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

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ASIA PACIFIC

Non-nicotine e-cigarette liquids in Australia

2019-10-11

What are e-cigarettes and vaping?

E-cigarettes are battery-powered devices that heat e-cigarette liquids to make an emission intended for inhalation. The emission consists of very fine particles (aerosols) that are inhaled by the user. The use of e-cigarettes is often called vaping.

NICNAS' work on e-cigarette liquids

To date, there has been limited information about:

- the chemicals in e-cigarette liquids sold in Australia
- the chemicals in e-cigarette emissions
- the health concerns of these chemicals

To address the lack of public information surrounding e-cigarettes, NICNAS have completed an investigation and published a report. The report provides information about the identity and known hazards of chemicals available for vaping. However, there isn't enough information available about the inhalation toxicity of these chemicals to conclusively assess their health risks. Just prior to finalising the report (September 2019), NICNAS became aware of new information from the US about a possible link between e-cigarettes and severe lung disease, as well as reports of deaths linked to vaping. The Commonwealth Chief Medical Officer and State and Territory Chief Health Officers addressed these concerns in a statement entitled 'E-cigarettes linked to severe lung illness'.

What chemicals are inhaled during vaping?

People who vape are exposed to:

- chemicals intentionally included in e-cigarette liquids. Many of these are flavouring chemicals and it's unknown if these chemicals are safe when inhaled
- chemicals produced when e-cigarette liquid is heated. Many of these chemicals could be harmful to human health
- chemicals present as contaminants in e-cigarette liquid. Some of these chemicals can also be harmful to human health

What about e-cigarettes that contain nicotine?

What are e-cigarettes and vaping?

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Some e-cigarette liquids sold in other countries contain nicotine, but they cannot legally be sold in Australia. The Therapeutic Goods Administration (TGA) regulates nicotine and products containing nicotine. Nicotine is currently classified as a dangerous poison under Schedule 7 of the Poisons Standard. It has specific exemptions:

- for certain nicotine replacement therapies
- for tobacco prepared and packed for smoking
- when labelled and packed for the treatment of animals

Drugs, poisons and controlled substances legislation in all states and territories prohibits the commercial supply of nicotine for use in e-cigarettes

Rules on importing and manufacturing the chemicals in e-cigarette liquids

Chemicals used in e-cigarette liquids that do not contain nicotine (or are not marketed as having a therapeutic use, such as being an aid to smoking cessation) are regulated as industrial chemicals in Australia. The import or manufacture (introduction) of these chemicals is subject to the same requirements as any other industrial chemical. Anyone who introduces an industrial chemical into Australia must register with us. If the Australian Inventory of Chemical Substances (the Inventory) lists a chemical used in an e-cigarette liquid, then we generally don't need to assess the chemical before it is introduced into Australia. However, if the chemical is not on the Inventory, or the Inventory lists it with specific conditions, NICNAS generally must assess it before it can be introduced. Further information is available at:

- [Read our summary of the key points from the report](#)
- [Download the entire report \[Word 397 KB\]](#)

NICNAS, 2 October 2019

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

New Chemical Products Luximax Herbicide containing cinmethylin

2019-10-11

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has received an application for registration of a new product containing a new active constituent. The product is Luximax Herbicide.

Particulars of The Application

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has received an application for registration of a new product containing a new active constituent.

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Proposed product name(s):	Luximax Herbicide
Applicant company:	BASF AUSTRALIA LTD
Name of active constituent:	cinmethylin
Signal heading:	Schedule 5
Summary of proposed use:	For the pre-emergence control of annual ryegrass (<i>Lolium rigidum</i>) and suppression of certain grass weeds in wheat (not durum wheat).
Pack sizes:	10L, 20L, 110L, 1000L
Withholding period:	HARVEST: NOT REQUIRED WHEN USED AS DIRECTED GRAZING: DO NOT GRAZE OR CUT FOR STOCK FOOD FOR 7 WEEKS AFTER APPLICATION.

Summary of the APVMA's evaluation of Luximax Herbicide

The APVMA has evaluated the application and in its assessment in relation to whether the safety criteria have been met in accordance with the definition set out in section 5A of the Agvet Code, and proposes to determine that:

- The APVMA is satisfied that the proposed use of Luximax Herbicide would not be an undue hazard to the safety of people exposed to it during its handling and use.
- The APVMA is satisfied that the proposed use of Luximax Herbicide will not be an undue hazard to the safety of people using anything containing its residues.
- The APVMA is satisfied that the proposed use of Luximax Herbicide containing the active constituent cinmethylin is not likely to be harmful to human beings if used according to the product label directions.
- The APVMA is satisfied that the proposed use of Luximax Herbicide is not likely to have an unintended effect that is harmful to animals, plants or the environment if used according to the product label directions.

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- The APVMA has evaluated the application and in its assessment in relation to whether the efficacy criteria have been met in accordance with the definition set out in section 5B of the Agvet Code, and proposes to determine that: In relation to its assessment of efficacy under section 14(3)(f), the APVMA is satisfied that data from trials supporting the efficacy of the product adequately demonstrate that, if used according to the product label directions, the product is effective for its proposed uses.
- The APVMA has evaluated the application and in its assessment in relation to whether the trade criteria have been met in accordance with the definition set out in section 5C of the Agvet Code, and proposes to determine that: The APVMA is considering whether the proposed use of Luximax Herbicide would not adversely affect trade between Australia and places outside Australia.

Further Information

A Public Release Summary (PRS) of the evaluation of this product is available from the [APVMA website's 'Public Consultation' page](#)

Making a Submission

The APVMA now invites the submission of any relevant comments as to whether Luximax Herbicide should be registered. Submissions should relate only to matters that are required by the APVMA to be taken into consideration in determining whether the safety, efficacy or trade criteria have been met. Submissions should state the grounds on which they are based. Submissions must be received by the APVMA within 28 days of the date of the notice. Relevant comments will be taken into account by the APVMA in deciding whether the product should be registered and in determining appropriate conditions of registration and product labelling.

APVMA Gazette, 8 October 2019

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

Safe Work Australia is pleased to announce the launch of the National Return to Work Strategy 2020-2030

2019-10-11

Safe Work Australia has released the National Return to Work Strategy 2020-2030. The Strategy sets an ambitious 10-year action plan to improve return to work outcomes for workers across Australia. It was developed in partnership with governments, business, industry and

Safe Work Australia has released the National Return to Work Strategy 2020-2030.

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unions, and endorsed by work health and safety ministers. Consultation was also undertaken with academics, peak bodies, organisations and representatives from the insurance, legal and health sectors to help identify national policy issues and action areas to address them. The return to work process can be complex and involves a range of stakeholders. The Strategy aims to better support workers through this process, and help stakeholders to do the same. Improving national return to work outcomes can be achieved through the commitment and participation of all stakeholders who participate in the return to work process. Safe Work Australia encourages you to [download a copy of the Strategy](#).

Safe Work Australia, 27 September 2019

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

Workplace exposure standards open for public comment – Release 4 - Caprolactam to clopidol

2019-10-11

Safe Work Australia is evaluating the [Workplace exposure standards for airborne contaminants](#) to ensure they are based on the highest quality evidence and supported by a rigorous scientific approach. Release 4: Caprolactam to clopidol is now open for public comment. Please note that this Release includes chemicals that do not currently have an Australian workplace exposure standard. These are: chloromethyl methyl ether and chrysene.

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

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

Comments can be submitted on the draft evaluation reports and recommendations for Release 4 via [Engage](#), the consultation platform. Please note some evaluation reports have been deferred to Release 5. Public comment will close on 25 October 2019. The feedback Safe Work Australia receive will be considered when making final recommendations for workplace exposure standards. The draft evaluation reports and

Safe Work Australia are calling for comments on the recommendations for Release 4: Caprolactam to clopidol.

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recommendations for the remaining chemicals will be released throughout 2019 and 2020.

Safe Work Australia, 27 September 2019

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

Submissions open on proposed amendments to the Fire Fighting Chemicals Group Standard 2017

2019-10-11

New Zealand's Environmental Protection Authority (EPA) are seeking submissions on proposed amendments to the Fire Fighting Chemicals Group Standard 2017. In 2018, the agency carried out an investigation into the importation, manufacture, use and disposal of legacy firefighting foams containing PFAS (perfluoroalkyl and polyfluoroalkyl substances) at airports, ports, refineries, bulk fuel storage sites, petrochemical sites and on New Zealand-registered ships. Following the investigation, EPA have been reviewing the Fire Fighting Chemicals Group Standard 2017 ("the Group Standard") to ensure it meets the requirements of the Hazardous Substances and New Organisms Act 1997 and manages the risks to public health and the environment posed by these chemicals. The proposed amendments to the Group Standard are intended to decrease the environmental and public health risks due to firefighting foams. The proposed amendments will phase out firefighting foams containing PFAS, provide for the disposal of PFAS firefighting foams and PFAS waste products, and set restrictions on the use of PFAS firefighting foams during the 5-year phase out period. EPA consider that the proposed amendments will enhance the efficiency and effectiveness of the Group Standard by clarifying the requirements for firefighting chemicals in New Zealand, further reducing the possible adverse effects of these chemicals to people and the environment. This will be achieved by restricting the use of PFAS chemicals in firefighting foam and providing clear requirements on use and disposal. Further information on the consultation is available at: [Read the consultation document and proposed amendments](#)

NZ EPA, 30 September 2019

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

New Zealand's Environmental Protection Authority (EPA) are seeking submissions on proposed amendments to the Fire Fighting Chemicals Group Standard 2017.

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China MEE Solicits Information Concerning Six Persistent Organic Pollutants

2019-10-11

On 18 September 2019, the Chinese Ministry of Ecology and Environment (MEE) issued a notice to solicit information concerning six persistent organic pollutants (POPs), including short-chained chlorinated paraffins (SCCPs); decabromobiphenyl ether (DecaBDE); polychlorinated naphthalenes (PCN); hexachlorobutadiene (HCBD); pentachlorophenol (PCP) and its salts and esters; and pentadecafluorooctanoic acid (PFOA), its salts and PFOA-related compounds. Previously, the Stockholm Convention on Persistent Organic Pollutants and its Conference of the Parties decided to exercise prohibitive or restrictive measures against the six POPs. For the time being, the decision has not come into force in China. After the arrangements are put in place in China in the future, the aforementioned substances other than HCBD will be prohibited from production, use, import or export (except for specific exempted purposes). Their wastes should be disposed of with their POP properties eliminated. The disposal process shall not result in recycling, regeneration, direct reuse, etc. of POPs. Notably, HCBD will be completely prohibited from production, use, import or export. The Convention also requires measures be taken to reduce or eliminate unintentional releases of HCBD and PCN. Thus, in a bid to gain a comprehensive understanding of the six POPs and inform the implementation of the decision, the MEE wants to solicit information on the following four aspects:

- Information concerning the production and use of six POPs (production volume, use volume, usage, etc.)
- Feasibility of immediately discontinuing their use for purposes other than specific exempted ones
- Feasibility of discontinuing their use for specific exempted purposes in five years
- Feasibility of release control

Individuals or entities can submit relevant information in writing or via email to the MEE before 31 October 2019.

Chemlinked, 30 September 2019

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

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U.S. Department of Labor Proposes Revisions to OSHA's Beryllium

2019-10-11

The United States Department of Labor's Occupational Safety and Health Administration (OSHA) placed on public inspection today a proposal to protect workers in shipyards and construction from beryllium exposure by more appropriately tailoring the requirements of the standards to the exposures in these industries. The proposal ensures consistency with the general industry standard where appropriate based on a July 2017 final rule clarifying certain requirements with respect to materials containing only trace amounts of beryllium. The proposed changes would maintain safety and health protections for workers, while facilitating compliance with the standards, and yielding some cost savings. The proposed rule would revise the following paragraphs: Definitions; Methods of Compliance; Respiratory Protection; Personal Protective Clothing and Equipment; Hygiene Areas and Practices; Housekeeping; Medical Surveillance; Hazard Communication; and Recordkeeping. The proposal also sets a hearing date for December 3, 2019. OSHA will continue enforcement of the permissible exposure limit. Comments, materials, and other information may be submitted electronically at <http://www.regulations.gov>, the Federal e-Rulemaking Portal, by facsimile or mail. See the Federal Register notice for submission details.

U.S OSHA, 7 October 2019

<http://www.osha.gov>

Domoic Acid Webinar: Research on Effects of Repeat Low-Level Exposures and Its Implications for Human Toxicity

2019-10-11

On 30 July 2019, California's Office of Health Hazard Assessment (OEHHA) hosted the Domoic Acid Webinar: Research on Effects of Repeat Low-Level Exposures and Its Implications for Human Toxicity. The webinar included scientific lectures followed by a panel discussion with a question and answer session at the end. A recording of the webinar and [transcript of the audio portion](#) are now available. Domoic acid is a neurotoxin that is produced by some species of the algae *Pseudo-nitzschia* and can

The United States Department of Labor's Occupational Safety and Health Administration (OSHA) placed on public inspection today a proposal to protect workers in shipyards and construction from beryllium exposure by more appropriately tailoring the requirements of the standards to the exposures in these industries.

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accumulate in shellfish, including crustaceans. Following large algal blooms along the California coast, the contamination of shellfish can be widespread. Consuming contaminated shellfish poses potential health concerns for humans. For more information on domoic acid, visit [OEHHA's marine biotoxin page](#). This webinar examined recent research on the adverse neurological and developmental effects that may result from repeat oral exposure to low levels of domoic acid.

Topics included:

- Prenatal exposure and neurological effects in offspring
- Pharmacokinetic modelling during pregnancy and domoic acid disposition
- Epidemiological study of effects of chronic, low-level domoic acid exposure
- Implications of research for shellfish consumers

OEHHA, 3 October 2019

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

Groundwater Contaminant Regulation in California: State Water Board Lowers Notification Levels and Announces First Step Towards Developing an MCL for Certain Compounds

2019-10-11

In June of 2018, the California State Water Resources Control Board (State Water Board) Division of Drinking Water (DDW) provided recommendations for PFOA and PFOS notification levels. On 13 July 2018, the State Water Board [released guidelines](#) based on DDW's recommendations for testing and reporting on two PFAS compounds—PFOA and PFOS. The interim notification level for PFOA was 14 parts per trillion (ppt) and 13 ppt for PFOS. Notification levels are non-regulatory health-based advisory levels established by the DDW for chemicals in drinking water that lack an enforceable regulatory standard called a maximum contaminant levels (MCLs). In addition to setting interim notification levels for PFOA and PFOS, the State Water Board also included an interim response level of 70 ppt combined for PFOS and PFOA whereby if the combined level is exceeded, the State recommended the water system remove the source from service. These guidelines did not require public water systems to test for PFOA and PFOS, but did require water systems voluntarily opting to test to report if the notification levels were

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exceeded. On 31 July 2019, AB 756 passed as the California Legislature's first PFAS-related action. AB 756 adds Section 116378 to the California Health and Safety Code and *authorises the State Water Board to order a public water system to monitor for PFAS in accordance with conditions set by the State Water Board. Practical detection limitations currently reduce the scope of the law to 14-18 compounds.* The effect of the legislation is that the State Water Board can now require public water systems to test for PFAS. First, if any monitoring undertaken pursuant to such State Water Board order results in a confirmed PFAS detection, the water system must report that detection in its annual consumer confidence report. Second, for PFAS compounds with notification levels, water systems are required to report the detections response levels, in accordance with H&S Code 116455, which requires a retail water system to notify its governing body and other governing bodies who may be stakeholders. Third, where a detection exceeds the response level, the water system must take the water source out of use or provide public notification within 30 days of the confirmed detection. AB 756 establishes a variety of requirements for providing sufficient public notice in the event of a detection exceeding the response level, including requiring community water systems to provide notice by mail and e-mail to each water system customer. California has embarked on a state-wide assessment to identify the scope of PFAS contamination in the state, focusing primarily on PFOA and PFAS. In April 2019, in the first phase of this investigation, the State Water Board ordered more than 200 public systems state-wide to sample over 600 drinking water wells near airports, landfills, and areas where PFAS was previously found. Data from these locations will continue to be collected, and "more water system data of other types of sources at industrial sites and waste water treatment systems will be collected" to help determine the prevalence of PFAS constituents in groundwater in the state. Most recently, on 23 August 2019 the State Water Board announced it had lowered its notification levels for PFOA and PFOS to 5.1 ppt and 6.5 ppt, respectively. The announcement also stated that response levels for these contaminants will be updated this fall. In the same press release, the State Water Board also announced it has begun the process to establish regulatory standards for these two chemicals by requesting the California Office of Health Hazard Assessment to establish a public health goal (PHG). A PHG is a level of a chemical contaminant in drinking water below which there are no known or expected health risks. PHGs are non-enforceable standards based entirely on health considerations. Once a PHG is established, an MCL can be developed. The State Water Board is required to set an MCL for a contaminant as close to the PHG as possible, taking into consideration the best available treatment technology

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and cost-effectiveness. California now has the lowest notice levels for PFAS in the entire country. With the State Water Board possessing the authority to require public water systems to sample for PFAS compounds and response levels forthcoming this fall for two of these compounds, industrial companies and property owners of industrial sites in California should track these regulatory developments closely. Companies and property owners should also monitor the activities of local and regional water districts charged with protecting water resources within a discretely defined boundary.

National Law Review, 4 October 2019

<http://www.natlawreview.com>

PHMSA's New Rules Aim to Overhaul Pipeline Safety

2019-10-11

On 1 October 2019, the Pipeline and Hazardous Materials Safety Administration (PHMSA) published three final rules relating to the transportation of hazardous liquids and gas along regulated sectors of the nation's infrastructure. As published, the final rules, and their overall impacts, include the following:

I. Pipeline Safety: Enhanced Emergency Order Procedures

This rule amends a 14 October 2016 interim final rule concerning PHMSA's authority to institute an emergency order in addressing imminent safety concerns and unsafe practices. As amended, the final rule provides: (i) the manner in which PHMSA can institute an emergency order; (ii) the duration and scope of such an emergency order; and (iii) a mechanism for the aggrieved pipeline owner and/or operator to seek judicial review of an emergency order. This final rule has an effective date of 2 December 2019.

II. Pipeline Safety: Safety of Hazardous Liquid Pipelines

This rule dramatically broadens a pipeline owner/operator's reporting and inspection requirements for hazardous liquid pipelines. The final rule includes: (i) extending an operator's reporting requirements to liquid gravity and rural gathering lines; (ii) requiring the inspection of pipelines affected by extreme weather and natural disasters; (iii) requiring integrity assessments at least once every 10 years of onshore hazardous liquid pipeline segments outside of high-consequence areas; (iv) requiring onshore hazardous liquid pipeline segments outside of high-consequence areas to be capable of accommodating in-line inspection tools; (v) extending the required use of leak detection systems

On 1 October 2019, the Pipeline and Hazardous Materials Safety Administration (PHMSA) published three final rules relating to the transportation of hazardous liquids and gas along regulated sectors of the nation's infrastructure.

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beyond high consequence areas to include all regulated, non-gathering hazardous liquid pipelines; and (vi) subject to limited exceptions, requiring all pipelines in or affecting high-consequence areas be capable of accommodating in-line inspection tools within 20 years. This final rule has an effective date of 1 July 2020.

III. Pipeline Safety: Safety of Gas Transmission Pipelines: [Maximum Allowable Operating Pressure] Reconfirmation, Expansion of Assessment Requirements, and Other Related Amendments

This final rule concerns increased pipeline owner/operator requirements for gas transmission pipelines and is effectively the regulatory counterpart to PHMSA's overhaul of hazardous liquid pipelines. The final rule includes: (i) increased integrity management requirements; (ii) operator reconfirmation of maximum allowable operating pressure of previously untested natural gas transmission pipelines and other pipelines, as applicable; (iii) assessment of pipelines in populated areas that are not designated high-consequence areas; (iv) reporting exceedances of maximum allowable operating pressure; (v) requiring operators to consider the risk for seismicity in integrity management; (vi) increased safety features for in-line inspection launchers and receivers; and (vii) increased recordkeeping provisions.

National Law Review, 4 October 2019

<http://www.natlawreview.com>

EUROPE

Circular Economy & Product Design Mandates: EU Bans Halogenated Flame Retardants in Electronic Components and Imposes Reparability Obligations

2019-10-11

The European Commission (EC) has adopted a new set of eco-design requirements for ten categories of energy-consuming products, including refrigerators, washing machines, and televisions pursuant to the Ecodesign Directive (2009/125/EC). Under the new Ecodesign Regulations for Electronic Displays, the use of halogenated flame retardants in electronic display enclosures and stands will be prohibited effective 1 March 2021. The new Ecodesign Regulations applicable to electronic displays and certain categories of household appliances will also impose reparability

Under the new Ecodesign Regulations for Electronic Displays, the use of halogenated flame retardants in electronic display enclosures and stands will be prohibited effective 1 March 2021.

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requirements on manufacturers and importers of covered products placed on the market in the EU beginning 1 March 2021.

Ban on the Use of Halogenated Flame Retardants and New Information Disclosure Obligations

Annex II of the new Ecodesign Regulations for Electronic Displays, adopted by the EC on 1 October 2019, impose a new set of “material efficiency” requirements on covered electronic displays, effective 1 March 2021. Under Point D, Paragraph 4 of Annex II, the use of halogenated flame retardants will be prohibited in the enclosures and stands of electronic displays. “Halogenated flame retardants” is defined in the Regulation as a flame retardant (i.e., “a substance that markedly retards the propagation of a flame”) containing any halogen. The Regulation will apply to all electronic displays, including digital signage displays, computer monitors and televisions, with a screen area greater than 100 square centimetres (or 15.5 square inches). According to the EC, this prohibition is necessary to address recycling issues caused by the presence of halogenated flame retardants in the plastic components of electronic displays. Several industry groups have opposed the ban, arguing that its adoption was procedurally flawed and questioning whether the EC has the legal authority to restrict chemical substances under the Ecodesign Directive. The new Ecodesign Regulations for Electronic Displays also impose marking requirements on manufacturers and importers that are aimed at informing the public of the chemicals contained within certain component parts of covered electronics. The new marking requirements include the following obligations:

- Marking plastic components to specify the type of polymer used.
- Marking plastic components to specify the use of flame retardants (by using the symbol “FR”).
- Marking electronic displays to indicate whether the screen panel contains cadmium in certain specified amounts.

If any homogenous material part of an electronic display contains cadmium in a concentration by weight exceeding 0.01%, as defined in the EU RoHS Directive, the product must be affixed with a “Cadmium inside” logo. If the concentration values are below 0.01% by weight, the product must be affixed with a “Cadmium free” logo. These new restrictions in the EU targeting halogenated flame retardants follow a 2017 U.S. Consumer Protection Safety Commission [announcement](#) of intention to restrict the use of halogenated flame retardants in certain types of consumer products, including electronic casings. More recently, the Washington

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Department of Ecology also announced that organhalogen flame retardants in electronics are on its preliminary list of chemical-product combinations that will be evaluated for potential priority designation under the state's new Safer Products for Washington Program.

Right-to-Repair Obligations

The new Ecodesign Regulations for Electronic Displays, Household Refrigerators, Dishwashers, Washing Machines and Washer-Driers, and Refrigerating Appliances with a Direct Sales Function also impose reparability requirements on manufacturers and importers of covered products. The new requirements, which go into effect on 1 March 2021, generally fall into three categories:

1. The availability of specified spare parts, which must be made available to end users and professional repairers for certain minimum time periods.
2. Access to specified repair and maintenance information for use by professional repairers to enable maintenance work on covered products.
3. Information availability requirements on free access websites that include, among other things, detailed instruction manuals, and the availability of software and firmware updates for use by end users and third parties.

According to the EC's press release on the new EcoDesign Regulations, the Regulations' reparability requirements are the first of their kind in the EU and are intended to contribute the EU's "circular economy objectives by improving the life span, maintenance, re-use, upgrade, recyclability and waste handling of appliances."

National Law Review, 9 October 2019

<http://www.natlawreview.com>

Public consultation: aflatoxins in food

2019-10-11

The European Food Safety Authority (EFSA) is launching a public consultation on the risks to public health related to the presence of aflatoxins in food. Aflatoxins are mycotoxins produced by two species of *Aspergillus*, a fungus found especially in areas with hot and humid climates. Aflatoxins are known to be genotoxic (capable of damaging DNA) and carcinogenic. Most human exposure comes from contaminated grains and their derived products. Additionally, aflatoxin M1 can be found

The European Food Safety Authority (EFSA) is launching a public consultation on the risks to public health related to the presence of aflatoxins in food.

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in milk. The CONTAM Panel concluded that the dietary exposure of the European population to aflatoxins raises a possible health concern. The deadline for submitting comments is 15 November 2019.

EFSA, 4 October 2019

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

EFSA Opens Consultation Period on Two Pilot Assessments on the Risks Caused by Multiple Pesticide Residues in Foods

2019-10-11

On 17 September 2019, the European Food Safety Authority (EFSA) opened a consultation period on two pilot assessments of the risks posed to humans by residues of multiple pesticides in food. EFSA is seeking comments from interested parties on the assessments. The first assessment considers the chronic effects of multiple pesticides on the thyroid system. The second looks at acute effects on the nervous system. EFSA produced the assessments in collaboration with the National Institute for Public Health and the Environment for the Netherlands (RIVM) using monitoring data from 2014, 2015, and 2016. In approving pesticides for use in the European Union (EU), EFSA establishes a maximum level of pesticide residue (MRL) allowed in food or animal feed. The MRL considers the cumulative effects of pesticides. Pesticides may only be placed on the EU market if they have no harmful effects on humans, including cumulative effects. In the two pilot assessments, EFSA classified pesticides into "cumulative assessment groups" (CAG) based upon whether they produce similar toxic effects in a specific organ or system. EFSA states that "[t]he overall draft conclusion for both assessments are that consumer risk from dietary cumulative exposure is below the threshold that triggers regulatory action for all the population groups covered." In 2020, EFSA will prepare the assessments in the final, which will serve to "inform risk managers in the European Commission and Member States who regulate the safe use of pesticides in the EU." EFSA will present the assessments at a special stakeholder event in Brussels, Belgium, on 22 October 2019. The meeting is intended to allow stakeholders with expertise and interest in the area to discuss the technical issues relating to the draft assessments. Registration for the meeting closes on 11 October 2019. All comments must be submitted by 15 November 2019. Comments on the "Cumulative dietary risk characterisation of pesticides that have chronic effects on the thyroid" may be submitted at <https://ec.europa.eu/eusurvey/runner/>

On 17 September 2019, the European Food Safety Authority (EFSA) opened a consultation period on two pilot assessments of the risks posed to humans by residues of multiple pesticides in food.

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PC CRA Thyroid Sept-2019. Comments on the "Cumulative dietary risk characterisation of pesticides that have acute effects on the nervous system" may be submitted at https://ec.europa.eu/eusurvey/runner/PC_CRA_Nerv_Syst_Sept-2019.

The two draft assessments are available on EFSA's [website](#).

National Law Review, 9 October 2019

<http://www.natlawreview.com>

European Chemicals Agency proposes tight controls for uses of BPA, dechlorane plus, and two glycol ethers

2019-10-11

The European Chemicals Agency (ECHA) is proposing strict regulation of many uses of bisphenol A (BPA), the flame retardant dechlorane plus, two glycol ethers, and several metal-containing compounds. If the European Commission concurs with this plan, which ECHA released 1 October, companies in most cases will be prohibited from using the substances unless they apply for and receive authorisation from ECHA to do so. However, the proposal would not affect use of BPA, an oestrogenic compound, in the manufacture of materials such as polycarbonate. ECHA classifies BPA as toxic for reproduction. The proposal would tightly control use of dechlorane plus, a polychlorinated flame retardant used in adhesives, sealants, polymers, computers, electronics, and vehicle textiles. ECHA deems this substance as very persistent and very bioaccumulative. ECHA considers ethylene glycol monoethyl ether and ethylene glycol monomethyl ether to be toxic for reproduction. The proposal would require authorization for uses of these substances other than as intermediates in making other materials. The proposal also covers 9 substances that contain lead or tin and are also considered toxic for reproduction. They include tetraethyl lead used as an additive in aviation fuel. The proposal would not impact fuel that contains less than 0.1% of this substance.

Chemical & Engineering News, 2 October 2019

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

The European Chemicals Agency (ECHA) is proposing strict regulation of many uses of bisphenol A (BPA), the flame retardant dechlorane plus, two glycol ethers, and several metal-containing compounds.

REACH Update

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Get ready for new REACH requirements for nanomaterials

2019-10-10

By 1 January 2020, companies must provide more information on nanomaterials on the EU market under the REACH Regulation. The European Chemicals Agency (ECHA) encourages potential registrants to familiarise themselves with the new legal requirements and get ready. The new information requirements concern companies that manufacture or import nanoforms of substances that are subject to registration under REACH. Nanoforms of substances are those that fulfil the European Commission's recommendation for a definition of a nanomaterial. The revised REACH annexes addressing nanoforms introduce clarifications and new provisions for:

- characterisation of nanoforms or sets of nanoforms covered by the registration (Annex VI);
- the chemical safety assessment (Annex I);
- registration information requirements (Annexes III and VII-XI); and
- downstream user obligations (Annex XII).

The purpose is to make sure companies provide enough information to demonstrate the safe use of their nanoforms for human health and the environment. The amendments apply to all the new and existing registrations covering nanoforms. This means that registrants are expected to update their existing dossiers with nanoform-specific information by 1 January 2020.

Available guidance and test guidelines

ECHA's new nano-specific guidance helps companies to comply with the changes in Annex VI. In addition, the guidance on read-across between nanoforms or sets of nanoforms is being updated to reflect the changes. Both documents are expected to be ready by the end of 2019. The draft documents are published on the [ongoing guidance consultation page](#). The 2017 ECHA guidance for human health and the environment is also being updated. The OECD is revising some of their existing test guidelines used under REACH, to ensure that data generated on nanoforms is reliable and meets regulatory standards. An [overview of the revised REACH Annexes and the available test methods](#) are available on the EU observatory for nanomaterials (EUON).

IT tools and reporting formats for nanomaterials

By 1 January 2020, companies must provide more information on nanomaterials on the EU market under the REACH Regulation.

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On 30 October 2019, IUCLID will be updated with new data fields for reporting the characteristics of nanoforms and sets of nanoforms. From that day onwards, registrants who intend to submit registrations covering substances in nanoform must provide complete characterisation information on their nanoforms or sets of nanoforms. The completeness check will include a verification that the sets of nanoforms are accompanied by a justification for creating the set. As before, the IUCLID tool will include the means to link these nanoforms or sets of nanoforms with the relevant data on their properties and hazards in the other parts of the dossier. The updated IUCLID manual will advise registrants on how to fill the data fields. They are also encouraged to use the Validation assistant tool to check that all the required elements for their nanoforms are included before submitting their dossier to ECHA. ECHA will update its manual on dissemination and confidentiality under the REACH Regulation, which, together with the Dissemination preview tool in IUCLID, will assist registrants in preparing their dossiers. Companies submitting information on nanoforms must use the new version of IUCLID as it is not possible to prepare a successful submission with previous versions.

Support activities

ECHA is hosting a [webinar on 12 November 2019](#) to introduce the guidance on identifying and reporting nanoforms and sets of nanoforms. During the webinar, companies have the possibility to get advice directly from ECHA's experts. ECHA's helpdesk is ready to assist companies to prepare for the new requirements.

Further information is available at:

- [Commission Regulation \(EU\) 2018/1881: amending REACH Annexes to address nanoforms of substances](#)
- [European Commission: Definition of a nanomaterial](#)
- [Register for our webinar on revised REACH information requirements for nanomaterials](#)
- [EU nanomaterials observatory \(EUON\): Overview of REACH Annex modifications and available methods](#)
- [Practical guide: How to prepare registration dossiers that cover nanoforms](#)
- [Guidance on grouping and read-across between nanoforms](#)
- [Nano-specific appendices to the guidance on information requirements and chemicals safety assessment](#)
- [ECHA's activities on nanomaterials](#)

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- [Contact ECHA's helpdesk](#)

ECHA, 8 October 2019

<http://echa.europa.eu>

ECHA to support identifying new POPs

2019-10-10

The European Chemicals Agency (ECHA) will support the European Commission and Member States to develop risk profiles for methoxychlor and Dechlorane Plus[®]. This contributes to global work to eliminate or limit the use of the most hazardous persistent organic pollutants. In early October 2019, the Organic Pollutants Review Committee (POPRC) agreed that methoxychlor (EC 200-779-9, CAS 72-43-5) and Dechlorane Plus[®] (EC 236-948-9, CAS 13560-89-9) fulfil the screening criteria as persistent organic pollutants (POPs). Together with the Commission, ECHA will support the committee in the preparation of risk profiles for these two substances and will launch a public consultation on the drafts in early 2020. If the POPRC adopts the risk profiles, it will conduct risk management evaluations and then eventually recommend to list these substances as persistent organic pollutants in the Stockholm Convention. Listing under this convention would either result in their worldwide elimination or in the strict restriction of their production and use. Dechlorane Plus[®] is mainly used as a flame retardant and has been identified as a substance of very high concern (SVHC) under REACH. Methoxychlor is a pesticide and its use in the EU has already been banned since 2002. Both substances have adverse effects to humans and the environment. As of July 2019, ECHA supports the Commission and the Member States to identify and propose new POPs from the EU to the Stockholm Convention. Further information is available at:

- [Understanding POPs](#)
- [ECHA starts work on persistent organic pollutants](#)
- [POPRC Press release](#)
- [POPRC meeting information](#)

ECHA, 9 October 2019

<http://echa.europa.eu>

The European Chemicals Agency (ECHA) will support the European Commission and Member States to develop risk profiles for methoxychlor and Dechlorane Plus[®].

Call for evidence on possible restriction of lead in shot, bullets and fishing tackle

2019-10-10

The European Chemicals Agency (ECHA) invites interested parties to submit evidence and information on the use of lead in gunshot outside of wetlands, bullets in any terrain and in fishing tackle by 16 December 2019. ECHA has begun to investigate the need for restricting the use of lead in gunshot, bullets and fishing tackle. The intention to prepare a restriction proposal has now been added in the Registry of Intentions and is supported by a call for evidence and information. The call is intended for companies, trade associations, hunting, fishing or sports shooting organisations, scientific bodies and any other stakeholders or Member States holding relevant information, including hunters and fishers and all others with an interest in this issue. The focus of ECHA's investigation is on the risks posed by lead to the environment and wildlife as well as risks to humans through consumption of game meat. The Agency is specifically looking for information on:

- the quantities of lead used or released to the environment and the resulting human health or environmental impacts;
- current best practice to minimise lead exposure to humans or the environment during use;
- alternatives to lead shot, bullets and lead in fishing tackle; and
- other socio-economic impacts on society with regard to a possible restriction, such as costs and/or benefits to any affected stakeholders.

The information received through the call for evidence will help the Agency prepare its restriction proposal.

Background

The European Commission has requested ECHA to develop an Annex XV dossier for a possible restriction on the placing on the market and use of lead in ammunition in terrestrial environments, bullets in any terrain and in fishing tackle. The proposal aims to address concerns posed by lead gunshot, bullets and fishing tackle to the environment, reduce the mortality of an estimated one to two million birds, and reduce health risks to a significant population of hunters and their families who frequently eat game meat killed with lead shot or bullets. ECHA has earlier proposed a restriction on the use of lead shots over wetlands. This proposal is currently with the Commission for decision making. Further information is available at:

The European Chemicals Agency (ECHA) invites interested parties to submit evidence and information on the use of lead in gunshot outside of wetlands, bullets in any terrain and in fishing tackle by 16 December 2019.

REACH Update

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- [Call for evidence - deadline 16 December 2019](#)
- [Register for information session on 10 October 2019](#)
- [Hot topics - lead in shot, bullets and fishing weights](#)
- [Registry of Intentions](#)
- [Commission request to ECHA](#)
- [ECHA identifies risks to terrestrial environment from lead ammunition](#)

ECHA, 3 October 2019

<http://echa.europa.eu>

Intention to restrict substances in disposable baby diapers submitted

2019-10-10

France submitted an intention to restrict the placing on the market of disposable baby diapers containing groups of chemicals such as polycyclic aromatic hydrocarbons (PAHs), formaldehyde, dioxins, furans and polychlorinated biphenyls (PCBs) for submission on 9 October 2020. Further information is available at:

[Registry of restriction intentions](#)

ECHA News, 9 October 2019

<http://echa.europa.eu>

New intentions and proposals to harmonise classification and labelling

2019-10-10

Five intentions for a proposal to harmonise the classification and labelling were received for:

- [Aqueous extract from the seeds of *Lupinus albus* \(Fabaceae\), germinated](#) (EC 701-313-1, CAS -) by the Netherlands;
- [Dimethyl propylphosphonate](#) (EC 242-555-3, CAS 18755-43-6) by Ireland;
- [Reaction mass of 4,4'-\[2,2,2-trifluoro-1-\(trifluoromethyl\)ethylidene\]diphenol and benzyl\(diethylamino\)diphenylphosphonium 4-\[1,1,1,3,3,3-hexafluoro-2-\(4-hydroxyphenyl\)propan-2-yl\]phenolate \(1:1\)](#) (EC 943-265-6, CAS -),

France submitted an intention to restrict the placing on the market of disposable baby diapers containing groups of chemicals such as polycyclic aromatic hydrocarbons (PAHs), formaldehyde, dioxins, furans and polychlorinated biphenyls (PCBs) for submission on 9 October 2020.

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- Benzyltriphenylphosphonium, salt with 4,4'-[2,2,2-trifluoro-1-(trifluoromethyl)ethylidene]bis[phenol] (1:1) (EC 278-305-5, CAS 75768-65-9) and
- Phosphorus(1+), (N-ethylethanaminato)diphenyl(phenylmethyl)-, (T-4)-, salt with 4,4'-[2,2,2-trifluoro-1-(trifluoromethyl)ethylidene]bis[phenol] (1:1) (EC 479-100-5, CAS 577705-90-9) by Sweden.

Three proposals to harmonised classification and labelling were submitted for:

- foramsulfuron (ISO); 2-[(4,6-dimethoxypyrimidin-2-yl) carbamoyl]sulfamoyl-4-formamido-N,N-dimethylbenzamide; 1-(4,6-dimethoxypyrimidin-2-yl)-3-(2-dimethylcarbamoyl-5-formamidophenylsulfonyl)urea (EC 605-666-1, CAS 173159-57-4) by Finland; and
- Dibutylamine (EC 203-921-8, CAS 111-92-2) and
- Triethylamine (EC 204-469-4, CAS 121-44-8) by Austria.

Further information is available at: Registry of CLH intentions

ECHA News, 9 October 2019

<http://echa.europa.eu>

Janet's Corner

CHEMWATCH

Global Warming

2019-10-06



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Methoxychlor

2019-09-30

Methoxychlor is a synthetic organochlorine with the molecular formula $C_{16}H_{15}Cl_3O_2$. [1] In its pure form, methoxychlor is a pale-yellow powder that has a slightly fruity or musty odour. It does not readily evaporate into air or dissolve in water. [2]

USES [3]

Methoxychlor was used as an insecticide effective against a wide range of pests including biting flies, houseflies, mosquito larvae, cockroaches, and chiggers. It was used on field crops, vegetables, fruits, stored grains, livestock, pests, homes, gardens, lakes, and marshes. Furthermore, methoxychlor was used against the elm bark-beetle vectors of Dutch elm disease. In veterinary practices, methoxychlor was used as an ectoparasiticide (a medicine used to kill parasites that live on the exterior of their host). In 2000, all pesticide uses of methoxychlor were suspended and all products voluntarily cancelled.

IN THE ENVIRONMENT [2]

Methoxychlor does not occur naturally in the environment. Most methoxychlor enters the environment when it is applied to forests, agricultural crops, and farm animals. It can be applied to forests and crops by aerial spraying. This process can contaminate nearby land and water. Methoxychlor that is released into the air will eventually settle to the ground, although some may travel long distances before settling. Rain and snow cause methoxychlor to settle to the ground more quickly. Once methoxychlor is deposited on the ground, it becomes bound to the soil. Because of this, methoxychlor does not tend to move rapidly from one place to another. However, soil particles that contain methoxychlor can be blown by the wind or be carried by rainwater or melted snow into rivers or lakes. Most methoxychlor stays in the very top layer of soil, but some of the products that it breaks down into may move deeper into the ground. Smaller amounts of methoxychlor in air may settle directly into rivers, lakes, and other surface waters. Once methoxychlor is in water, it usually binds to sediments or organic matter and settles to the bottom. Methoxychlor is broken down in the environment by several processes. However, these processes are slow and may take months. In soil, bacteria and other microorganisms break down some methoxychlor, and some is broken down by a reaction with water or materials in soil. In air and

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water, some methoxychlor is broken down by sunlight. Reactive chemicals normally present in the air also break down methoxychlor. Some of the breakdown products are capable of producing harmful effects similar to those caused by exposure to methoxychlor. Methoxychlor can accumulate in some living organisms, including algae, bacteria, snails, clams, and some fish. However, most fish and animals change methoxychlor into other substances that are rapidly released from their bodies, so methoxychlor does not usually build up in the food chain.

SOURCES & ROUTES OF EXPOSURE

Sources of Exposure [4]

Most people are not exposed to methoxychlor on a regular basis. Low levels are sometimes found in food, but it is not usually detected in air or water. People who work in factories that make methoxychlor or products containing it may breathe it in the air or get it on their skin. People who work or live near farms that use methoxychlor on crops or livestock may be exposed to above average levels in air, soil, or water. People who use pesticides containing methoxychlor for home gardening or spraying pets may be exposed to above-average levels in air and on their skin. People living near a hazardous waste site that contain methoxychlor may breathe it in air, swallow contaminated soil or water, or get it on their skin.

Routes of Exposure [2]

Scientists do not know how much or how quickly methoxychlor is absorbed into your body if you breathe it in or if it contacts your skin. If you get methoxychlor-contaminated soil or water on your skin, some of it may pass through your skin and enter your bloodstream. If you breathe methoxychlor-containing dust into your lungs, some of the dust will deposit in your lungs. Dust that deposits in the upper part of your lungs is likely to be coughed up and swallowed. Dust that deposits deep in your lungs is likely to remain long enough for the methoxychlor to pass through the lining of your lungs and enter your bloodstream. If you swallow food, water, or soil containing methoxychlor, most of it will rapidly pass through the lining of your stomach and intestines and enter your bloodstream. Once methoxychlor enters your bloodstream, it is distributed to all parts of your body. Animal studies suggest that methoxychlor is changed into other substances called metabolites by your liver. Most of these metabolites leave your body within 24 hours, primarily in your faeces, with lesser amounts in your urine. Some methoxychlor can

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enter the fat in your body, but methoxychlor does not accumulate or build up in fat.

HEALTH EFFECTS [3]

Acute Effects

Information on the acute systemic effects of methoxychlor in humans is not available. Dermal contact with methoxychlor is slightly irritating to skin in humans. Depression of the central nervous system, progressive weakness, trembling, convulsions, diarrhoea, and possibly death are symptoms reported in animals acutely exposed to methoxychlor. Mild liver effects were reported in animals orally exposed to methoxychlor. Tests involving acute exposure of rats, mice, and rabbits, have demonstrated methoxychlor to have low to moderate acute toxicity from oral or dermal exposure. (5)

Chronic Effects

Information on the chronic inhalation effects of methoxychlor in humans is not available. However, exposure to chemically related organochlorine pesticides has caused liver and kidney damage in humans. In human volunteers who ingested low levels of methoxychlor for 6 weeks, no gastrointestinal, haematological, liver, testes, or menstrual cycle effects were observed. Chronic oral exposure of animals to methoxychlor has resulted in effects to the liver, kidneys, body weight, and nervous system. EPA has not established a Reference Concentration (RfC) for methoxychlor. The Reference Dose (RfD) for methoxychlor is 0.005 milligrams per kilogram body weight per day (mg/kg/d) based on the excessive loss of litters in rabbits.

Reproductive/Developmental Effects

No information is available on the reproductive or developmental effects of methoxychlor in humans. Methoxychlor and its metabolites possess oestrogenic properties. Reproductive and developmental effects have been reported in animals orally exposed to methoxychlor. Effects to the development of the female reproductive system, gross and histopathological changes in the male and female reproductive systems, effects on male and female reproductive function (i.e., decreased fertility in males and females, decreased spermatogenesis, and interference with oestrus cycling), and changes to hormone levels have been reported in orally exposed animals. In rabbits orally exposed to methoxychlor, excessive loss of litters (abortions) was observed. Skeletal effects were

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observed in the offspring of rats exposed to methoxychlor by gavage (experimentally placing the chemical in the stomach). Long-term oral exposure to methoxychlor has been reported to increase fetotoxicity in animals, as well as to affect the reproductive development and reduce the fertility of offspring.

Cancer Risk

No human studies are available on the carcinogenicity of methoxychlor. A number of animal cancer studies have been carried out on methoxychlor, with both positive and negative results. EPA considers the data to be inconclusive, based on problems with the data and interpretation of the results. EPA has classified methoxychlor as a Group D, not classifiable as to human carcinogenicity, based on the fact that human data are unavailable and animal evidence is inconclusive.

SAFETY [5]

First Aid Measures

- After Inhalation: If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen.
- After Eye Contact: Assure adequate flushing of the eyes by separating the eyelids with fingers.
- After Ingestion: If swallowed, wash out mouth with water provided person is conscious. Call a physician.

Fire Fighting Measures

- Extinguishing Media: Water spray, carbon dioxide, dry chemical powder, or appropriate foam.
- Special Risks: Methoxychlor emits toxic fumes under fire conditions.
- Special Protective Equipment for Firefighters: Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes.

Exposure Controls and Personal Protective Equipment

Exposure Controls

- Use methoxychlor only in a chemical fume hood.
- A safety shower and eye bath should be in close proximity.
- Wash thoroughly after handling.
- Wash contaminated clothing before reuse.

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Personal Protective Equipment

The following personal protective equipment is recommended when handling methoxychlor:

- appropriate government approved respirator,
- chemical-resistant gloves,
- safety goggles,
- other protective clothing

REGULATION [5,6,7,8]

United States

- OSHA: The Occupational Safety & Health Administration has set a Permissible Exposure Limit (PEL) for methoxychlor for both the general and construction industry of 15 mg/m³ TWA
- ACGIH: The American Conference of Governmental Industrial Hygienists (ACGIH) has established a Threshold Limit Value (TLV) for methoxychlor of 10 mg/m³ TWA; Appendix A4 (Not Classifiable as a Human Carcinogen)
- NIOSH: The National Institute for Occupational Safety and Health (NIOSH) has stated that methoxychlor is a potential carcinogen

Australia

- Safe Work Australia: Safe Work Australia has established a time-weighted average concentration for methoxychlor of 10 mg/m³ over an 8 hour work day
- Australian Drinking Water Guidelines: The Australian Drinking Water Guidelines specifies a concentration of 0.3mg/L

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Princeton physicists discover topological behaviour of electrons in 3D magnetic material

2019-09-24

An international team of researchers led by scientists at Princeton University has found that a magnetic material at room temperature enables electrons to behave counterintuitively, acting collectively rather than as individuals. Their collective behaviour mimics massless particles and anti-particles that coexist in an unexpected way and together form an exotic loop-like structure. The study was published this week in the journal *Science*. The key to this behaviour is topology—a branch of mathematics that is already known to play a powerful role in dictating the behaviour of electrons in crystals. Topological materials can contain massless particles in the form of light, or photons. In a topological crystal, the electrons often behave like slowed-down light yet, unlike light, carry electrical charge. Topology has seldom been observed in magnetic materials, and the finding of a magnetic topological material at room temperature is a step forward that could unlock new approaches to harnessing topological materials for future technological applications. “Before this work, evidence for the topological properties of magnets in three dimensions was inconclusive. These new results give us direct and decisive evidence for this phenomenon at the microscopic level,” said M. Zahid Hasan, the Eugene Higgins Professor of Physics at Princeton, who led the research. “This work opens up a new continent for exploration in topological magnets.” Hasan and his team spent more than a decade studying candidate materials in the search for a topological magnetic quantum state. “The physics of bulk magnets has been understood for many decades. A natural question for us is: Can magnetic and topological properties together produce something new in three dimensions?” Hasan said. Thousands of magnetic materials exist, but most did not have the correct properties, the researchers found. The magnets were too difficult to synthesise, the magnetism was not sufficiently well understood, the magnetic structure was too complicated to model theoretically, or no decisive experimental signatures of the topology could be observed. Then came a lucky turning point. “After studying many magnetic materials, we performed a measurement on a class of room-temperature magnets and unexpectedly saw signatures of massless electrons,” said Ilya Belopolski, a postdoctoral researcher in Hasan’s laboratory and co-first author of the study. “That set us on the path to the discovery of the first three-dimensional topological magnetic phase.” The exotic magnetic crystal consists of cobalt, manganese and gallium, arranged in an orderly, repeating three-dimensional pattern. To explore the material’s

In a room-temperature magnet, researchers find behaviours of electrons that mimic massless particles and anti-particles

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topological state, the researchers used a technique called angle-resolved photoemission spectroscopy. In this experiment, high-intensity light shines on the sample, forcing electrons to emit from the surface. These emitted electrons can then be measured, providing information about the way the electrons behaved when they were inside the crystal. "It's an extremely powerful experimental technique, which in this case allowed us to directly observe that the electrons in this magnet behave as if they are massless. These massless electrons are known as Weyl fermions," said Daniel Sanchez, a Princeton visiting researcher and Ph.D. student at the University of Copenhagen, and another co-first author of the study. A key insight came when the researchers studied the Weyl fermions more closely and realised that the magnet hosted an infinite series of distinct massless electrons that takes the form of a loop, with some electrons mimicking properties of particles and some of anti-particles. This collective quantum behaviour of the electrons has been termed a magnetic topological Weyl fermion loop. "It truly is an exotic and novel system," said Guoqing Chang, a postdoctoral researcher in Hasan's group and co-first author of the study. "The collective electron behaviour in these particles is unlike anything familiar to us in our everyday experience--or even in the experience of particle physicists studying subatomic particles. Here we are dealing with emergent particles obeying different laws of nature." It turns out that a key driver of these properties is a mathematical quantity that describes the infinite series of massless electrons. The researchers were able to pin down the role of topology by observing subtle changes in the difference of the behaviour of electrons living on the surface of the sample and deeper in its interior. The technique to demonstrate topological quantities through the contrasts of surface and bulk properties was pioneered by Hasan's group and used to detect Weyl fermions, a finding published in 2015. The team recently used an analogous approach to discover a topological chiral crystal, work published in the journal *Nature* earlier this year that was also led by Hasan's group at Princeton and included Daniel Sanchez, Guoqing Chang and Ilya Belopolski as leading authors.

Theoretical predictions

The relationship between the topology and magnetic quantum loop particles was explored in the Hasan group's theoretical predictions published in October 2017 in *Physical Review Letters*. However, the group's theoretical interest in topological magnets dates back much earlier to theoretical predictions published in *Nature Materials* in 2010. These theoretical works by Hasan's group were funded by U.S. Department of Energy's office of Basic Energy Sciences. "This work represents the

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culmination of about a decade of seeking to realise a topological magnetic quantum phase in three dimensions,” Hasan said. In 2016, Duncan Haldane, Princeton’s Sherman Fairchild University Professor of Physics, won the Nobel Prize in Physics for his theories predicting the properties of one- and two-dimensional topological materials. An important aspect of the result is that the material retains its magnetism up to 400 degrees Celsius—well above room temperature—satisfying a key requirement for real-world technological applications. “Before our work, topological magnetic properties were typically observed when the thin films of materials were extremely cold—a fraction of a degree above absolute zero—requiring specialised equipment simply to achieve the necessary temperatures. Even a small amount of heat would thermally destabilise the topological magnetic state,” Hasan said. “The quantum magnet studied here exhibits topological properties at room temperature.” A topological magnet in three dimensions reveals its most exotic signatures only on its surface—electron wavefunctions take the shape of drumheads. This is unprecedented in previously known magnets and constitute the tell-tale signature of a topological magnet. The researchers observed such drumhead-shaped electronic states in their data, providing the crucial decisive evidence that it is a novel state of matter. Patrick Lee, the William & Emma Rogers Professor of Physics at the Massachusetts Institute of Technology, who was not involved in the study, commented on the importance of the finding. “The Princeton group has long been at the forefront of discovering new materials with topological properties,” Lee said. “By extending this work to a room temperature ferromagnetic and demonstrating the existence of a new kind of drumhead surface states, this work opens up a new domain for further discoveries.” To understand their findings, the researchers studied the arrangement of atoms on the surface of the material using several techniques, such as checking for the right kind of symmetry using the scanning tunnelling microscope in Hasan’s Laboratory for Topological Quantum Matter and Advanced Spectroscopy located in the basement of Princeton’s Jadwin Hall. An important contributor to the finding was the cutting-edge spectroscopy equipment used to carry out the experiment. The researchers used a dedicated photoemission spectroscopy beamline recently built at the Stanford Synchrotron Radiation Lightsource, part of the SLAC National Accelerator Laboratory in Menlo Park, California. “The light used in the SLAC photoemission experiment is extremely bright and focused down to a tiny spot only several tens of micrometres in diameter,” said Belopolski. “This was important for the study.” The work was carried out in close collaboration with the group of Professor Hsin Lin at the Institute of Physics, Academia Sinica in Taiwan, and Professor Claudia Felser at the Max

Planck Institute for the Chemical Physics of Solids in Dresden, Germany, including postdoctoral researcher Kaustuv Manna as co-first author. Driven by the tantalising possibility of applications, the researchers went one step further and applied electromagnetic fields to the topological magnet to see how it would respond. They observed an exotic electromagnetic response up to room temperature, which could be directly traced back to the quantum loop electrons. "We have many topological materials, but among them it has been difficult to show a clear electromagnetic response arising from the topology," Hasan added. "Here we have been able to do that. It sets up a whole new research field for topological magnets."

EurekaAlert, 19 September 2019

<http://www.eurekaalert.org>

Platinum-graphene fuel cell catalysts show superior stability over bulk platinum

2019-10-02

Platinum is one of the most commonly used catalysts for fuel cells because of how effectively it enables the oxidation reduction reaction at the centre of the technology. But its high cost has spurred research efforts to find ways to use smaller amounts of it while maintaining the same catalytic activity. "There's always going to be an initial cost for producing a fuel cell with platinum catalysts, and it's important to keep that cost as low as possible," said Faisal Alamgir, an associate professor in Georgia Tech's School of Materials Science and Engineering. "But the real cost of a fuel cell system is calculated by how long that system lasts, and this is a question of durability. "Recently there's been a push to use catalytic systems without platinum, but the problem is that there hasn't been a system proposed so far that simultaneously matches the catalytic activity and the durability of platinum," Alamgir said. The Georgia Tech researchers tried a different strategy. In the study, which was published on September 18 in the journal *Advanced Functional Materials* and supported by the National Science Foundation, they describe creating several systems that used atomically-thin films of platinum supported by a layer of graphene - effectively maximising the total surface area of the platinum available for catalytic reactions and using a much smaller amount of the precious metal. Most platinum-based catalytic systems use nanoparticles of the metal chemically bonded to a support surface, where surface atoms of the particles do most of the catalytic work, and the catalytic potential of the atoms beneath the surface is never utilized as fully as the surface atoms, if at all. Additionally, the researchers

Films of platinum only two atoms thick supported by graphene could enable fuel cell catalysts with unprecedented catalytic activity and longevity, according to a study published recently by researchers at the Georgia Institute of Technology.

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showed that the new platinum films that are at least two atoms thick outperformed nanoparticle platinum in the dissociation energy, which is a measure of the energy cost of dislodging a surface platinum atom. That measurement suggests those films could make potentially longer-lasting catalytic systems. To prepare the atomically-thin films, the researchers used a process called electrochemical atomic layer deposition to grow platinum monolayers on a layer of graphene, creating samples that had one, two or three atomic layers of atoms. The researchers then tested the samples for dissociation energy and compared the results to the energy of a single atom of platinum on graphene as well as the energy from a common configurations of platinum nanoparticles used in catalysts. "The fundamental question at the heart of this work was whether it was possible that a combination of metallic and covalent bonding can render the platinum atoms in a platinum-graphene combination more stable than their counterparts in bulk platinum used commonly in catalysts that are supported by metallic bonding," said Seung Soon Jang, an associate professor in the School of Materials Science and Engineering. The researchers found that the bond between neighbouring platinum atoms in the film essentially combines forces with the bond between the film and the graphene layer to provide reinforcement across the system. That was especially true in the platinum film that was two atoms thick. "Typically, metallic films below a certain thickness are not stable because the bonds between them are not directional, and they tend to roll over each other and conglomerate to form a particle," Alamgir said. "But that's not true with graphene, which is stable in a two-dimensional form, even one atom thick, because it has very strong covalent directional bonds between its neighbouring atoms. So, this new catalytic system could leverage the directional bonding of the graphene to support an atomically-thin film of platinum." Future research will involve further testing of how the films behave in a catalytic environment. The researchers found in earlier research on graphene-platinum films that the material behaves similarly in catalytic reactions regardless of which side - graphene or platinum - is the exposed active surface. "In this configuration, the graphene is not acting as a separate entity from the platinum," Alamgir said. "They're working together as one. So, we believe that if you're exposing the graphene side, you get the same catalytic activity and you could further protect the platinum, potentially further enhancing durability."

EurekAlert, 18 September 2019

<http://www.eurekalert.org>

Using high energy density material in electrode design enhances lithium sulfur batteries

2019-10-02

Lithium ion batteries aren't keeping up with energy demands from higher power electronic devices, electric vehicles and smart electric grids. To develop higher capacity batteries, researchers have looked to lithium sulfur batteries because of sulfur's high theoretical capacity and energy density. But there are still several problems to solve before lithium sulfur batteries can be put into practical applications, such as sulfur's intrinsically low electrical conductivity and the rapid capacity decay caused by polysulfides escaping from the cathode. The biggest problem is the shuttling effect that occurs during cycling. This effect causes the diffusion of polysulfides from the cathode, creating capacity loss. It also consumes a lot of fresh lithium and electrolytes, and reduces battery performance. To solve the shuttling problem and improve lithium sulfur battery performance, the authors of a paper published in APL Materials, from AIP Publishing, created a sandwich-structured electrode using a novel material that traps polysulfides and increases the reaction kinetics. ZIF-67 is a metal-organic framework (MOF) constructed from metal ions or metal clusters and organic ligands. It holds great promise in gas storage and separation, catalysis and energy storage. MOF-derived materials are also attractive in energy storage due to their robust structure, porous surface and high conductivity. A sandwich-structured electrode with sulfur immobilised in between PZ67 layers, PZ67/S/PZ67, improves the practical energy density of the lithium sulfur battery to three to five times higher than that of lithium ion batteries. The PZ67 is composed of polar materials, and the porous carbon showed a synergistic effect in the chemical interaction, served as a physical barrier, offered a high conductivity to prohibit the polysulfide shuttling effect and enhanced the batteries' cycling performance. "The porous PZ67 can not only absorb the polysulfides to form a confinement, it can also improve the kinetics of the actual active materials' reaction during the battery cycling," author Siwu Li said. "That means it may also improve the discharge voltage of the battery, and that is a big contribution to improving the energy density of the batteries." The sandwich-structured electrode that confines soluble polysulfides could be useful for anyone working to confine soluble materials, Li said. His team plans to continue their work in order to scale up the process of fabricating the hybrid electrode using a hot pressing

A sandwich-structured electrode enhances reaction kinetics, prohibits shuttling effect, improves lithium sulfur battery performance

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procedure. They also plan to address instabilities on the anode side of lithium sulfur batteries, possibly by adding a protective layer.

Science Daily, 30 September 2019

<http://www.sciencedaily.com>

Tetravinylallene, a small but powerful molecule, synthesized for first time

2019-10-02

Many natural compounds used in medicine have complex molecular architectures that are difficult to recreate in the lab. Help could come from a small hydrocarbon molecule, called tetravinylallene, which has been synthesised for the first time by Australian scientists. As detailed in the journal *Angewandte Chemie*, tetravinylallene can be used to construct complex molecular frameworks more quickly and with less environmental impact than by using established methods. Tetravinylallene has a remarkably unsaturated molecular structure. Binding of two carbon atoms to each other can be achieved with three types of bonds; either single, double, or triple bonds. Bonds other than single bonds are called "unsaturated" (for example, unsaturated fatty acids contain a mixture of double and single bonds). How these bonds are arranged in a molecule determines its reactivity. Molecules are less reactive and more stable when double bonds alternate with single bonds, but two double bonds in a row give a strained electron configuration, which makes the molecule reactive. Graduate student Cecile Elgindy, working with Professor Michael S. Sherburn at the Australian National University, Canberra, synthesised the highly unsaturated compound tetravinylallene for the first time. The molecule possesses two adjacent double bonds in its centre, both of which are flanked by two entities composed of a single bond followed by a double bond. Tetravinylallene is electronically strained and it is also symmetric, which would allow chemists to perform multiple reactions in one step. That would make it possible to construct new molecules with complex architectures in fewer steps and with fewer chemicals. Analogues of tetravinylallene do already exist, but those molecules are smaller and less symmetric. The researchers admit that the synthesis of tetravinylallene was challenging; however, a five-step procedure involving sequential attachment of four small molecules to each other was successful. The scientists also prepared derivatives of tetravinylallene with a slightly altered structure but unchanged bond system. The researchers made use of tetravinylallene in a proof-of concept synthesis by transforming it into a compound with a complex steroidal architecture. In that procedure,

Many natural compounds used in medicine have complex molecular architectures that are difficult to recreate in the lab. Help could come from a small hydrocarbon molecule, called tetravinylallene, which has been synthesised for the first time by scientists.

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only one reaction partner was necessary and all reactions were controlled simply by varying conditions such as the reaction temperature and solvent. The study positions tetravinylallene as an intriguing and potent new chemical with practical utility in the synthesis of natural products and drugs. It joins the group of existing small hydrocarbons packed with double bonds but excels because of its symmetry. Tetravinylallene might inspire synthetic chemists who are on the lookout for new methods to synthesise natural products and drugs, or who wish to push the frontiers of basic research.

Science Daily, 30 September 2019

<http://www.sciencedaily.com>

A new concept could make more environmentally friendly batteries possible

2019-10-02

A new concept for an aluminium battery has twice the energy density as previous versions, is made of abundant materials, and could lead to reduced production costs and environmental impact. The idea has potential for large scale applications, including storage of solar and wind energy. Researchers from Chalmers University of Technology, Sweden, and the National Institute of Chemistry, Slovenia, are behind the idea. Using aluminium battery technology could offer several advantages, including a high theoretical energy density, and the fact that there already exists an established industry for its manufacturing and recycling. Compared with today's lithium-ion batteries, the researchers' new concept could result in markedly lower production costs. "The material costs and environmental impacts that we envisage from our new concept are much lower than what we see today, making them feasible for large scale usage, such as solar cell parks, or storage of wind energy, for example," says Patrik Johansson, Professor at the Department of Physics at Chalmers. "Additionally, our new battery concept has twice the energy density compared with the aluminium batteries that are 'state of the art' today." Previous designs for aluminium batteries have used the aluminium as the anode (the negative electrode) -- and graphite as the cathode (the positive electrode). But graphite provides too low an energy content to create battery cells with enough performance to be useful. But in the new concept, presented by Patrik Johansson and Chalmers, together with a research group in Ljubljana led by Robert Dominko, the graphite has been replaced by an organic, nanostructured cathode, made of the carbon-based molecule anthraquinone. The anthraquinone cathode has

A new concept for an aluminium battery has twice the energy density as previous versions, is made of abundant materials, and could lead to reduced production costs and environmental impact.

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been extensively developed by Jan Bitenc, previously a guest researcher at Chalmers from the group at the National Institute of Chemistry in Slovenia. The advantage of this organic molecule in the cathode material is that it enables storage of positive charge-carriers from the electrolyte, the solution in which ions move between the electrodes, which make possible higher energy density in the battery. "Because the new cathode material makes it possible to use a more appropriate charge-carrier, the batteries can make better usage of aluminium's potential. Now, we are continuing the work by looking for an even better electrolyte. The current version contains chlorine -- we want to get rid of that," says Chalmers researcher Niklas Lindahl, who studies the internal mechanisms which govern energy storage. So far, there are no commercially available aluminium batteries, and even in the research world they are relatively new. The question is if aluminium batteries could eventually replace lithium-ion batteries. "Of course, we hope that they can. But above all, they can be complementary, ensuring that lithium-ion batteries are only used where strictly necessary. So far, aluminium batteries are only half as energy dense as lithium-ion batteries, but our long-term goal is to achieve the same energy density. There remains work to do with the electrolyte, and with developing better charging mechanisms, but aluminium is in principle a significantly better charge carrier than lithium, since it is multivalent -- which means every ion 'compensates' for several electrons. Furthermore, the batteries have the potential to be significantly less environmentally harmful," says Patrik Johansson.

Science Daily, 30 September 2019

<http://www.sciencedaily.com>

Researchers develop a gel-like fluid to prevent wildfires

2019-10-02

A preventive treatment developed by Stanford researchers could greatly reduce the incidence and severity of wildfires. The approach, outlined Sept. 30 in Proceedings of the National Academy of Sciences, involves an environmentally benign gel-like fluid that helps common wildland fire retardants last longer on vegetation. Applied to ignition-prone areas, these materials retain their ability to prevent fires throughout the peak fire season, even after weathering that would sweep away conventional fire retardants. By stopping fires from starting, such treatments can be more effective and less expensive than current firefighting methods. "This has the potential to make wildland firefighting much more proactive, rather than reactive," said Eric Appel, the study's senior author and an assistant

A preventive treatment developed by Stanford researchers could greatly reduce the incidence and severity of wildfires.

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professor of materials science and engineering. “What we do now is monitor wildfire-prone areas and wait with bated breath for fires to start, then rush to put them out.” A century of fire suppression plus hotter, drier weather has intensified the destructive power of wildfires and lengthened the season of threat. While the 2019 season has been relatively calm in the West so far, the past two years have brought four of the 20 largest and eight of the 20 most destructive wildfires in California’s history. Across the country, federal firefighting costs in 2018 came to more than \$3 billion—the highest total ever.

Long-lasting, environmentally benign

Wildfires are a critical part of some ecosystems, but the vast majority in the U.S. are human-caused. Many of them originate in the same hotspots, such as roadsides, campgrounds and remote electrical lines, time after time. Treating these areas prophylactically could provide a highly targeted approach to wildfire prevention, but, until now, long-lasting and environmentally benign materials have not been available. Aside from clearing and burning potential fuels, wildfire management generally revolves around fire suppressants and retardants, with many suppressants used as short-term retardants. To fight active fires, crews use suppressants, such as gels that carry water and superabsorbent polymers found in diapers. These gels are frequently used as short-term retardants on buildings in the path of encroaching fires, but they lose effectiveness once the water entrapped in them evaporates—something that often occurs in less than an hour during normal wildland fire conditions. The most widely deployed commercial wildland fire retardant formulations use ammonium phosphate or its derivatives as the active fire-retarding component. However, these formulations only hold retardants on vegetation for short periods of time, so they can’t be used preventively. By contrast, the Stanford-developed technology—a cellulose-based gel-like fluid—stays on target vegetation through wind, rain and other environmental exposure. “You can put 20,000 gallons of this on an area for prevention, or 1 million gallons of the traditional formulation after a fire starts,” said study lead author Anthony Yu, a Ph.D. student in materials science and engineering at Stanford.

Complete fire prevention

The researchers have worked with the California Department of Forestry and Fire Protection (CalFire) to test the retardant materials on grass and chamise—two vegetation types where fire frequently starts. They found the treatment provides complete fire protection even after half an inch

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of rainfall. Under the same conditions, a typical commercial retardant formulation provides little or no fire protection. The researchers are now working with the California Department of Transportation and CalFire to test the material on high-risk roadside areas that are the origin of dozens of wildfires every year. "We don't have a tool that's comparable to this," said Alan Peters, a CalFire division chief in San Luis Obispo who monitored some of the test burns. "It has the potential to definitely reduce the number of fires." The Stanford-developed treatment contains only nontoxic starting materials widely used in food, drug, cosmetic and agricultural products. The unique properties of these gel-like retardant fluids allow them to be applied using standard agricultural spraying equipment or from aircraft. While it washes away slowly, providing the ability to protect treated areas against fire for months, the materials eventually degrade. "We hope these new materials can open the door to identifying and treating high-risk areas to protect people's lives and livelihoods," said Appel.

Phys.org, 30 September 2019

<http://phys.org>

Borophene on silver grows freely into an atomic 'skin'

2019-10-02

Borophene has a nearly perfect partner in a form of silver that could help the trendy two-dimensional material grow to unheard-of lengths. A well-ordered lattice of silver atoms makes it possible to speed the growth of pristine borophene, the atom-thick allotrope of boron that so far can only form via synthesis by molecular-beam epitaxy (MBE). By using a silver substrate and through careful manipulation of temperature and deposition rate, scientists have discovered they can grow elongated hexagon-shaped flakes of borophene. They suggested the use of a proper metal substrate could facilitate the growth of ultrathin, narrow borophene ribbons. New work published in *Science Advances* by researchers at Rice and Northwestern universities, Nanjing University of Aeronautics and Astronautics and Argonne National Laboratory will help streamline the manufacture of the conductive material, which shows potential for use in wearable and transparent electronics, plasmonic sensors and energy storage. That potential has fuelled efforts to make it easier to grow, led by Rice materials scientist Boris Yakobson, a theorist who predicted that borophene could be synthesised. He and collaborators Mark Hersam at Northwestern and lead author Zhuhua Zhang, a Rice alumnus and now a professor at Nanjing, have now demonstrated through theory and

Borophene has a nearly perfect partner in a form of silver that could help the trendy two-dimensional material grow to unheard-of lengths.

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experimentation that large-scale, high-quality samples of borophene are not only possible but also allow qualitative understanding of their growth patterns. Unlike the repeating atomic lattices found in graphene and hexagonal boron nitride, borophene incorporates a regular, woven-in array of “vacancies,” missing atoms that leave hexagonal holes among the triangles. This not only affects the material’s electronic properties but also influences how new atoms join the flake as it is being formed. The Yakobson lab’s calculations showed the edge energies—atoms that are less stable along the edges of 2-D materials than those in the interior—are significantly lower than those in graphene and boron nitride and that the conditions can be manipulated to tune the edges for optimum growth of ribbons. Initial calculations showed borophene in equilibrium should form as a rectangle, but experiments proved otherwise. The confounding factor was in the flake’s edges that, forced by the vacancies, appear in variations of zigzag and armchair configurations. Atoms settle one by one into the “kinks” that appear along the edges, but as armchairs are more energetically stable and present a higher barrier to the atoms, they prefer to join the zigzags. Rather than extending the flakes in all directions, the atoms are selective about where they settle and elongate the structure instead. “On the atomic scale, edges don’t act as though you cut the lattice with a pair of scissors,” Yakobson said. “The dangling bonds you create reconnect with their neighbours, and the edge atoms adapt slightly different, reconstructed configurations.” So, the origin of the shapes must not lie in equilibrium,” he said. “They are caused by the kinetics of growth, how fast or slow the side edges advance. Opportunely, we had developed a theoretical framework for graphene, a nanoreactor model that works for other 2-D materials, including boron.” Controlling the flow of atoms as well as temperature gives the researchers a simpler way to control borophene synthesis. “Silver (111) provides a landing for boron atoms, which then diffuse along the surface to find the edges of a growing borophene flake,” Zhang said. “Upon arrival, the boron atoms are lifted onto the edges by silver, but how difficult such a lift is, depends on the edge’s orientation. As a result, a pair of opposite zigzag edges grow very slowly while all other edges grow very fast, manifested as an elongation of the boron flake.” The researchers said the ability to grow needle-like ribbons of borophene gives them the potential to serve as atom-width conductive wires for nanoelectronics devices. “Graphene-based electronics that have been conceived so far mostly rely on ribbonlike building blocks,” Yakobson said.

“Metallic boron ribbons with high conductivity will be a natural match as interconnects in circuitry.”

Phys.org, 30 September 2019

<http://phys.org>

How An Eclipse Proved Einstein's Theory Of Relativity

2019-10-02

A new book tells the stories of astronomers who worked for a decade to get images of a solar eclipse. The work ultimately showed Albert Einstein's theory of relativity was correct. Einstein's theory of general relativity is a cornerstone of modern physics and cosmology. When it was first published, however, there was little hard evidence to show that it was actually correct. It wasn't until 1919—nearly a decade after Einstein began working on the theory—that astronomer Arthur Eddington finally delivered that evidence with an expedition to view a solar eclipse. According to Einstein's theory, light traveling past a massive object like the sun should bend due to the object's immense gravity. With the sun's light blotted, Eddington measured the positions of distant stars made visible in the background. He showed that when the light from those stars passed by the sun, they looked to be in a slightly different place compared to when the sun wasn't in the picture. The findings demonstrated that the conception of gravity laid out in the theory of relativity had been correct. For Eddington as well as Einstein, the expedition was a triumph. But his hadn't been the first eclipse expedition to try demonstrate Einstein's theory. In a new book called *Proving Einstein Right* (Public Affairs, 2019), S. James Gates Jr., director of the Theoretical Physics Centre at Brown University, and writer Cathie Pelletier tell the story of the seven astronomers and their decades-long, occasionally star-crossed quests capture the key eclipse measurement. Here, Gates explains the quest to prove Einstein right:

Q
First, refresh us on the basics about Einstein's theory of relativity.

A
Most of us learn our first lesson about gravity when we're in school. We are told that planets attract each other and that the sun attracts the Earth. That's why the Earth stays in orbit around the sun and why the moon stays in orbit around the Earth. This stems from Newton's universal law of gravitation. But Newton himself knew that there was something missing

A new book tells the stories of astronomers who worked for a decade to get images of a solar eclipse.

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from his formulation. It worked for explaining the motions of planets and apples falling on heads, but it left out the mechanism through which objects attract each other from a distance. That's where Einstein's new view of gravity comes in. Einstein introduced the space-time continuum and showed that objects within that continuum also shape it—bending it and warping it. It's through that bending and warping that objects influence each other from a distance. You can think of it like waves on the water. One object creates a wave, and another object encountering that wave responds. That's what gravity is, and that's what Einstein explained with the theory of relativity.

Q

How does an eclipse provide evidence for this?

A

Most people have had an experience that looks like the following: You have a glass of water and you hold it up, maybe passing it back and forth in front of your eyes. If there's an object behind the glass, you'll notice that as you move the glass back and forth, the location of the object seems to change. Now, the object doesn't actually move, but what does move is the path of the light that gets to your eye—and that's what you detect as the motion of the object. Basically, Einstein's theory of gravity says that massive objects also influence on the path of light like the glass does. So, as the light from distant stars passes by the massive sun, the position of those stars would appear to change, even if they weren't literally moving.

Q

Arthur Eddington gets most credit for making that observation, but you chose in your book to include many others in the story. Could you talk a bit about that?

A

This book really evolved. When my co-author and I started to write, we did think that it would wind up mostly be about Sir Arthur Eddington. But as we began to explore and look at some of the other competitors of Sir Arthur, we realized that there was this fellowship of people who were all trying to do the same thing around the same time. It was kind of a race, and some of participants had very interesting lives and stories. The story begins even before Einstein had a complete formulation of his theory. He had made some initial calculations that suggesting an eclipse may reveal this effect. So, starting in 1911, you have people trying to make this

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measurement, some of whom were imprisoned during World War I. You have people who had their equipment impounded by authorities during the war. You have people who run into difficulty getting equipment to some remote locations.

There were just so many stories and characters in what really became a scientific band of brothers trying to make this measurement.

Q

What other characters are particularly memorable?

A

One that stands out for me is William W. Campbell. He was a remarkable man and certainly as talented as Sir Arthur. He built the Lick Observatory, which still operates today, and served as its first director. He was also president of the University of California, Berkeley and played a big role in building it up to the world-class institution it is today. He was on an expedition in 1922 that actually found better support for Einstein's theory of light bending than Eddington's expedition 1919. To this very day, there are people who have made the claim that Eddington cooked the books with his observations. There were some photographic plates that Eddington threw out and didn't include in his calculations, and some people have imputed some nefarious intentions to that. So, the 1922 observation by Campbell really closed the case. Then there was Frank Dyson, who was basically Eddington's sponsor. Eddington almost got sent to jail for being a pacifist during World War I, and Dyson was the person who kept him out of the hoosegow. Another character is Erwin Finlay-Freundlich, who led an expedition to Crimea in 1914, but he was arrested when the war started and had his equipment impounded, so he never made his measurement. There were all these great stories to tell, and my co-author, Cathie Pelletier, really helped in bringing them to life.

Futurity, 30 September 2019

<http://www.futurity.org>

Cuban "Sonic Attacks" May Have Been Caused By Neurotoxins

2019-10-02

Was it a powerful futuristic weapon? Probably not — new research suggests that the culprit could have been neurotoxins from pesticides used in the area, according to CBC News. While questions remain, the

Scientists may have finally figured out what was behind those mysterious "sonic attacks" that gave U.S. and Canadian embassy staff visiting Cuba bizarre, concussion-like symptoms back in 2016.

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study suggests that Cuba's aggressive anti-Zika campaign may likely have resulted in the diplomatic staff getting inadvertently poisoned. In 2016, Cuban officials began aggressively spraying pesticides in offices and diplomats' homes as often as every two weeks, CBC News reports. The study, acquired and shared online by Radio-Canada, found that small doses of the pesticides used could have caused the symptoms the staff experienced. It's not the first time scientists have implicated pesticides in the alleged sonic attacks, but this new study lends weight to that hypothesis. "There are very specific types of toxins that affect these kinds of nervous systems... and these are insecticides, pesticides, organophosphates — specific neurotoxins," lead author Alon Friedman, a medical neuroscientist at Dalhousie University, told CBC News. While the pesticides could explain many of the symptoms people experienced, experts differ on other parts of the story. The scientists suggest that the psychological symptoms may have been caused by mass hysteria or people simply paying more attention to existing problems, while a psychiatrist who evaluated the survivors says she didn't see any evidence of psychiatric disorders.

Futurism, 20 September 2019

<https://futurism.com>

Researchers synthesise 'impossible' superconductor

2019-10-02

Researchers from the United States, Russia, and China have bent the rules of classical chemistry and synthesised a "forbidden" compound of cerium and hydrogen -- CeH₉ -- which exhibits superconductivity at a relatively low pressure of 1 million atmospheres. The paper came out in Nature Communications. Superconductors are materials capable of conducting an electric current with no resistance whatsoever. They are behind the powerful electromagnets in particle accelerators, maglev trains, MRI scanners, and could theoretically enable power lines that deliver electricity from A to B without losing the precious kilowatts to thermal dissipation. Unfortunately, the superconductors known today can only work at very low temperatures (below -138 degrees Celsius), and latest record (-13 degrees Celsius) requires extremely high pressures of nearly 2 million atmospheres. This limits the scope of their possible applications and makes the available superconducting technologies expensive, since maintaining their fairly extreme operating conditions is challenging. Theoretical predictions suggest hydrogen as a potential candidate for room-temperature superconductivity. However, coaxing

Researchers from the United States, Russia, and China have bent the rules of classical chemistry and synthesised a "forbidden" compound of cerium and hydrogen -- CeH₉ -- which exhibits superconductivity at a relatively low pressure of 1 million atmospheres.

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hydrogen into a superconductive state would take a tremendous pressure of some 5 million atmospheres; compare with 3.6 million atmospheres at the centre of the Earth. Compressed so hard, it would turn into a metal, but that would defeat the purpose of operating at standard conditions. "The alternative to metallising hydrogen is the synthesis of so-called "forbidden" compounds of some element -- lanthanum, sulfur, uranium, cerium, etc. -- and hydrogen, with more atoms of the latter than classical chemistry allows for. Thus normally, we might talk about a substance with a formula like CeH_2 or CeH_3 . But our cerium superhydride -- CeH_9 -- packs considerably more hydrogen, endowing it with exciting properties," explained an author of the study, Professor Artem R. Oganov of Skoltech and the Moscow Institute of Physics and Technology (MIPT). As materials scientists pursue superconductivity at higher temperatures and lower pressures, one may come at the cost of the other. "While cerium superhydride only becomes superconductive once cooled to -200 degrees Celsius, this material is remarkable in that it is stable at a pressure of 1 million atmospheres -- less than what the previously synthesised sulfur and lanthanum superhydrides require. On the other hand, uranium superhydride is stable at an even lower pressure, but needs considerably more cooling," added co-author Ivan Kruglov, a researcher at MIPT and Dukhov Research Institute of Automatics. To synthesise their "impossible" superconductor, the scientists placed a microscopic sample of the metal cerium into a diamond anvil cell, along with a chemical that releases hydrogen when heated -- in this case with a laser. The cerium sample was squeezed between two flat diamonds to enable the pressure needed for the reaction. As the pressure grew, cerium hydrides with a progressively larger proportion of hydrogen formed in the reactor: CeH_2 , CeH_3 , etc. The team then used X-ray diffraction analysis to discern the positions of the cerium atoms and thus indirectly reveal the structure of the new compound. The CeH_9 crystal lattice is comprised by cages of 29 hydrogen atoms in a near-spherical formation. The atoms in each cage are held together by covalent bonds, not unlike those in the familiar H_2 molecule of the hydrogen gas, but somewhat weaker. Each cage provides a cavity that houses one cerium atom. The advent of USPEX -- developed by Skoltech and MIPT's Artem Oganov -- and other computer algorithms predicting the crystal structure of previously unheard of "forbidden" compounds has enabled researchers to study the single-metal hydrides in minute detail. The next step is adding a third element into the mix: The triple compounds of hydrogen and two different metals are uncharted territory. Since the number of possible combinations is great, researchers

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are considering using AI algorithms to select the most promising candidates.

EurekaAlert, 1 October 2019

<http://www.eurekaalert.org>

Optoceutics: A new technique using light for regenerative medicine

2019-10-02

Using light to facilitate the formation of new blood vessels: it is the breakthrough outcome of a research study carried out by researchers at Istituto Italiano di Tecnologia (IIT) in Milan (Italy). The study was published in Science Advances. For the first time, the research group has shown that it is possible to specifically conduct the fate of tissue cells by using visible light together with photo-sensitive and biocompatible materials. This discovery opens up new horizons for regenerative medicine. In fact, regenerative medicine has the purpose of repairing, regenerating and replacing cells, tissues and even organs damaged by congenital defects, diseases, injuries or aging in order to re-establish the physiological functions. Currently available techniques, comprising gene therapy and biomedical engineering, make use of chemical cues, drugs and physical stimuli, but unfortunately often lack selectivity and reversibility. Thanks to this new study, regenerative medicine can count on a new technique: Optoceutics. The study has been conducted by an IIT research group led by the responsible for the OptoCell Lab Maria Rosa Antognazza, in collaboration with two Italian partners, the University of Pavia and Fondazione IRCCS Policlinico San Matteo in Pavia. "We are talking about a completely new technique that could lead us to important outcomes in tissue engineering. The use of light as a stimulus is much more versatile and much less invasive compared to the use of electrodes; it can be directed in a more specific way on different cell populations objects of the treatment. The purpose is to create a new area of investigation, which we call "optoceutics", able to walk side by side with pharmaceutical and electroceutical technology with huge application potential." says Maria Rosa Antognazza, IIT researcher. It is in this context that the research team, along with the cardiovascular physiologist and first author of the study Francesco Lodola, has shown that it is possible to apply the new method to progenitor cells of the endothelial tissue. The researchers managed to effectively promote the in vitro angiogenesis process by using photo active materials as cellular substrates and by stimulating them with short pulses of visible light. These results pave the way to a number of

A new study published on Science Advances shows that it is possible to specifically conduct the fate of tissue cells by using visible light.

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interesting developments in the treatment of cardiovascular diseases. The next step will be strengthening the potentiality of the proven technique using other cell models of interest for tissue regeneration. The possibility of modulating the cell fate by optical stimulation allows researchers to be highly precise and minimally invasive; therefore, it may be suitable for several applications in the therapeutic field.

EurekAlert, 30 September 2019

<http://www.eurekalert.org>

Converting CO₂ to valuable resources with the help of nanoparticles

2019-10-02

An international research team has used nanoparticles to convert carbon dioxide into valuable raw materials. Scientists at Ruhr-Universität Bochum in Germany and the University of New South Wales in Australia have adopted the principle from enzymes that produce complex molecules in multi-step reactions. The team transferred this mechanism to metallic nanoparticles, also known as nanozymes. The chemists used carbon dioxide to produce ethanol and propanol, which are common raw materials for the chemical industry. The team led by Professor Wolfgang Schuhmann from the Centre for Electrochemistry in Bochum and Professor Corina Andronescu from the University of Duisburg-Essen, together with the Australian team led by Professor Justin Gooding and Professor Richard Tilley, reported in the *Journal of the American Chemical Society* on 25 August 2019. "Transferring the cascade reactions of the enzymes to catalytically active nanoparticles could be a decisive step in the design of catalysts," says Wolfgang Schuhmann.

Particle with two active centres

Enzymes have different active centres for cascade reactions, which are specialised in certain reaction steps. For example, a single enzyme can produce a complex product from a relatively simple starting material. In order to imitate this concept, the researchers synthesised a particle with a silver core surrounded by a porous layer of copper. The silver core serves as the first active centre, the copper layer as the second. Intermediate products formed at the silver core then react in the copper layer to form more complex molecules, which ultimately leave the particle. In the present work, the German-Australian team showed that the electrochemical reduction of carbon dioxide can take place with the help

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of the nanozymes. Several reaction steps on the silver core and copper shell transform the starting material into ethanol or propanol. "There are also other nanoparticles that can produce these products from CO₂ without the cascade principle," says Wolfgang Schuhmann. "However, they require considerably more energy." The researchers now want to further develop the concept of the cascade reaction in nanoparticles in order to be able to selectively produce even more valuable products such as ethylene or butanol.

Science Daily, 27 September 2019

<http://www.sciencedaily.com>

New design of bioactive peptide nanofibers keeping both temperature reversibility and stiffness control

2019-10-02

A collaboration mainly led by scientists from Tokyo University of Agriculture and Technology (TUAT) in Japan has developed a new method of molecular design to control both temperature reversibility and stiffness of nanofibers that are gel-forming peptides. The peptide nanofiber hydrogel can be used as biomedical materials. This method will allow the peptide nanofibers more biomedical applicable. The researchers published their results on July 8th in Chemistry-A European Journal. In general, some of peptides form nanofiber hydrogels. These peptides are short chains of natural amino acids found in all living organisms. Since these are bio-friendly, these have been widely used in medicine such as tissue recovery materials, regenerative medical materials, extracellular matrices, cell culture materials, and drug delivery containers. "For some medical applications of nanofiber peptides, we need to develop a technique to control both stiffness (mechanical strength) and temperature response changing between gel (solid) and sol (liquid)," said Takahiro Muraoka, PhD, corresponding author on the paper and associate professor in the Department of Applied Chemistry, Graduate School of Engineering at TUAT. "It is, however, difficult to make better the both features at the same time. For example, when increasing stiffness of a peptide nanofiber by replacement of a simple amino acid alanine to a more hydrophobic amino acid phenylalanine, it is known that temperature response is often lost." In their experiments, they found that an amino acid replacement that was thought to make a softer gel unexpectedly formed a harder gel. They used 5 sets of different peptides that had 16 amino acids. Interestingly, one particular peptide did not lose temperature response. The peptide (concentration at 1% in solution) formed gel (solid) at 20°C (68°F) and

Scientists have developed a new method of molecular design to control both temperature reversibility and stiffness of nanofibers that are gel-forming peptides.

when increasing temperature to 80°C (178°F) the gel became sol (liquid). When reducing temperature from 80°C to 20°C, gel was again formed. "This temperature reversible feature is applicable for drug delivery by local injection," said Muraoka. They replaced alanine in the middle of the peptide to glycine, the simplest amino acid. The glycine replacement usually makes the gel softer. They used regular analytical instrument such as CD, IR, and TEM microscopy to understand precisely how the gel was formed. They also used a computational approach, called molecular dynamics simulation. "Based on our results, we are now able to design peptides better by computer simulation," said Muraoka. Furthermore, the peptide nanofiber was cell adhesive, which is suitable as a biomaterial for cell culture and tissue regeneration. "This research will open new avenues towards designing peptide nanofibers more biomedical applicable," Muraoka added.

Science Daily, 27 September 2019

<http://www.sciencedaily.com>

Chemists obtain new material for antibacterial food coatings

2019-10-02

RUDN University chemists have developed a simple and convenient method for producing derivatives of the natural polymer chitosan. These derivatives are non-toxic and have a pronounced antibacterial activity at the level of modern antibiotics. These substances can be used in the production of antibacterial protective films for food. The article is published in the journal Food Chemistry. Preservatives are widely used in the food industry. They are necessary to extend the shelf life of products. On the other hand, preservatives reduce food quality. Some of them can cause allergies (benzoic acid) or be toxic (nitrates, nitrites). Synthetic waxy substances used to coat fruits can be carcinogenic (biphenyl is prohibited in the US and EU). This explains the importance of finding new preservatives that are effective and safe. Chitosan is a natural polymer derived from chitin, the main component of insect and crustacean shells. It has antibacterial properties and is already used in the food industry for packaging and coating products with a protective film. However, its activity is far inferior to antibiotics. To obtain non-toxic and highly active derivatives of chitosan, RUDN University chemists Andreii Kritchenkov and Margarita Kurasova and their colleagues have modified chitosan with organic azides by "sewing" them to the polymer chain. Azides are derivatives of hydrazoic acid (HN₃). Both organic and inorganic azides are

RUDN University chemists have developed a simple and convenient method for producing derivatives of the natural polymer chitosan. These derivatives are non-toxic and have a pronounced antibacterial activity at the level of modern antibiotics.

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toxic, but their compounds with chitosan are not poisonous. Antibacterial activity of the obtained substances, azido chitosan, was significantly higher than that of chitosan. The experiment showed that samples of polymers based on chitosan had antibacterial activity at the level of antibiotics. The researchers compared this parameter for azido chitosan with the two most common antibiotics—ampicillin and gentamicin. Antibacterial activity was determined by diffusion into the agar (nutrient) layer. A disk of filter paper impregnated with the test substance (or comparison antibiotic) was placed on the agar layer sown with a bacterial culture. The substance penetrates the agar, killing bacteria or slowing their reproduction. As a result, a growth suppression zone is formed around the disk, which differs from the rest of the agar surface visually. The value of an antibacterial activity is estimated by the diameter of the formed zones. Toxicity was determined by a standard colorimetric test. An obtained derivative of chitosan—azido chitosan—prevented *Staphylococcus aureus* growth in a zone of 26 mm in diameter (the indicator for ampicillin was 30 mm), and of 18 mm for *Escherichia coli* (in gentamycin it was 22 mm). That is, the polymer has almost the same antibacterial activity as antibiotics. This is extremely important, because the use of antibiotics as components of antibacterial films is highly unacceptable because it leads to the emergence of resistant strains of bacteria. Chitosan compounds do not have this disadvantage. New chitosan derivatives can be used as harmless and effective preservatives to create protective films for food on this basis.

Phys.org, 30 September 2019

<http://phys.org>

Scientists develop high-precision sensor based on laser-textured gold film

2019-10-02

Scientists at Far Eastern Federal University (FEFU) with colleagues from Russia, Japan, and Australia have developed a multi-purpose sensor based on a specially designed gold film, the surface of which contains millions of parabolic nanoantennas produced by femtosecond laser printing. The sensor identifies molecules at trace concentrations, detecting them in liquid and gas environments. It can be easily adjusted to provide different modalities, including biological studies, medical and security tasks. The related research is published in *Nanomaterials*. The sensor reacts to the tiniest changes of the surroundings in the close proximity to its surface, e.g. gas or organic molecules, changes in the local refractive index of a liquid, etc. and can be applied for bioanalysis,

Scientists at Far Eastern Federal University (FEFU) with colleagues from Russia, Japan, and Australia have developed a multi-purpose sensor based on a specially designed gold film, the surface of which contains millions of parabolic nano-antennas produced by femtosecond laser printing.

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environmental monitoring, food quality analysis, and various security systems. "Despite the significant progress that science has made in the field of high-precision physicochemical sensors over the past several decades, flexible in expensive technologies for manufacturing cheap multi-purpose sensors combining different measurement modalities within a single device are still required. Existing lithographic technologies for such sensors fabrication are time and money consuming and therefore are not suitable for mass production. We proposed efficient and cheap laser printing technology to solve the mentioned issue. Using it we can easily produce sensor elements with the desired surface morphology and resonant properties, optimized to merge different sensing modalities and to have sufficient mechanical strength to operate in liquid environments," said Aleksandr Kuchmizhak, research fellow at the FEFU STI for Virtual and Augmented Reality. The sensor system based on nanotextured gold film was fabricated by direct femtosecond-laser printing. The exposure of such an ultrathin gold film to single femtosecond pulses resulted in formation of millions of hollow parabolic nanostructures (nanovoids), the so-called nanoantennas. An ordered array of these nanostructures has pronounced resonant optical properties. They effectively convert incident radiation of the visible and IR spectral ranges into special surface waves, so-called surface plasmons, which provide the sensor with its remarkable sensitivity to changes in the surroundings. Scientists from FEFU, FEB RAS and MEPhI, as well as from Nagoya Institute of Technology (Japan), Tokai University (Japan) and Swinburne University of Technology (Australia) took part in the work. Previously, scientists from FEFU and Swinburne University of Technology teamed up with Indian and Japanese colleagues, had developed an optical element based on an array of cross-shaped silicon nanoantennas. Being arranged in an appropriate way, these nanoantennas formed a spiral waveplate for middle-IR and THz spectral ranges allowing for the conversion of an ordinary Gaussian beam to a singular vortex beam. The optical element aimed to conduct advanced laboratory studies of the proteins' structure in IR spectral range, as well as to study new chiral molecular compounds.

Phys.org, 30 September 2019

<http://phys.org>

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New catalyst outshines platinum for producing hydrogen

2019-10-02

Hydrogen, the most abundant element in the universe, packs a powerful punch. And because it contains no carbon, it produces only water when used as a fuel. But on Earth, hydrogen most often exists in combination with other elements, which means it needs to be extracted. To harness the clean power of hydrogen for energy applications and other uses, researchers are looking at affordable ways to produce and store hydrogen. New research from Pacific Northwest National Laboratory (PNNL) shows that a pairing of humble minerals outshines other precious metal materials when it comes to producing hydrogen. With collaborators from Oregon State University (OSU), the researchers tested a molybdenum-phosphide (MoP) catalyst with wastewater in a small reactor called a microbial electrolysis cell (MEC). Test results showed that MoP worked better than platinum, a precious and expensive metal typically used for its high catalytic performance. The MoP catalyst also produced hydrogen five times as fast as other non-platinum catalysts reported in related studies. But the real kicker? Their catalyst also worked well with seawater. "If you can produce hydrogen from seawater, the resource pool is pretty much unlimited," said Yuyan Shao, a material scientist at PNNL who led the catalyst research. Like seawater, the MoP catalyst material is widely available, and therefore, cheap. The catalyst also worked with wastewater, another ubiquitous resource. Details of the team's study appear in the journal ACS Catalysis. The findings stem from a three-year project funded by the Department of Energy's Fuel Cell Technologies Office.

A better alternative

One of the most common methods for producing hydrogen is a process called electrolysis. This process combines electricity with various chemicals, called electrolytes, and a solid catalyst material. The ensuing reaction produces hydrogen, but the entire process uses a lot of energy and costly resources like platinum. Fermentation using renewable sources or waste streams holds promise for affordable hydrogen production. But the fermentation process works slowly, yields are low, and the product stream requires expensive clean-up due to other by-products from fermentation. In MECs, an electrical current is coupled with bacteria to decompose organics and make hydrogen. Unfortunately, the cells also use costly platinum for the reaction surface, and if non-platinum catalysts are used, hydrogen yields remain low. At OSU, researchers developed a hybrid MEC design in which fermentation and electrolysis take place in a

Hydrogen, the most abundant element in the universe, packs a powerful punch.

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single pot as opposed to separate steps, and the by-products are directly consumed in the process. This integrated design increases productivity and lowers equipment costs. But with the high cost of platinum, the team needed a catalyst that could lower production costs to around two dollars per kilogram of hydrogen.

Second-phase surprise

Building on prior discoveries with the MoP catalyst, PNNL researchers investigated the catalyst for use in MECs. The research team started with the MoP combination because of its affinity for activating, or separating, water molecules. The catalyst is also tunable—the amount of each mineral can be adjusted. According to the team's hypothesis, this tuning would optimise the amount of hydrogen produced in a single reaction. They were partly right. Under a powerful microscope, they found that the catalyst assembled into a mixture of two distinct crystal phases—MoP and MoP2. The atomic structure for each phase was different, leading to different reactions. While MoP2 released hydrogen atoms from the water molecules, MoP converted the hydrogen atoms to hydrogen gas molecules. The two active sites boosted the overall reaction. "We did not expect the simultaneous formation of the two crystal phases," said Shao. "The two phases work way better than the single phase." The researchers ran their experiments under neutral pH conditions in both the hybrid cell at OSU using wastewater and in another reactor at PNNL using seawater, with consistent results. Shao said these findings give the researchers confidence that the method is sound, eliminates platinum and other by-products, and holds great promise for advancing hydrogen and fuel cell technologies.

Phys.org, 30 September 2019

<http://phys.org>

Silicon technology boost with graphene and 2D materials

2019-10-02

Silicon semiconductor technology has done marvels for the advancement of our society, who has benefited tremendously from its versatile use and amazing capabilities. The development of electronics, automation, computers, digital cameras and recent smartphones based on this material and its underpinning technology has reached skyrocket limits, downscaling the physical size of devices and wires to the nanometre

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regime. Although this technology has been developing since the late 1960s, the miniaturization of circuits seems to have reached a possible halt, since transistors can only be shrunk down to a certain size and not further beyond. Thus, there is a pressing need to complement Si CMOS technology with new materials, and fulfil the future computing requirements as well as the needs for diversification of applications. Now, graphene and related two-dimensional (2D) materials offer prospects of unprecedented advances in device performance at the atomic limit. Their amazing potential has proven to be a possible solution to overcome the limitations of silicon technology, where the combination of 2D materials with silicon chips promises to surpass the current technological limitations. In the new review article in Nature, a team of international researchers including ICFO researchers Dr. Stijn Goossens and ICREA Prof at ICFO Frank Koppens, and industrial leaders from IMEC and TSMC have come together to provide an in-depth and thorough review about the opportunities, progress and challenges of integrating atomically thin materials with Si-based technology. They give insights on how and why 2D materials (2DMs) could overcome current challenges posed by the existing technology and how they can enhance both device component function and performance, to boost the features of future technologies, in the areas of computational and non-computational applications. For non-computational applications, they review the possible integration of these materials for future cameras, low power optical data communications and gas and bio-sensors. In particular, image sensors and photodetectors, where graphene and 2DMs could enable a new vision in the infrared and terahertz range in addition to the visible range of the spectrum. These can serve for example in autonomous vehicle, security at airports and augmented reality. For computational systems, and in particular in the field of transistors, they show how challenges such as doping, contact resistance and dielectrics/encapsulation can be diminished when integrating 2DMs with Si technology. 2DMs could also radically improve memory and data storage devices with novel switching mechanisms for meta-insulator-metal structures, avoid sneak currents in memory arrays, or even push performance gains of copper wired based circuitry by adhering graphene to the ultrathin copper barrier materials and thus reduce resistance, scattering and self-heating. The review provides insight to all stakeholders about the challenges and impact of solving the 2D material integration with CMOS technology. It provides a roadmap of 2D integration and CMOS technology, pinpointing the stage at which all challenges regarding growth, transfer, interface, doping, contacting, and design are currently standing today and what possible processes are expected to be resolved to achieve such goals of moving from a research

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laboratory environment to a pilot line for production of the first devices that combine both technologies. The first 2D material-CMOS roadmap, as presented in this review, gives an exciting glimpse in the future, with first pilot production to be expected already in just a few years from now.

EurekAlert, 30 September 2019

<http://www.eurekalert.org>

A new, natural wax coating that makes garments water-resistant and breathable

2019-10-02

There is a growing concern over the environmental impact of textile production and many waterproof products on the market are prepared with toxic chemicals. This is increasing demand for new sustainable material alternatives, but making non-toxic, breathable and waterproof textiles, sustainably and economically has thus far proven to be a challenge. Now Aalto researchers have developed an ecological and water repellent wax particle coating suitable for wood cellulose fibres, which also retains the breathability and natural feel of the textile. The coating uses carnauba wax, which is also used in such things as medicines, foodstuffs, as well as the surface treatment of fruits and car waxes. The new coating is suitable not only for textiles but also for other cellulose-based materials. During the processing, the wax is thawed and decomposed in water into wax particles that are anionic (i.e. negatively charged) just like cellulose. For the wax particles to adhere well to the cellulose surface, something cationic (i.e. positively charged) is needed as a buffer, since the oppositely charged particles attract one another. In previous studies, a natural protein called polylysine was used for this. However, as Aalto University PhD student Nina Forsman points out, 'Polylysine is very expensive so in our current study, it's been substituted with a much cheaper, cationic starch that's already commercially available'. Though cationic starch is not quite as effective as polylysine, two layers of the starch mixed with two wax particles are sufficient to make the textile waterproof. The researchers compared the breathability of textiles treated with natural wax with textiles that had been treated with commercial products. Ecological wax particles made the textiles waterproof and also retained their breathability, while textiles treated with commercial controls had reduced breathability. The multidisciplinary research team also included designer Matilda Tuure from the Aalto University School of Arts, Design and Architecture and as part of her master's thesis, she designed and manufactured three coats for which the wax coatings were put through their paces.

Researchers have developed an ecological and water repellent wax particle coating suitable for wood cellulose fibres, which also retains the breathability and natural feel of the textile.

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Waxing and dyeing at the same time

The wax coating can be applied to the textile by dipping, spraying or brushing onto the surface of the textile, and all three methods were tested. They found that dipping is suitable for smaller items of clothing and spraying or brushing is better for larger ones. In industrial-scale production, wax treatment could be part of the textile finishing process along with the colour pigmentation of the wax, which makes dyeing and waterproofing possible at the same time. The research team found that the wax coating is not resistant to detergent washing, so the product is best suited for less frequently washed outer garments such as jackets. For the sake of simplicity of use, the consumer could potentially apply the coating themselves to the textile after each wash, and this requires more research and development though. The effect of the drying temperature after wax treatment on waterproofing was also observed, and it was concluded that the best water resistance is obtained when the drying temperature is lower than the melting temperature of the wax. "We tested the coating on different textile materials: viscose, tencel, cotton, hemp and cotton knitwear. We found that the surface roughness of textiles affects how well it repels water - the rougher the surface, the better. This is because, on a rough surface, water droplets contact the textile surface in a smaller area," says Forsman.

EurekaAlert, 30 September 2019

<http://www.eurekaalert.org>

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Disturbing New Evidence Suggests Soot Particles Can Cross The Placenta After All

2019-10-03

Tiny carbon particles dumped into the atmosphere by industry and transport have been found on the wrong side of the placenta - a critical barrier meant to protect unborn babies from harm. Only last year researchers spotted ominous flecks of soot in placental white blood cells, the first solid indication that the pollutants could migrate so close to a foetus. Now there's evidence that these potential toxins can creep even closer still. Researchers from Belgium's Hasselt University and East-Limburg Hospital used high resolution imagery to highlight tiny accumulations of black particles on both the mother's and foetus's side of every placenta taken from 28 births. Further testing on the tiny clumps confirmed they were firmly embedded in the tissue, and were made up of the kind of potentially hazardous 'black carbon' particles emitted by combustion engines and fossil fuel power plants. While the study stops short of linking carbon particles with birth complications, it does show the barrier at the core of the placenta isn't filtering out enough of the material already associated with a variety of serious health concerns for developing bodies. Christine Jasoni is the Director of the Brain Health Research Centre at the University of Otago in New Zealand. While she wasn't involved in the study, she finds the prospect of a new disease route alarming. "There is considerable epidemiological evidence that when a pregnant mother is exposed to air pollution there are long-term consequences for the health of her offspring," says Jasoni. "The biggest risk is for low birth weight, which significantly increases life-long risk for a collection of diseases, including diabetes, cardiovascular disease, asthma and stroke." The placenta can be pictured as two hands with their fingers interlaced. One hand belongs to the mother and is anchored firmly to the wall of the uterus. The other is technically part of the foetus, consisting of a network of blood vessels that extend down the umbilical cord and into the growing body. Where those two sets of 'fingers' meet there are structures that keep the mother's and foetus's blood from mixing while still permitting an exchange of gases, wastes, hormones, and nutrients. As efficient as this barrier between mother and child is, it isn't great at keeping out nasty materials such as alcohol, various pathogens, and even some nanosized particles. This latest study strongly indicates that bits of black carbon that enter the lungs of a mother can not only worm their way through her own vascular system into her placenta, but are capable of slipping past vital structures into foetal tissue. The researchers also showed the concentrations of these deposits increase with the level of air pollution in

Tiny carbon particles dumped into the atmosphere by industry and transport have been found on the wrong side of the placenta - a critical barrier meant to protect unborn babies from harm.

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the external environment by comparing the placentas of 10 mothers living near busy roads with another 10 living in quieter zones. An additional five placentas from spontaneous preterm births were also studied, revealing particles could be detected from as early as just 12 weeks into gestation. Given the known links between air quality and foetal development, knowing this wall between mother and child is permeable to nanoscale soot particles is worth investigating. But it's also worth keeping in mind that this could also be a sign of nature living up to expectation. "Since one of the functions of the placenta is to act as a barrier preventing toxins passing from the mother into the foetus, the placenta could be seen here as performing its normal job – accumulating the black carbon particles so they don't get into and damage the foetus," says Jasoni. Still, knowing the difference between a healthy-looking placenta and one that's overloaded, could help researchers pinpoint the mechanisms behind the hazardous effects of black carbon. From birth through early development and well into our twilight years, the fine particles of carbon hanging about in the atmosphere jeopardise our health on a range of levels. While nations such as the US have worked hard over the years to improve air quality, there's still a long way to go. Especially when children who aren't even born yet are among those at risk. This research was published in Nature Communications.

Science Alert, 18 September 2019

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

Scientists Have Built Knives Out of Human Poop to Test Whether They Work

2019-10-03

In what might constitute the year's strangest salvo against the scourge of "fake news", anthropologists have experimentally tested whether you can really make a knife out of frozen excrement. They conclude that you cannot. Back in 1998, University of British Columbia anthropologist and popular writer Wade Davis recounted in his book *Shadows in the Sun* a tale told to him by an Inuit man named Olayuk Narqitarvik. The story tells how an elderly man refused to move into a settlement back in the 1940s or '50s, planning instead to live alone on the ice. In an attempt to prevent him from staying, the account goes, his family took away all his tools. "So, in the midst of a winter gale, he stepped out of their igloo, defecated, and honed the faeces into a frozen blade, which he sharpened with a spray of saliva," Davis writes. "With the knife he killed a dog. Using its rib cage as a sled and its hide to harness another dog, he disappeared into the

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darkness." Whether the tale was meant to be apocryphal or not is unclear; Davis says he has always told the story with a sense of humour and considered it symbolic of how the Inuit thrive in their cold environment. But the idea of using faeces as a tool isn't unprecedented. Danish Arctic explorer Peter Freuchen, for example, wrote in an autobiographical account in 1953 that he once shaped his excrement into the form of a chisel, waited for it to freeze, and then used it to escape from a pit of ice and snow. Experimental archaeologist Metin Eren, of Kent State University, Ohio, remembers hearing Davis tell the fascinating story from Narqitarvik on NPR when he was still in high school. While it might have started as a funny story, Eren adds, he says he has seen many people using it as real evidence of Inuit ingenuity (for which there is plenty of other evidence, he adds; Inuit sled runners were made from fish, for example, notes Davis in an email). That's potentially worrying, he says, especially in today's climate of "fake news". So, he and his colleagues decided to test and see if a knife fashioned from frozen poop really could be used to kill a dog. Eren's experimental archaeology lab is used to refashioning and testing traditional tools for their strength and abilities. And Eren is used to dedicating himself to his work: He almost lost a finger once, he recalls, knapping a stone tool. In this case, Eren ate a high-protein diet, as the Inuit traditionally do, for eight days. (He ate a lot of salmon, beef, and turkey, though he cheated a few times by eating up his toddler's leftovers of macaroni cheese and applesauce.) "The diet was way harder than I thought," Eren says. "The first day was awesome because I love steak. After the third day, I had headaches." Starting on the fourth day, he collected the necessary "raw material", which he shaped into knives either by hand or with a ceramic mould, and then froze at -20 degrees Celsius. Eren says he did everything possible to try to make the experiment succeed, including keeping the knife cold and sharpening it with a metal file, and trying to cut cool hide (rather than the warm hide you would get from a fresh kill). But the knife didn't cut; it melted, leaving streaks on the animal hide. "It was like a brown crayon," Eren says. The notion of archaeologists working with faeces isn't unheard of. Many archaeologists study coprolites—fossilised or preserved faeces—to glean something about ancient animal or hominin diets, and even gut health. Neanderthal coprolites, for example, have been used to determine if those hominins ate more meat or plants, and showed signs that Neanderthals had worm infections. The results of Eren's study don't necessarily take away from the value of Narqitarvik's anecdote or Davis' retelling of it; such stories still say something about Inuit ways of transmitting cultural values and lessons. "I wonder if from the storyteller's [Narqitarvik's] point of view, if they're so hung up on a distinction about literal truth," says Henry Huntington, an independent expert in Indigenous

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knowledge in the Arctic who is based in Eagle River, Alaska. "It could be a lesson in resourcefulness, generally; the idea that you never run out of options." "The entire point of the anecdote," wrote Davis in an email, "is to remind audiences and readers that the Inuit do not fear the cold; they take advantage of it. This is indisputably true." "Traditional Inuit stories often used sexual and bodily references as humorous rather than purely educational details for their audiences," notes Brendan Griebel, an independent Arctic archaeologist based in Nunavut, Canada. "As in any culture, it makes for good storytelling." Despite the humour of the story, Eren points out that some people — including The Arctic Institute — have retold and used the story as if it were fact. The use of untested claims to support even positive assumptions can be harmful, Eren notes, as it can snowball. "The problem is, by using an unsupported story to support a stance, even if that's a good stance, it's a slippery slope," he says. "Then you can start having other unsupported claims that are racist or problematic." Eren says he understands that many will find his paper funny (and the endless puns it invokes: "our data collection was regular," he jokes). "But the overarching message is really important," he adds.

Science Alert, 18 September 2019

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

Australia has a huge shortage of the medical isotope needed for scans

2019-10-03

Australia is facing possibly its worst ever shortage of medical isotopes, meaning 10,000 people or more may miss out on vital diagnostic scans. The isotope molybdenum-99 is crucial to the diagnosis of conditions such as cancer, heart disease, neurological disease, and skeletal, renal and digestive disorders. Uranium fission produces the isotope, which then decays into the commonly used imaging agent technetium-99m. But now, a problem at Australia's only nuclear reactor has stopped the extraction of molybdenum-99 after it is produced. The reactor itself is unaffected, but a valve fault in the facility that extracts the medical isotope is to blame. As a result, the medical community only has around 31 per cent of its normal supply of the medical isotopes this week, and as many as 10,000 people may be missing out on vital scans, says nuclear medicine advisor Geoff Currie, at Charles Sturt University, Australia. Supply is set to drop even lower next week as the last of Australia's domestic supplies run out, he says. Supplies of molybdenum-99 are precarious due to its relatively short half-life of 67 hours, meaning the isotope decays too quickly to be

The nuclear power plant in Baywater, Australia, is the largest in the southern hemisphere

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stored for a long period of time. Once inside the body, technetium-99m emits gamma rays that are detectable, making it easy to create images of muscles, bones and other areas of interest. Without it, imaging for everything from suspected bone fractures to pre-surgery scans are being delayed. For example, a patient diagnosed with breast cancer may be unable to have the scans necessary to show their surgeon which lymph nodes to closely examine to evaluate cancer spread, delaying the surgery by days or more, says Currie. "Right now these hospital departments don't know whether they will be able to operate next week or not," he says. "So that creates a great deal of uncertainty and stress amongst the patients as well as the medical staff." A key driver of the shortage is that the malfunction occurred during a scheduled three-week shutdown of a South African reactor for maintenance. Molybdenum-99 is a scarce resource, with only five to 11 reactors producing it normally, and global supplies are tenuous. The Australian facility produces enough to supply around one third of the world's demand of the isotope, although it is almost entirely used domestically. Nevertheless, the shortage has begun to have ripple effects, creating a strain on other countries' supplies as any excess is now being directed to Australia, says Currie. In the meantime, ANSTO is in discussions with the South African facility to obtain more, although it will take time for the reactor to be running at full capacity. Molybdenum-99 has a half-life of around 66 hours, which allows it to be delivered to hospitals and sometimes other countries, where it decays into the usable technetium-99m. It is likely to take at least two or three weeks for the country's supply to return to normal although there is no clear timeline from ANSTO on the possible fix, possibly leading to longer delays.

New Scientist, 18 September 2019

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

Microbe that got man drunk could help explain common liver disease

2019-10-03

A man in China who, after eating high-carbohydrate or sugary meals, became so intoxicated that he blacked out, has led researchers to discover strains of bacteria in the human gut that could be an important driver of the world's most common liver disease. That condition, non-alcoholic fatty liver disease (NAFLD), affects an estimated 1 billion people worldwide, and nearly one in three Americans. The excess fat in liver cells that is characteristic of the disease usually does not cause any symptoms, but in about 25% of people with NAFLD, the accumulation progresses and

A man in China who, after eating high-carbohydrate or sugary meals, became so intoxicated that he blacked out, has led researchers to discover strains of bacteria in the human gut that could be an important driver of the world's most common liver disease.

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sometimes causes life-threatening cirrhosis or liver cancer. Scientists found that the Chinese man's odd malady stems from gut bacteria that synthesise alcohol from his meals. Researchers say the finding could lead to better ways of predicting who will develop severe forms of NAFLD and may even suggest ways to thwart its progression. Obesity, diabetes, and other conditions are associated with NAFLD, but no single underlying mechanism explains why fat builds up in the liver of so many people. Some studies have tied gut bacteria to NAFLD, but the idea has remained controversial. The complexity of intestinal flora makes it difficult to sort the contributions of single species. The new finding, published in *Cell Metabolism* today, focuses on a novel strain of *Klebsiella pneumoniae* that predominates in a small cohort of NAFLD patients and also caused liver damage in mouse experiments. "I have to admit this is pretty impressive," says infectious disease specialist David Haslam of Cincinnati Children's Hospital Medical Centre in Ohio, who has been circumspect about earlier attempts to tie intestinal microbes to NAFLD. Jing Yuan, a microbiologist at the Capital Institute of Paediatrics in Beijing and lead author of the paper, says she and her colleagues became intrigued in June 2014, when a 27-year-old man sought care in Beijing for bouts of unexplained intoxication that dated back 10 years and were getting worse. Some thought he must be a closet drinker, and his mother regularly had him use a breathalyser. That showed high blood alcohol levels even when she was certain he had not had alcohol. Even odder, when he drank several colas, he sometimes became drunk. Doctors previously had diagnosed the man's intoxication problem as autobrewery syndrome, a rarely reported condition in which people become drunk from starchy or sugary foods. It is thought to be caused by gut fermentation, aided by an abundance of yeast. But antifungal treatment had no effect on the man. Liver biopsies showed he had non-alcoholic steatohepatitis (NASH), the severe form of NAFLD. He was moved to the intensive care unit and closely observed. Doctors noted that after he ate a meal high in sugar, his blood alcohol level rose to as high as 400 milligrams per decilitre. "That's equivalent to 15 shots of 40% [80-proof] whisky," Yuan says. Because some other microbes can metabolize sugars into alcohol, Yuan and colleagues analysed 14 of the man's stool samples taken at different times for species-specific bacterial DNA fragments. They found that when he was most intoxicated, 18.8% of the bacteria in a sample were *K. pneumoniae*, a 900-fold increase over normal. When they put these bacteria in a medium of yeast and sugar, they could isolate strains of the bacterium that produced high, medium, or low levels of alcohol. That's equivalent to 15 shots of 40% [80-proof] whisky. The researchers next analysed faeces from 43 patients with NAFLD, 32 of whom had the severe form, and compared them with

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48 healthy people. The team found high levels of high-alcohol- (HiAlc) or medium-alcohol-producing *K. pneumoniae* strains in samples from 61% of the patients versus 6% of the controls. To probe further whether these gut microbes might explain the liver disease, the researchers fed mice HiAlc *K. pneumoniae*, alcohol, or a mixture of yeast and sugars as a control. By 4 weeks, mice given the bacteria or alcohol had evidence of liver damage, but the others did not. The researchers also put microbes from the original patient into mice raised germ free. Again, the animals suffered liver damage. "The studies are carefully done, and the results are quite convincing," says gastroenterologist Anna Mae Diehl, whose lab at Duke University in Durham, North Carolina, specializes in NAFLD. Viruses known as phages can kill specific bacteria. In HiAlc-infected mice pre-treated with the phages that target those bacteria, the rodents did not suffer any detectable liver abnormalities. "This raises the possibility that phage might be used to treat NASH," Haslam says. The medical literature offers no evidence that people with NAFLD feel drunk when they don't drink alcohol, and mice with HiAlc did not develop measurable blood alcohol levels. So, the researchers decided to also give those rodents high doses of glucose. Blood alcohol levels skyrocketed in the mice, which behaved as if they were inebriated. Giving glucose or fructose to the NAFLD patients similarly produced big jumps in blood alcohol levels that healthy controls didn't experience. This result suggests giving oral glucose coupled with a blood alcohol test could lead to a diagnostic for HiAlc *K. pneumoniae* and possibly even predict which NAFLD patients will progress to NASH. "That's very intriguing and exciting if confirmed in larger human trials," Haslam says. Yuan and colleagues report that the initial patient they studied recovered from his bacteria-driven autobrewery syndrome after he began to take antibiotics and changed his diet. His NASH has abated, too. Her team is now planning to study the gut microbes of a large group of people, including children, over time. "We want to investigate why some people have high-alcohol-producing strains of *K. pneumoniae* in their gut while others don't," she says. Diehl cautions that the new study speaks only to a subset of NAFLD patients. But she predicts "this work will attract a lot of attention."

Science, 19 September 2019

<http://sciencemag.org/>

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Can the world make the chemicals it needs without oil?

2019-10-03

Black, gooey, greasy oil is the starting material for more than just transportation fuel. It's also the source of dozens of petrochemicals that companies transform into versatile and valued materials for modern life: gleaming paints, tough and mouldable plastics, pesticides, and detergents. Industrial processes produce something like beauty out of the ooze. By breaking the hydrocarbons in oil and natural gas into simpler compounds and then assembling those building blocks, scientists long ago learned to construct molecules of exquisite complexity. Fossil fuels aren't just the feedstock for those reactions; they also provide the heat and pressure that drive them. As a result, industrial chemistry's use of petroleum accounts for 14% of all greenhouse gas emissions. Now, growing numbers of scientists and, more important, companies think the same final compounds could be made by harnessing renewable energy instead of digging up and rearranging hydrocarbons and spewing waste carbon dioxide (CO₂) into the air. First, renewable electricity would split abundant molecules such as CO₂, water, oxygen (O₂), and nitrogen into reactive fragments. Then, more renewable electricity would help stitch those chemical pieces together to create the products that modern society relies on and is unlikely to give up. "This is very much a topic at the forefront right now," says Daniel Kammen, a physicist at the University of California, Berkeley. Chemists in academia, at start-ups, and even at industrial giants are testing processes—even prototype plants—that use solar and wind energy, plus air and water, as feedstocks. "We're turning electrons into chemicals," says Nicholas Flanders, CEO of one contender, a start-up called Opus 12. The company, located in a low-slung office park in Berkeley, has designed a washing machine-size device that uses electricity to convert water and CO₂ from the air into fuels and other molecules, with no need for oil. At the other end of the commercial scale is Siemens, the manufacturing conglomerate based in Munich, Germany. That company is selling large-scale electrolyzers that use electricity to split water into O₂ and hydrogen (H₂), which can serve as a fuel or chemical feedstock. Even petroleum companies such as Shell and Chevron are looking for ways to turn renewable power into fuels. Changing the lifeblood of industrial chemistry from fossil fuels to renewable electricity "will not happen in 1 to 2 years," says Maximilian Fleischer, chief expert in energy technology at Siemens. Renewable energy is still too scarce and intermittent for now. However, he adds, "It's a general trend that is accepted by everybody" in the chemical industry.

Black, gooey, greasy oil is the starting material for more than just transportation fuel.

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A sharp rise in supplies of solar, wind, and other forms of renewable electricity lies behind the trend. In 2018, the world surpassed 1 terawatt (TW) of installed solar and wind capacity. The second TW is expected by mid-2023, at just half the cost of the first, and the pace is likely to accelerate. One recent analysis suggests lower prices for renewable generation could prompt the development of 30 to 70 TW of solar energy capacity alone by 2050, enough to cover a majority of global energy needs. "In the near future there will be a bunch of renewable electrons around," says Edward Sargent, a chemist at the University of Toronto in Canada. "And a lot of them are going to be cheap." According to the National Renewable Energy Laboratory, the cost of utility-scale solar power should drop by 50% by 2050 and the cost of wind power by 30%. That surge in renewables has already led to brief periods when electricity supplies exceed demand, such as midday in sunny Southern California. The result is dramatic price drops. At times, utilities even pay customers to take electricity so that excess supply doesn't melt transmission lines. "This gives us an opportunity to make something valuable with these electrons," Sargent says. One potential role for those electrons is to displace the fossil fuels that now provide the heat needed to drive industrial reactions. In the 24 May issue of *Science*, Sebastian Wismann and Ib Chorkendorff of the Technical University of Denmark in Kongens Lyngby and colleagues reported redesigning a conventional fossil fuel-powered reactor that makes H₂ from methane and steam to run on electricity. In their new reactor, electricity flowing through an iron alloy tube encounters resistance, pushing temperatures as high as 800°C. The heat causes methane and steam flowing through the tube to react, stripping H₂ from methane more efficiently than traditional methods and potentially offering both cost savings and reduced climate impact. But even if the heat comes from electricity, reactions such as those that generate fuel from methane still emit waste CO₂. Chemists want to go further, harnessing electrons not just as a source of heat, but as a direct input to the reactions. Industrial chemists already use electricity to smelt aluminium from bauxite ore and generate chlorine from salt—electron-adding reactions for which electrically driven chemistry is ideally suited. But as with H₂, most commodity chemicals are made from fossil fuels, transformed with heat and pressure generated by more fossil fuels. Giving up those fuels doesn't involve chemical magic. Key industrial chemicals such as carbon monoxide (CO) and ethylene can already be made by adding electrons to abundant starting materials such as CO₂ and water, if efficiency is no object. The trick is to do so economically. That process requires a cheap source of renewable electricity. But according to an analysis in the 26 April issue of *Science* led by Sargent

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and Thomas Jaramillo, a chemical engineer at Stanford University in Palo Alto, California, that's not the only prerequisite. Sargent, Jaramillo, and colleagues compared the costs of making a variety of simple industrial compounds with fossil fuels or renewable electricity. They found that electrosynthesis would be competitive for producing chemical staples such as CO, H₂, ethanol, and ethylene if electricity cost 4 cents per kilowatt hour (kWh) or less—and if the conversion of electrical energy to energy stored in chemical bonds was at least 60% efficient. If electricity's cost fell further, more compounds would be within reach. In a May 2018 analysis in *Joule*, Sargent and colleagues found that under stricter market assumptions, including an electricity price of 2 cents/kWh, synthesising formic acid, ethylene glycol, and propanol would all be feasible. "This gives us a clear set of targets," says chemist Phil De Luna, a Sargent collaborator at National Research Council Canada in Toronto. Sargent's papers are "right on the mark," says Harry Gray, a chemist at the California Institute of Technology (Caltech) in Pasadena, who has analysed what's needed to displace fossil fuels with electrosynthesis. Of making commodities by electrosynthesis, he says, "I think we'll be there within 10 years."

Kammen notes that several utility-scale solar and wind projects already meet one benchmark, delivering power at or below 4 cents/kWh, and the cost of renewables continues to decline. But reaching 60% conversion efficiency of electrical to chemical energy is a bigger challenge, and that's where researchers are focusing their efforts. The simplest processes, those that make H₂ and CO, are already reaching that second benchmark. According to Fleischer, commercial electrolyzers from Siemens and other companies already do better than 60% efficiency in splitting water to produce H₂. Siemens uses an established technology called proton-exchange membrane (PEM) electrolyzers, which apply a voltage between two electrodes, one on each side of a polymer membrane. The voltage splits water molecules at a catalyst-coated anode into O₂, hydrogen ions, and electrons. The membrane only allows hydrogen ions to pass to the other catalyst-coated electrode, the cathode, where they meet up with electrons to generate H₂ gas. The cost of the H₂ produced has fallen dramatically in recent years as the size of electrolyzers has increased to industrial scale. Still, Bill Tumas, an associate lab director at the National Renewable Energy Laboratory in Golden, Colorado, noted last month at a meeting of the American Chemical Society that the cost of the electrolyzers, as well as their component electrode materials and catalysts, needs to drop further to generate H₂ at a price competitive with massive thermal plants that break apart methane. Opus 12 and other companies also rely on PEM electrolyzers but add a supplementary catalyst to the

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cathode to split piped-in CO₂ into CO and O₂. The CO can be captured and sold for use in chemical manufacturing. Or it can be combined with hydrogen ions and electrons generated at the anode to construct a range of other building blocks for industrial chemistry, including gases such as ethylene—the raw material for certain plastics—and liquids such as ethanol and methanol. According to Etosha Cave, Opus 12's chief scientific officer, the company has already produced 16 commodity chemicals. And it is working to scale up its reactors over the next few years to process tons of CO₂ per day, most likely captured from flue gas from power plants and other industrial sources. The growing supply of renewable energy has some chemists thinking about ways to generate carbon-neutral fuels. Last month, in Dresden, Germany, a company called Sunfire completed a test run of a high-temperature electrolysis reactor, known as a solid-oxide fuel cell, that promises even higher efficiency than PEM electrolyzers. The reactor is at the heart of a four-stage test plant that generates fuel from water, CO₂, and electricity. The first stage of the boxcar-size plant separates CO₂ from air and then feeds the CO₂ to Sunfire's fuel cell. It works a bit differently from its PEM counterparts: It uses electricity to split both water and CO₂ at the cathode, generating a mix of CO, H₂, and negatively charged oxygen atoms, or oxide ions. Those ions travel through an oxygen-permeable solid membrane to the anode, where they give up electrons and combine to produce O₂. The mix of CO and H₂, known as synthesis gas, then moves to a third reactor, which assembles them into more complex hydrocarbons. At the fourth stage, those hydrocarbons are combined with more H₂ and refashioned into the mix of hydrocarbons in gasoline, diesel, and jet fuel. Because the plant works at high temperatures, the water- and CO₂-splitting reactions convert electrical energy to chemical bonds at nearly 80% efficiency, the company says.

Sunfire's test plant now makes about 10 litres of fuel per day. The company is already scaling up the technology and plans to open its first commercial plant, in Norway, next year. The setup will be part of a larger plant that will use 20 megawatts of hydropower to produce 8000 tons of transportation fuel per year, enough to supply 13,000 cars. Its method will avoid producing 28,600 tons of CO₂ annually from fossil fuels. Another advance could also boost efficiency: using industrial waste as the source of electrons needed to split off CO from CO₂. Oxygen's formation at the anode, producing electrons, is normally so sluggish that 90% of the overall process's electrical energy goes to this reaction. In the 22 April issue of *Nature Energy*, chemist Paul Kenis of the University of Illinois in Urbana and colleagues reported spiking the anode with glycerol—a clear, viscous liquid that's a by-product of biodiesel production—which gives

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up its electrons more readily. By doing so, the technique could reduce the energy requirement for splitting CO₂ by 53%. And as a bonus, when glycerol loses electrons, it produces a combination of formic acid and lactic acid, two common industrial compounds used as preservatives and in cleaning products and cosmetics. "You take a waste and turn it into something of value," Kenis says. Though simple industrial chemicals may be poised for greening, directly synthesising most complex hydrocarbons with electricity remains too inefficient and costly. Even making compounds with just two carbons, such as ethylene and ethanol, typically captures only about 35% of the input of electrical energy in the final compound. With three-carbon compounds and beyond, the efficiency can drop below 10%. The problems are twofold: First, every time new bonds are forged, some energy is lost. And generating more-complex hydrocarbons inevitably means making more side products. That outcome forces producers to separate their desired compound, at extra cost. But innovations are starting to help there, too, including better catalysts. In the 21 August online issue of *Joule*, for example, Sargent and his colleagues report creating a device that uses a membrane coated with a copper catalyst to convert CO₂ and steam to a mix of two-carbon compounds, including ethylene and ethanol, with 80% efficiency. They achieved that efficiency by pressing one electrode directly onto the membrane, thereby eliminating a fluid-filled gap that was sapping energy and was causing the device to break down quickly. One class of complex molecules that could prove easier to make with electricity is carbon nanotubes. Those long, hollow, straw-like molecules—prized for their strength and electronic capabilities—are commonly made through chemical vapor deposition: In a heated quartz tube, cobalt and iron catalysts strip away carbon atoms from pumped-in acetylene gas and add them to growing nanotubes that take seed on the metal particles. That process is energy intensive and expensive, typically costing about \$100,000 to produce 1 ton of nanotubes. But in 2015 in *Nano Letters*, Stuart Licht, a chemist at George Washington University in Washington, D.C., and colleagues reported an electrolysis approach calculated to cost one-100th as much. Licht's setup starts with molten lithium carbonate spiked with metal catalysts. An electric current, strips carbon atoms from the lithium carbonate and adds heat that sustains the reaction. The catalysts pick up the carbons and insert them into growing nanotubes. Bubbling CO₂ into the mix then regenerates the lithium carbonate. The process is 97.5% efficient. Because it uses waste CO₂, Licht notes it is carbon negative: Making each ton of carbon nanotubes uses 4 tons of CO₂. The nanotubes can then be mixed into cement to create a high-strength composite that sequesters the carbon, keeping it from oxidising and returning to the atmosphere.

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The tubes can also be mixed with metals such as aluminium, titanium, and stainless steel to strengthen them. C2CNT, a company Licht formed to commercialise the technology, is one of 10 finalists for the Carbon XPrize, which will award \$20 million for successful technologies for turning CO₂ into products.

How quickly the vast majority of chemical plants sprawling over the world's industrial zones will shift from fossil fuels to green power is a matter of debate. Nate Lewis, a chemical engineer at Caltech, says the transition will be slow. One major hurdle, he notes, is that renewables are intermittent, meaning chemical plants relying on them will be inefficient. Economists capture the idea with a measure called the capacity factor, a ratio of a plant's output over time compared with what's theoretically possible. Fossil fuel-powered chemical plants can run around the clock, although downtime for maintenance and for other issues typically reduces their capacity factor to about 60%. But the inputs to a plant powered by renewables themselves have low capacity factors: Wind and hydropower typically come in just under 50%, and solar drops to below 25% because of night-time and cloudy days. "Your full capacity is only being used for a few hours a day," says Harry Atwater, a chemist at Caltech and head of the Joint Centre for Artificial Photosynthesis, a solar fuel collaboration among Caltech, Lawrence Berkeley National Laboratory, and other institutions. The upshot, Lewis notes, is that any plant powered by renewables would take longer to make a profit, making investors reluctant to back such projects. Plants driven by renewables could stay online longer if they drew on multiple power sources or had a steadier power supply thanks to batteries or another form of energy storage, Kammen notes. But those solutions can add cost, Lewis says. "We're still a long way away" from generating most commodity chemicals profitably from renewables. Producing enough renewable electricity to remake the chemical industry is also a challenge. In an analysis in the 4 June issue of the Proceedings of the National Academy of Sciences, for example, researchers concluded that running the global chemical industry on renewables would require more than 18 petawatt hours of electricity, or 18,000 terawatt hours, every year. That's 55% of the total global electricity production expected from all sources in 2030. Perhaps the most likely outlook for industrial chemistry is a gradual greening. Until chemists can find catalysts able to make complex hydrocarbons with high efficiency, companies may use renewable electricity to produce simple molecules such as H₂ and CO and then fall back on fossil fuels to drive the reactions to stitch those together into more complex hydrocarbons. But as chemists develop new reactors and find ever-more-charmed combinations of catalysts—and as renewable

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energy continues to surge—the plants that churn out chemical staples will inevitably become more like the green variety, fully sustained by sun, air, and water.

Science, 19 September 2019

<http://sciencemag.org/>

Toxic skin-whitening creams should be ‘avoided at all costs,’ UK officials warn

2019-10-03

Skin-whitening creams can be as toxic as paint strippers and should be “avoided at all costs,” the UK’s Local Government Association has warned. The creams “act like paint stripper and increase the risk of cancer,” said the LGA, which represents regional councils in England and Wales. Many skin-whitening products are banned in the UK due to harmful ingredients -- but recent seizures of banned products indicate they are still being sold in a booming industry, the LGA said in its press release. Most of those products include the banned ingredient hydroquinone -- a bleaching agent which is “the biological equivalent of paint stripper,” said the LGA statement. It essentially removes the top layer of skin, increasing cancer risk and potentially causing liver and kidney damage. Mercury, another common banned ingredient, can cause reduced resistance to bacterial and fungal infections, liver damage, anxiety, depression or psychosis, according to the World Health Organization. “Skin creams containing banned ingredients are very dangerous and could seriously damage your health, scar you for life and even kill you, so they should be avoided at all costs,” said Blackpool Councillor Simon Blackburn in the press release. Skin-whitening creams with natural or non-harmful ingredients are legally allowed, but they are often expensive, driving up the demand for cheap and dangerous banned products, said the LGA. Company executives who are caught selling these banned products can be fined up to 20,000 pounds (about \$24,500) and jailed for up to a year. The illegal creams and products are often sold at local markets, said the LGA -- but they are on shelves at cosmetics stores as well. In May, hundreds of products containing hydroquinone were seized from stores in areas outside London. The owners of one store were fined 6,500 pounds (about \$8,000) and ordered to pay 8,010 (about \$9,800) to the local council. Last August, a shopkeeper in South London was sentenced to 20 months in prison after selling products with hydroquinone and mislabelling their cosmetics.

Skin-whitening creams can be as toxic as paint strippers and should be “avoided at all costs,” the UK’s Local Government Association has warned.

[Booming global industry](#)

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Globally, the demand for whiteners is climbing, projected to reach \$31.2 billion by 2024, especially in Asia, the Middle East and Africa, according to market intelligence firm Global Industry Analysts. The Asia-Pacific market is the most lucrative region, making up more than half of the global market -- an estimated \$7.5 billion out of \$13.3 billion -- in 2017, according to Future Market Insights. The products are particularly popular in places where beauty norms often favour lighter skin. Routine skin-whitener use ranges from 25% in Mali to 77% in Nigeria, and it's 40% in China, Malaysia, the Philippines and South Korea, according to the World Health Organisation. A 2017 study found that more than half of survey respondents in India had tried skin whiteners. But skin safety and health concerns aside, many critics say skin-whitening products are inherently problematic for furthering the racialized narrative of fair-skinned beauty. The issue also made headlines recently after two Japanese comedians reportedly joked that tennis star Naomi Osaka, who is of Haitian and Japanese descent, should bleach her skin. The comments sparked outrage on social media, and the two comedians issued apologies on the entertainment company's website. Osaka responded to the comments on Sunday on Twitter. "Too sunburned' lol that's wild. Little did they know, with Shiseido anessa perfect uv sunscreen I never get sunburned," she posted.

CNN, 30 September 2019

<http://www.cnn.com>

Stop using Internet Explorer immediately; also, why are you still using Internet Explorer?

2019-10-03

We shouldn't still be having this conversation, but here we are. Recently, Microsoft warned users of its once beloved Internet Explorer that a critical vulnerability in the browser allows malicious actors to hijack the computers of those running the outdated program. In other words, if you still use Internet Explorer, you should really stop. Like, right now. "The vulnerability could corrupt memory in such a way that an attacker could execute arbitrary code in the context of the current user," reads the warning in part. "If the current user is logged on with administrative user rights, an attacker who successfully exploited the vulnerability could take control of an affected system." Microsoft writes that, "yes," this vulnerability has been exploited. Now, notably, this is not the first time someone from Microsoft has urged users to ditch the discontinued browser. In February of this year, a security researcher with the company urged that people

We shouldn't still be having this conversation, but here we are.

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stop using IE as a default browser. Oh, and in April we learned that simply having Internet Explorer on your computer — not even using it — is a security risk. This latest addition to the “delete Internet Explorer now” chorus minces no words in warning any holdouts of the browser — stating that all a victim has to do is visit a specifically crafted website and it’s game over. “An attacker could then install programs; view, change, or delete data; or create new accounts with full user rights,” reads Monday’s advisory. Microsoft gives credit to Clément Lecigne of Google’s Threat Analysis Group for disclosing the vulnerability. Sure, there’s a wonky fix available, but you have to do it manually. So, go ahead and delete that relic from your forgotten past, and hop on the Firefox train.

Mashable, 25 September 2019

<https://mashable.com>

Climate change: Electrical industry’s ‘dirty secret’ boosts warming

2019-10-03

It’s the most powerful greenhouse gas known to humanity, and emissions have risen rapidly in recent years, the BBC has learned. Sulphur hexafluoride, or SF₆, is widely used in the electrical industry to prevent short circuits and accidents. But leaks of the little-known gas in the UK and the rest of the EU in 2017 were the equivalent of putting an extra 1.3 million cars on the road. Levels are rising as an unintended consequence of the green energy boom. Cheap and non-flammable, SF₆ is a colourless, odourless, synthetic gas. It makes a hugely effective insulating material for medium and high-voltage electrical installations. It is widely used across the industry, from large power stations to wind turbines to electrical sub-stations in towns and cities. It prevents electrical accidents and fires. However, the significant downside to using the gas is that it has the highest global warming potential of any known substance. It is 23,500 times more warming than carbon dioxide (CO₂). Just one kilogram of SF₆ warms the Earth to the same extent as 24 people flying London to New York return. It also persists in the atmosphere for a long time, warming the Earth for at least 1,000 years. So why are we using more of this powerful warming gas? The way we make electricity around the world is changing rapidly. Where once large coal-fired power stations brought energy to millions, the drive to combat climate change means they are now being replaced by mixed sources of power including wind, solar and gas. This has resulted in many more connections to the electricity grid, and a rise in the number of electrical switches and circuit breakers that are needed

The expansion of electrical grid connections has increased use of SF₆

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to prevent serious accidents. Collectively, these safety devices are called switchgear. The vast majority use SF6 gas to quench arcs and stop short circuits. "As renewable projects are getting bigger and bigger, we have had to use it within wind turbines specifically," said Costa Pirgousis, an engineer with Scottish Power Renewables on its new East Anglia wind farm, which doesn't use SF6 in turbines. "As we are putting in more and more turbines, we need more and more switchgear and, as a result, more SF6 is being introduced into big turbines off shore. "It's been proven for years and we know how it works, and as a result it is very reliable and very low maintenance for us offshore."

How do we know that SF6 is increasing?

Across the entire UK network of power lines and substations, there are around one million kilograms of SF6 installed. A study from the University of Cardiff found that across all transmission and distribution networks, the amount used was increasing by 30-40 tonnes per year. This rise was also reflected across Europe with total emissions from the 28 member states in 2017 equivalent to 6.73 million tonnes of CO2. That's the same as the emissions from 1.3 million extra cars on the road for a year. Researchers at the University of Bristol who monitor concentrations of warming gases in the atmosphere say they have seen significant rises in the last 20 years. "We make measurements of SF6 in the background atmosphere," said Dr Matt Rigby, reader in atmospheric chemistry at Bristol. "What we've seen is that the levels have increased substantially, and we've seen almost a doubling of the atmospheric concentration in the last two decades."

How does SF6 get into the atmosphere?

The most important means by which SF6 gets into the atmosphere is from leaks in the electricity industry.

Electrical switchgear the world over often uses SF6 to prevent fires

Electrical company Eaton, which manufactures switchgear without SF6, says its research indicates that for the full life-cycle of the product, leaks could be as high as 15% - much higher than many other estimates. Louis Shaffer, electrical business manager at Eaton, said: "The newer gear has very low leak rates but the key question is do you have newer gear? "We looked at all equipment and looked at the average of all those leak rates, and we didn't see people taking into account the filling of the gas. Plus, we looked at how you recycle it and return it and also included the catastrophic leaks."

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How damaging to the climate is this gas?

Concentrations in the atmosphere are very small right now, just a fraction of the amount of CO₂ in the air. However, the global installed base of SF₆ is expected to grow by 75% by 2030. Another concern is that SF₆ is a synthetic gas and isn't absorbed or destroyed naturally. It will all have to be replaced and destroyed to limit the impact on the climate. Developed countries are expected to report every year to the UN on how much SF₆ they use, but developing countries do not face any restrictions on use. Right now, scientists are detecting concentrations in the atmosphere that are 10 times the amount declared by countries in their reports. Scientists say this is not all coming from countries like India, China and South Korea. One study found that the methods used to calculate emissions in richer countries "severely under-reported" emissions over the past two decades.

Why hasn't this been banned?

SF₆ comes under a group of human-produced substances known as F-gases. The European Commission tried to prohibit a number of these environmentally harmful substances, including gases in refrigeration and air conditioning, back in 2014. But they faced strong opposition from industries across Europe. "In the end, the electrical industry lobby was too strong and we had to give in to them," said Dutch Green MEP Bas Eickhout, who was responsible for the attempt to regulate F-gases. "The electric sector was very strong in arguing that if you want an energy transition, and you have to shift more to electricity, you will need more electric devices. And then you also will need more SF₆." "They used the argument that otherwise the energy transition would be slowed down."

What do regulator and electrical companies say about the gas?

Everyone is trying to reduce their dependence on the gas, as it is universally recognised as harmful to the climate. In the UK, energy regulator Ofgem says it is working with utilities to try to limit leaks of the gas. "We are using a range of tools to make sure that companies limit their use of SF₆, a potent greenhouse gas, where this is in the interest of energy consumers," an Ofgem spokesperson told BBC News. "This includes funding innovation trials and rewarding companies to research and find alternatives, setting emissions targets, rewarding companies that beat those targets, and penalising those that miss them."

Are there alternatives - and are they very expensive?

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The question of alternatives to SF₆ has been contentious over recent years. For high-voltage applications, experts say there are very few solutions that have been rigorously tested. "There is no real alternative that is proven," said Prof Manu Haddad from the school of engineering at Cardiff University. "There are some that are being proposed now but to prove their operation over a long period of time is a risk that many companies don't want to take." However, for medium voltage operations there are several tried-and-tested materials. Some in the industry say that the conservative nature of the electrical industry is the key reason that few want to change to a less harmful alternative. "I will tell you, everyone in this industry knows you can do this; there is not a technical reason not to do it," said Louis Shaffer from Eaton. "It's not really economic; it's more a question that change takes effort and if you don't have to, you won't do it."

Some companies are feeling the winds of change

Sitting in the North Sea some 43km from the Suffolk coast, Scottish Power Renewables has installed one of world's biggest wind farms where the turbines will be free of SF₆ gas. East Anglia One will see 102 of these towering generators erected, with the capacity to produce up to 714MW (megawatts) of power by 2020, enough to supply half a million homes. Previously, an installation like this would have used switchgear supplied with SF₆, to prevent the electrical accidents that can lead to fires. Each turbine would normally have contained around 5kg of SF₆, which, if it leaked into the atmosphere, would add the equivalent of around 117 tonnes of carbon dioxide. This is roughly the same as the annual emissions from 25 cars. "In this case we are using a combination of clean air and vacuum technology within the turbine. It allows us to still have a very efficient, reliable, high-voltage network but to also be environmentally friendly," said Costa Pirgousis from Scottish Power Renewables. "Once there are viable alternatives on the market, there is no reason not to use them. In this case, we've got a viable alternative and that's why we are using it." But even for companies that are trying to limit the use of SF₆, there are still limitations. At the heart of East Anglia One sits a giant offshore substation to which all 102 turbines will connect. It still uses significant quantities of the highly warming gas.

What happens next?

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The EU will review the use of SF₆ next year and will examine whether alternatives are available. However, even the most optimistic experts don't think that any ban is likely to be put in place before 2025.

BBC News, 13 September 2019

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

Students exposed to pollution before exams get worse grades according to new study

2019-10-03

Students exposed to high levels air pollution before taking exams get worse grades according to recent studies. Two separate studies looked at school kids taking their exams and cross-referenced it with studies of pollution levels in study halls by experts at London School of Economics. The experts found air quality has as big an impact on results as class size and that high levels of pollutants can lower exam scores by more than three percent. The researchers studied 2,400 students taking more than 10,000 exam papers. Dirtier air, or areas with high concentrations of a substance known as PM₁₀, caused performance to drop by around two percent. The World Health Organisation (WHO) has set advisable limits on matter such as PM₁₀. The WHO limit for PM₁₀ is 50 micrograms per cubic metre, and the study revealed that some exam halls had pollution levels as high as 75 micrograms. This was found to be potent enough to reduce a student's score by 3.4 percent. Another study which took place in Israel looked at around 400,000 exams taken by teenagers there. It revealed that high levels of PM_{2.5}, which is like a finer form of pollution compared with PM₁₀, was linked to poor results. Sefi Roth, of the London School of Economics had a hand in both studies and told The Times that students should consider their exposure to pollution on the day of an exam. "They can limit their outdoor activity on polluted days or take less polluted routes when they go to school," said Roth. A link between pollution and cognitive performance "would imply that a narrow focus on traditional health outcomes, such as hospitalisation and increased mortality, may understate the true cost of pollution as mental acuity is essential to worker productivity in many professions," he added.

Irish Post, 30 September 2019

<https://www.irishpost.com>

Students exposed to high levels air pollution before taking exams get worse grades according to recent studies.

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Zantac Pulled From Shelves by Walgreens, Rite Aid and CVS Over Carcinogen Fears

2019-10-03

The pharmacy chains Walgreens, Rite Aid and CVS have moved to stop selling the heartburn medicine Zantac and its generic versions after the Food and Drug Administration warned this month that it had detected low levels of a cancer-causing chemical in samples of the drug. A Walgreens spokesman said in a statement on Monday that the company had pulled the drug from its shelves "while the FDA continues its review of the products." A Rite Aid spokesman said the company was "in the process of removing Zantac and generic versions sold under the Rite Aid name from its shelves." Walgreens and CVS, which announced its move on Saturday, both noted that the drug, which is known as ranitidine, has not been recalled. The companies said customers who had bought the products could return them for a refund. The FDA has said it is investigating the source of the contamination as well as the risk to patients, recommending that they talk to their doctors and that those who take over-the-counter versions consider switching to a different medication. Zantac, the brand-name version of the drug, is sold by Sanofi, but generic versions are widely sold. This month, the drug maker Novartis said that its generic-drug division, Sandoz, had stopped distributing a prescription form of ranitidine worldwide while it investigates the FDA's findings. GlaxoSmithKline has also stopped shipping its generic version of the drug, as well as Dr. Reddy's Laboratories, a major generic manufacturer. The companies, including Sanofi, have stopped short of recalling their products in the United States. In a statement on Monday, Sanofi said that the levels of the contaminant that the F.D.A. had found in "preliminary tests barely exceed amounts found in common foods." The company added: "We are working closely with the FDA and are conducting our own robust investigations to ensure we continue to meet the highest quality safety and quality standards." Last week, Apotex, which makes store-branded versions of Zantac for Walgreens, Walmart and Rite-Aid, recalled its ranitidine products. The European Medicines Agency is also reviewing the drug. Canada has ordered a halt to all distribution of ranitidine while it investigates. In its warning on 13 September, the FDA said that it had found low levels of a cancer-causing contaminant, a type of nitrosamine called nitrosodimethylamine, or NDMA, in the heartburn medications. Nitrosamines can cause tumours in the liver and other organs in lab animals, and they are believed to be carcinogenic in humans. NDMA can form during manufacturing if the chemical reactions used to make the drug are not carefully controlled, the FDA has said. Ranitidine is a

The United States Food and Drug Administration has said it is investigating the source of contamination in Zantac and its generic versions.

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histamine blocker that works to lower the acid created in the stomach, according to the F.D.A. The medication is sometimes prescribed to prevent ulcers of the stomach and intestines as well as gastroesophageal reflux disease, the agency says. CVS said it would continue to sell other histamine blockers, including Pepcid, Tagamet and the generic equivalents famotidine and cimetidine.

New York Times, 30 September 2019

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

These tea bags release billions of plastic particles into your brew, study shows

2019-10-03

A couple of years ago, Nathalie Tufenkji stopped by a Montreal cafe on her way to work and ordered a cup of tea. She sat down with her mug, enjoying its warmth, before she noticed something strange: Her tea bag appeared to be made of plastic. "I thought, 'That's not a very good idea, putting plastic into boiling water,'" she told The Washington Post. Tufenkji was worried that the plastic bags could leach particles into the beverage that she and her fellow customers were consuming, and as a professor of chemical engineering at McGill University, she was well positioned to investigate. She dispatched her student Laura Hernandez to purchase tea bags from stores in the area and bring them back to the lab. It turns out Tufenkji's hunch was right. The bags were releasing plastic particles into the brewed tea. Billions and billions of them. Hernandez, Tufenkji and their fellow researchers at McGill University tested four kinds of plastic tea bags in boiling water, and found that a single bag would release more than 11 billion microplastic and 3 billion nanoplastic particles. You would not be able to see the contamination with your own eyes; the researchers had to use an electron microscope. But it's there. Their findings were published in the American Chemical Society journal *Environmental Science & Technology* this month. The four brands of tea they tested came from regular grocery stores in Montreal. After emptying and cleaning the tea bags of any trace of tea leaves, they submerged them in water heated to 203 degrees Fahrenheit, and then they left the bags to steep for five minutes. The researchers then examined the water for leftover particles, placing drops on a slide and examining them under an electron microscope. There, they could see particles of varying sizes, some a little larger, some frighteningly small. Further testing of additional samples revealed their structures and confirmed that the material was made of the same plastic materials as PET, a kind of polyester, and nylon. It was clear,

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Tufenkji said, that the plastic was coming from the tea bags themselves, not the tea. Though Tufenkji declined to name the brands they used for fear of singling out one company over others, she said that some frequent tea drinkers could be repeatedly dosing themselves with billions of particles of plastic as they drank the beverage day after day. Some of the particles, she noted, would be small enough to potentially infiltrate human cells. Some manufacturers sell tea in plastic bags rather than loose or in paper bags, even as the public becomes increasingly aware of how plastic is clogging our bodies of water, as well as our bodies. While the health implications of consuming plastic are unknown, people around the world are inadvertently eating quite a lot of it. Earlier this year, a report by the World Wide Fund for Nature estimated that on average, a person might ingest 5 grams of plastic a week, the equivalent size of a credit card. Researchers at the University of Newcastle in Australia compiled dozens of studies on the presence of plastic in water, as well as in food such as shellfish and even beer. Studies are underway to establish how plastic consumption can affect human health, according to WWF's study. While the McGill study did not explore the human health effects of consuming this plastic, when some of the particles were given to water fleas, they began acting erratically and developed some deformities, Tufenkji said. "We just wanted to make the public aware of this," she said. "We want consumers to know that this is made of plastic so they can have the choice about whether this is really what they want to purchase."

Washington Post, 28 September 2019

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

Screen time: How smartphones really affect our bodies and brains

2019-10-03

You'll get square eyes!" my mother used to say as I sat for hour after hour glued to the TV. I ignored her, of course. It was just something parents said. Fast-forward a few decades and now I'm the parent. My 5-year-old lives in a world where screens aren't fixed pieces of furniture, but lie around on the kitchen table, on the sofa, by the bed, constantly accessible. You can't even avoid them by going outside. "Screens are not only in our pockets, they're on billboards, buses and bins," says Tim Smith, a psychologist at Birkbeck, University of London. The concerns have multiplied with the screens. In the past decade, we have heard that they will rewire our brains, strip us of cognitive abilities and damage our mental health. Many of us feel more distracted by them, feeling grumpier, guiltier and more tired as

If you believe the headlines, screens are supposed to warp our skeletons, damage our mental health and alienate us from our families. But the evidence paints a more nuanced picture

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a result. The list of ills makes square eyes sound benign. So, should we take these concerns more seriously? Given the amount of time so many of us spend with our lit-up devices, it is an important question. The trouble is, many of the most emphatic answers are the least reliable. Smartphones and tablets are not only TVs, they are chat rooms, shopfronts, banks and photo albums. We use them to work and play, to record physical activity and monitor sleep. We can look up peer-reviewed papers or scroll through anti-vaxxing forums, crucial distinctions that disappear when we use the umbrella term "screen time". As the fears grow and the debate becomes ever more heated, it's time to separate the proven health advice from the hyperbole.

Are screens bad for our bodies?

Smartphone pinky, tech neck, bone spurs at the back of our skulls: the ailments we are meant to have inflicted on ourselves through excessive phone use all sound terrifying. Hence the headlines. In truth, there is no good evidence that such alarming conditions are caused by our tech habit. Any harm is likely to be far less spectacular. The World Health Organization, for example, recommends limiting screen time as a way of tackling obesity, voicing no health concerns related to screens in particular. What about the effect of staring at small, bright screens on our eyesight? In the past few years, more children in the UK have been prescribed glasses, says Max Davie at the Royal College of Paediatrics and Child Health in London. This has led some to claim that phones and tablets are to blame. But Davie thinks the increase in prescriptions has more to do with aggressive management of existing conditions. "At the moment, we don't have sufficient evidence for a causal link," he says. One thing that does appear to be taking a hit is sleep. Studies have shown that people who are given a book to read in bed find it harder to go to sleep if they read it on a screen rather than on paper. This is probably because of the blue light that most screens emit, which throws off our circadian rhythm and tricks us into thinking it is daytime. Of course, most of us who look at our phones last thing at night aren't reading a book. Much sleep disruption is related to mental stimulation: waiting for the next notification, say, or scrolling through endless news feeds. Insufficient or disrupted sleep has been linked to increased risk for all manner of health problems, including depression and other mental health concerns. "If there are any recommendations to be adopted, not using screens in the hour before bed seems to be the one with the greatest support," says Smith.

Are screens messing with my head?

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From video games to gambling, the apps and websites we can access on our phones have sparked widespread concern. Big tech companies are also adept at tapping into our need for social validation, hooking us on likes, retweets and follower counts. In testimony to a US Senate hearing in June, Tristan Harris, a former Google designer and co-founder of the Centre for Humane Technology, argued that the internet has created a culture of mass narcissism. This has led many to worry about the emotional stresses of a hypersocial world on adolescents. A quick online search brings up dozens of papers linking screen use or social media with detrimental effects on mental health, including depression, anorexia and suicide. Some figures suggest girls are more affected. "After two decades in decline, the mental health [problems] of 10 to 14-year-old girls have shot up 170 per cent in the last eight years," Harris said in his testimony. Such sound bites are alarming. They are also widely believed, thanks to popular books like *iGen* by Jean Twenge, a psychologist at San Diego State University, which claims that digital technology has wrecked a generation. The trouble is that the underlying data can be used to tell different stories, says Amy Orben at the University of Oxford, who studies the impact of digital technology – and social media in particular – on mental health. Ultimately, social media is just one of many different things that might affect someone's well-being. Without controlled studies, it is difficult to draw meaningful conclusions. When Orben started looking into screen use a few years ago, she wanted to explore some of the more extreme claims researchers were making. For example, Twenge has linked social media use with teenage depression and suicide. Orben was curious to look at the evidence herself. She found it didn't stack up. First, she spotted shortcomings in several large studies from 2017 that claimed to reveal correlations between the use of devices with screens and depressive symptoms in users. "I found that changing how the data was analysed would give me very different results," says Orben. To put her and her colleagues' results in perspective, they compared the effect of device use to other things in an adolescent's life. For instance, they looked at the effect of wearing glasses and found that this was correlated more negatively with well-being than screen use. They also looked at how often adolescents ate potatoes. "Potatoes are in a similar ballpark to screens," says Orben. That doesn't mean they should be banned from schools. Twenge stands by her findings, pointing in turn to what she considers flaws in Orben's statistical methods. For Davie and others, however, the effect of screen time and social media use on mental health remains speculative. "We cannot regard social media overall as good or bad," says Davie. He believes Orben has done fantastic work in myth-busting, but warns against making blanket statements about individuals. He says he

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would never tell bereaved parents that an Instagram post about self-harm played no part in the death of their child, for example. "We don't know that in individual cases social media is not responsible," he says.

Am I addicted to my phone?

Unless you are using it for purposes, we already know are addictive, such as accessing gambling websites, the answer is probably not. Yet reaching for my phone has become an annoying tic and a phantom buzz in my pocket can make me pull out my phone and check for messages that aren't there. Whenever there is a lull in my concentration – in the middle of writing this sentence, for example – my thoughts return to my phone. What's going on? In front of the US Senate, Harris painted a damning picture of the methods that tech companies like Facebook and Twitter use to command our attention in what he described as a "race to the bottom of your brainstem". He called out design tricks like pulling down on the screen to refresh it, which shares characteristics with the mechanism of slot machines. "It has the same kind of addictive qualities that keep people in Las Vegas hooked," he said. We are also in thrall to the recommendation algorithms that know what we want better than we do. More than 70 per cent of viewing time on YouTube consists of people watching videos suggested by the platform rather than sought out deliberately. "You sit down to watch one video and wake up 2 hours later and say 'Oh my god, what just happened?'" said Harris. "The answer is that you had a supercomputer pointed at your brain." All this means we are often sucked into our phones, thoughts elsewhere, even when we have more immediate things to focus on – such as crossing a road. The risks have led authorities in a handful of towns, including Augsburg in Germany, to install traffic lights on the ground in the hope that distracted pedestrians won't step in front of a bus. Although the increased risk of distraction is very real, talk of addiction may be too simplistic. "I think we need to be very careful about the use of the word 'addiction,'" says Davie. "Addiction has a specific meaning of compulsive use, requiring increasing doses and a damaging effect on your life. But there are a lot of people who spend 8 hours a day playing games and that's just how they like to spend their time. It's OK as long as it's not interfering with the rest of your life." You aren't addicted, but you may have a terrible habit.

How much screen time should kids have?

This is where I struggle most. Not only do I get distracted by my phone when I should be paying attention to my daughter – "Dad. Dad. Dad!" – but I use screens to distract her all the time. When I need to cook, when I

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need to make a work call, when I'm feeling tired, I just stick her in front of a screen. Is this a problem? It all depends who you ask and how old your child is. There are no guidelines for teenagers, for example, and even the advice for younger children is far from clear. The American Academy of Paediatrics (AAP) discourages parents from allowing children under 2 to have any interaction with screens and recommends no more than an hour a day for 2 to 5-year-olds. The World Health Organization says that children under 3 should have no screen time and those aged 3 to 4 should be limited to an hour a day, but its focus once more is on curbing childhood obesity. The UK government largely follows the AAP's guidelines. But the Royal College of Paediatrics and Child Health has opted not to recommend time limits at all. "There's general confusion," says Smith. He thinks the college's approach is the most logical. It bases its position on a regular review of research and has concluded that there isn't enough evidence of positive or negative effects for any guidelines to be issued. "That's a very honest way of creating evidence-based policy," says Smith. The college's view is that advice is only as good as it is effective. "People's support for an outright ban on screen time for children under 2 lasts until they spend a day where there are children of different ages in the same room," says Davie. "Then they quickly realise it's unworkable." He thinks guidelines that are hard to comply with fail to help families establish good habits and are ignored. "When it comes to negative impact, potatoes are in a similar ballpark to screens". It isn't all negative. In 2016, Smith and his colleagues found no evidence that spending time interacting with a screen – rather than moving around or interacting with other humans – delayed certain developmental milestones, such as learning to walk and talk. On the contrary, they found a correlation between screen use and earlier development of fine motor skills, such as the ability to pick up blocks and stack them in a tower. Once again, there is no causal link. It could be that those infants who happen to develop fine motor skills early are simply more likely to pick up and play with a screen. It is possible, though, that the prodding and swiping needed to work a screen trains these skills. We shouldn't underestimate the value of screen use for older children too. Not only do they provide unprecedented access to many forms of valuable information and entertainment, but educating children about the dangers they will find online requires them to have some familiarity with it. "In order to think critically, kids need to engage," says Smith.

How can I learn to stop worrying and love my screens?

The explosion of mobile phone use has revolutionised our lives. I can download movies and podcasts, write articles, communicate with my

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family and broadcast to the world all at the push of a button. This is unprecedented power, but there are still many important questions about these maddening, valuable devices that we have been unable to answer. What is clear, however, is that many initial reactions have been more knee-jerk than evidence-based. Rather than impose arbitrary constraints, we should take a look at our use of screens and ask how they fit with the activities and lifestyles we want as individuals and families. Orben, who is 24, has grown up with social media. For her and her peers, managing how they spend time with their screens was part of growing up. "Like any social media user, there are times when I feel I should use it less, that I need to feel in control," she says. "We all have ways in which we try to self-regulate." Maybe you tweak your phone's settings to reduce the number of alerts you get, or uninstall certain apps so they aren't readily available. Some have suggested introducing "mental speed bumps" that interrupt the habit of checking a phone too often, such as writing a note to yourself on your lock screen or simply wrapping a rubber band around the device as a reminder. Apple and Android phones and tablets now come with widgets that let you monitor and manage screen use. You can set time limits, turn off notifications and track what you have been doing on the device. There are also "night-time" settings that cut the blue light emitted by the screen and a "wind-down" mode designed to make the screen less enticing by turning it black and white. These all help us become more conscious of our usage. But Apple and Google could do more, says Smith. "It's a little bit of a misdirection," he says. For one thing, these widgets don't allow you to explore your screen use for periods of more than a week, which you might want to do to see if any lifestyle changes are making a difference. Every new technology with widespread impact has given rise to new fears. Orben recalls an article from 1941 that lamented how adolescents in the US were addicted to radio programmes. "In a lot of parenting magazines from that time, you could just replace the word 'radio' with 'social media' and you could probably publish that today," she says. So, the best bet may simply be to ask yourself what level of screen use makes you and those around you happy and try to stick to it. If you find yourself overindulging, don't panic – and certainly don't feel guilty. Nobody knows anything worth getting scared about.

New Scientist, 25 September 2019

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

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

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Characteristics of PM2.5 and Black Carbon Exposure Among Subway Workers

PUBLIC HEALTH RESEARCH

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Update of the DevTox data database for harmonized risk assessment and alternative methodologies in developmental toxicology: Report of the 9th Berlin Workshop on Developmental Toxicity

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Health Needs Assessment of Five Pennsylvania Plain Populations

Prenatal and childhood exposure to chlordecone and sex-typed toy preference of 7-year-old Guadeloupean children