has created an entirely new range of molecular receptors. By forcing porphyrin molecules to turn inside out, into the shape of a saddle, they were able to exploit the formerly inaccessible core of the system. Then, by introducing functional groups near the active centre they were able to catch small molecules -- such as pharmaceutical or agricultural pollutants, for example pyrophosphates and sulphates -- and then hold them in the receptor-like cavity. Porphyrins are colour-intense compounds so when a target molecule is captured this results in the colour changing drastically. This underlines the value of porphyrins as bio-sensors because it is clear when they have successfully captured their targets. Karolis Norvaiša, an Irish Research Council-funded PhD Researcher at Trinity, and first author of the study, said: "These sensors are like Venus flytraps. If you bend the molecules out of shape, they resemble the opening leaves of a Venus flytrap and, if you look inside, there are short stiff hairs that act as triggers. When anything interacts with these hairs, the two lobes of the leaves snap shut." The peripheral groups of the porphyrin then selectively hold suitable target molecules in place within its core, creating a functional and selective binding pocket, in exactly the same way as the finger-like projections of Venus flytraps keep unfortunate target insects inside. The discovery was recently published in the print version of the leading international journal *Angewandte Chemie International Edition* and is featured as a hot paper. It has also been selected as the journal's cover illustration. The work highlights the beginning of an EU-wide H2020 FET-OPEN project called INITIO, which aims to detect and remove pollutants. The work was made possible by initial funding from Science Foundation Ireland and an August-Wilhelm Scheer guest professorship award for Professor Senge at the Technical University of Munich. Professor Senge added: "Gaining an understanding of the porphyrin core's interactions is an important milestone for artificial

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porphyrin-based enzyme-like catalysts. We will slowly but surely get to the point where we can realise and utilise the full potential of porphyrin-substrate interfaces to remove pollutants, monitor the state of the environment, process security threats, and deliver medical diagnostics.”

Science Daily, 20 November 2019

<http://www.sciencedaily.com>

The good side of carbon monoxide

2019-11-27

Most people think of carbon monoxide as harmful, and with good reason—the colourless, odourless gas sends 50,000 people in the U.S. to hospitals each year when their furnaces malfunction or car engines run in poorly ventilated spaces. But at low concentrations, carbon monoxide has a beneficial side that scientists are trying to harness to treat diseases, according to an article in Chemical & Engineering News (C&EN), the weekly newsmagazine of the American Chemical Society. Carbon monoxide exerts its harmful effects by taking oxygen’s place in binding to haemoglobin in the blood, thereby starving tissues of oxygen. However, the body naturally makes small amounts of carbon monoxide, and at these levels, the gas serves useful functions by interacting with and regulating signalling proteins. Studies in cells and animals have shown that carbon monoxide can suppress inflammation, protect tissues from oxidative stress and prevent cell death, Contributing Editor Alla Katsnelson writes. Other research suggests that the versatile molecule could help treat many diseases, ranging from sepsis to cancer, but first scientists must find safe, effective ways to deliver the gas inside the body. Although clinical trials have shown that inhaling small, controlled amounts of carbon monoxide is safe, such treatments would need to be done in a hospital setting. Therefore, scientists are exploring other delivery options, such as pill and liquid forms. Multiple research groups are developing prodrugs—compounds that release carbon monoxide after undergoing a chemical reaction inside the body. A company called Hillhurst Biopharmaceuticals plans to conduct clinical trials on a liquid carbon monoxide formulation they developed to treat sickle cell disease. And others are planning trials of the inhaled gas to see if it can improve outcomes in lung transplants. These researchers are hoping that the good side of carbon monoxide will soon see the light of day, Katsnelson writes.

Phys.org, 20 November 2019

<http://phys.org>

Most people think of carbon monoxide as harmful, and with good reason—the colourless, odourless gas sends 50,000 people in the U.S.

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Researchers create the first straws using polyhydroxyalkanoate (PHA) plastic

2019-11-27

The Polymers and Advanced Materials Group of the Universitat Jaume I in collaboration with the Laboratory of New Materials and Nanotechnology of the Institute of Agrochemistry and Food Technology of the Spanish Centre for Advanced Scientific Research (IATA-CSIC) have developed, together with the company Ocenic Resins, S.L. a plastic formulation suitable for making straws that are 100 percent biodegradable. These are the first straws developed based on a plastic called polyhydroxyalkanoate (PHA). PHAs are naturally generated by some bacteria when subjected to controlled feeding conditions. Therefore, it is a renewable, non-oil and completely natural material. Additionally, these plastics can be obtained by feeding residues to bacteria; their production does not require oil, and they also allow waste to be valued that would otherwise have to be treated (further reducing its CO₂ footprint). Since these plastics are naturally synthesized by living beings (such as cellulose present in plants, chitin present in fungi or in insects or proteins), their disintegration in the environment takes place spontaneously, thus being able to serve as food to the same bacteria that produce them. Luis Cabedo Mas, researcher in charge of the project, in addition to their environmental advantages, says, "The properties of these materials are excellent for the manufacturing of single-use products and food packaging." Thus, straws made from this material perfectly resist hot liquids without altering the flavour of the drink (unlike paper straws). As far as industrial viability is concerned, it should be pointed out that this material can be processed using current manufacturing technologies, which makes it technically very attractive for companies in the sector. Proof of this is that the company Ocenic Resins, S.L. is already industrially manufacturing these straws and, very likely, they will soon be commercially available.

Phys.org, 20 November 2019

<http://phys.org>

Breaking (and restoring) graphene's symmetry in a twistable electronics device

2019-11-27

A recent study from the labs of James Hone (mechanical engineering) and Cory Dean (physics) demonstrates a new way to tune the properties of two-dimensional (2D) materials simply by adjusting the twist angle

The Polymers and Advanced Materials Group of the Universitat Jaume I in collaboration with the Laboratory of New Materials and Nanotechnology of the Institute of Agrochemistry and Food Technology of the Spanish Centre for Advanced Scientific Research (IATA-CSIC) have developed, together with the company Ocenic Resins, S.L.

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between them. The researchers built devices consisting of monolayer graphene encapsulated between two crystals of boron nitride and, by adjusting the relative twist angle between the layers, they were able to create multiple moiré patterns. Moiré patterns are of high interest to condensed matter physicists and materials scientists who use them to change or generate new electronic material properties. These patterns can be formed by aligning boron nitride (BN, an insulator) and graphene (a semimetal) crystals. When these honeycomb lattices of atoms are close to alignment, they create a moiré superlattice, a nanoscale interference pattern that also looks like a honeycomb. This moiré superlattice alters the quantum mechanical environment of the conducting electrons in the graphene, and therefore can be used to program significant changes in the observed electronic properties of the graphene. To date, most studies on the effects of moiré superlattices in graphene-BN systems have looked at a single interface (with either the top or bottom surface of the graphene considered, but not both). However, a study published by Hone and Dean last year demonstrated that total rotational control over one of the two interfaces was possible within a single device. By designing a device that has persistent alignment at one interface, and tunable alignment at the other, the Columbia team has now been able to study the effects of multiple moiré superlattice potentials on a layer of graphene. "We decided to look at both the top and bottom surfaces of the graphene in a single nanomechanical device," said Nathan Finney, a PhD student in Hone's lab and co-lead-author of the paper, published online 30 September by Nature Nanotechnology and now the cover story of the November print edition. "We had a hunch that by doing so, we would be able to potentially double the strength of the moiré superlattice using the coexisting moiré superlattices from the top and bottom interfaces." The team discovered that twisting the angle of the layers enabled them to control both the strength of the moiré superlattice as well as its overall symmetry, inferred from the significant changes in the electronic properties of the graphene observed. At angles close to alignment, a highly altered graphene band structure emerged, observable in the formation of coexisting non-overlapping long-wavelength moiré patterns. At perfect alignment, the graphene's electronic gaps were either strongly enhanced or suppressed, depending on whether the top rotatable BN was twisted 0 or 60 degrees. These changes in the electronic gaps corresponded to the expected changes in in symmetry for the two alignment configurations--inversion symmetry broken at 0 degrees, and inversion symmetry restored at 60 degrees. "This is the first time anyone has seen the full rotational dependence of coexisting moiré superlattices in one device," Finney notes. "This degree of control over the symmetry and the strength of

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moiré superlattices can be universally applied to the full inventory of 2D materials we have available. This technology enables the development of nanoelectromechanical sensors with applications in astronomy, medicine, search and rescue, and more."The researchers are now refining the ability to twist monolayers of a wide range of 2D materials to study such exotic effects as superconductivity, topologically induced ferromagnetism, and non-linear optical response in systems that lack inversion symmetry.

EurekAlert, 21 November 2019

<http://www.eurekalert.org>

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How the world's most widely used insecticide led to a fishery collapse

2019-11-27

In May of 1993, rice farmers living near Lake Shinji, in southwestern Japan, began widely using an insecticide called imidacloprid. Within the same year, populations of arthropods that form the base of the food web, such as crustaceans and zooplankton, began to plummet. By the end of 1994, two commercially important fish that depend on these creatures for food, eel and smelt, crashed as well. And as the use of imidacloprid and other neonicotinoids has grown over the years, the fish have never recovered. These findings, from a paper published in *Science* in early November, are the first to show that neonicotinoids, a class of toxic insecticides that are the world's most widely used, can seep into aquatic ecosystems and significantly disrupt fisheries, dramatically reducing their yields. What's more, scientists think that Japan is not an isolated example, but rather a dramatic illustration of neonicotinoids' potential to seriously harm aquatic ecosystems worldwide. The situation at Lake Shinji is unique in that scientists have studied the fishery since at least the early 1980s—more than a decade before and after the insecticides were introduced. Such datasets are rare. Researchers at Shinji have logged reams of information about water quality, populations of arthropods and zooplankton, and the quantity of fish. That allowed the study's authors, led by Masumi Yamamuro, with the Geological Survey of Japan and the University of Tokyo, to find a clear connection between the introduction of neonicotinoids and the collapse of the food web. When the scientists averaged populations of the lake's zooplankton—tiny crustaceans and other animals eaten by fish—for 12 years before and after the introduction of neonicotinoids in 1993, they found that mean zooplankton biomass declined by 83 percent. One type of midge larvae, known as *Chironomus plumosus*, could not be found at all in a 2016 survey. That came a shock to Yamamuro. "I was so surprised," she says. "In 1982, when I was an undergraduate student, there were tons of them." Darren Walls, a spokesperson from Bayer Crop Science, into which Monsanto was folded when the two companies merged in 2018, disputed the clear link between neonicotinoid use and fishery collapse. Bayer is one of the largest producers of neonicotinoids. "The strong conclusions made in the publication are clearly not supported," says Walls, since "it is well known that aquatic environments are dynamic systems that may be influenced by many physical and chemical variables." But six other researchers National Geographic interviewed, none of whom participated directly in the study, disagreed—and many were surprised by the strength

Neonicotinoids wiped out plankton and fish in a Japanese lake, and are likely harming aquatic ecosystems worldwide, new research suggests.

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of the link shown here. "This study convincingly demonstrates that the decline of two major fish of commercial importance, smelt and eel, was caused by neonicotinoids, since none of the other possible factors that could affect fish changed over time," says Francisco Sanchez-Bayo, an ecotoxicologist at the University of Sydney who wasn't involved in the paper. Though the study could only show a link between pesticide use and fishery collapse, the near-immediate decline of plankton and fish following neonicotinoid introduction is impossible to explain away, Sanchez-Bayo adds. For instance, a host of other potential causal factors has not significantly changed over the years, such as salinity, chlorinity, sediment content, dissolved oxygen, and other water quality measures. Olaf Jensen, an expert on the impacts of aquatic pollutants at Rutgers University, likens the impacts of neonicotinoids to a continual major stressor. "The annual application of pesticides is a recurring environmental disturbance, like a mini-oil spill," he says.

Aquatic data lacking

Neonicotinoids, commonly called neonics, were first produced on a large scale in the 1990s. These substances, which are chemically similar to nicotine, were hailed as safer alternatives to the industrial chemicals that they replaced since they are more selectively toxic to arthropods, and less deadly to large animals like mammals. The chemicals work by blocking receptors present in insects' nervous systems, causing paralysis and death. However, a growing body of research shows that the chemicals can have unintended consequences. They are fatal to several species of bees and butterflies, for example, and the three most commonly used neonicotinoids—imidacloprid, clothianidin, and thiamethoxam—have been banned for outdoor use in the European Union for this reason. But their impact on freshwater and marine ecosystems have been studied far less, says Jason Hoverman, an aquatic ecologist at Purdue University. "While neonicotinoid research has predominantly focused on terrestrial systems, this study suggests that adverse effects in aquatic systems are possible and occur by altering the food web," Hoverman says. These insecticides are systemic, absorbed by plants, and stored in their leaves and other tissues. The chemicals are often used to coat seeds; but these coatings are often washed off into the soil and exit as runoff. Neonicotinoid contamination of surface waters, like lakes and streams, is common around the world, studies show. The paper suggests the regulators may need to rethink how they approve these chemicals, or what studies need to happen beforehand, suggests Dave Goulson, a biology professor at the University of Sussex in England who wrote a letter,

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along with 232 other signatories, arguing for more restrictions on the substances. Generally, regulatory studies include short-term impacts on specific animals—but the indirect and long-term impacts, like those to the food web, are not studied, adds Rutgers' Jensen, who wrote an analytical piece from his perspective accompanying the study in *Science*. When researchers have looked, they have often found major problems with neonics. For example, a September study in *Science* found a link between neonicotinoid use and major impacts on birds, whose populations have been declining. This adds to a growing body of work that finds neonicotinoids can reduce populations of non-target insects, and that these chemicals are a contributor to the global decline in arthropods.

A global problem

Yamamuro says that the impacts may be especially notable in Shinji because it is a brackish environment, with lower levels of species diversity than freshwater lakes—and thus more susceptible to harm from neonicotinoids. "I think similar collapses may have occurred in other brackish environments, such as lagoons and upper estuaries in rice-culturing and neonicotinoid-using countries," she says. Pesticides are easily taken up and carried away by water in rice paddies, and Yamamuro says she expects the impacts from this type of agriculture to be particularly significant. However, since neonicotinoids are water soluble and persistent, the issue of contamination is a global one, she says, and likely to occur even in areas where neonics are applied to crops grown on dry land, like corn and soybeans. "Neonicotinoids need to be much more tightly regulated," says Nathan Donley, with the environmental group Centre for Biological Diversity, who suggests that this paper is one more reason to invest much more heavily in research into non-chemical means of pest control, such as multiple cropping, the use of cover crops, and the like. Purdue's Hoverman agrees that "a perpetual challenge for society is balancing the need for food production with the environmental impacts of those activities." "Obviously, pesticides are designed to kill and, when applied to the landscape, will do their job. Investing in technologies that reduce our reliance on pesticides would reduce environmental impacts." The researchers closed out their paper by quoting Rachel Carson's 1962 classic *Silent Spring*, about pesticides: "These sprays, dusts, and aerosols are now applied almost universally to farms, gardens, forests, and homes—nonselective chemicals that have the power to kill every insect, the 'good' and the 'bad,' to still the song of birds and the leaping of fish in the streams." Now, nearly 60 years later, they note, Carson's words are eerily

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prescient. "The ecological and economic impact of neonicotinoids on the inland waters of Japan confirms Carson's prophecy," they conclude.

National Geographic, 13 November 2019

www.nationalgeographic.com.au

Everyone needs to stop building giant glass skyscrapers right now

2019-11-27

Two cars, a lemon, and a bottle of Lucozade: just a few of the objects that have been melted by London's Walkie Talkie building. But the heat radiating off the glass towers awkwardly angled 160-metre-tall walls isn't the heat we should be most worried about. The Walkie Talkie, like all glass skyscrapers, is warming up the world in a much more all-encompassing way. "This is now a climate emergency," says Diana Ürge-Vorsatz, professor of environmental sciences and policy at the Central European University in Hungary and member of the Intergovernmental Panel on Climate Change (IPCC). She believes all-glass skyscrapers should be banned. "If we want to reach any reasonable climate objective, I don't think we have any other option." Any building playing host to hundreds of people is going to have a huge climate footprint, but the glass is particularly problematic. The sunlight has unlimited access into the building, but no way to get out. "With an all glass building, you're fighting the environment rather than working with it," says Simon Sturgis, who is an adviser to the government as well as chairman of the Royal Institute of British Architects sustainability group. Conventional glass skyscrapers are just tall green houses. The heat inside can't escape because the whole structure is wrapped in a glass skin. That's great for tomatoes, but for people it just means more air conditioning. The amount of energy used for cooling has more than doubled since 2000, and it will double again by 2040 if we don't curb our reliance on air conditioning, according to the International Energy Agency. "Even in a moderate climate, cooling issues are becoming more and more severe, and the proliferation of glass buildings is accentuating that fact," says Henrik Schoenefeldt, senior lecturer in sustainable architecture at the University of Kent. It's a vicious cycle: we build a glass skyscraper, then have to cool that glass skyscraper, which uses energy, which contributes to the climate crisis, which increases the temperature. The hotter weather makes the glass building even harder to cool, but we have to keep cooling it because sweaty co-workers are not happy co-workers, and so the cycle goes on. This problem can't be solved by just turning off the AC. "We don't want people to sweat in overheated buildings, that's not the point,"

Towering glass structures are an environmental nightmare. And there's a growing consensus that we should stop building them

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Ürge-Vorsatz says. "The point is that with responsible architecture you can keep people cool without unnecessary cooling." We need to build better buildings. Conventional glass skyscrapers are sealed up, so there's no natural ventilation. But architects have developed a way to add windows to the coveted glass aesthetic. "You can make efficient buildings that are highly glazed, but it requires a lot of effort technologically and you have to think about how the building is layered," Schoenefeldt says. The RHW.2 office tower in Vienna has two outer glass walls with a cavity between them, so the inner windows can be opened to get some fresh air. "They have maintained the prism aesthetic but made it more environmentally conscious with the second skin." The Austrian office block uses just 20 per cent of the energy a similar-sized conventional glass building in the UK would use, he says. And, while the tower's £800m price tag is £4.6m more than a less-innovative version would cost, the extra upfront amount was recovered after four years of use. "The buildings are so efficient you can make real economic savings in the operational costs," says Schoenefeldt. Many modern glass skyscrapers use this construction technique, as well as other technological advancements such as blinds that automatically adjust to block sunlight from entering the building. It sounds like the perfect, technology-focused solution. But it's not, Sturgis says. Cutting down cooling isn't enough to redeem these glass structures. "This facade is designed to reduce cooling load but the problem with it is it's very high in embodied energy," he says. Embodied energy is the energy it takes to make the material. Timber has a low embodied energy because it actually pulls carbon out of the air as it grows, whereas glass is very energy intensive. While Sturgis concedes that these layered facades lessen cooling issues, he points out that glass doesn't last a lifetime. "The glazing needs to be replaced every 30 to 40 years," he says. "That creates a big carbon problem." And the glass panels are stuck together with plastic, so even recycling them is difficult. Really, it's our obsession with tall glass boxes that's the issue. Glass is great for making windows, but when it comes to the rest of the building, even with innovative solutions, it can't compete as a sustainable material. And that just won't cut it anymore. "Yes, glass is beautiful, but in the 21st century when we face a climate emergency, we need to redefine aesthetics," says Ürge-Vorsatz. "A building can be beautiful without being, from a climate perspective, extremely irresponsible." Bio-based materials like timber provide a better option. In Vancouver, an 18-storey students' residence building was built out of timber in 2016. The project redefined the height limits for wooden buildings, and a new 40-storey timber skyscraper is under construction. It will be a zero-emissions building – and that should always be the goal. "If you're building a very tall building you should expect it to last a hundred years, so surely

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you should be taking into account the climatic change that is going to happen,” says Sturgis. If you don’t factor that in, you’re stuck with that error for a century or more. “They’re lock-in risks,” says Ürge-Vorsatz. “Once you build a skyscraper it pre-determines our emissions for decades to come, so we definitely need legislation in this area.” Some restrictions are already being discussed and implemented. New York’s major Bill de Blasio called for a ban of all-glass skyscrapers earlier this year. “He’s already converted to a heavy criteria rather than banning them outright,” says Sturgis, “but the fact that he’s fingered them as being a problem is very interesting.” As awareness of the environmental issues linked to these buildings goes up, they will become more of an investment risk. “The Bank of England is going to start stress-testing financial institutions for climatic risk in two years time,” says Sturgis. “One thing they don’t like is financial risk, and if all-glass buildings are perceived to be risky in a climate sense, you can only see this going one way.” As the world moves towards a zero-carbon target, glass skyscrapers will be forced out of fashion by investors who see them as a risky investment and brands who don’t want their sustainably minded customers to judge them by their office’s carbon footprint. The skyscrapers of the future will still need windows, but glass should be 40 per cent of the facade, at most, and long-life materials will make up the rest. Think more Empire State Building, less Gherkin. It’s pretty simple, but that’s the key. “Sustainability is about going back to basics, and not depending heavily on complex technology,” says Schoenefeldt, and that’s impossible to achieve when a building’s inhabitability is dependent on air conditioning. When Crystal Palace was built in 1850 for the Great Exhibition, the giant glass structure didn’t have the luxury of air conditioning and it was a disaster. Giant sheets had to be draped over it to prevent visitors from melting. The fact that glass structures haven’t progressed far from that point is a big hint that they’re not the future. As Sturgis says: “If you’re going to build a tall building, there’s a better way to do it than all-glass.”

Wired, 11 November 2019

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

Deciphering the real message about BPA

2019-11-21

Idaho—Patricia Hunt, a geneticist at Washington State University, and I walk a long, curved route through the arboretum at the University of Idaho — past the big red barn, through the woods and up a hill by the water tower painted with a big yellow “I”. It’s the same water tower we could see directly out from her back patio. Yet our path back to the house

“The government keeps testing chemicals for safety using the same old approaches developed 50 years ago”

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was a far more natural course than any straight-line path. Such a lack of linearity, Hunt explained, can also describe the relationship between the dose of a chemical — say, bisphenol A (or BPA) — and its level of impact on the body. Historically, government toxicologists have assumed that the greater the exposure to a toxic chemical, the greater the harm — or, as the old adage goes, “the dose makes the poison.” A dose-response curve should therefore always be monotonic, meaning it will never change direction from positive to negative, or vice versa. But academic scientists, especially those who study endocrinology, are finding that this principle is not always true, at least not for chemicals such as BPA that mimic and mess with our hormones. These endocrine-disrupting chemicals, studies show, can wreak havoc at extremely small doses. This disagreement is just one of many front lines in an ongoing conflict between federal regulators and academics, which intensified with the launch in 2012 of a multimillion-dollar government-led project called Consortium Linking Academic and Regulatory Insights on BPA Toxicity, or Clarity for short. The project combines a traditional regulatory toxicology study from the government — dubbed the Core Study — and investigational studies from academics. The government and most of the 14 participating academic scientists have completed their respective studies for the collaborative project. An integrated report that pulls together all the findings is currently underway and expected to be completed by the end of 2019. The goal of Clarity is to reconcile a long-standing dispute over data and conclusions on BPA’s health effects, although the implications could be far broader. BPA is just one of hundreds of chemicals we’re exposed to in our everyday lives that are suspected of scrambling the natural hormone messages in our bodies. Through interviews and emails obtained via Freedom of Information Act requests, EHN found a series of red flags concerning deficiencies in the FDA’s science on BPA, including how it dictated much of the Clarity study design and methods. As EHN detailed, a number of these factors limited Clarity’s robustness to detect health effects — from insistence by the FDA to use of a strain of animal that had been shown to be insensitive to hormone disruptors, to the choice of a stressful means to deliver BPA to the animals, to the provision of small numbers of animals to some of the academic scientists. But then there’s the question of what happened as the data came in. What patterns did researchers look for when plotting the dose of the chemical versus the response of the animals? Where did they draw the line on what is considered significant evidence of an effect? And how did they present what they found? Once again, a number of contentious issues emerged in the course of EHN’s investigation. Take North Carolina State University biology professor Heather Patisaul’s research on the brain: In three studies

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now, including one that was published as part of Clarity, she has found effects of BPA on the developing rodent brain at just 2.5 micrograms per kilogram of body weight. For context, that is approximately 120,000 times below the lowest dose that has been shown in other studies to alter uterine weight — one of the traditional tests looked at by the FDA. In some cases of what scientists call non-monotonicity, a chemical may have effects at low doses and no effects at higher doses; in others, further effects may only appear as doses get really high. In either case, the result is a curve that changes direction, such as a U-shape. But if researchers were to only look for a strictly increasing line, by enlisting the statistical methods best suited to identify a linear trend, then their calculations would likely conclude that the chemical has no impact on that endpoint of interest. It's also possible that the health effects of a chemical differ across doses. "Very high and very low doses can do entirely different things," Frederick vom Saal, a professor of biology at the University of Missouri-Columbia and a Clarity investigator, told EHN. Take, for example, diethylstilbestrol (DES), the oestrogenic drug that was once commonly prescribed to pregnant women. Studies have found that exposures in the womb to 100 parts per billion of DES can cause mice to become scrawny as adults, while exposures to 1 ppb can result in severe obesity. There is only one way to fairly evaluate a dose-response relationship, Richard Stahlhut, a biologist at the University of Missouri-Columbia, told EHN. "You look for straight lines, you look for curves," he said. "Then you tell people what you found." However, A. John Bailer, chair of the department of statistics at Miami University in Ohio, is among scientists not fully convinced of non-monotonic dose responses. He underscored a need to better understand their biologic basis. "A mechanistic understanding would give us the real insights," he told EHN. Scott Belcher, a biologist at North Carolina State University, and a Clarity investigator, pointed to a number of studies that provide evidence for cellular mechanisms driving these non-monotonic responses, including opposing effects from multiple hormone receptors and negative feedback loops, a key regulatory mechanism in living things. "Most simply put, biological systems are complicated and are controlled by multiple types of regulation," he told EHN. Despite the large body of evidence from vom Saal and others, the FDA continues to deny the relevance of very low dose exposures and non-monotonicity. In an email to EHN, Marianna Naum, an FDA spokesperson, said that the agency had "extensively reviewed the low-dose BPA literature and was "unable to construct a plausible or logical comprehensive toxicological profile or explanation for the many claimed effects of BPA, largely due to the inconsistencies that currently exist within this literature." This attitude keeps the stalemate alive, while we all remain Guinea pigs in

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a grand experiment on our hormones. “We thought Clarity would help, but the way the results turned out, it has kind of exacerbated the difference between people who think of low-dose effects as important and non-monotonic dose-responses as real and physiologically important, and those that don’t,” said Jerry Heindel, the health scientist administrator at NIEHS when Clarity was initiated. “That’s the biggest hurdle we still have to get through.”

On the hunt

Hunt abruptly stops during our stroll through the arboretum, which is just across the state border and a few miles from her lab at Washington State University. “Look, a wild orchid,” she said. Pink petals pop in the otherwise predominantly green landscape. Unexpected discoveries may be a relatively frequent occurrence for Hunt: She has twice found bisphenols coursing through the bodies of animals not intentionally dosed with a chemical in her studies, a result of degrading plastic cages housing the mice. Generally, however, scientific research tends to be a bit more prescribed. To find any particular effect of a chemical, you usually need to look for it — or at least recognise it. The problem is, government regulators and academics tend to look for and recognise different things: Regulators look for the obvious – changes in body weight, or a fast-growing tumour. Endocrinologists look for subtle changes – learning behaviour, anxiety, memory – that may not appear until years later, or even subsequent generations. This has been another major point of contention in the ongoing debate over the testing and regulation of endocrine-disrupting chemicals. “Typically, the tests they use for regulatory purposes are a little more rigid. They are not as cutting edge as you might see from academic labs doing it on their own,” said John Meeker, an environmental health scientist at the University of Michigan School of Public Health, who is not involved in Clarity. “This can lead to big differences in study conclusions, as well as the overall view of the toxicity of a particular agent.” In one of University of Illinois at Chicago researcher Gail Prins’ studies, for example, she found that while BPA didn’t appear to stimulate prostate cancer by itself, if there was an early life exposure to BPA, an additional estrogen or testosterone exposure later in life then significantly increased the risk of prostate cancer. The most significant effects appeared in the lowest dose groups. Other Clarity studies by academic investigators found a number of low-dose BPA effects, including changes in gene expression within specific regions of the brain, ovarian follicle development and spatial navigation. “The government keeps testing chemicals for safety using the same old approaches developed 50 years ago, and then they tell us that everybody

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is good to go," said Laura Vandenberg, an environmental health researcher at the University of Massachusetts-Amherst's School of Public Health and who was not involved in Clarity. "You don't have to see a tumour to determine something adverse is going on." In an email to National Institute of Environmental Health Sciences (NIEHS) colleagues in February 2018, Nigel Walker, a toxicologist at NIEHS who helped lead the study, highlighted one of the key questions that Clarity aimed to answer: "Are we missing any signals using 'traditional' approaches that newer technologies and approaches pick up"?

High bars

Which is worse, deeming something as safe when it's not or saying something causes harm when it doesn't? The two scenarios are referred to, respectively, as false negatives and false positives. "The FDA uses very, very conservative statistics with a low risk of false positives," said Patisaul. "That's always been a sticky wicket with the FDA versus academic scientists." By applying conservative statistics throughout the Clarity Core Study that generally minimize false positives, noted Patisaul, the government increased the risk of false negatives — or the chance of deeming a chemical innocent when it was actually guilty of harm. It is a balancing act, explained Bailer. With conservative methods, you may be less likely to see real effects. "But the counter response is: You are less likely to see false effects," he told EHN. Even with a high bar, statistically significant effects emerged from the government's data. In tests for mammary gland cancerous growths, for example, the Core Study detected significant effects at the lowest dose of BPA in the part of the study where exposure stopped when the rats were weaned. But through the government's "weight-of-evidence approach," they discounted the finding as "unlikely" to be a "plausible BPA treatment-related lesion." Their rationale: similar effects were not observed at the highest doses, the effect was not observed in animals exposed over their entire lifetimes and, as noted earlier, lesions were found in historical controls. (EHN gave the FDA a chance to comment, but the agency declined.) Patisaul disagreed with their methods and rationale. "There are certainly cases where developmental-only exposure has different effects than lifelong exposure," she said. "Just because you don't know why something is happening doesn't mean that the phenomenon is erroneous or 'not biologically plausible.'" "This attitude is certainly not precautionary nor protective of public health and emphasises the lengths to which this group will go to bury potentially important outcomes," added Patisaul. Vom Saal said he faced a particularly high bar to uncover potentially important outcomes

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in his Clarity study. The weights of the rats that the FDA provided him for analysis of the effects of BPA on the development of the urogenital system, he explained, ranged widely — the heaviest rat weighed at least 250 percent more than the lightest rat. To prevent bias, all Clarity scientists were blinded to the BPA exposure levels of the animals and tissues that they received for study. Once the data were unblinded, vom Saal learned that his BPA-unexposed rats also weighed significantly less than the BPA-unexposed rats in the government's Core Study. Increased variability in weights could cause increased variability in other measures of interest. A statistical fallout of that variability can be a watering down of the differences between exposed and unexposed rats. "This was just not done correctly," said vom Saal.

Deciphering data

On the winding walk through a densely wooded portion of the arboretum, Hunt points out an abundance of money plants — their bright magenta blooms scattered across the forest floor. "They are weeds," she says. "Or wildflowers, depending on your point of view." Again, two different people can be looking at the same thing yet call it two very different things — whether out in the world or in the lab. And it can be a result of bias, noted Bailer. "The eye wants to see what the eye wants to see," he said, suggesting that a scientist might, for example, see a non-monotonic pattern in data where such a dose-response effect does not actually exist. Further, two different scientists may also take the same findings and make a number of different choices that ultimately weave a very different story for the public. What results do they include and how do they interpret those results? Which of the results do they emphasize in the study's conclusions, abstract and title? How do they publicize that end product to the rest of us? Prins argued that the FDA has repeatedly come up with study results that show effects of BPA, "but then spin it in the discussion section to say there are no BPA effects." Critics suggest that the FDA may spin results across studies as well. For example, FDA risk assessments have generally relied largely on a small number of older industry-funded guideline studies. "The playing field is slanted. Industry gets more input," said Hunt. The FDA's 2014 risk assessment of BPA is one such example. Of the 36 studies that they identified as related to neurological endpoints, the FDA chose only one to include in the risk assessment. That study was funded by industry. Then, of 25 reproduction-related studies, they determined that none were appropriate for the risk assessment as they did not follow the validated protocols traditionally accepted by the FDA. "If you cherry pick for the answer you want, you can get it," said Patisaul.

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"I would argue that's not in the interest of public health." When the FDA declared BPA "safe" in its previous 2008 risk assessment, reporters at the Milwaukee Journal Sentinel dug up evidence that the decision was influenced by the American Chemistry Council, a leading industry trade group. Further, the FDA's science review board rejected the conclusions in that assessment. By 2008, more than 1,000 studies of BPA health effects had been published yet the FDA based its conclusion of BPA's safety on only two studies, which were funded by the plastic industry and had been deemed flawed by outside scientists and government officials.

The agency defends their risk assessments of BPA. "Guideline and academic studies are independently evaluated on a case by case basis to determine if enough information is available to have confidence in the data to address the relevant risk assessment question," Naum, the FDA spokesperson, wrote in an email to EHN. "The FDA's conclusions were based on a comprehensive, transparent, review using predefined scientifically supported criteria for evaluating the available science." Clarity provides yet another opportunity to combine a lot of data into a more comprehensive assessment of BPA. An analysis of all the data from the collaboration remains in the works. "This is where we are going to get the most compelling evidence," added Hunt. Still, just what the feds will do with that evidence remains unclear. The FDA did not respond to questions concerning how it will use the Clarity findings, or what it would take for the results or conclusions to prompt the agency to revise its view on the safety of BPA or the criteria for determining a safe dose of a chemical. Naum only stated that the agency will "continue to monitor developments in the field," including previous reviews and the results of the Clarity Core Study, and will "take steps appropriate to protect public health." In an email on May 8, 2012, Retha Newbold, a developmental endocrinologist with NIEHS, wrote to Walker, the toxicologist at NIEHS, of her disappointment in not getting more assurance from Jason Aungst, the toxicology branch chief at the FDA, that the agency would use the data generated from Clarity. "He is already planning his reasons why they may not use it," she wrote. Aungst helped lead that 2014 risk assessment. Walker responded: "Like most data for FDA one can only ensure data 'can be used' for decision making, not that it 'will be.'" In February 2018, he emailed other NIEHS colleagues lamenting a lack of a "plan, timeframe or strategy" from the FDA on how it "plans to do an update to its assessment of data on BPA."

The final word

Leaving a room filled with plastic cages of mice — big brown ones and tiny pink ones — Hunt and I step onto a sticky mat and change out

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of the Crocs we had worn inside. The process helps to ensure further contaminants including pathogens are not spread to the mice in the lab. We place the Crocs back on shoe racks just as one of Hunt's colleagues walks by holding an empty reusable pod for a Keurig coffee machine. She looks knowingly at Hunt and says, "unfortunately, it's plastic." Hunt reassures her that, actually, this one is made of silicone. "So, you're ok," she says. "But good on you to think about that." Not everyone thinks about the potential health risks of BPA, let alone the hundreds of other endocrine-disrupting chemicals found in common consumer products. Not surprisingly, scientists who study the chemicals for a living are more apt to consider exposures. Hunt, for example, now opts for email receipts on her stops by the Moscow Food Co-op. She knows that most cash register receipts, too, are among the everyday things that can leach BPA or one of its substitutes, such as bisphenol S, onto the skin and into the body. Some scientists fear that the public has not been receiving accurate information on BPA. A curious consumer might look for answers online. Yet the top hit in a Google search of "bisphenol A safety" is a link to an industry-sponsored website titled "Facts About BPA." In fact, the search result appears in a stand-out box filled with material pulled from the site. Without having to click a link, you could read that BPA has a "safety track record of 50 years," and that no "cause-and-effect relationship between BPA and any human health effects" has been shown. Patisaul suggested that the public has also not been receiving the "correct message," because "the FDA has been issuing statements before research has been done and before they've had a chance to comprehensively look at all the data." The most recent case-in-point was a late February 2018 statement from Stephen Ostroff, the deputy commissioner for foods and veterinary medicine at the FDA, which highlighted the agency's interpretations of the just-released draft of the Clarity Core Study. It did not mention the significant findings of effects at low doses of BPA in both the Core Study and in the peer-reviewed studies from academic collaborators that had been published by that time. National headlines appeared shortly thereafter. From NPR to Newsweek, the media was once again relaying the message from the FDA that the public need not worry about BPA. Clarity participants had agreed at the start of the project that they would not make any policy statements, nor any conclusions, without considering all of the data. Even NIEHS was caught off-guard by the FDA's move. Earlier in February, Virginia Guidry, of the NIEHS Office of Communications and Public Liaison, emailed Walker and other colleagues about a conversation she had with a communications official at the FDA regarding the Core Study release. "I told her we were planning a reactive approach, ready for questions but no press release. They are doing the same," she wrote.

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"The announcement from the FDA that has spread like wildfire is in direct contrast with that agreement," said Patisaul. "We had published four papers. Other Clarity participants had published papers. And the FDA said nothing. Then, when they issued their draft report — which was not even peer-reviewed — they made this big sweeping statement that BPA is fine. That's disingenuous." Pete Myers, CEO and chief scientist of Environmental Health Sciences, suggested that the move was a tactic by the FDA to control the media. The press — and the public — would pay less attention when the full report is unveiled, he told EHN. "The second wave doesn't receive the same coverage," said Myers. (Editor's note: Myers is also the founder of EHN, though the publication is editorially independent.) A fury of emails between NIEHS colleagues followed the FDA statement. In one of those emails, Walker suggested that FDA officials had drafted "a statement to reiterate their current policy stance on the safety of BPA." The FDA did not respond to EHN's questions regarding why they issued the statement. They further declined to respond to the subsequent criticisms. On that industry website, which belongs to the American Chemistry Council, three key findings from the government's research on BPA are listed. One of them has been front-and-centre in Clarity: "No risk of health effects at typical consumer exposure levels." Hunt and other non-government scientists have co-authored a paper currently under peer review that also calls into question the other two: "Consumer exposure to BPA is extremely low" and "BPA is rapidly eliminated from the body." "We are woefully underestimating exposure levels," said Hunt. "All of our regulatory decisions have been based on assumptions about metabolism and levels of human exposure that are questionable." The stakes are high. With BPA just the tip of the iceberg, any conclusions and admission by the FDA of BPA's problems could cause the dominoes to really fall. It would be "like a death knell for industry," she added. "I think the feds are very sensitive to that."

Environmental Health News, 15 November 2019

<http://www.environmentalhealthnews.org/>

Dirty fuels kill millions as investment in clean cooking runs short

2019-11-27

Meagre investment is hindering countries' ability to meet a global target to ensure universal access to clean, modern cooking fuel by 2030 and end the millions of deaths caused by indoor pollution every year, say clean energy experts. Three billion people globally cook with dirty solid

Three billion people cook with dirty fuels on open fires or stoves that produce high levels of carbon monoxide, killing four million people annually

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fuels such as charcoal and wood on open fires or traditional stoves that produce high levels of carbon monoxide, killing four million people annually, says the World Health Organization. The use of dirty fuels for cooking also contributes to deforestation and climate change - accounting for approximately 2 percent of global carbon emissions, equivalent to annual air travel emissions, according to the World Bank. Businesses developing solutions ranging from energy efficient cooking stoves to biomass renewable fuels have mushroomed in recent years, but many lack funds to offer affordable products to poor communities in the developing world. "No one's life should be limited by the way they cook, yet globally three billion people depend on polluting open fires or inefficient harmful stoves to cook their food," said Dymphna van der Lans, CEO of the Clean Cooking Alliance. "Despite its far-reaching benefits, clean cooking is too often seen as a second-tier priority. "The level of funding in the sector falls far short of sufficiently matching the global magnitude of this challenge," she said, referring to a clean cooking target set by countries as part of 17 goals known as the Sustainable Development Goals. Total investment in clean cooking businesses was \$40 million in 2017. The Clean Cooking Alliance estimates \$4 billion is required annually to ensure universal access to cleaner options of cooking by 2030. With population growth outpacing the number of people gaining access in clean cooking by four times, World Bank officials warn that 2.2 billion people will still not have access by the end of the next decade if current trends continue. Campaigners attribute the failure to attract credible funding to multiple factors. The industry has a much lower profile than other social business sectors such as solar energy and microfinance, which attract high levels of funding, while many countries lack specific policies to promote the sector, they say. One of the biggest challenges to attracting investment is consumer demand, say clean energy experts. Many communities lack awareness about the harmful health and environmental impacts and see a clean cook stove as an unnecessary expense when firewood is free. "People have been cooking traditionally for hundreds and thousands of years and it's difficult to move away from that," said Olivia Coldrey, lead finance specialist from Sustainable Energy for All. "So, if you take a rural women's who has always cooked using firewood, it's difficult to get her to change her behaviour by saying I am going to give you a cook stove and you are going to pay for it." Coldrey said countries needed to treat the dangers faced by dirty cooking in the way they responded to the HIV/AIDS epidemic and a global campaign should be launched to promote awareness - not just for consumers, but also donors and investors. "We haven't eradicated HIV AIDS, but we've made people's lives a lot easier," she said. "We need a

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similar sort of campaign giving out a simple message - after all, it's killing millions of people."

Thomson Reuters News, 22 November 2019

<https://www.thomsonreuters.com>

After Deaths, Ban on Flavoured Vapes to Be Passed by New York City

2019-11-28

The New York State attorney general, Letitia James, filed a lawsuit against Juul Labs this week, accusing the company of deceptive marketing practices. The New York City Council agreed on Thursday to ban flavoured e-cigarettes amid heightened concerns about the use of such products, making New York City the most populous jurisdiction in the country to impose such a ban. The ban would cover all flavoured e-cigarettes and e-liquid vaping products, including ones that are menthol flavoured. At least 30 members of the 51-member City Council have signed on as co-sponsors of the legislation. Similar bans have been introduced or are being considered around the country: Voters in San Francisco approved a referendum to ban flavoured vaping products in June 2018, and the Massachusetts Legislature passed a ban on flavoured tobacco on Wednesday. Other states, including New York and Michigan have attempted to impose temporary bans on flavoured vaping products through executive orders, but those efforts have been stalled by lawsuits challenging the moves. "The vaping industry launched a full-force effort to stop this because they knew if it was done here, they couldn't stop it across the country," said Councilman Mark Levine, a Democrat from Manhattan who is chair of the health committee and the bill's primary sponsor. "If we can do it here, it will go nationwide." There is already a national momentum building against e-cigarette use. The attorneys general of New York and California each filed lawsuits against Juul this week, charging that the company practiced deceptive marketing by failing to mention that their products contained nicotine and also targeted young people with enticing flavours like mango. On Tuesday, the A.M.A. called for a "total ban on all e-cigarette and vaping products" that do not meet Food and Drug Administration standards as smoking cessation tools. The new legislation, which is expected to be passed by the City Council on Tuesday, includes menthol-flavoured products; the only vaping liquid that would be allowed for sale are tobacco-flavoured products. The bill would then go to Mayor Bill de Blasio to sign. "The mayor supports it. We will either sign it or let it lapse into law," said Freddi Goldstein, Mr.

Nearly 50 people have died in recent months in the United States from vaping-related respiratory illnesses

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de Blasio's press secretary. The Council, however, set aside a companion measure that would have banned the sale of menthol cigarettes amid concerted lobbying efforts and opposition from the Rev. Al Sharpton, whose non-profit National Action Network has regularly taken five-figure contributions from the tobacco giant Reynolds American. That legislation has come under attack from some civil rights activists who say that since menthol cigarettes are largely smoked by African-Americans, banning them would create an underground market that could lead to tragedies like the death of Eric Garner, a Staten Island man who died after a confrontation with police officers who accused him of selling loose cigarettes. Others have argued for a ban, citing health concerns. Mr. Levine said there is still a "strong commitment" to the menthol ban. Kirsten John Foy, a civil rights activist who was formerly a part of Mr. Sharpton's organisation, said that delaying a menthol cigarette ban was a capitulation to the tobacco industry. The vaping industry's lobbying efforts have also been strenuous, if less successful. In 2019 alone, Juul paid more than \$250,000 to lobbyists from five separate firms to lobby on its behalf in New York City, mostly related to the flavoured e-cigarette bill, state filings show. (The company also paid to lobby against restrictions in Albany.) The City Council speaker, Corey Johnson, who has shared on social media about his use of e-cigarettes to quit smoking cigarettes, "proudly supports" the vaping legislation, said his spokeswoman Jennifer Fermino, and is meeting with stakeholders to find a compromise on the menthol ban.

Vaping industry officials have said generally that removing their products from the market would eliminate one tool that adults have used to help stop smoking cigarettes. Tony Abboud, executive director of the Vapor Technology Association, said in a statement Thursday night that the trade industry group "stand ready to continue working with the City of New York on effective regulations and real solutions that will achieve the twin goals of restricting youth vaping, which is already illegal, and preserving flavoured vapor as an alternative for adult consumers desperately trying to quit smoking." But in a sign of the mounting pressure, Juul stopped selling its non-menthol flavoured products in the United States in October. New data from the Food and Drug Administration and Centres for Disease Control and Prevention shows what they called a "disturbing" rise in the use of e-cigarettes by youth that is "reversing progress" made in the decline of tobacco use by young people. In 2019, more than 5 million middle and high school students used e-cigarettes, up from 3.6 million in 2018, a 39 percent increase. Nearly 50 people have died in recent months from respiratory illnesses that the authorities have connected to vaping, including a 17-year-old Bronx boy who was believed to be

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the first teenager in the United States to die of a vaping-related illness. On Wednesday, the New York State Department of Health confirmed the death of a Manhattan man in his 30s from an illness associated with vaping. Mr. Levine, a married father of 16- and 19-year old sons, said one of his sons used to vape but has since quit. "This issue is personal with me," Mr. Levine continued. "They have been surrounded by vaping since the moment either of them got to middle school and the temptation is irresistible."

New York Times, 21 November 2019

<http://www.nytimes.com/>

The World Burns All Year. Are There Enough Planes to Douse the Flames?

2019-11-28

Sharing the giant air tankers that fight fires 5,000 gallons of water at a time used to be simpler. California's wildfires faded before Australia's bush fires surged, leaving time to prepare, move and deploy planes from one continent to another. But climate change is subverting the system. Fire seasons are running longer, stronger, hotter. The major fires now blanketing Sydney in smoke started early, within days of the last California blazes. And the strain is global. Countries that used to manage without extra help, like Chile, Bolivia and Cyprus, have started competing for plane and helicopter contracts as their own fires intensify. That is stretching capacity for the companies that provide most of the globe's largest firefighting aircraft, and increasing anxiety for fire officials worldwide. "We're all feeling it," said Richard Alder, general manager of Australia's National Aerial Firefighting Centre. "As fire seasons ramp up and get longer — and they definitely seem to be doing that, the science tells us that — it places more demand on aircraft to support the firefighting. And it's only one part of the equation." The age of fire is upon us, scientists say, and the public and private system built to contain it is being pushed to its limits. While firefighting is still primarily done on the ground, governments and frightened residents are increasingly demanding costly assistance from the air. The European Union created a reserve fund this year for firefighting aircraft, with contracts allowing for deployments across national borders. Bolivia leased the world's only Boeing 747 water bomber to fight fires in the Amazon in August, after the plane had been used in Israel in 2016, Chile in 2017 and California in 2018. Meanwhile in Asia, South Korea is reaching out to companies like 10 Tanker Air Carrier in New Mexico, while Indonesia borrowed an air tanker from Australia a

As climate change pushes California's fire season into Australia's, an intricate system of resource sharing struggles with the load.

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few years ago that came from Coulson Aviation in Canada, which is now doubling the size of its contract fleet, while developing new technologies for mapping and fighting fires at night. What these companies and fire officials say they are planning for is a world ablaze year-round. "It's coming from all over," said John E. Gould, president of 10 Tanker Air Carrier, who started his career fighting fires in Alaska in the 1970s. "Fires are affecting climates and places they never used to affect." That has forced firefighting "to be a global effort, not a state or national effort," said Stuart Ellis, the chief executive of the Australasian Fire and Emergency Service Authorities Council, which manages fire planning for Australia, New Zealand and the Pacific. "It's not just a firefighting issue," he added. "We need to be more critical of our planning decisions. We need to examine building in bush-fire-prone areas. People love living in the bush, but as the bush is becoming more vulnerable, is that viable?" In Australia, the conservative government has yet to confront such difficult questions as it rejects a discussion of climate change and its impact. But the country is fast becoming a fiery test case for the pressures that are building worldwide. Australia is more vulnerable than most: It is arid and expansive, with large cities sprawling toward wilderness. Climate change is already delivering a sharp shift in precipitation, spurring a lengthy drought. Dry areas are now drier and larger, with forests that used to be reliably moist becoming tinderboxes waiting for a spark. This week, more than 1,000 firefighters have been battling more than 120 blazes in four states as dangerous fire conditions and record temperatures persist. In some areas, no significant rainfall is expected until January. "We're starting to see unprecedented conditions," said Joëlle Gergis, a climate scientist at the Australian National University. "We had bush fires starting as early as winter — and by the time spring came around, we had fires in subtropical rainforest." Fire officials and scientists say they are being forced to imagine, for the first time, overlapping and intensifying demands. "Something is clearly changing," said Richard Thornton, the chief executive of the Melbourne-based Bushfire and Natural Hazards Cooperative Research Centre. "And the climate is driving all of that." The fires of this new era cannot always be tamed. Neither aircraft nor ground crews can do much for the blazes that spread quickly with powerful winds. The Tubbs Fire that destroyed parts of Santa Rosa, Calif., in 2017 jumped an eight-lane freeway. The winds supercharging the Camp Fire that burned through the town of Paradise, Calif., last year pushed water bombers too high into the air to drop their payload. Nonetheless, aircraft use, and fire management costs, are soaring. Chile, which expanded its contracts with Coulson this year, spent more than three times as much on firefighting from 2014 to 2018 as it did during the previous five-year period. The United States Forest Service spent more

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than \$1 billion on fire suppression in 13 of the 18 years between 2000 and 2017. Costs surpassed \$2 billion for the first time in 2017 and 2018, when California's fire seasons were especially severe. In Australia, too, firefighting expenses are rising. And because the responsibility largely resides with individual states, fire officials are increasingly worried whether the system can handle what's on the way.

Firefighters are already hard to deploy across state lines: Of Australia's 300,000 fire and emergency service personnel, roughly 85 percent are volunteers who tend to stay where they live. Large airplanes and helicopters that dump water or other firefighting materials are thus increasingly seen as the most vital weapons for what officials call "surge capacity" — the ability to add resources as fires defy control. Two years ago, the National Aerial Firefighting Centre — which coordinates air support for all of Australia's states and territories — sent a proposal to Parliament asking for a more than 70 percent increase in its annual federal funding, to 26 million Australian dollars (\$17.7 million). But the request was ignored. And state governments are now bearing the burden. There will be seven large air tankers in Australia this fire season; a DC-10 owned by 10 Tanker touched down in New South Wales last weekend, ahead of the usual Dec. 1 start date, after fighting the recent fires in California. The state also recently bought a 737 Fireliner — along with two lead planes — from Coulson Aviation for 26.3 million Australian dollars (\$17.9 million). It can carry 4,000 gallons of liquid along with 72 passengers. But buying or leasing a water tanker is not as easy as ordering hoses, or even sharing a few hundred firefighters, as the United States and Australia do now as well. The planes being modified are typically decades old. It can take years to turn them into firefighting weapons, and officials are anxious about whether the market will meet their needs. All 18 of the large air tankers that the United States Forest Service plans to use through 2022 will come from private contractors, according to the agency's aviation strategy. The more that fires surge into fall for California, the worse it may be for Australia and the rest of the world when it's time to share. "I suspect we're all becoming more nervous," said Mr. Alder, who has been fighting fires in Australia for decades. "We're keeping a watchful eye on it."

New York Times, 21 November 2019

<http://www.nytimes.com/>

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Can insects help clean up palm oil's tarnished image?

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A pioneering entrepreneur believes insects can help improve the reputation of the palm oil industry, which for years has been accused of causing widespread deforestation, while slashing commercial farming's voracious water use. Patrick Crowley, founder of Chapul, the first insect protein foods company in the United States, is proposing a "circular economy" for palm oil farmers so that waste and by-products are used for farming insects on plantations. "The problem is the human behaviour of clearing rainforests and peat bogs. It's not palm. It's the practice. That's how I see it," Crowley told the Thomson Reuters Foundation. Palm oil is the world's most widely used edible oil, found in everything from margarine to soap, but has faced scrutiny in recent years from green groups and consumers, who have blamed its production for forest loss, fires and worker exploitation. Crowley's insect plan, already being piloted for four years in Indonesia, the world's biggest palm oil producer, involves using empty palm fruit bunches that are often burned or left to rot after being processed. This waste has little or no market value but is high in fibre, the 40-year-old former hydrologist-turned-CEO said on the sidelines of a conference in Dubai on food production in areas with poor soils and water scarcity. Natural fungi and bacteria are added to this palm fruit waste to start the fermentation process, increasing its protein content and making it more digestible for insects, he said. Black soldier flies, which are good at converting waste into protein, are given this waste just once before they are then ready to be harvested and fed to farmed fish, probably the world's fastest growing food-producing sector. Such insects replace fish meal, which is becoming increasingly scarce and expensive, and palm plantations are attractive because they provide "the largest concentration of homogenous waste" that can be converted into feed with consistent quality, said Crowley. Scientists say insect waste, known as frass, is also a great natural fertiliser and can go back into plantations to help boost palm yields, Crowley said. "We're already seeing an increase in productivity and decrease in use of pesticides in our pilot," he said. Crowley was looking at ways to cut agriculture's water usage - 70% of the world's freshwater is currently used for farming - when watching a TED talk on insects made him "a reluctant entrepreneur". He used crowdfunding to set up Chapul - the Aztec word for grasshopper - a year before the United Nations' Food and Agriculture Organization (FAO) published a report on insects. The agency highlighted that they emit fewer greenhouse gases and less ammonia than cattle or pigs, require less land and water - and there are more than 1,900 edible insect species. Crowley said a consortium of

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partners bought land on Sumatra island to scale up their 2,000 square metres (0.2 hectare) pilot facility into five farms of 5 hectares each. These farms would use a total of 1 million tonnes of waste per year, produce 200,000 tonnes of larvae, and save 20 million tonnes of greenhouse gas emissions, he added. Eduardo Mansur, director of land and water division at the FAO, said it is not only important but also necessary to transform the economic systems into circular models. "Is it possible to do it at once in all sectors? No, but we have to start where we can and agriculture sector, especially water in agriculture, offers a lot of opportunities" he said. "But we have to do it at a scale that will have positive impact to the planet."

Thomson Reuters News, 21 November 2019

<https://www.thomsonreuters.com>

Office Workers May Be Breathing Potentially Harmful Compounds in Cosmetics

2019-11-28

We often think of pollution as an outdoor problem. But many office workers are constantly breathing a complex soup of invisible airborne substances including ozone, carbon dioxide, particulate matter and volatile organic compounds (VOCs). The latter are gases that can be released from moulds, building materials, human metabolism—and personal care products such as lotions, deodorants, hair spray and cosmetics. Some VOCs have been linked to health effects including fatigue, difficulty concentrating, eye, nose and throat irritation, and even cancer. Whether exposure to these substances in offices poses a significant risk to human health remains an open question, however. Benjamin Franklin suspected the unhealthy effects of indoor air back in 1785. "I am persuaded that no common Air from without, is so unwholesome as the Air within a close Room, that has been often breath'd and not changed," he wrote in a letter to Dutch physician Jan Ingenhousz. Over the years scientists have tried to back up his claim, and recent research provides some support for it. In one of the largest studies of its kind, researchers at Purdue University have now used a sophisticated system of sensors to measure the complex dynamics of VOCs in an office environment. The findings, presented in October at the American Association for Aerosol Research Conference in Portland, Oregon, cannot prove that any one indoor air component causes health problems—but they could be used to design better-ventilated offices and advance research on the issue. The study took place at Purdue's Living Labs, a simulated open office equipped with thousands of sensors as well as an instrument called

Some cosmetics and deodorants contain chemicals that, when released into the air, may pose a risk to human health

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"The Nose," a highly sensitive mass spectrometer that can sniff out VOCs, ozone, carbon dioxide and aerosols. Researchers used temperature sensors embedded in office chairs to track the occupancy of 20 graduate students who spent their days working there. Brandon Boor, an assistant professor of Civil Engineering at Purdue, and his team found that humans were the dominant source of VOCs in the model office's air. Nearly 2,000 such compounds can come from simply being alive: exhaled breath, sweat, saliva and the like. Concentrations of human-derived VOCs varied throughout the day in the experiment, but usually peaked in mid-afternoon when occupancy was highest. VOC concentrations also depended on factors such as whether the office had recently been cleaned, whether someone had just applied a personal care product, and how well the ventilation system was working. Ozone gas from the outside air—which came in through the ventilation system—was highly reactive with indoor surfaces such as walls and furniture, and with VOCs left behind by occupants. The researchers found that the gas reacted with human skin oil to create new VOCs. It also reacted with chemicals called monoterpenes from a freshly peeled mandarin orange to form new, nanometre-sized ultrafine particles. (Monoterpenes can also come from manufactured sources such as scented personal care products and cleaning fluids.) The investigators further found that VOCs from personal care products peaked in the morning, when freshly deodorized graduate students arrived. A chemical called D5—found in thousands of such products—was detected at levels comparable to or greater than those of isoprene, one of the major VOCs in exhaled human breath, and was relatively high in the staff hangout area. The team also detected related compounds called D4 and D6, but these were found at much lower levels than D5. "Our preliminary results suggest that similar amounts of isoprene and D5 can be released into the office air," Boor says. "The emissions of D5 are likely dependent on the amount and type of personal care products the occupants are wearing." He notes that results from his study apply only to this model office. His team is working on emission factors that may allow them to generalise their results to other settings. Office workers may not have a lot of control over how much carbon dioxide their co-workers exhale, how much skin oil they produce, or even whether they decide to peel an orange. But they do have some control over their own use of personal care products, says Carrie Redlich, a pulmonologist and director of the Occupational and Environmental Medicine Program at Yale School of Medicine. "If someone is symptomatic"—maybe they have a headache or their asthma is acting up—"in an environment where people are wearing a lot of perfumed products, the question is: Do we really need [these products]?" she asks. "I've seen enough patients who are very symptomatic

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in response to those [substances]. In some jobs, people may not be able to get up and walk away from what's triggering their symptoms, and it may really impact their ability to keep that job."

Researching the Chemical Risks

Some research suggests that compounds such as D4, D5 and D6—which are derived from silicone and called cyclic volatile methyl siloxanes (cVMSs)—could pose a risk to human health, although the vast majority of studies have been done on animals and are far from definitive. D4, D5 and D6 are all found in personal care products, and D5 is most abundant. Animal studies have linked D4 to impaired fertility, and both D4 and D5 to uterine cancer. But the animals were subjected to very high doses of the chemicals, for long durations and in highly unusual settings, according to Charles McKay, the former president of the American College of Medical Toxicology and current associate medical director of the Connecticut Poison Control Centre at the University of Connecticut Health Centre. "Those experimental conditions often have very little to do with human exposure to much, much lower doses," McKay says. "Studies did show uterine cancer issues in one animal model at very high doses, but I'm not sure that has any bearing on the human setting." (McKay has been retained previously by law firms representing pharmaceutical and medical device companies or their opponents, but with the exception of one case involving a car wax product, these cases were not related to cVMS compounds.) Most of the animal studies have been sponsored by the silicone industry, and those that showed a connection with uterine cancer were done in rats. Industry representatives have argued the hormonal mechanism that may contribute to uterine cancer after exposure to D4 and D5 is different in rats than in humans, so studies of the former may not be relevant to the latter. Critics point out the industry ties and the dearth of independent studies. "As a common pattern, if facts of concern are found, the industry launches a firework of publications that try to downplay such results and to argue that the results of rat studies are not relevant to humans for various reasons, usually published as half a dozen sponsored papers in special [perhaps paid] issues of journals that at least have a reputation of being close to industry," says Christoph Rücker, a chemist at Leuphana University Lüneburg in Germany, and co-author of a review study about siloxanes. The European Union recently decided to regulate these compounds. Citing environmental risks, the EU's REACH program has listed D4, D5 and D6 as substances of very high concern, and labelled them as PBT (persistent, bioaccumulative and toxic) and vPvB (very persistent, very bioaccumulative). Starting after January

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31, 2020, the EU will limit D4 and D5 concentrations to 0.1 percent in wash-off products such as shower gels, shaving foams and shampoos. The EU has also proposed restricting D4, D5 and D6 in all consumer and professional products, such as dry-cleaning fluid. The silicone industry has sued the European Court of Justice over these actions. Linda Loretz, chief toxicologist for the Personal Care Products Council (a national trade association) and Karluss Thomas, senior director of the Silicones, Environmental, Health, and Safety Centre (a subgroup of the American Chemistry Council that represents 90 percent of silicone chemical manufacturers in North America) point out the large body of research reviewed by regulatory bodies in a number of countries including the U.S. Environmental Protection Agency. Loretz and Thomas say D4 and D5 do not pose risks to human health, although some of the research is inconclusive. Studying cVMSs and human health is “complex” and “controversial,” according to Rücker. Few studies have been conducted in humans, and not much research has been conducted in the past 10 years. “There are only [a handful] of experts on toxicity of siloxanes, and these are employees of the silicone industry,” Rücker says. “The industry is free to publish or not to publish the results of their studies.” These compounds have been used in consumer products for almost 80 years. Children may have higher exposures than adults, with relatively high concentrations in baby products. “Siloxanes are clearly one of the major contaminants in indoor air and dust, [which] form an important pathway of human exposure,” says Kurunthachalam Kannan, deputy director of the Division of Environmental Health Sciences at New York State Department of Health’s Wadsworth Centre. But assessing risk to humans for these compounds is “sometimes politically sensitive,” he says. Whether or not these specific chemicals prove to be a risk, office workers could benefit from a little fresh air. Benjamin Franklin would throw open the windows, throw off his clothes and take so-called “air baths.” But if office heating, ventilation and air conditioning systems are functioning adequately, people may not need to strip down. Their co-workers may thank them for it.

Scientific American, 21 November 2019

<http://www.sciam.com>

Hyperpalatable foods are a modern bogeyman. But what even are they?

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In the secret labs of corporate giants, scientists are engineering foods with “hyperpalatable” formulas to hijack our brains’ reward mechanisms,

In the secret labs of corporate giants, scientists are engineering foods with “hyperpalatable” formulas to hijack our brains’ reward mechanisms, turning us into addicts for their products.

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turning us into addicts for their products. This claim has been the subject of books, documentaries and the columns of “investigative journalists”, and is continually amplified by social media. According to the narrative, the driving force behind the rise in obesity rates in recent decades is the hyperpalatability of certain modern formulations of food, specifically designed to trigger a psychological “bliss point” where those who consume them lose all self-control. As stories go, it has it all: deception, intrigue and a link to your everyday life. But how much of it is backed by science? Are there universal formulations of ingredients that can be deployed to trigger this response, causing food to act more like a drug? Perhaps surprisingly, given the frequency with which the term is used, even in academic literature, there has been little attempt to define what exactly constitutes hyperpalatability. Nebulous descriptions like “loaded with sugar”, “fat-filled” or cultural labels like “fast food” or “junk food” have filled the void. Given that people are referring to incredibly precise ubiquitous formulations of foods, it does seem surprising that there doesn’t seem to be any clear record for these in the scientific literature. To tackle this issue, a team at the University of Kansas Medical Centre set out to define clear criteria for hyperpalatability for the first time. Trawling through thousands of studies, this month they identified examples of such foods – from biscuits to macaroni cheese – and analysed the make-up of their ingredients using nutrition software. Perhaps unsurprisingly, their results didn’t report a single “magic bullet” recipe, but three clusters of loose formulations that matched the nebulous descriptions. First up were foods in which more than 20 per cent of the calories came from both fat and sugar, such as cakes, cookies and pancakes. No surprise there. Then there were foods in which more than 25 per cent of their calories came from fat and which contained more than 0.3 per cent sodium (from salt) by weight. This tended to include mainly meat, dairy or egg products such as bacon, omelettes and cheesy dips. Finally came foods with more than 40 per cent of calories coming from carbs and containing 0.2 per cent or more sodium by weight, like pasta and breads. Looking at these results, it may be surprising how many diverse foods match the criteria for what is often described as an incredibly precise, modern formulation. Indeed, given that salt is used universally in savoury foods and carbohydrates and fats are the two key energy sources for our species, the two clusters based on fat and salt or carbs and salt cover a lot of everyday meals. A plain grilled steak, for example, would meet the criteria, as would a bowl of brown rice, as long as both were seasoned enough. This doesn’t exactly fit the narrative of hyperpalatability as a modern spectre concocted in the labs of big processed food manufacturers. Indeed, when the researchers compared these clusters to a database of everyday foods eaten in the US, they found

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that 62 per cent of all entries matched these criteria. This even included vegetable dishes such as carrots served with butter. After all, vegetables are so low in calories that you don't have to add much fat to make this more than 25 per cent of the dish's energy, turning them instantly into allegedly drug-like hyperpalatable foods. Even the category of foods that derive at least 20 per cent of their calories from sugar and fat is a pretty open one. Brownies fit it perfectly, but so could a large baked sweet potato and a quarter of an avocado. In fact, this "clean eating" meal could match all three clusters depending on seasoning, making it an archetypical example of a hyperpalatable food too. What this reveals is that, despite being pitched as a modern corporate evil, food combinations such as salt and fat, or sugar and fat, are also home-cooking techniques that predate the modern rise in obesity, and aren't necessarily unhealthy either. So, is there really much more to the term hyperpalatable than just being tasty? It is important to point out that this field of research is new, with a 550 per cent increase in published papers in the past 20 years. Indeed, even the claim that food can be addictive in the same way as drugs like cocaine are is still raging in academia. As we have only just figured out a definition of hyperpalatability (or should that be definitions?), it is strange how bold the media claims have often been. I, for one, can't wait to find out what further research uncovers.

New Scientist, 22 November 2019

<http://www.newscientist.com/>

Technical Notes

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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

Physical and chemical characterisation of McIntyre Powder: An aluminium dust inhaled by miners to combat silicosis

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

Associations between Indoor Air Pollution and Acute Respiratory Infections among Under-Five Children in Afghanistan: Do SES and Sex Matter?

Residential sources of pesticide exposure during pregnancy and the risks of hypospadias and cryptorchidism: the French ELFE birth cohort.

Isopropylated and tert-butylated triarylphosphate isomers in house dust from South China and Midwestern United States