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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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New guide for working with silica and silica containing products now available

2019-09-20

On 17 September 2019, Safe Work Australia released a new guide for working with silica and silica containing products. The new guide will help persons conducting a business or undertaking to understand and make decisions about protecting their workers from exposure to silica dust. The national guide for Working with silica and silica containing products provides information about controlling the risks of exposure to silica dust when working with silica and products containing silica, like composite stone products. To learn more about silica, [visit our crystalline silica and silicosis web page](#)

Safe Work Australia, 17 September 2019

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

Seeking stakeholder input into the management of the APVMA GMP Code

2019-09-20

Submissions are invited from those interested in the revision and management of the Australian Code of Good Manufacturing Practice for Veterinary Chemical Products (the GMP Code), under the *Agricultural and Veterinary Chemicals Code (Manufacturing Principles) Determination 2014*. This includes the governance of the GMP Code, comments on the risk-based scheduling and management of GMP audits, and suggestions for proposed revisions to the GMP Code. The role of the regulator in the auditing of APVMA-licensed manufacturing facilities is to periodically assess whether the manufacturer's quality assurance system is operating effectively and provide the manufacturer with a compliance report to strengthen areas of weakness. The legislation outlines the license conditions for manufacturers of veterinary products (*Agricultural and Veterinary Chemicals Code Regulations 1995, r61*). The APVMA is seeking feedback in relation to the GMP Code to ensure the guidance provides clear information to assist manufacturers and auditors in their adherence to the Code, and the identification and resolution of non-compliance. A number of broad areas to inform discussion about the GMP Code are below, however, submissions may canvas other issues of importance to stakeholders. The consultation considers:

On 17 September 2019, Safe Work Australia released a new guide for working with silica and silica containing products.

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- the governance of the GMP Code (eg, the role and composition of the Manufacturing Licensing Scheme-Industry Liaison Committee (MLS-ILC))
- comments on the current auditor management process, where manufacturers directly contract external, APVMA-approved auditors
- comments from manufacturers on the impact of the risk-based audit interval determination to decrease non-compliance, and to reduce the regulatory burden on compliant sites
- the core elements of GMP, outlined in the GMP Code and Annexes
- the scope of the GMP Code in the context of international schemes to support the export of products manufactured in Australia. This may include reference to other international schemes, like the Pharmaceutical Inspection Co-operation Scheme (PICS) or FAMI-QS
- recommendations so we can ensure adequate consultation on any proposed changes to the GMP Code
- the type and frequency of further support, if any, that should be provided to manufacturers or auditors to ensure compliance with the GMP Code.

Making a submission

The consultation period is open until close of business on 29 November 2019. Note that all submissions received are subject to legislation, including the *Freedom of Information Act 1982*, the *Privacy Act 1988* and the *Agvet Codes*. In providing your submission to the APVMA, you agree to the APVMA publicly disclosing your submission in whole or summary form. Following consideration of comments received from this consultation, a discussion paper outlining proposed changes to the governance and management of the GMP Code will be published for a subsequent consultation.

APVMA, 9 September 2019

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

Tabling of Report on the Review into the 2016 Medicinal Cannabis amendments to the Narcotic Drugs Act 1967

2019-09-20

Late last year, Minister Greg Hunt appointed Professor John McMillan AO to conduct a Review and Report on the operation of the *Narcotic Drugs Act 1967* (the Act) in accordance with section 26A of the Act. Professor McMillan's Final Report on the Review of the Act was tabled in Parliament

The Final Report contains 26 recommendations to improve the regulatory framework for the cultivation, production and manufacture of medicinal cannabis in Australia.

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on 5 September 2019. The Final Report contains 26 recommendations to improve the regulatory framework for the cultivation, production and manufacture of medicinal cannabis in Australia. Minister Hunt has accepted all 26 recommendations put forward by Professor McMillan, which broadly aim to reduce the regulatory burden on industry, promote and allow greater flexibility in the administration of the legislation to support industry innovation and development. A two-stage reform process is proposed to be undertaken to ensure that the recommendations are appropriately implemented with some reforms being implemented as early as later this year. Further details on the implementation of these reforms will be published in due course. Further details on the Review process are available: [Review of the Narcotic Drugs Act 1967](#).

TGA, 5 September 2019

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

Consultation to improve hazardous substance decision-making

2019-09-20

New Zealand's Government is proposing to strengthen the assessment process for hazardous substances. This will mean that the potential risks to people and the environment are better managed. The Environment Protection Authority approve and set controls on hazardous substances to manage these risks. EPA have been working closely with the Ministry for the Environment (MfE) on the proposals, which will also provide the agency with more flexibility and discretion when making decisions, and improve efficiency. The new proposals include the ability to better use international information about substances from certain trusted international regulators, and improve the quality of information received from applicants. MfE are seeking your views on the proposals, which can be found on their website:

[Hazardous substances assessments: Improving decision-making - Ministry for the Environment website](#)

NZ EPA, 10 September 2019

<http://www.epa.gov>

New Zealand's Government is proposing to strengthen the assessment process for hazardous substances.

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China Issues Guideline for Environmental Risk Assessment of Chemical Substances

2019-09-20

On 3 September 2019, the Chinese Ministry of Ecology and Environment (MEE) and National Health Commission (NHC) jointly issued a final Technical Framework Guideline for Environmental Risk Assessment of Chemical Substances (Trial). This Trial Guideline provides a basic framework, including evaluation steps, technical requirements, and report preparation, for the environmental risk assessment of a single chemical substance under standard production and uses. The Trial Guideline does not apply to mixtures or exposures due to accidents or leakages. The “four-step” evaluation includes hazard identification, dose-response assessment, exposure assessment, and risk characterisation. It also outlines uncertainty analysis, data quality assessment, spatial scale of exposure assessment, risk assessment of persistent, bioaccumulative, and toxic (PBT) and very persistent and very bioaccumulative (vPvB) chemical substances, and consideration for risk assessment of metals and their compounds. This Trial Guideline outlines the process to conduct risk assessments of chemicals under standard production and uses and will be part of implementation guidance documents to the Environmental Risk Assessment and Control Regulation for Chemical Substances (Notification Draft) and the Measures on the Environmental Management of New Chemical Substances (Notification Draft) that were notified to the World Trade Organization (WTO) last week. The Trial Guideline intends to strengthen the environmental management of chemicals to establish a sound technical method system and to standardise the environmental risk assessment of chemicals in China.

National Law Review, 13 September 2019

<http://www.natlawreview.com>

Taiwan Promulgates Revised Chemical Control Act Enforcement Rules

2019-09-20

On 3 September 2019, the revision to Taiwan's *Toxic Chemical Substances Control Act Enforcement Rules* was approved with the changes scheduled to take effect on 16 January 2020. Taiwan EPA aligned the enforcement rules with the new *Toxic and Concerned Chemical Substances Control Act* (TCCSCA, previously known as Taiwan TCSCA), and renamed it as the *Toxic and Concerned Chemical Substances Control Act Enforcement Rules*. The

On 3 September 2019, the Chinese Ministry of Ecology and Environment (MEE) and National Health Commission (NHC) jointly issued a final Technical Framework Guideline for Environmental Risk Assessment of Chemical Substances (Trial).

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TCCSCA Enforcement Rules were drafted in April. Most of the proposed changes have been adopted in the final version. Major changes include:

- Update the definition of the “suspension of handling” as “the interruption in manufacture, import, sale, use, or storage” and delete the time period of “for at least two years” (Article 7)
- Add a provision defining “mail orders, online shopping” as “transactions made via radios, television broadcasts, telephones, facsimiles, catalogues, newspapers, magazines, the Internet, flyers, or any other similar channels” (Article 8)
- Add a provision that the EPA will entrust on-site verification tasks to relevant institutes or groups (Article 12)
- Add a provision that firefighting units shall be notified of the diagrams of the entire handling site and the interior layout of the site in written and electronic format (Article 18)

As planned, more than 30 subordinate regulations will be revised or fleshed out in line with the TCCSCA. Further information is available at:

- [Taiwan Introduces Toxic and Chemical Substances of Concern Control Act](#)
- [Toxic and Chemical Substances of Concern Control Act Enforcement Rules](#)(TCCSCA Enforcement Rules)
- [Taiwan Expects More Supporting Regulations for Toxic and Concerned Chemicals](#)

Chemlinked, 12 September 2019

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

China Issues Guidance Framework for Environmental Risk Assessment of Chemicals

2019-09-20

On 3 September 2019, China Ministry of Ecology and Environment (MEE) issued a [notice](#) to publish *the Framework Guide to the Technology Methods of Environmental Risk Assessment for Chemical Substances (Trial)*, which is an important supporting document for *Environmental Risk Assessment and Control Regulation for Chemical Substances*. This Guide specifies the basic framework for risk assessment, and clarifies the basic points, technical requirements, and report preparation as well. It is worthy noticing that the Guide applies to environmental risk assessments of different exposure pathways for the normal production and use of a single chemical substance, and does not apply to risk assessment under accidental

On 3 September 2019, China Ministry of Ecology and Environment (MEE) issued a notice to publish the Framework Guide to the Technology Methods of Environmental Risk Assessment for Chemical Substances (Trial), which is an important supporting document for Environmental Risk Assessment and Control Regulation for Chemical Substances.

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exposure conditions. Four basic assessment steps are specified at first in the basic points, they are Hazard Assessment, Dose (or Concentration) - Response (or Effect) Characterisation, Exposure Assessment and Risk Characterization. The guide specially introduces several situations to explain that risk assessment does not always need to go through the full four steps above. For example, if the conclusions of the first and second steps indicate that the chemical is at a very low risk to ecosystem and human health, no follow-up risk assessment is required. The third part of the Guide: Technical Requirements are also carried out around these four steps, and each of them is described from two aspects: ecosystem impact and impact on human health. Three possible assessment conclusions and corresponding further-step measures are specified in the Guide:

- If no unreasonable risks are found, risk prevention or control measures will not be required.
- If unreasonable risk exists, further risk prevention and control measures are needed to reduce the risk.
- If the risks are not certain, assessment will be conducted again after information of the substance is supplemented.

At the same time, the Guide also regulated other important risk assessment items, such as uncertainty assessment, data quality assessment, spatial scale of exposure assessment and so on. The assessment methods for PBT substances, vP/vB substances and metals and their compounds are also described in the Guide, too. According to the Guide, the risk assessment report is supposed to contain Assessment Purpose, the Scope of Assessment, Data Collection and Data Assessment, Hazard Assessment, Dose (or Concentration) - Response (or Effect) Characterization, Exposure Assessment, Risk Characterization, Uncertainty Assessment and Assessment Conclusion, etc. Scientific and reasonable risk assessment for chemical substances is the basic requirement for the safe use of the substances, and the core content of the risk control of chemical substances. It is predictable that China will release a series of related documents on the risk assessment for chemical substances. Further information is available at: [MEE Notice](#)

Chemlinked, 12 September 2019

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

AMERICA

U.S. EPA to eliminate all mammal testing by 2035

2019-09-20

The United States Environmental Protection Agency (EPA) in Washington, D.C., announced recently that it will stop conducting or funding studies on mammals by 2035. The move, which is already eliciting strong reactions from groups supporting or opposing experiments on animals, makes EPA the first federal agency to put a hard deadline on phasing out animal research. EPA's decision "is a decisive win for taxpayers, animals, and the environment," says Justin Goodman, vice president of advocacy and public policy at the White Coat Waste Project, a Washington, D.C.-based animal activist group that has slammed such research as a waste of taxpayer money. "Animal tests are unreliable and misleading," he asserts. But Jennifer Sass, a senior scientist at the Natural Resources Defence Council, a Washington, D.C.-based environmental group, blasts EPA's decision. "It's very disappointing and very frustrating," Sass says. Ending animal testing, she argues, "is going to allow potentially dangerous chemicals to get out there into the environment and into consumer products." EPA relies on animal testing to gauge the safety of chemicals, whether it be a new pesticide or a potential pollutant in the environment. But chemical companies have long complained that the tests—many of which they pay for—are expensive and time-consuming. And animal advocacy organizations have urged the agency to move toward nonanimal models, such as computer programs and "organ-on-a chip" technology, a collection of cells designed to mimic entire organs. Legislation, including a 2016 amendment to the Toxic Substances Control Act, has required EPA to move away from animal experiments. In June, EPA Administrator Andrew Wheeler sent an internal memo outlining a plan to eventually phase out the agency's animal testing, first reported by *The Intercept*. In the memo, which became official today, Wheeler writes that "animal testing is expensive and time-consuming," and that scientific advances that don't involve animals are allowing researchers to evaluate chemicals faster, more accurately, and at lower cost. The agency, he writes, will redirect its resources toward these "New Approach Methods" and away from animal testing. "The EPA will reduce its requests for, and our funding of, mammal studies by 30 percent by 2025 and eliminate all mammal study requests and funding by 2035." After that date, any studies will require administrator approval. At a news conference in Washington, D.C., this morning, Wheeler also announced \$4.25 million in funding to five institutions to develop nonanimal alternatives to current tests: Johns Hopkins University in

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Baltimore, Maryland; Vanderbilt University and Vanderbilt University Medical Centre, both in Nashville; Oregon State University in Corvallis; and the University of California, Riverside. It's not clear how many animals or research projects will be affected by the changes. EPA says the total number of animals used in toxicology studies submitted to the agency annually ranges from 20,000 to more than 100,000. Goodman estimates there are about 20,000 animals in EPA labs—including rabbits, mice, and rats—most of which are used to gauge the safety of environmental pollutants such as smog and ozone. Other animals—including rabbits, guinea pigs, and dogs—are tested by chemical companies (or the testing is outsourced to contract research organisations) to meet EPA requirements on the safety of new products. Goodman says the new EPA policy will affect both realms. Companies will no longer need to use as many—or any animals—to meet EPA standards, and the agency itself will no longer conduct mammal testing. (Goodman says some toxicology testing is conducted on fish, and he expects that to continue.) “This is the most comprehensive and aggressive plan in U.S. history to cut government animal testing,” Goodman says. “I think it’s going to be the gold standard for other agencies.” Sass says she’s concerned that EPA’s proposed changes will give the chemical industry, which will need to develop its own nonanimal alternatives, too much control over these technologies. “A lot of nonanimal tests are done by contractors, so they’re proprietary,” she says. “There’s no way for experts to evaluate how these chemicals are tested. You’re going to have a black box funded by industry.” At the press conference, Wheeler denied that the policy shift was influenced by chemical companies. Instead, he said he was motivated by his mother, who is an animal lover, and his zoologist and veterinarian sisters. EPA has also recently teamed up with the animal rights group People for the Ethical Treatment of Animals (PETA), and representatives from PETA, the White Coat Waste Project, and the Humane Society of the United States took part in today’s press conference. Sass says even though scientists have made great strides in creating nonanimal models, they’re often still no match for the real thing. She notes that to determine whether a chemical causes a disease like lupus, researchers need to see the impact on the entire immune system, not just a few cells in a dish or on a computer. And the learning disabilities caused by lead poisoning would not have been picked up without animal experiments, she says. “You can’t test whether a cell has ADHD [attention deficit hyperactivity disorder].” Ann Bartuska, vice president for land, water, and nature at Resources for the Future, a Washington, D.C.–based non-profit that conducts independent research into environmental and energy issues, says Sass raises legitimate concerns. “The process needs to be transparent so others

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can evaluate how effective these new approaches are." But Bartuska, a former deputy undersecretary at the U.S. Department of Agriculture (which conducts and funds numerous animal studies), notes that EPA has a science advisory board that will oversee the plan, and she says the agency has given itself enough time to make sure nonanimal alternatives work before it completely phases out its mammal research. "It's a very major step that I think will have an impact on other federal agencies," she says. "It's right to be cautious, but something has to change."

Science, 10 September 2019

<http://sciencemag.org/>

US to ban flavoured e-cigarettes after hundreds get strange illness

2019-09-20

On 11 September, United States President Donald Trump announced that he has directed the US Food and Drug Administration (FDA) to ban the sale of flavoured e-cigarettes. This comes after six people have died as a result of an unexplained lung illness, and more than 450 people across the US have been reported to be ill after using e-cigarettes. However, it is not known if there is actually a link between flavoured e-cigarettes and the illness. Trump made the announcement during a meeting with the head of the US Department of Health and Human Services, Alex Azar, and the head of the FDA, Ned Sharpless. The FDA said in a statement that the details of the ban will be formalised and announced soon. "Today president Trump announced that the Food and Drug Administration will be finalising guidance that removes all flavoured e-cigarettes from the marketplace," said Azar in video announcement, adding that tobacco-flavoured e-cigarettes will still remain available as they are sometimes used by people who are trying to quit smoking traditional cigarettes. There is little scientific evidence that flavoured e-cigarettes are medically more dangerous than other e-cigarettes. Additionally, some of the people who have been ill also said their e-cigarettes contained cannabinoid products, such as THC, which could be to blame. "It appears that cases were mainly seen in young users of e-cigarettes who bought bootlegged products illegally that contained cannabis ingredients," Lion Shahab at University College London told the Science Media Centre. "Flavours are therefore unlikely to be the cause of 'vaping lung disease' and banning them would not have prevented this recent outbreak." One of the biggest concerns with flavoured vaping products is that they are marketed to teens, said Azar. A recent FDA study found that vaping drastically increased among

Flavoured e-cigarettes could soon be banned in the US

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high school and middle school students between 2017 and 2018. "We've got to stop it or we're going to have a whole generation addicted to nicotine," said Azar. Some research has shown that regulating the flavours of e-cigarettes or the ability to modify vaping devices could lead to people smoking more traditional cigarettes. This ban is in line with actions taken by the cities of San Francisco, California and Boulder, Colorado, as well as the state of Michigan – which have all banned flavoured e-cigarettes. New York Governor Andrew Cuomo also announced that he will advance legislation to ban flavoured e-cigarettes. But it may not address the epidemic of mysterious lung disease that we're currently seeing. Scott Gottlieb, the former head of the FDA, tweeted that, "most of these severe cases, so far, appear to be symptoms that can occur when either oils or lipid-containing substances enter lungs. This points to illegal products that are being cut with dangerous chemicals as a culprit." A public database of hazardous chemical reactions launched in March 2017 by the US non-profit group Pistoia Alliance has secured the backing of the American Chemical Society (ACS) and its Chemical Abstracts Service (CAS) – a massive index of research papers and compound structures. Pistoia created this Chemical Safety Library (CSL) as a tool for researchers to share and learn about lab accidents and thereby prevent repeat incidents, and these two new partners will develop and launch an updated, more user-friendly version of the database. 'We are going to be working with ACS and CAS to collaborate on a "CSL two"', announced Carmen Nitsche, a business development consultant for the Pistoia Alliance, at the ACS's national meeting in San Diego on 26 August. 'What exactly it is going to be is not fully defined yet, but it will preserve the community contributions of incidents and near misses at chemistry labs,' she said. Under the updated CSL, Nitsche noted, self-reported chemical reaction data will continue to be made publicly available and deposited in PubChem, the US National Institutes of Health's chemical database. In addition, she said the International Union of Pure and Applied Chemistry (IUPAC) has agreed to endorse the new CSL and publicise it. 'We had money to run the CSL for a couple of years, which is what we did, and then we started looking at how we could partner to take it further,' Nitsche recalled. There has been relatively little action on the CSL for the better part of a year, and she said that is because it was unclear whether the database had a long-term future. 'One of the challenges is that people worry about confidentiality, so we can make a much more robust system if ACS builds something that is trusted,' Nitsche said. 'Pistoia Alliance is a small industry organisation, and now we have the ACS and IUPAC encouraging its use and saying, "This is good, this is an ethical and professional thing," they will feel more comfortable.' There are many barriers to sharing chemical incident data,

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including a desire for anonymity, a 'shame factor' and possible reputational damage, as well as potential litigation and regulation, according to Kristen Kulinowski, who is interim chief of the US Chemical Safety Board – a government agency charged with investigating serious industrial chemical accidents. 'If we now suddenly start talking about all of those things that are going wrong, or could go wrong, the government might come in and regulate,' she told the ACS conference. 'And then of course there's a cost to fixing what we find ... to keep things safe.' Kulinowski suggested that the US airline industry's use of a voluntary Aviation Safety Reporting System, which allows pilots and other aircraft crew members to confidentially report near misses to enhance air safety, could provide a valuable model for the chemical safety community. 'It is not for accidents ... or for criminal activities like intentional sabotage, and the information is collected by a trusted third party – Nasa – with subject matter expertise and is not shared with the regulator,' Kulinowski explained. In addition, she said this US Federal Aviation Administration system involves anonymised data but also allows for follow-up to gather additional information about real or potential safety mishaps, including trend analyses. 'There is a firewall between the collector of the information and a regulatory body,' she said.

Chemistry World, 5 September 2019

<https://www.chemistryworld.com>

CSB Releases New Safety Digest on Worker Participation to Help Prevent Catastrophic Chemical Incidents

2019-09-20

The United States Chemical Safety Board (CSB) issued a new safety digest on the value of worker participation to prevent chemical incidents. The digest notes that lack of worker participation was a factor in several major incidents investigated by the CSB because workers and their representatives were not engaged to help identify hazards and reduce risks. CSB Board Member Rick Engler said, "Worker engagement is key to an effective process safety program. After all, it's employees who are so often in direct contact with the hazards -- and have the experience and knowledge to help prevent them." The digest discusses four incidents that led to a total of 13 employee deaths, many injuries, and, in one case, 15,000 residents living near the facility seeking medical evaluation. The incidents took place at an explosives manufacturing site, a chemical production facility, and two oil refineries. They occurred in Nevada, Washington, California, and Louisiana. Each of these CSB investigations found that worker participation programs were inadequate, despite the

The United States Chemical Safety Board (CSB) issued a new safety digest on the value of worker participation to prevent chemical incidents.

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existence of federal regulations and industry standards. The CSB is an independent, non-regulatory federal agency whose mission is to drive chemical safety change through independent investigations to protect people and the environment. The agency's board members are appointed by the President and confirmed by the Senate. CSB investigations look into all aspects of chemical incidents, including physical causes such as equipment failure as well as inadequacies in regulations, industry standards, and safety management systems. For more information, contact public@csb.gov.

U.S Chemical Safety Board, 4 September 2019

<http://www.csb.gov>

CDC Seeks Additional Comment on Proposed NIOSH Project That Will Survey Engineered Nanomaterial Occupational Safety and Health Practices

2019-09-20

The United States Centres for Disease Control and Prevention (CDC) published a Federal Register notice on 11 September 2019, to provide an additional 30-day comment period on its proposed information collection project entitled "Survey of Engineered Nanomaterial Occupational Safety and Health Practices." 84 Fed. Reg. 47957. Previously, CDC published a Federal Register notice inviting comment on the proposed information collection project. According to CDC, no comments were submitted in response to its April 2019 notice. The goal of the project is to assess the relevance and impact of the National Institute for Occupational Safety and Health's (NIOSH) contribution to guidelines and risk mitigation practices for the safe handling of engineered nanomaterials in the workplace. The notice states that research under this project will survey companies who manufacture, distribute, fabricate, formulate, use, or provide services related to engineered nanomaterials. Under the project, the following activities and data collections will be conducted:

- *Company Pre-calls.* Sampled companies will be contacted to identify the person who will complete the survey and to ascertain whether the company handles engineered nanomaterials.
- *Survey.* A web-based questionnaire, with a mail option, will be administered to companies. The purpose of the survey is to learn directly from companies about their use of NIOSH materials and their occupational safety and health practices concerning engineered

The United States Centres for Disease Control and Prevention (CDC) published a Federal Register notice on 11 September 2019, to provide an additional 30-day comment period on its proposed information collection project entitled "Survey of Engineered Nanomaterial Occupational Safety and Health Practices." 84 Fed.

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nanomaterials. The Office of Management and Budget (OMB) is particularly interested in comments that will help:

- Evaluate whether the proposed collection of information is necessary for the proper performance of the functions of NIOSH, including whether the information will have practical utility;
- Evaluate the accuracy of NIOSH's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used;
- Enhance the quality, utility, and clarity of the information to be collected;
- Minimise the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology, *e.g.*, permitting electronic submissions of responses; and
- Assess information collection costs.

Nano & Other Emerging Technologies Blog, 12 September 2019

<http://nanotech.lawbc.com>

San Francisco's Fluorinated Chemical Ban Limited to Compostable Food Service Ware

2019-09-20

The final text of San Francisco's Plastic, Litter, and Toxics Reduction Law clarifies that a ban on fluorinated chemicals in food service items, which becomes effective in 2020, only applies to food service items that are compostable. The law states "No person may sell, offer for sale, or otherwise Distribute within the City... (4) beginning January 1, 2020, any Food Service Ware that is Compostable and not Fluorinated Chemical Free." (SF Municipal Code, Chapter 16 ("Food Service and Packaging Waste Reduction Ordinance," Section 1603). An earlier version of the law included all food service ware that was not fluorinated chemical free in the ban (see the PackagingLaw.com article, [San Francisco Bans Fluorinated Chemicals in Food Service Ware and More](#)). The law defines "fluorinated chemicals" as "a class of fluorinated organic compounds containing at least one fully fluorinated carbon atom, also known as perfluoroalkyl and polyfluoroalkyl substances, or PFAS chemicals." In addition to the ban on fluorinated chemicals in compostable food service ware, the law also requires that all food service ware contain a minimum post-consumer recycled content, effective 1 January 2020, although a specific minimum amount has not

The final text of San Francisco's Plastic, Litter, and Toxics Reduction Law clarifies that a ban on fluorinated chemicals in food service items, which becomes effective in 2020, only applies to food service items that are compostable.

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been proposed yet. Other aspects of the law became effective 1 July 2019. A summary of the Plastic, Litter, and Toxics Reduction Law that includes compliance dates can be found on the [SF Environment website](#).

National Law Review, 12 September 2019

<http://www.natlawreview.com>

EUROPE

EDCs among top priorities in EU Commission President plans for next political term

2019-09-20

The new President of the European Commission, Ursula von der Leyen has placed the protection of citizens' health and the environment at the core of her political term, including protection of citizens' health from endocrine disrupting chemicals (EDCs). *"Europe must lead the transition to a healthy planet"*, she writes in her [political guidelines and agenda](#) for Europe. *"European citizens' health and the planet's health go together: it is the quality of the air we breathe, the water we drink, the food we eat and the safety of the products we use"*. Recently, van der Leyen presented her team and the new structure of the next European Commission. As a next step, the European Parliament has to give its consent to the entire team of Commissioners that have been put forward. The [EDC-Free Europe](#) coalition is looking forward to working with this new Commission and all decision-makers to turn these announcements about a healthy planet into reality. With the view to *"move towards a zero-pollution ambition"*, President von der Leyen has indicated she is committed to put forward a cross-cutting strategy to protect citizens' health from environmental degradation and pollution, addressing endocrine disruptors, pesticides, hazardous chemicals, industrial emissions, and air and water quality. The strategy to address widespread exposure to EDCs is long overdue, as noted again by EU Environment Ministers in their [Council conclusions](#) in June. The [Resolution](#) adopted by the European Parliament in April calls for legislative proposals to remove endocrine disruptors from cosmetics, toys and food packaging by June 2020.

EDC Free Europe, 10 September 2019

<https://www.edc-free-europe>

The new President of the European Commission, Ursula von der Leyen has placed the protection of citizens' health and the environment at the core of her political term, including protection of citizens' health from endocrine disrupting chemicals (EDCs).

Regulatory Update

CHEMWATCH

New report shows how to substitute phthalates

2019-09-20

“What are”, you might ask? Phthalates – the hard-to-spell chemical group that is used (mainly) as plasticisers in plastics. Due to the rampant consumption of plastics in the world today, and the fact that phthalates are the go-to chemicals when it comes to plasticisers for this material, it means that these chemicals penetrate every nook and cranny of our daily lives. Leaving out the world’s plastic consumption, this would not have been a big problem – had it not been for the fact that phthalates are toxic and hazardous for human health and the environment. “Phthalates have been on the agenda for a long time, and have been known to be hazardous for several decades. Despite this, they’re still used in copious amounts. There are safer alternatives available, it’s only a matter of switching to them” says Dr. Jonatan Kleimark, Senior Chemicals Advisor at ChemSec. “There are safer alternatives available, it’s only a matter of switching to them” ChemSec, together with ChemTrust, Food Packaging Forum and scientists from the universities of Gothenburg and New York, formed part of a multi-year research project on hazardous chemicals in plastic packaging. In the project, phthalates were identified as one of the biggest culprits. One of the outcomes is the report [Replacing Phthalates](#), which will be presented tomorrow at [an event](#) in Gothenburg, Sweden. “In the report, we explore current uses and regulations connected with phthalates, but we put most effort into investigating the safer alternatives, trying to guide the way towards successful substitution”, says Dr. Kleimark.

[Replacing Phthalates](#)

Even if there are many alternatives to phthalates available on the market, one must be careful not to perform what is called a regrettable substitution. This is when you replace one hazardous chemical with another one that turns out to be equally hazardous – something that, unfortunately, happens a lot. Therefore, it is necessary to be certain that the alternative is actually safer. Some initiatives – like ChemSec’s [Marketplace](#) – aim to make safer alternatives more visible by gathering them in a global database so that companies can find them more easily. The database is connected to a business-to-business platform where potential buyers can connect directly with the supplier of an alternative.

ChemSec, 11 September 2019

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

They are found in the walls, floors and furniture of our homes and offices, in our children’s toys, in our favourite electric gadgets, in almost all packaging – they are even found in the groceries we buy from the supermarket.

Regulatory Update

CHEMWATCH

Third revision of carcinogens and mutagens directive (cmd)

2019-09-20

On 19 June 2019, the Official Journal of the European Union published the text of the third revision of the CMD: the directive protecting workers from the risks related to exposure to carcinogens or mutagens at work (Directive 2019/983 (EU), amending Directive 2004/37/EC). The revision not only introduces four new occupational exposure limit values (OELVs) for cadmium, beryllium, MOCA and formaldehyde, it also clarifies the scope of the rules and obliges the European Commission to make legislative proposals. The overall revision of the CMD is taking place in steps. This latest revision clarifies the scope of the rules protecting workers. In the European Union, many carcinogens are subject not to a harmonised classification but to a self-classification carried out by suppliers. The directive now stipulates that prevention measures must be adopted for both categories of substances, i.e. substances with a harmonised classification as 1A (proven carcinogenicity) or 1B (suspected carcinogenicity) carcinogens and mutagens, as well as substances classified in the same categories by their producers or importers. There are some basic rules that apply whenever carcinogenic substances are used in the workplace. Rules everyone should take into account, regardless of the job position one finds themselves in. Which measures to take is easy to remember: STOP keeps you safe! The Directive obliges the European Commission to make legislative proposals concerning the protection of workers exposed to hazardous drugs (including cytotoxic drugs primarily used for cancer treatment). Following the publication of the third revision of the directive, Member States now have to transpose it into their national legislation by 11 July 2021 at the latest. Further information is available at:

- Click [here](#) to read and download the EU Directive 2019/983 (in 24 languages).

Roadmap on Carcinogens, 12 September 2019

<https://roadmaponcarcinogens.eu>

On 19 June 2019, the Official Journal of the European Union published the text of the third revision of the CMD: the directive protecting workers from the risks related to exposure to carcinogens or mutagens at work (Directive 2019/983 (EU), amending Directive 2004/37/EC).

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INTERNATIONAL

Basel Ban Amendment to Restrict International Trade in Hazardous Recyclables

2019-09-20

Beginning in December 2019, the Ban Amendment to the Basel Convention will prohibit shipments of hazardous waste from OECD countries to non-OECD countries for disposal or recovery. While the Ban Amendment was originally adopted by the parties to the Basel Convention in 1995, it languished pending the need for sufficient ratifications to meet its entry into force threshold. Two recent ratifications have finally brought the Ban Amendment over the finish line. The Basel Convention is a global agreement governing the transboundary movement of hazardous and other wastes. The Convention imposes controls and, in some instances, trade bans on covered waste shipments destined for final disposal or recycling, making the agreement the primary international legal framework governing the circular economy. On 6 September 2019, Croatia submitted its ratification of the Basel Amendment to the depositary, following the ratification deposited by St. Kitts and Nevis on 29 August 2019. With those two ratifications, the Ban Amendment has reached the threshold requirement for ratification. The amendment will enter into force between parties who have accepted it on 5 December 2019 (i.e., 90 days after the depositary received Croatia's ratification).

Ban Amendment – Scope and Applicability

The Ban Amendment will affect shipments of "hazardous wastes" from parties listed in Annex VII of the Convention to countries not listed in Annex VII.

The parties listed in Annex VII are defined as those parties and other states that are members of the OECD, European Community (now the European Union), and Liechtenstein. The Ban Amendment will prohibit the following shipments from Annex VII countries:

- All shipments of "hazardous wastes" (defined broadly under the Convention, and including anything that is hazardous in the exporting or importing country) to non-Annex VII countries for final *disposal* (i.e., operations specified in Annex IV A of the Convention).
- All shipments of a subset of hazardous wastes (i.e., those defined under Article 1(1)(a) of the Convention) to non-Annex VII countries for

Beginning in December 2019, the Ban Amendment to the Basel Convention will prohibit shipments of hazardous waste from OECD countries to non-OECD countries for disposal or recovery.

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recycling and similar recovery operations specified in Annex IV B of the Convention.

- If a waste is hazardous due to the laws of the exporting or importing country but not according to Article 1(1)(a) of the Convention, the Ban Amendment will not apply if the shipment is for recycling.

The Ban Amendment also does not affect shipments of “other wastes” under the Convention, which is significant in light of the recent amendment of the Convention to add certain plastic wastes as “other wastes” under Annex II. Entry into force at the international level means that the Annex VII-listed countries that have ratified the Ban Amendment will be required to have legislation or other measures in place to implement the requirement to stop exports. That obligation will apply to Annex VII-listed parties who have ratified the agreement regardless of whether the destination country is a party to the Ban Amendment (or even to the Basel Convention itself) – it applies to all “states” not listed in Annex VII. Many developing countries have also ratified the Ban Amendment, and they and others will likely adopt measures as a matter of their domestic law to refuse hazardous waste imports from Annex VII-listed countries (whether those countries on Annex VII have ratified the Ban Amendment or not). Indeed, many non-OECD countries have already done so by adopting import bans or refusing consents for certain imports.

Impact on International Shipments for Recycling

The entry into force of the Ban Amendment could significantly affect logistics for management and recycling of hazardous wastes around the globe. It is noteworthy, for example, that several countries with advanced recycling infrastructure and capabilities (e.g., Singapore, China, and Malaysia) are not Annex VII countries. A wide range of recyclable hazardous wastes listed as presumptively hazardous in Annex VIII of the Convention are covered by the Ban Amendment, including certain types of end-of-life electrical and electronic equipment and scrap, certain types of waste batteries, and some spent catalysts. Beginning January 1, 2021, certain types of waste plastics will also be classified as presumptively hazardous under the Convention following recent amendments to Annex VIII. As a result, the Ban Amendment could disrupt some company recycling, product stewardship, and circular economy initiatives. In addition, the Convention has initiated a process to review and amend several of the Convention annexes that collectively define the universe of wastes considered “hazardous.” The parties have convened an Expert Working Group that will meet again in November (in Bratislava, Slovakia) to continue negotiations on the review of annexes. The outcome of this

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review is expected to further define and possibly expand the scope of hazardous wastes covered by the Convention and the Ban Amendment. The impact of the Ban Amendment's entry into force may be tempered by the fact that the EU has *already* implemented the Ban Amendment in its Waste Shipment Regulation as a matter of EU law, so any Ban Amendment restrictions on shipments from the EU should already be in place. As the US is a non-party to the Basel Convention, shipments of wastes covered under the Basel Convention (both "hazardous" and "other" wastes) are already prohibited under the Convention's ban on trade with non-parties, unless the shipment is covered by a separate "Article 11" agreement allowing the movement. Similarly, the Ban Amendment will not affect trade between Annex VII countries, between non-Annex VII countries, or shipments of hazardous waste from a non-Annex VII country to an Annex VII country. The Basel Convention continues to evolve and inform the environmental legal requirements governing the classification, management, and international movement of wastes in most countries worldwide. Companies should review their current waste management, product stewardship, and circular economy initiatives to ensure current and future operations account for the expanded scope of wastes covered by the Convention and the new legal prohibitions on certain international shipments.

National Law Review, 10 September 2019

<http://www.natlawreview.com>

REACH Update

CHEMWATCH

ECHA's scientific committees support restricting PAHs in granules and mulches

2019-09-19

The Committee for Socio-economic Analysis (SEAC) has adopted its final opinion supporting the proposal for restricting eight polycyclic aromatic hydrocarbons (PAHs) found in granules and mulches used, for example, in synthetic turf pitches and playgrounds. SEAC adopted its final opinion by simple majority, supporting the proposal by the Dutch National Institute for Public Health and the Environment (RIVM) and following an earlier opinion by the Committee for Risk Assessment (RAC) in June. The restriction proposal lowers the total concentration limit of eight PAHs to 20 mg/kg (0.002 % by weight). The concentration limits for PAHs in mixtures supplied to the general public are currently set at 100 mg/kg or 1 000 mg/kg for each of the substances. The PAHs all have been identified as causing cancer and the proposed concentration limits will be closer to the limit values for individual PAHs in articles supplied to the general public ([entry 50](#) of REACH Restrictions list). Currently, the levels of PAHs measured in granular infill material and mulches pose, at most, a very low level of concern ([ECHA study, 2017](#)). The aim of the proposed restriction is to ensure that the cancer risk from PAH exposure remains at a low level for those coming into contact (inhalation and skin contact) with the granules and mulches. This includes, for example, footballers, children playing on the pitches or playgrounds and workers installing and maintaining such surfaces. SEAC concluded that the proposed restriction is the most appropriate measure to control the risks posed by these substances, and that the measures proposed would be proportionate to the risk with limited economic impacts. The proposal does not affect existing fields but will ensure that the material used for maintaining (refilling) the fields is below the new limit. The final opinion of SEAC will be published in the coming weeks.

The Committee for Socio-economic Analysis (SEAC) has adopted its final opinion supporting the proposal for restricting eight polycyclic aromatic hydrocarbons (PAHs) found in granules and mulches used, for example, in synthetic turf pitches and playgrounds.

Substance	CAS number
Benzo[a]pyrene (BaP)	50-32-8
Benzo[e]pyrene (BeP)	192-97-2
Benzo[a]anthracene (BaA)	56-55-3
Chrysen (CHR)	218-01-9
Benzo[b]fluoranthene (BbFA)	205-99-2
Benzo[j]fluoranthene (BjFA)	205-82-3
Benzo[k]fluoranthene (BkFA)	207-08-9

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Substance	CAS number
Dibenzo[a,h]anthracene (DBAhA)	53-70-3

Table: Eight PAHs with their CAS numbers.

Next steps

Following SEAC's adoption of its final opinion, the opinions of both RAC and SEAC will be forwarded to the European Commission. The Commission will consider if the conditions for the restriction are met, prepare a draft restriction measure to amend the REACH Restrictions list (Annex XVII) and submit this for an opinion to Member States in the REACH Committee.

Microplastics restriction proposal

The restriction proposal on PAHs concerns risks to human health from the substances present in the infill material of artificial turfs. ECHA is also progressing with its proposal to restrict intentionally added microplastics which aims at reducing potential environmental risks. The granular infill material that is typically used in artificial turf pitches is understood to be an 'intentionally-added microplastic'. [A public consultation on this proposal](#) ends on 20 September 2019, after which RAC and SEAC will finalise their opinions to aid the Commission's decision making. In the framework of the public consultation, further information has been requested specifically on the use of granular infill material in synthetic turf to assess the implications and the possible need for a derogation. Further information is available at:

- [Restriction proposal for eight polycyclic aromatic hydrocarbons \(PAHs\) in granules and mulches](#)
- [Restrictions list](#)(Annex XVII to REACH)
- [Restriction proposal for intentionally added microplastics](#)
- [Public consultation](#)

ECHA, 18 September 2019

<http://echa.europa.eu>

REACH Update

CHEMWATCH

Act and prepare for 'no deal Brexit' to stay on the market and keep supplies

2019-09-19

As the deadline for the UK's withdrawal from the EU on 31 October 2019 is approaching, the European Chemicals Agency (ECHA) urges companies to act and prepare for a 'no deal' scenario. ECHA is reminding companies that they need to prepare for a 'no deal' scenario ahead of the UK's withdrawal from the EU, which is to take place on 31 October 2019. As of 1 November 2019, the UK will be a "third country". ECHA also urges downstream users located in the EU-27/EEA to act now to avoid disruptions in supply. Registrations made by UK manufacturers, importers and Only Representatives will become void if they are not transferred to EU-27/EEA before the UK withdraws from the EU. Downstream users in the EU-27/EEA can check the 'List of substances registered only by UK companies' on ECHA's website to see if they will be affected and need to take action. If they plan to get their supply from the UK after the withdrawal, they should register the substance themselves as an importer, unless an Only Representative has been appointed for that registration in the EU-27/EEA. UK-based manufacturers and formulators that want to keep substances registered under REACH legally on the EU-27/EEA market, can either transfer their business to, or appoint an Only Representative in one of the EU-27/EEA countries. Step-by-step instructions on how to transfer REACH registrations are available on ECHA's web pages for the UK's withdrawal from the EU. The manual form to notify exports of PIC substances has been reactivated. This form is part of a temporary procedure that ensures that EU-27 companies, which are planning to export PIC chemicals to the UK as of 1 November 2019, can comply with their obligations to notify their exports 35 days before the expected date of import. Further information is available at:

- [The withdrawal of the UK from the EU](#)
- [Questions and answers for companies](#)
- [Q&As on PIC and the UK's withdrawal from the EU](#)
- [How to notify PIC exports to the UK after the UK's withdrawal from the EU](#)
- [Manual export notification form](#)
- [Advice to companies](#)
- [How to transfer your UK REACH registrations prior to the UK withdrawal from the EU](#)
- [List of substances registered only by UK companies](#)

As the deadline for the UK's withdrawal from the EU on 31 October 2019 is approaching, the European Chemicals Agency (ECHA) urges companies to act and prepare for a 'no deal' scenario.

REACH Update

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- Ready for Brexit?
- Commission's "Brexit preparedness checklist for businesses"

ECHA, 12 September 2019

<http://echa.europa.eu>

Current calls for comments and evidence - extension of deadline

2019-09-19

The call for evidence deadline to gather evidence to re-evaluate certain derogations to entry 63 of Annex XVII of REACH has been extended. Several stakeholders approached the European Chemicals Agency (ECHA) with a request for a week's extension in order to submit more substantial comments. It has now been agreed to extend the current deadline from 19 September 2019 to 26 September 2019. Further information is available at: Current calls for comments and evidence

ECHA News, 18 September 2019

<http://echa.europa.eu>

New proposals to harmonise classification and labelling

2019-09-19

The European Chemicals Agency (ECHA) has published 2 proposals to harmonise classification and labelling. The two proposals were submitted for:

- N,N-dimethyl-p-toluidine (EC 202-805-4, CAS 99-97-8) by Germany
- Amines, N-C10-16-alkyltrimethylenedi-, reaction products with chloroacetic acid (Ampholyt 20) (EC -, CAS 139734-65-9) by Ireland

Further information is available at:

Registry of CLH intentions until outcome

ECHA News, 18 September 2019

<http://echa.europa.eu>

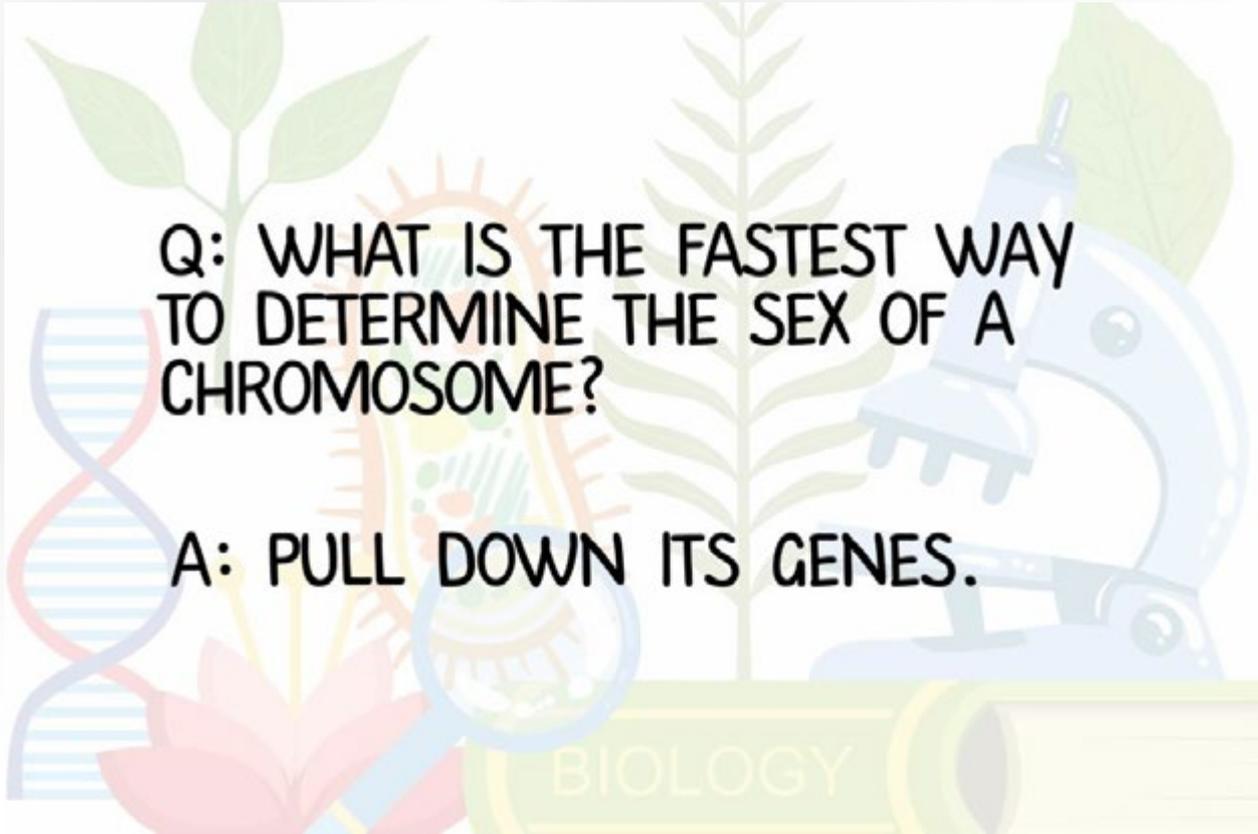
The call for evidence deadline to gather evidence to re-evaluate certain derogations to entry 63 of Annex XVII of REACH has been extended.

Janet's Corner

CHEMWATCH

How to determine the sex of a chromosome

2019-09-20



Q: WHAT IS THE FASTEST WAY TO DETERMINE THE SEX OF A CHROMOSOME?

A: PULL DOWN ITS GENES.

Reader's Digest

<https://www.rd.com/funny/funny-science-jokes/>

Hazard Alert

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Beryllium

2019-09-09

Beryllium is a toxic bivalent element, steel grey, strong, lightweight, primarily used as hardening agent in alloys. Beryllium has one of the highest melting points of the light metals. It has excellent thermal conductivity, is nonmagnetic, it resists attack by concentrated nitric acid and at standard temperature and pressures beryllium resist oxidation when exposed to air. [1]

Beryllium is a naturally occurring element that is present in rocks, coal, oil, soil, and volcanic dust. Some beryllium compounds are soluble in water. Two kinds of minerals, bertrandite and beryl, are commercially mined for the recovery of beryllium. The majority of beryllium that is mined is converted into alloys. [2]

USES [3]

Industrial grade beryl is used as a feedstock for beryllium metal, alloys and oxide, all of which have many high-tech applications particularly in the nuclear, electronic and ceramic industries. Beryllium is a structural material in space technology, inertial guidance systems, additive in rocket fuels, moderator and reflector of neutrons in nuclear reactors (e.g. at ANSTO, Lucas Heights). Pure beryllium metal is used to make aircraft disc brakes, nuclear weapons and reactors, aircraft-satellite-space vehicle structures and instruments, X-ray transmission windows, missile parts, fuel containers, precision instruments, rocket propellants, navigational systems, heat shields, and mirrors. Beryllium alloys such as beryllium-copper are used in electrical connectors and relays, springs, precision instruments, aircraft engine parts, non-sparking tools, submarine cable housings and pivots, wheels, and pinions. More specifically, beryllium oxide is used in the manufacture of specialty electrical and high-technology ceramics, special glass, electronic heat sinks, electron tubes, electrical insulators, electronics components, microwave oven components, nuclear fuels and nuclear moderators, gyroscopes, military vehicle armour, rocket nozzles, and laser structural components. Beryllium chloride is used in refining beryllium ores and as a chemical reagent. Beryllium fluoride is used in refining beryllium and manufacturing beryllium alloys, and as a chemical reagent. Beryllium nitrate is used as a chemical reagent, a gas mantle hardener and in refining beryllium ores.

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SOURCES & ROUTES OF EXPOSURE

Sources of Emission [3]

- Industry sources: Mining of ores containing beryllium can contribute to higher levels in air, soil and water, i.e. small quantities of beryl are produced as a by-product of feldspar mining at Broken Hill (NSW). Emissions to air can result from combustion of coal and oil in power plants.
- Diffuse sources: Some hazardous waste sites and tobacco smoke.
- Natural sources: Pure beryllium is not found in nature. Beryllium compounds can be found in mineral rocks, soil, coal, oil, and volcanic dust.
- Transport sources: Beryllium emissions are normally not associated with mobile sources.
- Consumer products: Small quantities can be found in products such as personal computers, televisions, calculators, and microwave ovens.

Routes of Exposure [4]

- Inhalation – Predominant route of exposure for the general and occupational populations.
- Oral – Major route of exposure for the general populations.
- Dermal – Minor route of exposure for general and occupational populations.

HEALTH EFFECTS [5]

Acute Effects

Acute inhalation exposure to high levels of beryllium has been observed to cause inflammation of the lungs and acute pneumonitis (reddening and swelling of the lungs) in humans; after exposure ends, these symptoms may be reversible. Acute animal tests have demonstrated beryllium compounds to vary in acute toxicity, ranging from high to extreme acute toxicity from oral exposure.

Chronic Effects

Chronic occupational exposure of humans to beryllium by inhalation has been reported to cause chronic beryllium disease (berylliosis), in which granulomatous lesions (noncancerous) develop in the lung. The onset of these effects may be delayed by 3 months to more than 20 years. Symptoms of chronic beryllium disease include irritation of the

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mucous membranes, reduced lung capacity, shortness of breath, fatigue, anorexia, dyspnea, malaise, and weight loss. In addition, chronic inhalation exposure has been observed to cause immunological effects in humans and animals. A skin allergy may result from dermal exposure to beryllium. Eye contact with beryllium dust has been observed to cause acute conjunctivitis in humans. Animal studies have also reported effects on the lung, such as chronic pneumonitis, from chronic inhalation exposure. The Reference Concentration (RfC) for beryllium is 0.00002 milligrams per cubic metre (mg/m³) based on respiratory effects in humans. The Reference Dose (RfD) for beryllium is 0.002 milligrams per kilogram body weight per day (mg/kg/d) based on small intestinal lesions in dogs.

Reproductive/Developmental Effects

The potential for beryllium to induce developmental or reproductive effects has not been adequately assessed. Limited information is available on the reproductive or developmental effects of beryllium in humans following inhalation exposure. A case control study found no association between paternal occupational exposure and the risk of stillbirth, pre-term delivery, or small-for-gestational-age infants, although this study has limited sensitivity. No data are available on reproductive or developmental effects in animals following inhalation.

Cancer Risk

Several human epidemiological studies have investigated the relationship between beryllium exposure in workers and lung cancer deaths. Although there are shortcomings in all the studies, the results are suggestive of a causal relationship between beryllium exposure and an increased risk of lung cancer. Beryllium compounds have been shown to cause lung cancer from inhalation exposure in rats and monkeys. EPA has classified beryllium as a Group B1, probable human carcinogen.

SAFETY [6]

First Aid Measures

- Inhalation: Breathing difficulty caused by inhalation of particulate requires immediate removal to fresh air. If breathing has stopped, perform artificial respiration and obtain medical help.
- Ingestion: Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.

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- Skin: Thoroughly wash skin cuts or wounds to remove all particulate debris from the wound. Seek medical attention for wounds that cannot be thoroughly cleansed. Treat skin cuts and wounds with standard first aid practices such as cleansing, disinfecting and covering to prevent wound infection and contamination before continuing work. Obtain medical help for persistent irritation. Material accidentally implanted or lodged under the skin must be removed.
- Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Treatment of Chronic Beryllium Disease: There is no known treatment that will cure chronic beryllium disease. Prednisone or other corticosteroids are the most specific treatment current available. They are directed at suppressing the immunological reaction and can be effective in diminishing signs and symptoms of chronic beryllium disease. In cases where steroid therapy has had only partial or minimal effectiveness, other immunosuppressive agents, such as cyclophosphamide, cyclosporine, or methotrexate, have been used. These latter agents remain investigational. Further, in view of the potential side effects of all the immunosuppressive medications, including steroids such as prednisone, they should be used only under the direct care of a physician. In general, these medications should be reserved for cases with significant symptoms and/or significant loss of lung function. Other symptomatic treatment, such as oxygen, inhaled steroids, or bronchodilators, may be prescribed by some physicians and can be effective in selected cases.

Exposure Controls & Personal Protection

Exposure Controls

- Whenever possible, the use of local exhaust ventilation or other engineering controls is the preferred method of controlling exposure to airborne particulate. Where utilised, exhaust inlets to the ventilation system must be positioned as close as possible to the source of airborne generation. Avoid disruption of the airflow in the area of a local exhaust inlet by equipment such as a man-cooling fan. Check ventilation equipment regularly to ensure it is functioning properly. Provide training on the use and operation of ventilation to all users. Use qualified professionals to design and install ventilation systems.
- Machining operations conducted under a flow of liquid coolant require complete hooded containment and local exhaust ventilation. Openings into the hood must be baffled to prevent release of fast moving

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particulate. The cycling through a machine of liquid lubricant/coolant containing finely divided beryllium particulate in suspension can result in the concentration building to a point where the particulate may become airborne during use. Prevent coolant from splashing onto floor areas, external structures or operators' clothing. Utilise a coolant filtering system to remove particulate from the coolant.

Personal Protective Equipment

Respiratory Protection

- When airborne exposures exceed or have the potential to exceed the occupational limits, approved respirators must be used as specified by an Industrial Hygienist or other qualified professional.
- Exposure to unknown concentrations of particulate requires the wearing of a pressure-demand airline respirator or pressure-demand self-contained breathing apparatus (SCBA). Use pressure-demand airline respirators when performing jobs with high potential exposures such as changing filters in a baghouse air cleaning device.

Other Protective Equipment

- Protective overgarments or work clothing must be worn by persons who may become contaminated with particulate during activities such as machining, furnace rebuilding, air cleaning equipment filter changes maintenance, furnace tending, etc.
- Contaminated work clothing and overgarments must be managed in a controlled manner to prevent secondary exposure to workers of third parties, to prevent the spread of particulate to other areas, and to prevent particulate from being taken home by workers.
- Wear gloves to prevent contact with particulate or solutions and to prevent metal cuts and skin abrasions during handling.
- Wear safety glasses, goggles, face shield, or welder's helmet when risk of eye injury is present, particularly during melting, casting, machining, grinding, welding, powder handling, etc.

REGULATION [2,7]

Exposure Limits

United States:

Exposure Limits and Health Effects (Updated September 6, 2012)

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Standard Set By	Exposure Limit	Health Effect Codes -- Health Effects and Target Organs
OSHA PEL - General Industry See 29 CFR 1910.1000 Table Z-1 (See also ANSI Z37.29-1970)	0.002 mg/m ³ TWA 0.005 mg/m ³ Ceiling 0.025 mg/m ³ Peak (30 minutes)	HE10 -- chronic beryllium disease (berylliosis [†])
		HE11 -- pneumonitis
		HE14 -- beryllium granuloma [†] , contact dermatitis
OSHA PEL - Construction Industry See 29 CFR 1926.55 Appendix A	0.002 mg/m ³ TWA	HE10 -- chronic beryllium disease (berylliosis [†])
		HE11 -- pneumonitis
		HE14 -- beryllium granuloma [†] , contact dermatitis
OSHA PEL - Shipyard Employment See 29 CFR 1915.1000 Table Z-Shipyards	0.002 mg/m ³ TWA	HE10 -- chronic beryllium disease (berylliosis [†])
		HE11 -- pneumonitis
		HE14 -- beryllium granuloma [†] , contact dermatitis
NIOSH REL 0.0005 mg/m ³ Ceiling Ca See Appendix A		HE2 -- lung cancer
		HE3 -- kidney stones; enlargement of the liver, spleen, and heart; multiple granulomas of the lung, spleen, liver, and lymph nodes
		HE4 -- heart failure leading to death
		HE10 -- tracheobronchitis, pneumonitis
		HE11 -- pulmonary oedema leading to death
	HE14 -- eye, upper respiratory, and skin irritation; contact dermatitis	

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Standard Set By	Exposure Limit	Health Effect Codes -- Health Effects and Target Organs
ACGIH TLV [®] (2008)	0.00005 mg/m ³ TWA (inhalable particulate matter) A1 Skin; dermal sensitizer (DSEN); respiratory sensitizer (RSEN)	HE9 -- beryllium sensitization
		HE10 -- chronic beryllium disease (berylliosis [†])
CAL/OSHA PELs	0.0002 mg/m ³ TWA 0.025 mg/m ³ Ceiling	HE9 -- beryllium sensitization
		HE10 -- granulomas of the lung

Australia:

Safe Work Australia has set an eight-hour time weighted average (TWA) exposure limit for beryllium of 0.002 mg/m³.

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Enhancing materials for hi-res patterning to advance microelectronics

2019-09-11

To increase the processing speed and reduce the power consumption of electronic devices, the microelectronics industry continues to push for smaller and smaller feature sizes. Transistors in today's cell phones are typically 10 nanometres (nm) across -- equivalent to about 50 silicon atoms wide -- or smaller. Scaling transistors down below these dimensions with higher accuracy requires advanced materials for lithography -- the primary technique for printing electrical circuit elements on silicon wafers to manufacture electronic chips. One challenge is developing robust "resists," or materials that are used as templates for transferring circuit patterns into device-useful substrates such as silicon. Now, scientists from the Centre for Functional Nanomaterials (CFN) -- a U.S. Department of Energy (DOE) Office of Science User Facility at Brookhaven National Laboratory -- have used the recently developed technique of infiltration synthesis to create resists that combine the organic polymer poly(methyl methacrylate), or PMMA, with inorganic aluminium oxide. Owing to its low cost and high resolution, PMMA is the most widely used resist in electron-beam lithography (EBL), a kind of lithography in which electrons are used to create the pattern template. However, at the resist thicknesses that are necessary to generate the ultra-small feature sizes, the patterns typically start to degrade when they are etched into silicon, failing to produce the required high aspect ratio (height to width). As reported in a paper published online on 8 July in the *Journal of Materials Chemistry C*, these "hybrid" organic-inorganic resists exhibit a high lithographic contrast and enable the patterning of high-resolution silicon nanostructures with a high aspect ratio. By changing the amount of aluminium oxide (or a different inorganic element) infiltrated into PMMA, the scientists can tune these parameters for particular applications. For example, next-generation memory devices such as flash drives will be based on a three-dimensional stacking structure to increase memory density, so an extremely high aspect ratio is desirable; on the other hand, a very high resolution is the most important characteristic for future processor chips. "Instead of taking an entirely new synthesis route, we used an existing resist, an inexpensive metal oxide, and common equipment found in almost every nanofabrication facility," said first author Nikhil Tiwale, a postdoctoral research associate in the CFN Electronic Nanomaterials Group. Though other hybrid resists have been proposed, most of them require high electron doses (intensities), involve complex chemical synthesis methods, or have expensive proprietary compositions. Thus, these resists are not

Scientists created organic-inorganic materials for transferring ultra-small features into silicon with a high aspect ratio.

optimal for the high-rate, high-volume manufacture of next-generation electronics.

Advanced nanolithography for high-volume manufacturing

Conventionally, the microelectronics industry has relied upon optical lithography, whose resolution is limited by the wavelength of light that the resist gets exposed to. However, EBL and other nanolithography techniques such as extreme ultraviolet lithography (EUVL) can push this limit because of the very small wavelength of electrons and high-energy ultraviolet light. The main difference between the two techniques is the exposure process. "In EBL, you need to write all of the area you need to expose line by line, kind of like making a sketch with a pencil," said Tiwale. "By contrast, in EUVL, you can expose the whole area in one shot, akin to taking a photograph. From this point of view, EBL is great for research purposes, and EUVL is better suited for high-volume manufacturing. We believe that the approach we demonstrated for EBL can be directly applied to EUVL, which companies including Samsung have recently started using to develop manufacturing processes for their 7 nm technology node." In this study, the scientists used an atomic layer deposition (ALD) system -- a standard piece of nanofabrication equipment for depositing ultrathin films on surfaces -- to combine PMMA and aluminium oxide. After placing a substrate coated with a thin film of PMMA into the ALD reaction chamber, they introduced a vapor of an aluminium precursor that diffused through tiny molecular pores inside the PMMA matrix to bind with the chemical species inside the polymer chains. Then, they introduced another precursor (such as water) that reacted with the first precursor to form aluminium oxide inside the PMMA matrix. These steps together constitute one processing cycle. The team then performed EBL with hybrid resists that had up to eight processing cycles. To characterise the contrast of the resists under different electron doses, the scientists measured the change in resist thickness within the exposed areas. Surface height maps generated with an atomic force microscope (a microscope with an atomically sharp tip for tracking the topography of a surface) and optical measurements obtained through ellipsometry (a technique for determining film thickness based on the change in the polarisation of light reflected from a surface) revealed that the thickness changes gradually with a low number of processing cycles but rapidly with additional cycles -- i.e., a higher aluminium oxide content. "The contrast refers to how fast the resist changes after being exposed to the electron beam," explained Chang-Yong Nam, a materials scientist in the CFN Electronic Nanomaterials Group, who supervised the project and conceived the

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idea in collaboration with Jiyoung Kim, a professor in the Department of Materials Science and Engineering at the University of Texas at Dallas. "The abrupt change in the height of the exposed regions suggests an increase in the resist contrast for higher numbers of infiltration cycles -- almost six times higher than that of the original PMMA resist." The scientists also used the hybrid resists to pattern periodic straight lines and "elbows" (intersecting lines) in silicon substrates, and compared the etch rate of the resists with substrates. "You want silicon to be etched faster than the resist; otherwise the resist starts to degrade," said Nam. "We found that the etch selectivity of our hybrid resist is higher than that of costly proprietary resists (e.g., ZEP) and techniques that use an intermediate "hard" mask layer such as silicon dioxide to prevent pattern degradation, but which require additional processing steps." Going forward, the team will study how the hybrid resists respond to EUV exposure. They have already started using soft x-rays (energy range corresponding to the wavelength of EUV light) at Brookhaven's National Synchrotron Light Source II (NSLS-II), and hope to use a dedicated EUV beamline operated by the Centre for X-ray Optics at Lawrence Berkeley National Lab's Advanced Light Source (ALS) in collaboration with industry partners. "The energy absorption by the organic layer of EUVL resists is very weak," said Nam. "Adding inorganic elements, such as tin or zirconium, can make them more sensitive to EUV light. We look forward to exploring how our approach can address the resist performance requirements of EUVL."

Science Daily, 27 August 2019

<http://www.sciencedaily.com>

Affordable, less intensive methane detection protocol

2019-09-11

A new testing protocol that uses existing, affordable water chemistry tests can help scientists and regulators detect sites showing evidence of new methane gas leaks caused by oil and gas drilling, according to Penn State researchers. The researchers took a testing protocol they had described in a paper last year in the Proceedings of the National Academy of Sciences and applied it to a much larger dataset of domestic water wells in three regions of Pennsylvania impacted by the fossil fuel industry. They looked for certain chemical constituents in the test results to determine if methane may have impacted the sites when the samples were collected. They published their findings in the journal Environmental Science & Technology and for the first time made public the datasets. The scientists wanted to see what percentage of the water wells showed certain

A new testing protocol that uses existing, affordable water chemistry tests can help scientists and regulators detect sites showing evidence of new methane gas leaks caused by oil and gas drilling, according to researchers.

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chemical changes that could indicate new methane contamination, like that which can occur during drilling and extraction of fossil fuels, and not pre-existing methane that is commonly found in Pennsylvania water. "We expected to see few sites, less than 1%, showing evidence of new methane," said Tao Wen, a postdoctoral scholar in the Earth and Environmental Systems Institute at Penn State. "We found 17 out of 20,751 samples, or about 0.08 %, that showed possible signs of methane contamination when those samples were collected." Unconventional shale gas wells dominate northeast Pennsylvania, whereas conventional oil and gas wells, including the first commercial oil well in the United States, dominate the northwest. The southwest has both conventional and unconventional oil and gas wells and a significant coal mining history. The researchers divided the water samples into five types. The two types that the scientists defined as samples most likely impacted by new methane contained high methane and sulfate levels and either low or high iron levels. "It's not uncommon to see methane in groundwater in the Marcellus shale and other shale plays," Wen said. "Also, if methane had been in the groundwater for a long time, bacteria would have reduced the iron and sulfate. The reduced forms would have precipitated as iron sulfide, or pyrite." The researchers classified low-methane samples, where methane measured less than 10 parts per million, as low priority samples. The other two types not impacted by new methane contained high amounts of methane and either high salts, indicating naturally occurring methane not caused by energy extraction, or freshwater and low sulfate levels, meaning that the methane had been there for a time. Of the 17 samples that came back positive for new methane, 13 came from the northeast. None came from sites within 2,500 feet of known problematic gas wells. State law holds oil and gas companies responsible for methane leaks that affect wells within that 2,500-foot area. The researchers' findings suggest that methane may migrate farther than previously thought if the new methane was derived from these known problematic gas wells. Only intensive field investigations could show whether this happened. The testing protocol can act as an effective screening tool for methane contamination and narrow the window for a more in-depth analysis, such as using carbon-stable or noble gas isotopes, according to Wen. "We focus on the Marcellus shale, but this testing protocol has the potential to be applied to other shale plays in the United States and other countries," he said. "It can benefit the global community."

Science Daily, 27 August 2019

<http://www.sciencedaily.com>

Biological risk potential of nanoparticles studied

2019-09-11

Nanoparticles are smaller than five nanometres -- a nanometre being one millionth of a millimetre -- which corresponds approximately to the size of macromolecules. Such tiny particles are very easily absorbed in body cells. There are two aspects to this feature. Firstly, it makes nanoparticles good vehicles for transporting a broad range of compounds or substances attached to them into normal diseased cells in a targeted manner. On the other hand, they can also pose health risks, for example in connection with particulate matter. One of the ways that particulate matter is created is in combustion processes, and part of that can be classified as nanoparticles. These extremely small particles can overcome the blood-air barrier and penetrate the body: The bronchial mucosa in the lungs doesn't filter out the particles. Instead, they make their way into the pulmonary alveoli and from there into the bloodstream. Together with work groups from the Chemistry department, HHU researchers from the Institute of Experimental Condensed Matter Physics working under Prof. Dr. Thomas Heinzl and from the Department of Haematology, Oncology and Clinical Immunology working under Prof. Dr. Rainer Haas have now studied what happens when body cells absorb such nanoparticles. The researchers used nanoparticles made from graphene; this is a special form of carbon that comprises two-dimensional layers of hexagonal carbon rings. They added these to special haematopoietic stem cells referred to as CD34+ stem cells. These cells are particularly sensitive to damaging environmental influences on account of their ability to divide throughout their lifespan. The assumption is that these cells would be damaged more by nanoparticles -- if at all -- than the more robust other cell types. The interdisciplinary team of researchers based in Düsseldorf was able to demonstrate that the carbon nanoparticles get into the cells, where they are encapsulated in special organelles called lysosomes. The lysosomes serve as a type of waste removal unit for the body where foreign bodies accumulate and are normally broken down with the help of enzymes. However, the researchers didn't observe any such process over the duration of the experiments, which lasted for several days. When comparing the active genes ("gene expression") of stem cells with and without the addition of nanoparticles, the researchers found that only one of a total of 20,800 recorded expressions had changed; minor effects were determined in a further 1,171 gene expressions. Prof. Heinzl had this to say regarding the findings: "Encapsulation of the nanoparticles in the lysosomes ensures that these particles are stored securely at least for a few days -- for the duration of our experiments -- and cannot damage

Carbon nanoparticles are a promising tool for biomedical applications, for example for targeted transportation of biologically active compounds into cells.

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the cell. This means the cell remains viable without any major change in gene expression." This insight is important if nanoparticles are to be used to deliver drugs into the cell. The experimental framework used here does not allow for any long-term statements to be made regarding any increased probability of cell mutation resulting in cancer. The research was carried out as a close collaboration between HHU's Faculty of Mathematics and Natural Sciences and Faculty of Medicine and University Hospital Düsseldorf. Düsseldorf School of Oncology (headed up by Prof. Dr. Sebastian Wesselborg) funded the doctoral scholarship of first author Stefan Fasbender. Prof. Haas said: "The proximity of the Hospital and the University and their close links in terms of content provides HHU with a particularly fruitful environment for translational research, where insights and expertise from basic research are combined with aspects relevant to treatment."

Science Daily, 27 August 2019

<http://www.sciencedaily.com>

This gadget scans your trash to tell you if it's recyclable

2019-09-11

One of the challenges in the broken recycling system is basic confusion: It often isn't obvious what a particular package is made from or whether it should go in a recycling bin or the trash. Items that could be recycled end up in the landfill, and recycling companies have to expend a lot of time and effort removing unrecyclable items from their facilities. While some brands start to adopt better labelling, a U.K.-based design firm is testing another solution—a simple device that you can point at an object to automatically identify its recyclability. The gadget, called R.I.D. (Recycling Identification Device), uses near-infrared spectrometry technology that beams invisible light at an object; because different materials absorb different wavelengths of light, it's possible to identify materials. "The distinguishing characteristics of a material are unique," says Jack Hands, a designer at Cohda, where a team designed and tested a prototype of the device. "We have been referring to it as a 'digital fingerprint,' so as the database of these identities develops, the materials will be independently recognisable." When someone holds the device up to a plastic container, the gadget lights up or buzzes to indicate if the material is recyclable or not. The designers suggest that cities could give the gadgets out to households along with an updatable RFID card that hangs on the recycling bin with data about what's locally recyclable. The whole system is low-cost and doesn't involve apps or any need for an internet connection. It could

This concept device could help end confusion about what bin to put your trash in—and take some pressure off our failing recycling system.

be useful even when waste is well-labelled, since what's recyclable in one city might not be in the next. "Even knowing the plastic used isn't enough . . . the materials that can be recycled vary from region to region on the capabilities of the local recycling centres," says Hands. It's common that plastic that isn't recyclable ends up in the recycling system, adding cost to the process, and also common that items that are recyclable end up in landfills. By one estimate, of the 8.3 billion-plus tons of plastic that humans have produced, around 6.3 billion tons weren't recycled. The design is just a concept, but the firm hopes to work with the government to help get it made. They also want people to think more about the problem. "Our main priority for the project and sharing it is to highlight a current issue and show how taking a personal responsibility for our own waste is a priority in shifting the current mindset," he says.

Fast Company, 6 September 2019

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

Engineers Build a Device That Effectively Transforms CO₂ Into Liquid Fuel

2019-09-11

Scientists have invented a new method for turning carbon dioxide into a liquid fuel that can efficiently store energy in fuel cells. The fuel could one day be the future of green transport, cramming more energy into the tank than the same volume of hydrogen while also serving as a building block for a whole chemical production industry. In recent years, a new kind of technology based on formic acid has attracted attention as the next generation of fuel cells. Formic acid isn't typically what comes to mind when we think of the fuel of the future. Found naturally contributing to the pain of bee and ant stings, it is a formidable energy carrier. It just currently takes a lot of effort to concentrate into a useful form. Engineers at Rice University in Houston, Texas, have rethought the entire production process and come up with a clever method to do away with some of the more involved steps, making the process far more efficient. "Usually people reduce carbon dioxide in a traditional liquid electrolyte like salty water," says chemist Haotian Wang. Those dissolved salts help convert the gas into a molecule that stores energy. But once you've got your fuel, you also have a thick briny soup to deal with, and sifting out the formic acid is painstaking work. "So, we employed solid electrolytes that conduct protons and can be made of insoluble polymers or inorganic compounds, eliminating the need for salts," says Wang. Replacing the electrolyte with a solid matrix was just one improvement. The second was

Scientists have invented a new method for turning carbon dioxide into a liquid fuel that can efficiently store energy in fuel cells.

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coming up with a robust catalyst to speed up the conversion process. A common challenge is keeping a catalyst right where you want it, without it degrading and needing to be replaced over time. Bismuth is just the catalyst for the job. Bulkier than other metals capable of the same task, it won't move about as easily. You just need enough material to turn a lab-test into an industry. The research team found a solution here as well. "Currently, people produce catalysts on the milligram or gram scales," says the investigation's lead author, Chuan Xia. "We developed a way to produce them at the kilogram scale." The resulting device is engineered to channel the carbon dioxide through the catalyst where it transforms into a negatively charged molecule called formate. From there it diffuses into the solid electrolyte core, where it meets hydrogen ions released from a second catalytic reaction with water, resulting in a highly concentrated solution of formic acid. So far, the process has been shown to convert about 42 percent of the electricity from a power source into a chemical form that can be used in fuel cells. This electricity can easily come from a renewable source, such as a photovoltaic cell or a wind turbine, providing a neat new way to store energy from otherwise variable power supplies. "It's also fundamental in the chemical engineering industry as a feedstock for other chemicals, and a storage material for hydrogen that can hold nearly 1,000 times the energy of the same volume of hydrogen gas, which is difficult to compress," says Wang. "That's currently a big challenge for hydrogen fuel-cell cars." Mining the atmosphere for carbon dioxide in order to satisfy our growing energy demands amid climate change sounds like a winning solution. Technology is leaping ahead in finding ways to use our overabundance in greenhouse gases to wean ourselves off polluting fuels, from finding ways to use it to charge batteries to taking a leaf from nature's page and improving on photosynthesis itself. Meanwhile, other researchers are keen to turn it into a solid material resource. If not simply bury the stuff deep underground in rock form again. However, we do it, it's going to need to satisfy the economy before it does our sense of self-preservation. This research was published in Nature Energy.

Science Alert, 8 September 2019

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

In a Huge Milestone, Engineers Build a Working Computer Chip Out of Carbon Nanotubes

2019-09-11

Silicon has had a very good run as the material upon which all of our electronics are based, but it's starting to reach its limits. Now there's a

Scientists just made the largest working computer chip to date out of carbon nanotubes.

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new contender for running our computers and smartphones: carbon nanotubes. Scientists just made the largest working computer chip to date out of this hugely promising material. And it could represent the start of an entirely new kind of computing revolution. As silicon transistors (the devices that carry the 1s and 0s of computers) start to bump up against the limits of physics in terms of size and density, the evidence so far points to carbon nanotubes being a faster and more energy efficient option. Processors (lots of transistors packed together) made from carbon nanotubes could help computing take the next leap forward. In this new study, researchers used rolled up sheets of carbon, each a single atom thick, to form 14,000 carbon nanotube field-effect transistors (CNFETs) – up from a previous attempt in 2013 that managed 178 transistors. “This is by far the most advanced chip made from any emerging nanotechnology that is promising for high-performance and energy-efficient computing,” says computer scientist Max Shulaker, from the Massachusetts Institute of Technology (MIT). “There are limits to silicon. If we want to continue to have gains in computing, carbon nanotubes represent one of the most promising ways to overcome those limits. [The paper] completely reinvents how we build chips with carbon nanotubes.” The 16-bit processor (the more bits, the more complexity) was even functional enough to run a basic program, producing the words “Hello, World! I am RV16XNano, made from CNTs” (Carbon Nanotube Transistors). What’s even more impressive is that the previous attempt at a chip involved only one a single bit. While carbon nanotubes have a lot of potential, manufacturing them into transistors is a real challenge. That’s due to defects in the material that mean some CNFETs don’t keep their semiconductor properties (the ability to conduct a current when voltage is applied), while others ‘clump together’ and impair the workings of the processor. Both these problems were overcome by the researchers. One of the fixes involved working out circuit designs that wouldn’t be affected by any CNFETs not semiconducting as they should be, allowing a little more room for error in the manufacturing processes. Currently, the material used in these chips requires 99.999999 percent purity, which is virtually impossible. The new technique only requires 99.99 percent purity, which still sounds high, but is actually 10,000 times less. While the team tweaked various parts of the manufacturing process, including adding an oxide compound layer, much of the processor construction process is the same as it is with silicon, and that bodes well for eventually replacing silicon with carbon nanotubes. “This work takes a big step forward and gets much closer to a commercial chip,” physicist Yanan Sun from the Shanghai Jiao Tong University in China, who wasn’t involved in the research, told Nature. These are promising times for computer scientists looking to explore a world of machines that

go beyond the limitations of silicon – finding a replacement for silicon is also an important part of developing practical quantum computers. We're not all the way there yet though: what we're seeing here is a proof-of-concept that hasn't yet been proved to be faster or more energy efficient than a comparable silicon processor. The team admits there's plenty of room for improvement. However, 14,000 transistors are a major step up from 178 transistors, and with the improvements made to the manufacturing process, the researchers reckon these chips could be viable within five years. "We think it's no longer a question of if, but when," says Shulaker. The research has been published in Nature.

Science Alert, 7 September 2019

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

Hard as a diamond? Scientists predict new forms of superhard carbon

2019-09-11

Superhard materials can slice, drill and polish other objects. Now, science is opening the door to the development of new materials with these seductive qualities. Researchers have used computational techniques to identify 43 previously unknown forms of carbon that are thought to be stable and superhard -- including several predicted to be slightly harder than or nearly as hard as diamonds. Now, science is opening the door to the development of new materials with these seductive qualities. Researchers have used computational techniques to identify 43 previously unknown forms of carbon that are thought to be stable and superhard -- including several predicted to be slightly harder than or nearly as hard as diamonds. Each new carbon variety consists of carbon atoms arranged in a distinct pattern in a crystal lattice. The study -- published on Sept. 3 in the journal Computational Materials -- combines computational predictions of crystal structures with machine learning to hunt for novel materials. The work is theoretical research, meaning that scientists have predicted the new carbon structures but have not created them yet. "Diamonds are right now the hardest material that is commercially available, but they are very expensive," says University at Buffalo chemist Eva Zurek. "I have colleagues who do high-pressure experiments in the lab, squeezing materials between diamonds, and they complain about how expensive it is when the diamonds break. "We would like to find something harder than a diamond. If you could find other materials that are hard, potentially you could make them cheaper. They might also have useful properties that diamonds don't have. Maybe they will interact differently with heat or

Researchers have used computational techniques to identify 43 previously unknown forms of carbon that are thought to be stable and superhard -- including several predicted to be slightly harder than or nearly as hard as diamonds.

electricity, for example." Zurek, PhD, a professor of chemistry in UB College of Arts and Sciences, conceived of the study and co-lead the project with Stefano Curtarolo, PhD, professor of mechanical engineering and materials science at Duke University.

The quest for hard materials

Hardness relates to a material's ability to resist deformation. As Zurek explains, it means that "if you try to indent a material with a sharp tip, a hole will not be made, or the hole will be very small." Scientists consider a substance to be superhard if it has a hardness value of over 40 gigapascals as measured through an experiment called the Vickers hardness test. All of the study's 43 new carbon structures are predicted to meet that threshold. Three are estimated to exceed the Vickers hardness of diamonds, but only by a little bit. Zurek also cautions that there is some uncertainty in the calculations. The hardest structures the scientists found tended to contain fragments of diamond and lonsdaleite -- also called hexagonal diamond -- in their crystal lattices. In addition to the 43 novel forms of carbon, the research also newly predicts that a number of carbon structures that other teams have described in the past will be superhard.

Speeding up discovery of superhard materials

The techniques used in the new paper could be applied to identify other superhard materials, including ones that contain elements other than carbon. "Very few superhard materials are known, so it's of interest to find new ones," Zurek says. "One thing that we know about superhard materials is that they need to have strong bonds. Carbon-carbon bonds are very strong, so that's why we looked at carbon. Other elements that are typically in superhard materials come from the same side of the periodic table, such as boron and nitrogen." To conduct the study, researchers used XtalOpt, an open-source evolutionary algorithm for crystal structure prediction developed in Zurek's lab, to generate random crystal structures for carbon. Then, the team employed a machine learning model to predict the hardness of these carbon species. The most promising hard and stable structures were used by XtalOpt as "parents" to spawn additional new structures, and so on. The machine learning model for estimating hardness was trained using the Automatic FLOW (AFLOW) database, a huge library of materials with properties that have been calculated. Curtarolo's lab maintains AFLOW and previously developed the machine learning model with Olexandr Isayev's group at the University of North Carolina at Chapel Hill. "This is accelerated material development. It's always going to take time, but we use AFLOW and machine learning to greatly accelerate the

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process," Curtarolo says. "The algorithms learn, and if you have trained the model well, the algorithm will predict the properties of a material -- in this case, hardness -- with reasonable accuracy." "You can take the best materials predicted using computational techniques and make them experimentally," says study co-author Cormac Toher, PhD, assistant research professor of mechanical engineering and materials science at Duke University. The first and second authors of the new study are UB PhD graduate Patrick Avery and UB PhD student Xiaoyu Wang, both in Zurek's lab. In addition to these researchers, Zurek, Curtarolo and Toher, the co-authors of the paper include Corey Oses and Eric Gossett of Duke University and Davide Proserpio of the Università degli Studi di Milano. The research was funded by the U.S. Office of Naval Research, with additional support from the Università degli Studi di Milano, and computational support from UB's Centre for Computational Research.

Science Daily, 9 September 2019

<http://www.sciencedaily.com>

New salt-based propellant proven compatible in dual-mode rocket engines

2019-09-11

For dual-mode rocket engines to be successful, a propellant must function in both combustion and electric propulsion systems. Researchers from the University of Illinois at Urbana-Champaign used a salt-based propellant that had already been proven successful in combustion engines, and demonstrated its compatibility with electro spray thrusters. "We need a propellant that will work in both modes," said Joshua Rovey, associate professor in the Department of Aerospace Engineering in The Grainger College of Engineering at the U of I. "So, we created a propellant that is a mixture of two commercially available salts -- hydroxylammonium nitrate and emim ethylsulfate. We have published other research papers showing that salt propellants work in the high-acceleration combustion mode. Now we know that this unique combination of salts will also work in the electric fuel-efficient mode." With electro spray or colloid propulsion, the thrusters electrostatically accelerate ions and droplets from these liquids. It's a technique that started in the biology/chemistry community, then the propulsion community began looking at it about 20 years ago. Rovey explained that liquid is fed through a very small diameter needle, or capillary tube. At the tip of the tube, a strong electric field is applied that interacts with the liquid in the tube because the liquid itself is a conductor. The liquid responds to that electric field. Small droplets and ions get

For dual-mode rocket engines to be successful, a propellant must function in both combustion and electric propulsion systems. Researchers have now used a salt-based propellant that had already been proven successful in combustion engines, and demonstrated its compatibility with electro spray thrusters.

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pulled out of the liquid -- spraying them out of the tube or needle. In this study, in addition to showing that the propellant could be sprayed, Rovey said they were interested in learning what kinds of chemical species come out in the plume. "Because no one has ever tried this type of propellant before, we expected to see species that no one else has ever seen before and, in fact, we did." Rovey said they also saw a new swapping of the constituents that make up the two different salts. "We saw some of the hydroxylammonium nitrate salt bonding with the emim ethyl sulfate salt. The two are mixed together inside the propellant, and are constantly bonding with each other and then detaching. "There's a chaotic nature to the system and it was unclear how those interactions within the liquid itself would propagate and show up in the spray. There are no chemical reactions happening. It's just that we start with A and B separately and when they come out in the spray, A and B are bonded together," he said. Rovey said these findings shed a lot of light on what's happening in these mixtures of salts that are possible propellants for electrosprays. But it also opens doors to a lot of other questions that will lead to fundamental studies that try to understand the interactions within these propellants and how that translates into what comes out in the spray itself.

Science Daily, 9 September 2019

<http://www.sciencedaily.com>

One-atom switch supercharges fluorescent dyes

2019-09-11

It only took the replacement of one atom for Rice University scientists to give new powers to biocompatible fluorescent molecules. The Rice lab of chemist Han Xiao reported in the *Journal of the American Chemical Society* it has developed a single-atom switch to turn fluorescent dyes used in biological imaging on and off at will. The technique will enable high-resolution imaging and dynamic tracking of biological processes in living cells, tissues and animals. The Rice lab developed a minimally modified probe that can be triggered by a broad range of visible light. The patented process could replace existing photoactivatable fluorophores that may only be activated with ultraviolet light or require toxic chemicals to turn on the fluorescence, characteristics that limit their usefulness. The researchers took advantage of a phenomenon known as photo-induced electron transfer (PET), which was already known to quench fluorescent signals. They put fluorophores in cages of thiocarbonyl, the moiety responsible for quenching. With one-step organic synthesis, they replaced an oxygen atom in the cage with one of sulfur. That enabled

A lab developed a single-atom switch to turn fluorescent dyes used in biological imaging on and off at will.

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them to induce the PET effect to quench fluorescence. Triggering the complex again with visible light near the fluorescent molecule's preferred absorbance oxidized the cage in turn. That knocked out the sulfur and replaced it with an oxygen atom, restoring fluorescence. "All it takes to make these is a little chemistry and one step," said Xiao, who joined Rice in 2017 with funding from the Cancer Prevention and Research Institute of Texas (CPRIT). "We demonstrated in the paper that it works the same for a range of fluorescent dyes. Basically, one reaction solves a lot of problems." Researchers worldwide use fluorescent molecules to tag and track cells or elements within cells. Activating the tags with low-powered visible light rather than ultraviolet is much less damaging to the cells being studied, Xiao said, and makes the long exposures of living cells required by super-resolution imaging possible. Super-resolution experiments by Theodore Wensel, the Robert A. Welch Chair in Chemistry at Baylor College of Medicine, and his team confirmed their abilities, he said. "We feel this will be a really good probe for living-cell imaging," Xiao said. "People also use photoactivatable dye to track the dynamics of proteins, to see where and how far and how fast they travel. Our work was to provide a simple, general way to generate this dye." The researchers found their technique worked on a wide range of common fluorescent tags and could even be mixed for multicolour imaging of targeted molecules in a single cell.

Science Daily, 9 September 2019

<http://www.sciencedaily.com>

Scientists establish new way to test for drug resistant infections

2019-09-11

Scientists have developed a method to test whether an infection is resistant to common antibiotics. Beta-lactam antibiotics (such as penicillin) are one of the most important classes of antibiotics, but resistance to them has grown to such an extent that doctors often avoid prescribing them in favour of stronger drugs. Scientists from the University of York modified an antibiotic from the beta-lactam family so that it can be attached to a sensor, enabling them to detect the presence of bacteria resistant to treatment. The new method could lead to clinicians being able to rapidly detect whether an infection is treatable with common antibiotics, reserving stronger alternatives for the patients that need them most. Antimicrobial resistance (AMR) is a major global threat accelerated by the inappropriate use of antibiotics. Co-author of the study, Callum Silver, a Ph.D. student from the Department of Electronic Engineering,

The research team are now working with clinicians at York Teaching Hospital NHS Foundation Trust to integrate this modified antibiotic into a rapid diagnostic test for antimicrobial resistance in urinary tract infections.

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said: "If we continue to use antibiotics in the way we currently do, we may find ourselves in a situation where we can no longer use antibiotics to treat patients—resulting in millions of deaths per year." This study paves the way for the development of tests which will give doctors important information on the bacteria they are dealing with so that common antibiotics can be used whenever possible. Resistance to new antibiotics can emerge very quickly after they come into use and so we need to reserve them for when they are really needed. "The discovery may also help to identify and isolate resistant bacteria, reducing the chances of large outbreaks." One of the major ways in which bacteria become resistant to treatment is through the production of enzymes that can break down beta-lactam antibiotics, rendering them ineffective. The researchers were able to test for the presence of these resistance enzymes by attaching the modified antibiotic to a sensor surface which enabled them to see whether or not the drug was broken down. The researchers used multiple techniques to show that the drug is still accessible to the enzyme, meaning the modified antibiotic could be used to develop things like urine tests for AMR bacteria in patients. Callum Silver added: "The lack of diagnostic techniques to inform doctors whether or not they are dealing with resistant bacteria contributes to the problem of AMR." "This modified antibiotic could be applied to a variety of different biosensing devices for use at the point-of-care." Dr. Steven Johnson, Reader in the University's Department of Electronic Engineering, said: "This important study is the result of a close collaboration between physical, chemical and biological scientists at the University of York and lays the foundation for a new diagnostic test for drug resistant infections." "We are now working with clinicians at York Teaching Hospital NHS Foundation Trust to integrate this modified antibiotic into a rapid diagnostic test for antimicrobial resistance in urinary tract infections."

Phys.org, 9 September 2019

<http://phys.org>

Cheap water treatment

2019-09-11

There's nothing new in treating water by sorption of organic solvents such as trichloroethylene (TCE). But finding a method that neutralises these contaminants, instead of just shifting them somewhere else, is no mean feat. A team led by Anna Śrębowata, professor at the IPC has improved a method of catalytic hydrotreatment, that is, transforming TCE into hydrocarbons that are environmentally less harmful. Thanks

The new nickel catalysts synthesised at the Institute of Physical Chemistry PAS allow for extremely effective water treatment in flow mode removing harmful organochlorine compounds.

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to scientists from the IPC PAS, not only the water in our taps, but also in our rivers, can be cleaner and safer for human health. Clean water is a treasure, but also a resource that is becoming more and more scarce. Various contaminants are widespread, and some are extremely difficult to remove. Such pollutants include trichloroethylene (known in Poland as TRI). This organic solvent used to be commonly used in, amongst others, organic syntheses, dry cleaning and for the industrial degreasing of metals during their processing. Due to its negative impact, its use has been officially banned since 2016. However, considering its stability, it may remain in both the water and soil for many years to come, explains MSc. Emil Kowalewski, a member of the team that developed the innovative method of removing this compound from water. The project is part of a global trend focused on the protection of water resources. The research may be of interest to wastewater treatment plants and become a potential starting point for the development of innovative water treatment systems. Why? Today's wastewater treatment plants are systems consisting of many physical, chemical and biological processes, but they effectively eliminate mainly conventional pollutants. Others may remain in the water if their concentrations are high enough. "Meanwhile, trichloroethylene should not be in water at all, because it is mutagenic, carcinogenic, teratogenic...," says the scientist, "and what's more, extremely long-lasting. It accumulates and stays at the bottom of reservoirs, and since its solubility in water is very poor, it can remain harmful for many years to come." "Today we deal with such compounds mainly by the process of sorption. However, in this way we're only transferring the threat from one place to another. An attractive solution seems to be catalytic hydrotreatment, i.e. transforming the TCE into less harmful hydrocarbons. However, in order to fully exploit the potential of this method, it was necessary to develop an efficient, stable and cheap catalyst," says Dr. Anna Śrębowata, professor at the IPC. "Previously, we carried out research with palladium catalysts. They were effective but expensive," notes Emil Kowalewski. The new nickel catalysts, developed at the IPC PAS, allow for a cheap and effective method of conducting the process of water treatment in flow mode, and at the same time they are easy to synthesize. "Using a catalyst in which nickel nanoparticles with a diameter of about 20 nm are deposited on the surface of activated carbon, we combine the sorption properties of carbon and the catalytic activity of nickel," explains Kowalewski. In their research, the scientists from the IPC PAS also showed that nickel nanoparticles deposited on activated carbon with a partially ordered structure show higher activity and stability than an analogous catalyst based on a support with amorphous structure. The scientists are, however, proudest of the innovative element of their research—introduction of the flow technology

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to the water purification from TCE. Thanks to this, the parameters of the process can be optimised, the amount of waste can be reduced, and at the same time catalysts which were inefficient or even ineffective in batch reactors (i.e. where a specific batch of product is treated at one time) can be used. "This was the case with our nickel catalyst," says Kowalewski. "Without flow technology, its capacity to utilise TCE declined in time, and the catalyst underwent poisoning. In the flow reactor, even after 25 hours, we did not observe any decrease in activity, although we conducted research on concentrations about 8000 times higher than the Polish standards of its content in drinking water. Where can the innovative method be used? Above all in water and wastewater treatment plants. Wherever we want the water reaching the end user to be clean, regardless of whether it's a user of tap water or a fish floating in the river. And what should be done with the products of the hydrotreatment of water to remove trichloroethylene? "The resulting compounds are hydrocarbons, mainly ethylene. But it's not enough for a banana maturation plant," smiles the scientist half-jokingly. "It will simply escape..."

Phys.org, 9 September 2019

<http://phys.org>

Selenium anchors could improve durability of platinum fuel cell catalysts

2019-09-11

Platinum has long been used as a catalyst to enable the oxidation reduction reaction at the centre of fuel cell technology. But the metal's high cost is one factor that has hindered fuel cells from competing with cheaper ways of powering automobiles and homes. Now researchers at the Georgia Institute of Technology have developed a new platinum-based catalytic system that is far more durable than traditional commercial systems and has a potentially longer lifespan. The new system could, over the long term, reduce the cost of producing fuel cells. In the study, which was published July 15 in the ACS journal Nano Letters, the researchers described a possible new way to solve one of the key causes of degradation of platinum catalysts, sintering, a process in which particles of platinum migrate and clump together, reducing the specific surface area of the platinum and causing the catalytic activity to drop. To reduce such sintering, the researchers devised a method to anchor the platinum particles to their carbon support material using bits of the element selenium. "There are strategies out there to mitigate sintering, such as using platinum particles that are uniform in size to reduce chemical

Researchers have developed a new platinum-based catalytic system that is far more durable than traditional commercial systems and has a potentially longer lifespan. The new system could, over the long term, reduce the cost of producing fuel cells.

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instability among them,” said Zhengming Cao, a visiting graduate student at Georgia Tech. “This new method using selenium results in a strong metal-support interaction between platinum and the carbon support material and thus remarkably enhanced durability. At the same time, the platinum particles can be used and kept at a small to attain high catalytic activity from the increased specific surface area.” The process starts by loading nanoscale spheres of selenium onto the surface of a commercial carbon support. The selenium is then melted under high temperatures so that it spreads and uniformly covers the surface of the carbon. Then, the selenium is reacted with a salt precursor to platinum to generate particles of platinum smaller than two nanometres in diameter and evenly distributed across the carbon surface. The covalent interaction between the selenium and platinum provides a strong link to stably anchor the platinum particles to the carbon. “The resulting catalyst system was remarkable both for its high activity as a catalyst as well as its durability,” said Younan Xia, professor and Brock Family Chair in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University. Because of the increased specific surface area of the nanoscale platinum, the new catalytic system initially showed catalytic activity three and a half times higher than the pristine value of a state-of-the-art commercial platinum-carbon catalyst. Then, the research team tested the catalytic system using an accelerated durability test. Even after 20,000 cycles of electropotential sweeping, the new system still provided a catalytic activity more than three times that of the commercial system. The researchers used transmission electron microscopy at different stages of the durability test to examine why catalytic activity remained so high. They found that the selenium anchors were effective in keeping most of the platinum particles in place. “After 20,000 cycles, most of the particles remained on the carbon support without detachment or aggregation,” Cao said. “We believe this type of catalytic system holds great potential as a scalable way to increase the durability and activity of platinum catalysts and eventually improve the feasibility of using fuel cells for a wider range of applications.”

Science Daily, 6 September 2019

<http://www.sciencedaily.com>

Secret messages hidden in light-sensitive polymers

2019-09-11

DNA is a long chemical sequence that carries genetic information. Inspired by this biological system, in recent years many research teams

Scientists have recently shown how valuable light-sensitive macromolecules are: when exposed to the right wavelength of light, they can be transformed so as to change, erase or decode the molecular message that they contain.

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have been exploring how to store and then decode information within synthetic macromolecules, also called polymers*. In a leap forward in this field, researchers at the Institut Charles Sadron (CNRS) and the Institut de Chimie Radicalaire (CNRS/Aix-Marseille Université) have developed light-sensitive polymers where light can change the information stored on the molecular scale. Three types of information change have been shown in this work: revealing, changing and erasing a message. These French scientists have shown that some polymers can act like invisible ink: when exposed to the appropriate wavelength, their monomers are transformed, and the sequence becomes legible. The message only appears if it is subjected to the right light source. This is the first example of a secret message stored on a molecule. This study also shows that monomers being changed by light can be used to erase or change the information contained in some polymers. Chemists have for example 'transformed copper into gold' by changing the chemical symbol for copper written on a polymer, Cu, into the chemical symbol for gold, Au. The polymers are 'read' using mass spectrometry, a technology used routinely in many analytical laboratories. The teams involved in this recent work now wish to continue it by exploring how to control the physical properties of the polymers using light, for applications other than information storage and decoding, such as design of new materials. - A polymer is composed of simple chemical units, monomers. A polymer can take the shape of a sequence of two different monomers that can be read as 0 or 1 in a message written in binary notation.

Science Daily, 4 September 2019

<http://www.sciencedaily.com>

Stretchy plastic electrolytes could enable new lithium-ion battery design

2019-09-11

The growing popularity of lithium-ion batteries in recent years has put a strain on the world's supply of cobalt and nickel - two metals integral to current battery designs - and sent prices surging. In a bid to develop alternative designs for lithium-based batteries with less reliance on those scarce metals, researchers at the Georgia Institute of Technology have developed a promising new cathode and electrolyte system that replaces expensive metals and traditional liquid electrolyte with lower cost transition metal fluorides and a solid polymer electrolyte. "Electrodes made from transition metal fluorides have long shown stability problems and rapid failure, leading to significant scepticism about their ability to be

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used in next generation batteries," said Gleb Yushin, a professor in Georgia Tech's School of Materials Science and Engineering. "But we've shown that when used with a solid polymer electrolyte, the metal fluorides show remarkable stability - even at higher temperatures - which could eventually lead to safer, lighter and cheaper lithium-ion batteries." In a typical lithium-ion battery, energy is released during the transfer of lithium ions between two electrodes - an anode and a cathode, with a cathode typically comprising lithium and transition metals such as cobalt, nickel and manganese. The ions flow between the electrodes through a liquid electrolyte. For the study, which was published 9 September in the journal *Nature Materials* and sponsored by the Army Research Office, the research team fabricated a new type of cathode from iron fluoride active material and a solid polymer electrolyte nanocomposite. Iron fluorides have more than double the lithium capacity of traditional cobalt- or nickel-based cathodes. In addition, iron is 300 times cheaper than cobalt and 150 times cheaper than nickel. To produce such a cathode, the researchers developed a process to infiltrate a solid polymer electrolyte into the prefabricated iron fluoride electrode. They then hot pressed the entire structure to increase density and reduce any voids. Two central features of the polymer-based electrolyte are its ability to flex and accommodate the swelling of the iron fluoride while cycling and its ability to form a very stable and flexible interphase with iron fluoride. Traditionally, that swelling and massive side reactions have been key problems with using iron fluoride in previous battery designs. "Cathodes made from iron fluoride have enormous potential because of their high capacity, low material costs and very broad availability of iron," Yushin said. "But the volume changes during cycling as well as parasitic side reactions with liquid electrolytes and other degradation issues have limited their use previously. Using a solid electrolyte with elastic properties solves many of these problems." The researchers then tested several variations of the new solid-state batteries to analyse their performance over more than 300 cycles of charging and discharging at elevated temperature of 122 degrees Fahrenheit, noting that they outperformed previous designs using metal fluoride even when these were kept cool at room temperatures. The researchers found that the key to the enhanced battery performance was the solid polymer electrolyte. In previous attempts to use metal fluorides, it was believed that metallic ions migrated to the surface of the cathode and eventually dissolved into the liquid electrolyte, causing a capacity loss, particularly at elevated temperatures. In addition, metal fluorides catalysed massive decomposition of liquid electrolytes when cells were operating above 100 degrees Fahrenheit. However, at the connection between the solid electrolyte and the cathode, such

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dissolving doesn't take place and the solid electrolyte remains remarkably stable, preventing such degradations, the researchers wrote. "The polymer electrolyte we used was very common, but many other solid electrolytes and other battery or electrode architectures - such as core-shell particle morphologies - should be able to similarly dramatically mitigate or even fully prevent parasitic side reactions and attain stable performance characteristics," said Kostiantyn Turcheniuk, research scientist in Yushin's lab and a co-author of the manuscript. In the future, the researchers aim to develop new and improved solid electrolytes to enable fast charging and also to combine solid and liquid electrolytes in new designs that are fully compatible with conventional cell manufacturing technologies employed in large battery factories.

EurekAlert, 9 September 2019

<http://www.eurekalert.org>

Electrochemistry breakthrough simplifies creation of coveted molecules for drugs, electronics

2019-09-11

A new chemistry method from scientists at Scripps Research in La Jolla, California, greatly simplifies the creation of an important class of compounds called hindered ethers, which are integral to many drugs and commercial products. Hindered ethers are often coveted for their special properties, but until now have required laborious methods to synthesise. The new method, reported in *Nature*, may also help bring "electrochemistry" into the mainstream of modern medicinal chemistry. Electrochemistry involves passing a current through a compound in liquid solution to generate a key reactive component. Traditional electrochemistry techniques are often very limited in their scope, but the Scripps Research scientists demonstrated the broad versatility of their technique by showing that it can perform faster, higher-yield syntheses of dozens of hindered ethers used in products today. "These are compounds that historically have required more than a dozen steps and more than a week of work to synthesize using standard methods," says Phil Baran, PhD, the Darlene Shiley Chair in Chemistry at Scripps Research and senior author of the study. "With our method, the compounds can be made in just a few steps--often in less than a day--and for that reason, drug companies that know of this new method already have started using it." Hindered ethers are particularly prized as structures in medicines because they can be made to powerfully resist enzymes in the human body that would otherwise degrade the drug molecules quickly. Yet the

New method for making hindered ethers significantly improves production yield while reducing expense and reaction steps

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standard approach to creating ethers, a 168-year-old process known as the “Williamson ether synthesis,” becomes unwieldy when the desired ether includes bulky side-groups of atoms. These atoms can hinder the ether’s reactivity (thus, the term “hindered”). Baran and his team in recent years began exploring new electrochemical methods with the hope of improving upon this old, yet somewhat neglected, realm of chemistry to create valuable molecules that were otherwise hard or impossible to make. To address the problem of synthesising hindered ethers, they investigated a little-used electrochemical method called the Hofer-Moest reaction, first published in 1902. This method can generate an important reactive intermediate molecule known as a carbocation (“carbo-cat-ion”) needed for ether synthesis from an inexpensive carboxylic acid. However, this method requires a high electric current and an expensive setup, including platinum electrodes. These and other factors have severely limited this reaction’s utility. Over the course of hundreds of experiments, Baran and his team developed their own easier and more versatile technique, which uses a low electric current compatible with the simplest electrochemistry equipment, a cheap carbon electrode, and improved solvents and electrolytes. In their paper, Baran and his colleagues describe more than 80 examples of hindered ethers they were able to create using the new method. These include:

- A key building-block of a potential cancer drug, which the team synthesised in just 15 hours with a yield of 51 percent, compared with six days and 3.4 percent yield for the standard method;
- A key building-block of a potential diabetes drug, which the team synthesised in three hours in a single step, compared with 2.5 days and five steps for the previous method;
- A key building-block of a potential HIV drug, which the team synthesised cheaply with one step in three hours, compared with six steps and two days, with a requirement for expensive reaction materials, for the previous method;
- A key building-block of liquid crystals used in LCD monitors, which the team made in one step in three hours, compared with four steps in two days for the previous method. LCD technology is widely used in products such as laptops, flat-screen TVs, digital cameras and watches.

In a selection of these and eight other real-world examples, the team found that the new method enabled an average yield of 43 percent, average step count of 1.5 and average time of 9.8 hours, compared with averages of 19 percent, 6.3 steps and about 100 hours using previous methods. “These are compounds that we know people care about and

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are making, so we expect this method to have a real impact," Baran says. He notes that the new method can be used at small or modest scales—for example, for the exploratory chemistry of drug discovery—but also for large-scale chemical production. Additionally, the method makes it easy for medicinal chemists to generate sets or "libraries" of closely related compounds; they can use the same basic setup and starting compound, and simply vary some of the reaction ingredients. The study was a collaboration with the laboratory of Donna Blackmond, PhD, professor and co-chair of chemistry at Scripps Research. "The contributions from Donna and her students were critical in helping us develop this chemistry," Baran says. "They elucidated a molecular understanding of each of the processes occurring in the reaction flask, so we could rationally optimise the new method." Baran and his team are now exploring other potential applications of their method. "Its ability to generate highly reactive carbocations under mild conditions suggests that we might be able to use it to make other classes of molecules that were previously inaccessible," Baran says.

EurekAlert, 9 September 2019

<http://www.eurekalert.org>

Scientists demonstrate how to improve steel properties

2019-09-11

Scientists from Tomsk Polytechnic University have updated the alloying process, i.e. improving the properties of metal with impurities, which not only enhances the wear resistance of materials but also provides new qualities required by hi-tech manufacturing, science, and energy. The study results were published in the journal *Surface and Coatings Technology* and presented at the conference on Surface Modification of Materials by Ion Beams (SMMIB) 2019 that recently took place in Tomsk. By now, traditional alloying methods are reported to have exhausted their technological potential. Therefore, metals are increasingly exposed to beams of charged particles, plasma flows, and laser radiation so as to obtain advanced materials. Ion implantation (ion doping) is one of those methods that can change elemental composition, microstructure, and morphology of surface layers that determine such properties as wear resistance, corrosion resistance, and others. Tomsk scientists developed a new method of ion implantation that dramatically expands the applications of the method in industry. According to Alexander Ryabchikov, the head of the Laboratory for Highly Intensive Ion Implantation, they have been able to experimentally improve the wear

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resistance of stainless steel by more than a hundred times. In addition, this technology makes it possible to manufacture details and products with needed specific surface properties. For example, a barrier layer is formed by ion doping of zirconium with titanium, thus preventing oxygen penetration. This can be used to increase the service life and safety of operation of nuclear fuel cells. Currently, the industrial use of ion doping is constrained by the small thickness of the formed ion-doped layers. The issue to be addressed through the increased kinetic energy of the ion flux implies the use of large accelerators, which is not cost-effective. "We proposed to increase the ion penetration depth into the material by enhancing the radiation-induced diffusion with high-density ion beams that are two to three orders of magnitude superior to those used in traditional ion implantation," said Alexander Ryabchikov. The results obtained in the laboratory confirm the possibility of creating a doped surface layer with a depth of several hundred micrometres, while other methods of ion doping enable a depth of several tens and hundreds of nanometres. The authors emphasise that the development of highly intensive implantation of ions with low energy could revolutionise the technology of improving material properties. Further research in this field will enable us to reduce the cost of the technology application and improve the quality of products.

Phys.org, 5 September 2019

<http://phys.org>

Extracting clean fuel from sunlight

2019-09-11

Securing enough energy to meet human needs is one of the greatest challenges society has ever faced. Previously reliable sources—oil, gas and coal—are degrading air quality, devastating land and ocean and altering the fragile balance of the global climate, through the release of CO₂ and other greenhouse gases. Meanwhile, earth's rapidly industrialising population is projected to reach 10 billion by 2050. Clean alternatives are a matter of urgent necessity. Researchers at ASU's Biodesign Centre for Applied Structural Discovery are exploring new technologies that could pave the way to clean, sustainable energy to help meet daunting global demand. In new research appearing in the *Journal of the American Chemical Society* (JACS), the flagship journal of the ACS, lead author Brian Wadsworth, along with colleagues Anna Beiler, Diana Khusnutdinova, Edgar Reyes Cruz, and corresponding author Gary Moore describe technologies that combine light-gathering semiconductors and catalytic

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materials capable of chemical reactions that produce clean fuel. The new study explores the subtle interplay of the primary components of such devices and outlines a theoretical framework for understanding the underlying fuel-forming reactions. The results suggest strategies for improving the efficiency and performance of such hybrid technologies, bringing them a step closer to commercial viability. The production of hydrogen and reduced forms of carbon by these technologies could one day supplant fossil fuel sources for a broad range of reduced carbon commodities, including fuels, plastics and building materials. "In this particular work we've been developing systems that integrate light capture and conversion technologies with chemical-based energy storage strategies," says Moore, who is an assistant professor in ASU's School of Molecular Sciences. Rather than direct generation of electricity from sunlight, this new breed of technology uses solar energy to drive chemical reactions capable of producing fuels, which store the sun's energy in chemical bonds. "That's where catalysis becomes extremely important. It's the chemistry of controlling both the selectivity of reactions and the overall energy requirements for driving those transformations," Moore says.

Something new under the sun

One of the most attractive sources for sustainable, carbon-neutral energy production is both ancient and abundant: sunlight. Indeed, adoption of solar energy technologies has gained significant momentum in recent years. Photovoltaic (PV) devices, or solar cells, gather sunlight and transform the energy directly into electricity. Improved materials and lowered costs have made photovoltaics an attractive energy option, particularly in sun-drenched states like Arizona, with large solar arrays covering multiple acres capable of powering thousands of homes. "But just having access to solar power using photovoltaics is not enough," Moore notes. Many renewables like sunlight and wind power are not always available, so storage of intermittent sources is a key part of any future technology to meet global human energy demands on a large scale. As Moore explains, borrowing a page from Nature's handbook may help researchers harness the sun's radiant energy to generate sustainable fuels. "One thing is clear," Moore says. "We are likely to continue using fuels as part of our energy infrastructure for the foreseeable future, especially for applications involving ground and air transportation. That's where the bioinspired part of our research becomes particularly relevant—looking to Nature for hints as to how we might develop new technologies for producing fuels that are carbon free or neutral."

Solar flair

One of Nature's more impressive tricks involves the use of sunlight to produce energy-rich chemicals, a process mastered billions of years ago by plants and other photosynthetic organisms. "In this process, light is absorbed, and the energy is used to drive a series of complex biochemical transformations that ultimately produce the foods we eat and, over long geological time scales, the fuels that run our modern society," Moore says. In the current study, the group analysed key variables governing the efficiency of chemical reactions used to produce fuel through various artificial devices. "In this paper, we've developed a kinetic model to describe the interplay between light absorption at the semiconductor surface, charge migration within the semiconductor, charge transfer to our catalyst layer and then the chemical catalysis step," said Wadsworth. The model the group developed is based on a similar framework governing enzyme behaviour, known as Michaelis-Menten kinetics, which describes the relationship between enzymatic reaction rates and the medium in which the reaction takes place (or substrate). Here, this model is applied to technological devices combining light-harvesting semiconductors and catalytic materials for fuel formation. "We describe the fuel-forming activities of these hybrid materials as a function of light intensity and also the potential," Wadsworth says. (Similar Michaelis-Menten-type kinetic models have proven useful in analysing such phenomena as antigen-antibody binding, DNA-DNA hybridization, and protein-protein interaction.) In modelling the dynamics of the system, the group made a surprising discovery. "In this particular system we are not limited by how fast the catalyst can drive the chemical reaction," Moore says. "We're limited by the ability to deliver electrons to that catalyst and activate it. That is related to the light intensity striking the surface. Brian, Anna, Diana, and Edgar have shown in their experiments that increasing the light intensity increases the rate of fuel formation." The discovery has implications for the future design of such devices with an eye toward maximising their efficiencies. "Simply adding more catalyst to the surface of the hybrid material does not result in greater rates of fuel production. We need to consider the light absorbing properties of the underpinning semiconductor, which in turn forces us think more about the selection of the catalyst and how the catalyst interfaces with the light absorbing component."

Ray of hope

Much work remains to be done before such solar-to-fuels solutions are ready for prime time. Making technologies like these practical for

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human demands requires efficiency, affordability and stability. "Biological assemblies have the ability to self-repair and reproduce; technological assemblies have been limited in this aspect. It's one area where we can learn more from biology," Moore says. The task could hardly be more urgent. Global demand for energy is projected to swell from around 17 terawatts today to a staggering 30 terawatts by mid-century. In addition to significant scientific and technological hurdles, Moore stresses that profound policy changes will also be essential. "There's a real question of how we're going to meet our future energy demands. If we're going to do it in an environmentally conscious and egalitarian manner, it's going to take a serious political commitment." The new research is a step on the long pathway to a sustainable future. The group notes that their findings are important because they are likely relevant to a wide range of chemical transformations involving light-absorbing materials and catalysts. "The key principles, particularly the interplay between illumination intensity, light absorption and catalysis should apply to other materials as well," Moore says.

Phys.org, 3 September 2019

<http://phys.org>

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Could Smoking Marijuana Help Men's Fertility?

2019-09-11

Men who smoke marijuana may have a better chance of having a baby with their female partner, compared with those who don't use the drug, a surprising new study suggests. The study, which was published 14 August in the journal *Human Reproduction*, involved several hundred couples undergoing fertility treatment with in vitro fertilisation (IVF). The researchers found that women who reported currently using marijuana had a higher likelihood of pregnancy loss, compared with women who didn't use marijuana. In contrast, couples whose male partner said he currently used marijuana had better chances of having a child, compared with couples whose male partner didn't currently use marijuana. This finding was unexpected, according to the authors, from the Harvard T.H. Chan School of Public Health in Boston. The researchers had hypothesized that marijuana smoking wouldn't be related to fertility outcomes in either men or women, as has been the case in previous studies. But the new result agrees with findings in an earlier study from the same group of researchers. In that study, men who reported ever having smoked marijuana had higher sperm counts, on average, than those who had never used the drug. Still, the new findings don't mean that men should start smoking marijuana to boost their fertility. Only a small number of participants said they smoked marijuana around the time of their fertility treatments, which reduces the strength of the results. At most, they suggest that marijuana may not have a harmful effect on men's fertility, the authors said. On the other hand, the researchers don't think their findings should be taken as evidence that marijuana has a beneficial effect for men undergoing fertility treatment. There is an urgent need for "additional research to clarify the role of marijuana use on human reproduction and on the offspring's health," the authors concluded. Despite the growing use and legalization of marijuana around the world, scientists know little about how the drug impacts fertility. And few studies have included both men and women. In the new study, the researchers analysed information from 200 couples who underwent fertility treatment at Massachusetts General Hospital between 2005 and 2017. The researchers also included data from an additional 220 women who underwent fertility treatment, but did not have a partner in the study. Participants were asked whether they were currently using marijuana, had used the drug in the past or had never used it. Overall, 44% of the women and 61% of the men in the study reported they had smoked marijuana at some point in their lives. But just 12 women (3%) and 23 men (12%) in the study said they were currently using marijuana. Among the small

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number of women who said they currently smoked marijuana and became pregnant during the study, more than 50% experienced a pregnancy loss, compared with just 26% of the women who were past marijuana users or who had never used the drug. This finding suggests that marijuana use among women “may be related to worse infertility treatment outcomes,” the authors said. But they caution that since very few women in the study were current marijuana users, it’s possible that this finding was due to chance. On the other hand, among couples whose male partner was a current marijuana user, 48% eventually had a live birth, compared with just 29% of couples whose male partner was a past marijuana user or who had never used it. The link held even after the researchers took into account some factors that could affect fertility, including the participants’ age, ethnicity, body mass index (BMI), tobacco smoking history, coffee intake, alcohol use and cocaine use. More and more patients are asking about the reproductive effects of marijuana, but doctors have had few studies to share when advising patients. “At least weekly, I have patients asking me about the effects of marijuana on male fertility,” said Dr. Neel Parekh, a urologist specialising in male fertility and men’s health at the Cleveland Clinic’s Glickman Urological & Kidney Institute. “There just isn’t a great answer we can give them yet.” In this sense, the new study is “a step in the right direction,” Parekh told Live Science. However, the new study by itself isn’t enough for doctors to recommend that men smoke marijuana prior to fertility treatment. Parekh noted that, with only 23 men in the study reporting current use of marijuana, “It’s hard to make that big of a statement saying marijuana is going to improve success rates” with fertility treatment. But Parekh agreed with the authors that, rather than showing a benefit per se, the study suggests that smoking marijuana may not hurt the chances of success with fertility treatment when the male partner uses it. The study authors note that their work included couples undergoing fertility treatment, and so the findings may not apply to couples trying to conceive without medical assistance. Indeed, Parekh noted that some forms of IVF use only a single sperm to fertilise an egg, and so with these treatments, a man’s sperm count isn’t usually a big deal. But when couples are trying to conceive naturally, sperm count matters more. In addition, the new study only asked about marijuana smoking and not other forms of marijuana use. More robust studies are now needed to look at this issue, said Parekh, and he expects to see more research in this area in the coming years.

Live Science, 28 August 2019

<http://www.livescience.com>

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Refreezing the Arctic: How to bring the ice back with geoengineering

2019-09-11

The Arctic is in a death spiral. The top of our world is heating up faster than anywhere else on the planet, setting new records for the speed and area of ice melt. We are on track this year to have one of the lowest summer sea ice coverages so far. It is a huge problem, because what happens in the Arctic doesn't stay in the Arctic. What's more, the Greenland ice sheet, which alone contains enough water to raise global sea levels by 6 metres, is disappearing. The frozen Arctic soil and sediment, or permafrost, is melting, releasing more and more carbon dioxide and methane into the atmosphere. This year, vast wildfires in the peatlands of Siberia have blazed for more than a month, and the Arctic warming is playing havoc with weather systems in the northern hemisphere too. But if you prefer to think simply in terms of money, the economic impact of unmitigated Arctic warming by the end of this century was recently estimated to be \$67 trillion. As US congressman Jerry McNerney says: "When it comes to the Arctic, we're in deep shit." You've heard the slogans: we are living in a time of climate emergency. But it is no good declaring an emergency without summoning help. So here it is: let's refreeze the Arctic. There are several imaginative ideas to manipulate its climate system to get the ice back. They won't be cheap or easy, but some researchers argue that the crisis in the north is too serious not to at least investigate ways to engineer the return of the ice. Climate intervention in the Arctic might be more necessary than it first appears because the region's death spiral is a feedback loop. As the shiny ice melts, models and satellite images suggest we could get a sea ice-free summer any year now. When the ocean is exposed, instead of reflecting sunlight, the dark water absorbs more of the sun's heat. Over the past 30 years, this change corresponds to a warming equivalent to a quarter of all the carbon dioxide released by human activity during that time. The warming is weakening the polar jet stream – the fast-flowing, high-altitude air current – in the northern hemisphere, resulting in more "blocked" weather patterns, and corresponding droughts, floods and heatwaves. The global risks are huge. "Allowing the Arctic to change in unrecoverable ways poses an enormous safety risk to communities around the world and could move the climate system beyond our ability to recover," says Kelly Wanser, director of SilverLining, a geoengineering NGO based in Washington DC. Of course, we could have prevented the Arctic from warming as much as it has if we had cut global greenhouse gas emissions when scientists first started advising us to do so, decades ago. But we didn't, and nor are we now. "It's a pious

The Arctic is heating up faster than anywhere else on Earth and the only way to save the ice may be to intervene directly. We look at the three ambitious projects that aim to do just that

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hope and anyway it would take a while," says Peter Wadhams, head of the Polar Ocean Physics Group at the University of Cambridge. This is why a growing number of scientists argue that, if we want to save the Arctic, we need to intervene directly by manipulating its climate system. There are three main proposals for doing this: increasing the extent of sea ice; artificially brightening the surface of the ice to reflect more sunlight; and cooling the Arctic air by brightening the clouds to deflect sunlight. All three ideas are forms of geoengineering: intervention in the environment on a scale big enough to counteract climate change. The concept bothers many scientists because they fear that the idea of a technological fix will undermine efforts to cut carbon dioxide emissions. "Well, we're not making them anyway," says Cecilia Bitz, a sea ice physicist at the University of Washington in Seattle. "Maybe intervention would be positive, showing that we have the capacity to improve the environment." For those advocating such action, a big concern is the methane already streaming out of the seabed as microbes break down thawed organic matter. "The fear is that this will grow from being a set of methane plumes to an outbreak," says Wadhams. "So, we need to bring back the ice around the coastal seas, and that might save us from a catastrophic methane burst." As well as this methane trapped under the sea, an estimated 1 trillion tonnes of carbon are in the top 3 metres of Arctic soils. If only a small fraction of this reaches the atmosphere, it will overwhelm any cuts in emissions we have made. "It seems that nature offers us a choice: instant methane from the seabed giving us a huge immediate burst of warming, or longer, slower warming from complex chemical processes as terrestrial permafrost thaws. Except that it's not an 'or', it's an 'and'!" The first potential solution comes from Steve Desch, an astrophysicist at Arizona State University. His plan is to build windmills that pump seawater onto surface ice during the winter, where it will freeze, thickening the sea ice and extending its coverage. This method was recently proposed to prevent the collapse of the Antarctic ice sheet too. Sea ice moves around, so Desch's idea is to locate the windmill-pumps on sea ice in the north of the Arctic. This would help thicken chunks of ice that are then protected from melting when they move south. "While that may seem like an impossible task, since the Arctic is a very large place, we outlined a mechanism, using simple, brute-force, steampunk technology that is not impossible, but enormous in scope," he says. "It's not like a space mirror larger than the Earth or something. It's pretty simple, but just a big job."

Desch has calculated that we would need 10 million windmills across the entire Arctic to refreeze it, at a cost of \$500 billion. That is a huge sum, but just a fraction of the estimated \$67 trillion economic impact of

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Arctic warming if we don't act. Bitz has evaluated Desch's idea in a paper currently submitted for publication. "The physics can work," she says. "The basic principles make sense. To me that's promising." But so far, Desch only has a prototype windmill that works in the lab. For a true test, field trials are essential. The second proposal for geoengineering the Arctic has had some success outside the lab. It involves covering the ice with shiny, white beads. The idea is that these microbeads increase the reflectiveness, or albedo, of thin, young ice, so protecting it from the sun. The leading advocate is Leslie Field, an engineer at Stanford University in California, who also runs Ice911 Research, a non-profit organisation exploring methods of restoring Arctic ice, mainly using hollow silica microspheres. These bright, non-toxic beads are chemically and physically similar to sand but smaller, more like powder, with a diameter of about 65 micrometres (0.065 millimetres). Field and her colleagues have tested the idea, most notably on about 4200 square metres of North Meadow Lake in Alaska. They have shown that the microspheres increase albedo by around 20 per cent and slow the ice melting. To cover 25,000 square kilometres of the Arctic with the stuff would cost about \$300 million for the materials alone, says Field. This represents just 0.7 per cent of summer ice coverage at its lowest extent on record: 3.4 million square kilometres in 2012. Yet many questions remain, not least whether it works on sea ice – so far it has only been tested on frozen lakes. And what happens to the beads when ice melts? Some sink and are incorporated into the mud on the lake floor, says Field. There are, however, concerns about the biological hazards of this approach. Bitz says she is worried about the ecological impact of adding millions of tonnes of silica to the Arctic. "For me this raises a red flag," she says. Ken Caldeira, who researches geoengineering at the Carnegie Institution for Science in California, has doubts about the workability of modifying the surface of the ice – whether by the methods proposed by Field or Desch – and about whether this could be an effective tool against climate change. "I am highly sceptical that this approach will prove feasible and desirable at scales required to be climatically substantial," he says. For Bitz, Wadhams and several other climate scientists who spoke to New Scientist, the most promising potential intervention is one that doesn't involve tinkering with the ice directly. Instead, it entails brightening the clouds over the Arctic. The idea dates back to the 1990s, when John Latham, now at the University of Manchester, UK, started thinking about ways of limiting the greenhouse effect by reducing the amount of sunshine reaching the planet's surface. Latham was fascinated by something called the Twomey effect, which describes how the amount of solar radiation that clouds reflect back into space depends on the concentration of tiny particles around which cloud droplets form. He

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realised that you could increase this concentration over oceans by seeding clouds with tiny droplets of salt water. We know from satellite images of ship tracks – the equivalent of the contrails left by airplanes – that clouds can be seeded by the sulphate emissions from ships. Latham and his colleagues have produced computer models showing how Arctic sea ice may be restored by brightening ocean stratocumulus clouds. These large, rounded clouds are by far the most common kind seen in the Arctic, and are usually found in groups covering huge areas. On paper, it looks promising, but testing it for real is quite another matter. To do so will require a system that can spray an ultra-fine mist of sea water into the lower atmosphere over a large area of ocean. Stephen Salter, an engineer at the University of Edinburgh, UK, has well-advanced plans for this, having developed proposals for remotely operated drone ships able to deliver the spray, which he presented to the UK government's Environmental Audit Committee's 2017 inquiry into Arctic sustainability. The thing holding him back is lack of funding.

For the price of Neymar

Shortly after I started corresponding with Salter, he sent me a photo of Brazilian footballer Neymar, beaming as his transfer to Paris St Germain was announced in 2017 at a cost to the French club of £198 million. Salter's point was made clear when he detailed the costs of his cloud-seeding project. For the price of Neymar, researchers could conduct all the preliminary trials and then run an entire fleet of ships for two years that might start to restore the damage done to the Arctic. "Among ideas to prevent Arctic collapse, the most viable in terms of the scale and nature of the problem involve increasing the reflection of sunlight from the atmosphere," says Wanser, who is also an adviser to the University of Washington's Marine Cloud Brightening Project. "However, our effective level of investment in sunlight reflection is zero. This leaves us with an enormous exposure to near-term climate risk and not enough fast-acting options to keep warming within safe levels." Several scientific assessments have identified marine cloud brightening as one of the most promising methods to manage sunlight levels, says Rob Wood at the University of Washington. We don't yet know how effective cloud brightening might be. But there is another reason to do this research: it could help solve one of the biggest puzzles related to how warm our planet could get. In the meantime, the region continues to turn from white to blue. Wadhams, who has led 40 expeditions to the Arctic, has seen enormous change in that time. "When I started going to the Arctic, you could think of the whole of the northern hemisphere as a solid continent," he says. "Ice connected

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Eurasia and North America. But now you have blue ocean. Physically and psychologically, the world is fragmented, and I think that is having an important change in how people think."

New Scientist, 28 August 2019

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

Bananas have benefited from climate change – but they won't in future

2019-09-11

Climate change has been relatively kind to banana suppliers so far – but in the decades to come, friend may turn to foe. Temperatures are likely to get so hot that the annual production gains enjoyed by banana suppliers will begin to drop. And in some places, total banana yields will begin to decline. Bananas are a staple crop for millions, and one of the world's top 10 crops in terms of the cultivated area devoted to their growth and the calories they provide to the global population. For the past 60 years, annual yields have been increasing by 1.37 tonnes a hectare as the world warms, and now stand at about 10-40 tonnes per hectare. But a new study by Dan Bebber at the University of Exeter, UK, and his colleagues suggests that as climate change continues, annual yield gains will begin to slump. By 2050, they may be down to 0.19-0.59 tonnes per hectare. "Bananas can take it pretty hot," says Bebber. "But some of our big suppliers are under serious threat, particularly in Latin America." India and Colombia will be so badly affected that total annual banana yields will begin to fall, he says. Bebber and Varun Varma of the National Centre for Biological Sciences in Bangalore, India, built a model of optimal conditions for banana production, based on databases from 27 countries stretching back to 1961, combined with temperature and rainfall records. Globally, the ideal average temperature for the crop appears to be 26.7°C, but the best level varies from country to country. Temperatures in the future were assumed to follow two of the UN climate science panel's worst scenarios. Bananas are cheap in high income countries, so producers are likely to be badly affected by any change in production yields. "For farmers, even small losses are a problem, particularly with bananas where the margins are tiny," says Bebber. An estimated 400 million people eat bananas as a staple starch, so there are food security implications too. Robert Caine at the University of Sheffield, UK, says developing countries may need to use modern technologies to combat the effects of climate change on farming. Bebber says the recent arrival of a deadly fungus in Latin America, Tropical Race 4 (TR4), is a more immediate and severe danger to bananas. But he

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says the fungal threat could potentially be less of a problem, because it could be solved by cross-breeding or genetic engineering. Adapting to a hotter Earth, on the other hand, would require changing the whole physiology of bananas.

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

Microbe Apocalypse Was Bigger Than The Dinosaur Die-Off

2019-09-11

Clues from Canadian rocks formed billions of years ago reveal a previously unknown loss of life even greater than the mass extinction of the dinosaurs 65 million years ago, according to new research. Rather than prowling animals, this die-off involved microorganisms that shaped the Earth's atmosphere and ultimately paved the way for those larger animals to thrive. "This shows that even when biology on Earth is comprised entirely of microbes, you can still have what could be considered an enormous die-off event that otherwise is not recorded in the fossil record," says Malcolm Hodgskiss, a PhD student in the geological sciences department at Stanford University and co-lead author of the study in the Proceedings of the National Academy of Sciences.

Hidden In Minerals

Because this time period preceded complex life, researchers cannot simply dig up fossils to learn what was living 2 billion years ago. Even clues left behind in mud and rocks can be difficult to uncover and analyze. Instead, the group turned to barite, a mineral collected from the Belcher Islands in Hudson Bay, Canada that encapsulates a record of oxygen in the atmosphere. Those samples revealed that Earth experienced huge changes to its biosphere—the part of the planet occupied by living organisms—ending with an enormous drop in life approximately 2.05 billion years ago that may also be linked to declining oxygen levels. "The fact that this geochemical signature was preserved was very surprising," Hodgskiss says. "What was especially unusual about these barites is that they clearly had a complex history." Looking at the Earth's productivity through ancient history provides a glimpse into how life is likely to behave over its entire existence—in addition to informing observations of atmospheres on planets outside our solar system. "The size of the biosphere through geologic time has always been one of our

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biggest questions in studying the history of the Earth," says Erik Sperling, an assistant professor of geological sciences at Stanford who was not involved with the study. "This new proxy demonstrates how interlinked the biosphere and levels of oxygen and carbon dioxide in the atmosphere are."

'Oxygen Overshoot'?

This relationship between the proliferation of life and atmospheric oxygen has given researchers new evidence of the hypothesized "oxygen overshoot." According to this theory, photosynthesis from ancient microorganisms and the weathering of rocks created a huge amount of oxygen in the atmosphere that later waned as oxygen-emitting organisms exhausted their nutrient supply in the ocean and became less abundant. This situation is in contrast to the stable atmosphere we know on Earth today, where the oxygen created and consumed balances out. The researchers' measurements of oxygen, sulfur, and barium isotopes in barite support this oxygen overshoot hypothesis. The research helps scientists hone their estimates of the size of the oxygen overshoot by revealing the significant biological consequences of oxygen levels above or below the capacity of the planet. "Some of these oxygen estimates likely require too many microorganisms living in the ocean in Earth's past," says co-lead author Peter Crockford, a postdoctoral researcher at the Weizmann Institute of Science and Princeton University. "So, we can now start to narrow in on what the composition of the atmosphere could have been through this biological angle." Additional co-authors are from Nanjing University; the University of Colorado, Boulder; and Woods Hole Oceanographic Institution. Support for the research came from Stanford University McGee and Compton Grants, the Northern Scientific Training Program, NSERC, National Geographic, the American Philosophical Society, the Geological Society of America, and the Agouron Institute.

Futurity, 29 August 2019

<http://www.futurity.org>

New research reveals that a human stomach pathogen is attracted to bleach

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Researchers at the University of Oregon have uncovered a molecular mechanism by which the human stomach pathogen *Helicobacter pylori* is attracted to bleach, also known as hypochlorous acid or HOCl. The study

Researchers at the University of Oregon believe the bleach-sensing mechanism could serve as a strategy for some bacterial pathogens to colonise and persist in inflamed tissue

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revealed that *H. pylori* uses a protein called TlpD to sense bleach and swim toward it, and that the bacteria *Salmonella enterica* and *Escherichia coli* can use TlpD-like proteins to detect bleach in the environment. The researchers propose *H. pylori* uses the protein TlpD to sense sites of tissue inflammation, which could help the bacteria colonize the stomach and perhaps locate damaged tissue and nutrients. The paper, "Helicobacter pylori senses bleach (HOCl) as a chemoattractant using a cytosolic chemoreceptor," appeared 29 August in the journal PLOS Biology. The health burden caused by *H. pylori* is particularly large, researchers say, because it infects about half the world's population with nearly 100 percent infection rates in some developing regions. The bacterium takes up residence inside small pockets in the stomach, called stomach glands, that are thought to shelter it from the hostile gastric environment. *H. pylori* causes chronic inflammation and stomach ulcers. It is a major risk factor for stomach cancer, one of the most common forms of cancer worldwide. "Part of the rationale for studying this particular protein is that we know the navigation system that *Helicobacter pylori* has is really important for the bacteria to be able to infect and cause disease," said lead author Arden Perkins, a postdoctoral fellow at the University of Oregon. "If we come to learn what the function of this protein is, there is potential that we might be able to disrupt its function with a new drug." *H. pylori*, like most bacteria, use special proteins to sense chemicals in their environment. The process, known as chemotaxis, allows them to regulate their flagella to swim toward or away from compounds they encounter. The research team set out to determine how bacteria respond to the presence of bleach, which is produced by white blood cells in the body and is a key part of how the immune system fights bacteria. "It's important that we understand the protein machinery of bleach sensing," said study co-author Karen Guillemin, a professor of biology and member of the UO's Institute of Molecular Biology. "It turns out that this is not a machinery that is exclusive to *Helicobacter pylori* and it allows us insights into other bacteria that have similar proteins." Work began 2.5 years ago to determine the molecular function of the TlpD protein, which the researchers knew was involved in regulating the bacteria's flagella. They knew TlpD was a sensor molecule but didn't know what it might be sensing. In order to get to the bottom of the uncharacterized protein's function, Perkins isolated the TlpD protein and two other proteins involved in transmitting the molecular signal to the flagella. "Isolating the components of the molecular signalling system gave us a much clearer understanding of what was going on," Guillemin said. Previous research had revealed that reactive oxygen species might be the compounds that were sensed by the TlpD protein, so Perkins tested different compounds, including hydrogen

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peroxide, superoxide and bleach. The surprising results showed that TlpD produced an attractant signal when exposed to bleach. Although it seemed counterintuitive for the bacteria to be attracted to a noxious chemical, further studies using live bacteria confirmed that the bacteria are unharmed by and attracted to sources of bleach at concentrations produced by the human body. Perkins and co-workers couldn't deny what they were seeing after repeatedly performing the experiment and controlling for different explanations. "This project started from this really rigorous molecular insight, and then we progressed to thinking about what this means for the behaviour of the bacteria," Guillemin said. "We were able to proceed with really strong confidence that the phenomenon we were studying made sense at a molecular level." Normally, bleach produced during inflammation is effective at killing bacteria. But *H. pylori* is unusual in making its home in inflamed tissue for decades apparently without being eradicated by the bleach. The research team believes *H. pylori* may be attracted to bleach as a means of locating and persisting inside the stomach glands, which are full of white blood cells but serve as crucial reservoirs for the bacteria. Surprisingly, the researchers found, the toxic compound produced by the white blood cells could be interpreted as an attraction signal by the invading bacteria. "We know that in the course of its infection, the bacteria is able to live in inflamed tissue for years and years, so this result suggests that maybe part of the way it does that is by being attracted to inflamed tissue," Perkins said. "It's clearly evolved sufficient protections to be able to endure that environment even though there are potentially high concentrations of bleach there." Researchers found TlpD-like proteins from *Salmonella enterica* and *Escherichia coli* are also able to detect bleach, indicating that bleach-sensing may be a previously unrecognized phenomena performed by many types of bacteria. The research eventually could lead to new therapies to disrupt the ability of harmful bacteria to sense their environment and could have implications for reducing antibiotic resistance. Typical antibiotics used clinically today kill or prevent bacteria from dividing by targeting things like the bacterial cell wall. As a result, bacteria face selective pressures to develop resistance to those kinds of drugs in order to survive. In the case of *Helicobacter pylori*, approximately 30 percent of infections are resistant to antibiotic treatment. With a more thorough understanding of the mechanisms at work, Guillemin said, researchers may then be able to develop more effective means of combatting bacteria. "It might be that there are less strong selective pressures for bacteria to overcome a drug that just makes them disoriented," Guillemin said. "By 2050 there's going

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to be pandemics of antibiotic-resistant bacteria, so there's a real need to think about new strategies."

EurekaAlert, 29 August 2019

<http://www.eurekaalert.org>

Watchdog faults EPA response to lead paint hazards

2019-09-11

The United States Environmental Protection Agency (EPA) is not effectively using a rule meant to protect against exposure to lead-based paint, an agency watchdog found. The EPA's Office of the Inspector General found, in a report released recently, that the agency's Lead Action Plan, which is meant to curb children's exposure to lead, lacked measurable outcomes. The report concluded that the agency did not have "an effective strategy" for implementing and enforcing the Lead Renovation, Repair and Painting (RRP) rule. The watchdog said the agency did not have controls to measure how effective the program would be in achieving its goals and said there was a lack of communication between the two EPA departments that oversee the rule. "The EPA does not have an effective strategy to implement and enforce the lead-based paint rule," the inspector general wrote in its report. "Explicit and measurable program objectives, goals and outcomes are needed to demonstrate whether the RRP program is achieving its intended results to protect the public by addressing hazards associated with renovation, repair and painting activities in target housing and child-occupied facilities." The EPA did not respond to a request for comment. The RRP rule specifically focuses on the renovation of homes built before 1978, where work might disturb lead-based paint. The rule was first established in 2008 and requires workers to be certified in lead-safe practices and certified by the EPA. Lead is a toxic substance and when ingested or put in the bloodstream it can lead to kidney and brain damage. It's especially dangerous to young children, leading to developmental disorders. Children are also more likely to be exposed to lead due to lead dust which collects on low surfaces. There is no safe level of lead exposure. Environmental groups called the EPA's approach to the lead rule "primarily a public relations tool." "Based on the failures and shortcomings described by the Inspector General, it appears that the Trump Administration's Lead Action Plan was primarily a public relations tool rather than a document to focus and prioritise the agency's efforts to reduce children's exposure to lead from these renovation projects," Tom Neltner, chemicals policy director at the Environmental Defence Fund, said in a statement. Environmentalists have previously challenged the

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EPA for its handling of regulations on lead, most recently filing a lawsuit in August arguing the agency doesn't do enough to protect children from lead contamination. Two environmental activist groups sued over the EPA's finalised June Dust-Lead Hazard Standards, which they argue are too lax to protect families. The rule, rolled out jointly by EPA Administrator Andrew Wheeler and Housing and Urban Development Secretary Ben Carson, was meant to protect children from harmful lead exposure. "Trump's EPA had a chance to follow mainstream science and correctly update these standards for children's sake," Earthjustice attorney Eve Gartner said at the time. "Instead it botched the opportunity and gave families a rule that falls far short of protecting children."

The Hill, 9 September 2019

<https://thehill.com>

How tampons and pads became so unsustainable

2019-09-11

Plastic pervades modern life, and menstruation is no exception. Since the middle of the 20th century, many tampons and menstrual pads have contained somewhere between a little and a lot of plastic in their basic design—sometimes for reasons that "improve" the design, but often for reasons less crucial. Getting a handle on how much plastic waste comes from menstrual products is tough, in part because it's labelled as medical waste and does not need to be tracked, and in part because so little research has even looked at the scope of the problem. But rough estimates for the likely output are staggering: In 2018 alone, people in the U.S. bought 5.8 billion tampons, and over the course of a lifetime, a single menstruator will use somewhere between 5 and 15 thousand pads and tampons, the vast majority of which will wind up in landfills as plastic waste. To dislodge plastic from menstrual care, though, will take more than design disruption, because the reasons plastic has lodged itself so deep in the design in the first place are tangled in a web of culture, shame, science, and more.

The plastic period problem

Most American women will menstruate for about 40 years in total, bleeding for about five days a month, or about 2,400 days over the course of a lifetime—about six and a half years, all told. All that menstrual fluid has to go somewhere. In the U.S., it usually ends up in a tampon or on a pad, and after their brief moment of utility, those products usually end up in the trash. The most common menstrual products are a veritable

A combination of technology and social pressure drove us toward sanitary products shot through with plastic. Is there a better solution?

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cornucopia of plastic. Tampons come wrapped in plastic, encased in plastic applicators, with plastic strings dangling from one end, and many even include a thin layer of plastic in the absorbent part. Pads generally incorporate even more plastic, from the leak-proof base to the synthetics that soak up fluid to the packaging. For Ann Borowski, who researched the ecological impact of sanitary products, the sheer numbers were astounding. "I don't want to contribute 40 years of garbage to a landfill just to manage something that shouldn't even be seen as a problem," she says. "It seems like something we should have a little more control of by now. I don't want to have that kind of burden on the planet."

A brief history of menstrual management

In ancient Greece, menstrual blood was seen by the writers of the time as something fundamentally insalubrious, a symbol of female excess, a "humour" that needed to be expelled from the body in order to maintain balance and health. The blood itself was considered unhealthy—even poisonous. That general attitude persisted for centuries. By the mid-1800s in the U.S., the culture around menstruation had hardened into a simple narrative: Period blood was perceived as "bad blood," both dirty and shameful, says Chris Bobel, an expert on menstruation at the University of Massachusetts, Boston. Colorado-based general practitioner Earle Cleveland Haas patented the first tampon with applicator in 1933. By the time dome-tipped plastic applicators were introduced in 1973, tampons were used by more than 70 percent of U.S. women. Although plastic applicators are recyclable, they are usually not accepted for sanitary reasons. But menstruation was an unavoidable reality that had to be dealt with. Women in the pre-20th century U.S. used a "bricolage" approach to managing it, repurposing all sorts of commonplace items into pad- or tampon-like objects, historian Susan Strasser explains. That meant leftover scraps of fabric, soft strips of bark, or whatever else was available and absorbent. But the tools left much to be desired. They were often bulky and unwieldy, and they had to be washed and dried—which meant they would be displayed publicly, a less-than-desirable situation in a culture that stigmatised menstruation. In 1921, the first pack of Kotex crossed a drugstore counter. Thus, began a new era: that of the disposable menstrual product. Kotex were made with Cellucotton, a hyper-absorbent plant-based material that had been developed during World War I for use as medical bandaging. Nurses started to repurpose the material for menstrual pads, and the practice stuck. Some physically active menstruators, like dancers and athletes, gravitated toward another emerging product: tampons. The tampons of the 1930s were not too

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different than the ones on drugstore shelves today, generally made of a wad of dense cotton or a paper-like material attached to a string. What all of the new products had in common was disposability. Marketing campaigns leaned into the idea that the new products would make menstruators “happy, well-poised, efficient modern women,” free from the tyranny of old “makeshift” strategies. (Disposables also meant that menstruators would have to stock up each month, locking them in to decades of purchases). “From the beginning, the companies pushed this idea that the way to be modern was to use these new disposable products,” says Sharra Vostral, a historian at Purdue University. The appeal and ubiquity of disposables grew as more women entered the workforce. The products offered both convenience—they were readily available in many drugstores—and discretion—women wouldn’t have to worry about bringing used cloths from work to home. It also allowed menstruators to “pass,” hiding their bodily functions from those around them, letting work continue uninterrupted. “This has been the standard,” says Bobel, “that women and girls always have to bend to norms and standards of the workplace, to be hyperefficient at all times. You can’t let your body slow you down, is the message.”

The outcome was a massive shift in the market. By the end of World War II, sales of disposable menstrual products had quintupled across the U.S.

What’s plastic in a pad?

By the 1960s, chemists were busily developing sophisticated plastics and other synthetics. The technologies leapt forward so quickly that manufacturers found themselves searching for new markets into which they could incorporate their new materials. One of the markets they found was menstrual products. Pad designs began to incorporate thin, flexible, leak-proof polypropylene or polyethylene as the base (or, in patent terms, the “backsheet”). Advances in sticky-stuff technology bolstered the use of flexible plastics, allowing the pads to be attached to underwear directly rather than hanging off a complicated, bulky belt system. By the late 1970s, designers realised they could make flexible plastic “wings” that would wrap around underwear and anchor a pad in place. And designers found ways to weave thin polyester fibres into the squishy part of the pad to wick fluid away into the absorbent cores, which were getting thinner as superabsorbent materials grew more sophisticated. All these product developments sound incremental, says Lara Freidenfelds, a historian who interviewed dozens of women about their experiences with menstruation for her book *The Modern Period*, but they add up to big changes in experience. “Adhesive or wings—those sound like a minor product

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improvements, but actually people talked about them being really important. Like, wow, that was a big one, that really improved my life," she says.

Tampons didn't escape plastic

In the early part of the 20th century many doctors, as well as members of the public, were squeamish about the idea that women—especially young women—might come into contact with their genitals during tampon insertion, says Elizabeth Arveda Kissling, a gender studies expert at Eastern Washington University and author of *Capitalizing on the Curse: The Business of Menstruation*. Maybe, inventors thought, the tampon could be inserted more "demurely" and hygienically with an applicator. The first recorded U.S. patent for tampons, from 1929, included a design for a telescoping cardboard applicator tube. Others suggested stainless steel or even glass. By the 1970s, plastics could be moulded into smooth, thin, flexible rounded shapes—perfect, some designers thought, for tampon applicators. But it's not just the applicator that's plastic: many tampons incorporate some bits of plastic in the absorbent part itself. A thin layer often helps hold the tightly-packed cotton part together. In some cases, the string is made of polyester or polypropylene.

Packaging for privacy

By the middle of the century, the major players in the U.S. menstrual products market were competing fiercely for customers but running out of technological advances to trumpet. To stand out, companies came up with more and more ways to offer their customers discreet purchase, use, and disposal options. An obsession with discretion was longstanding. In the 1920s, Johnson and Johnson printed slips in their magazine advertisements for their "Modess" brand sanitary napkins. Women would cut them out and hand them silently across the pharmacy counter, receiving a nearly unmarked box in return. But as the tide turned toward disposable, portable products, and as the products themselves shrank in size, the packaging focus shifted toward individual wrapping. Menstruators needed to be able to throw products in a bag and keep them clean, to carry them from desk to restroom, and then from restroom stall to waste container. That meant plastic wrapping for everything. In 2013, the discreet packaging projects hit their heights when Kotex introduced a tampon with a "softer, quieter wrapper to help keep it secret," designed for silent unwrapping. And disposal? There are plastics to help with that part of the process, too. In some public restrooms, little packets of scented plastic baggies sit on the bathroom stall walls, ready to enclose

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and disguise used sanitary products on their short path from stall to trash bin. "We're still selling shame along with the menstrual products," says Kissling.

Is the future plastic?

The new plastic-packed versions of both tampons and pads vastly improved many women's experience with their periods. But they also got generations of women and other menstruators hooked on plastic-centric products that will live on for at least 500 years after their brief usefulness has passed. It doesn't necessarily have to be this way. In Europe, most tampons are sold without applicators. In the U.S., there's growing interest in alternatives: In a recent survey, almost 60 percent of the women questioned were considering a reusable product (about 20 percent were currently users). "That's a tectonic shift in the way women are thinking about managing their periods," says Susannah Enkema, a researcher at the Shelton Group who worked on the survey. One of the popular alternatives is the reusable pad, a better-designed version of a very old technology. Others have embraced menstrual cups, another old technology that has recently seen a resurgence in popularity. Some companies are designing underwear that absorbs period blood directly and can be washed and used over and over, while other menstruators choose to bleed freely throughout their periods, eschewing the traditional stigma that comes from visible evidence of this most basic of biological realities. And breaking down the stigma around menstruation, says Bobel, is critical to moving toward a more socially and environmentally thoughtful future. "I'm not denying that we need something to bleed on," she says. "And at the same time, I want to acknowledge that we are fooling ourselves if we say promoting any product is going to fix the stigma. It's not." Change will come, she thinks, when the conversations change.

National Geographic, 6 September 2019

www.nationalgeographic.com.au

There's a new group of workers spreading organic pesticide on crops: bees

2019-09-11

Bees are great at retrieving tiny cargo: their main job is to visit flowering plants in order to gather pollen and nectar for their hive. Now one pesticide company has gained federal permission to ensure they're bringing something special along on each trip. The Canadian-based

The Canadian-based company Bee Vectoring Technologies just received EPA approval for an organic fungicide that bees can carry directly from hive to crop.

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company Bee Vectoring Technologies just received EPA approval for an organic fungicide that bees can carry directly from hive to crop. The breakthrough could help farmers eliminate the need for chemical spraying. It's called Vectorite, a white powder that farmers place in special trays for honeybees or bumblebees to pass through as they exit their hive. Vectorite carries a refined form of *Clonostachys rosea*, a fungus that feeds on other types of fungi that damage crops. "This is the first bee-vectored product that the EPA has approved, so what we have really done is created a new category," says BVT CEO Ashish Malik. In Florida, the company has used this system in commercial-size test fields to reduce grey mould on strawberries while increasing yields by at least 10%. In Georgia, it's done the same thing with blueberries to eliminate grey mould and the more nefarious monilinia blight that causes "mummy berry" shrivelling. (BVT has already proven its product doesn't harm the insects that carry it.) The exact impact of these applications vary by region because there may be different strains of pathogens, but Malik is hopeful that he can promise an increase of between 15% and 20% for those southern blueberry growers (although the exact net gain is still being calculated). In addition to those berries, the company sees its biotech as a great solution for sunflower and almond growers. Part of the allure for farmers is that bees are more effective than spraying synthetic pesticides because they tend to visit flowering crops at exactly the right time to deliver their payloads. With conventional sprays, it can take several applications and still not soak everything, so the bee-based system ensures a wider and more consistent delivery service. The other part is that many farmers are already in the business of contracting for visits from large scale swarms through commercial beekeepers or buy their own from companies that rear and ship whole hives. Fruit, nut, and seed farmers rely on bee pollination to ensure their crops get fertilized at the right time to produce the best yields. BVT's tray systems are engineered to be specifically adapted to these style hives. Vectorite may be organic, but BVT is targeting both conventional and organic farms. The company projects that it can reduce pesticide use by 50% to 75% at conventional farms that are willing to widely adopt the new practice. And as it develops and offers more types of pesticide protection, it could reduce pesticide use even more. "The beautiful part about our system is that you can deliver multiple microbes through that one flight the bees make, provided the microbes are safe to the bee," says Malik. The company raised \$3.1 million in funding in 2015 and has other operations pending their own country-specific approvals in Mexico and Southern Europe, along with interest in other places. "We can close the research phase. We can now talk about generating commercial revenue and building the business back up, not only in the U.S. but ultimately globally," he says.

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Doing so in a way that eliminates reliance on synthetic pesticides is both cost-effective and good for the environment. BVT has previously projected that services will be extremely competitive against traditional methods. And controlling diseases like botrytis more uniformly ensures that as more fruit hits stores, some of it will have a longer shelf life. The company's early estimate was 10 to 12 more days of ripeness in some cases. Now you have two reasons to thank bees for your fresh fruits.

Fast Company, 7 September 2019

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

Phosphate fertiliser 'crisis' threatens world food supply

2019-09-11

The world faces an "imminent crisis" in the supply of phosphate, a critical fertiliser that underpins the world's food supply, scientists have warned. Phosphate is an essential mineral for all life on Earth and is added to farmers' fields in huge quantities. But rock phosphate is a finite resource and the biggest supplies are mined in politically unstable places, posing risks to the many countries that have little or no reserves. Phosphate use has quadrupled in the last 50 years as the global population has grown and the date when it is estimated to run out gets closer with each new analysis of demand, with some scientists projecting that moment could come as soon as a few decades' time. Researchers say humanity could only produce half the food it does without phosphate and nitrogen, though the latter is essentially limitless as it makes up almost 80% of the atmosphere. "Phosphate supply is potentially a very big problem," said Martin Blackwell, at Rothamsted Research, an agricultural research centre in the UK, and lead author of a new study. "The population is growing and we are going to need more food." At current rates of use, a lot of countries are set to run out of their domestic supply in the next generation, including the US, China and India, he said. Morocco and the Moroccan-occupied territory of Western Sahara host by far the largest reserve, with China, Algeria and Syria the next biggest, together representing more than 80% of global rock phosphate. "In a few years' time, it could be a political issue with some countries effectively controlling the production of food by having control of rock phosphate supplies," Blackwell said. "There should be a lot more effort being put in so we are ready to deal with it. It is time to wake up. It is one of the most important issues in the world today." Prof Martin van Ittersum, at Wageningen University in the Netherlands, said problems would begin before the mineral is exhausted: "Well before we run out of phosphate, the resource may become much more expensive." Potential

Use of essential rock phosphate has soared, but scientists fear it could run out within a few decades

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solutions include recycling phosphate from human sewage, manure and abattoir waste, new plant breeds that can draw the mineral from the soil more effectively and better soil tests to help end the over-application of the fertiliser. Excessive use of phosphate is not only running down supplies but is also causing widespread pollution that leads to dead zones in rivers and seas. In 2015, research published in the journal *Science* cited phosphorus pollution as one of the most serious problems the planet faces, ahead of climate change. The new study, published in the journal *Frontiers of Agricultural Science and Engineering*, states: "The continued supply of phosphate fertilisers that underpin global food production is an imminent crisis." It notes that an estimate of the remaining years of rock phosphate supply fell from 300 to 259 in just the last three years, as demand rose. "If the estimated remaining number of years supply continues to decline at this rate, it could be argued that all supplies will be exhausted by 2040," the scientists wrote. "While this scenario is unlikely, it does highlight that imminent, fundamental changes in the global phosphorus trade, use and recycling efforts will be necessary," they said. "This is especially pertinent in China, India and the US, the three countries with largest populations on the planet, which rely on rock phosphate to feed their people." The European Commission declared phosphate a "critical raw material" in 2014, ie an essential resource with significant risk to supply. Only Finland has any reserves in the EU and most is imported to the bloc from Morocco, Algeria, Russia, Israel and Jordan. "The EU is highly dependent on regions currently subject to political crisis," according to an EC position paper. Commercial phosphate fertiliser was invented at Rothamsted in 1842 by dissolving animal bones in sulphuric acid. Blackwell and his colleagues have returned to this source to investigate an alternative supply of phosphate. They have turned bones, horns, blood and other abattoir waste into phosphate fertiliser and in new research found it worked as well or better than conventional fertiliser. Blackwell said it could potentially provide 15-25% of the UK's needs. Another potential source is recovering phosphate from human sewage; Thames Water opened a plant doing this in 2013. Van Ittersum said recycling phosphate from animal and human waste is vital, but that this will take time to implement as new technology and regulation will be needed to ensure contamination and infection of food crops does not occur. Reducing use is also key, said Blackwell. The soil tests available to farmers at the moment are not very advanced, he said, so farmers add extra phosphate to be sure. This means excess phosphate in most agricultural soils, estimated as representing a century's supply. But most of this soil phosphate is bound up in organic molecules and inaccessible to plants. Some plants produce acids and enzymes that can break these down, and

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scientists are using genetic modification to create new plant varieties that can access this phosphate. Van Ittersum said such research was urgent as it will take a lot of time to develop more efficient crops. Phosphate expert Marissa de Boer said the public lack of awareness means the issue is the “unknown” environmental crisis: “We really depend on phosphate but we take it for granted.” De Boer ran a five-year European Commission project on technologies to recycle phosphate and now runs SusPhos, a company looking to commercialise ways of extracting phosphate from human waste, food waste and industrial waste. She said recycled phosphate could meet the Netherlands’ needs if the technology proves successful: “As long as people have got to go to the toilet, and wastewater treatment is centralised, we can use our own phosphate.”

The Guardian, 6 September 2019

<http://www.guardian.com>

Weed killer linked to cancer: Could Australians die from using popular product?

The fallout from a controversial Californian court decision which found the commonly used herbicide Roundup causes cancer, is now being felt in Australia. Hundreds of users of Roundup here are preparing legal cases against chemical giant Monsanto, the manufacturer of the weed killer. Their cases add to the already 17,000 cases launched in the United States. Recently on 60 Minutes, reporter Liam Bartlett investigates the claim Roundup is unsafe and life-threatening. In 2014, Lee Johnson developed a rash on his knee that started to spread over his entire body. In his first Australian media interview, Lee Johnson the Californian cancer sufferer who was the first to take legal action against Monsanto tells Bartlett he was required to regularly use Roundup while working as a school groundsman. Johnson says despite always using the chemical carefully and following the instructions on the packaging, in 2014 he was diagnosed with incurable non-Hodgkins Lymphoma.

In August last year, a jury determined exposure to the chemical had caused Johnson’s cancer and awarded him US\$289 million compensation, later reduced to \$78 million. Brett Wisner, Lee Johnson’s lead attorney, says the legal cases exposing the risks of Roundup are reminiscent of the cases against tobacco companies. “Right now, we’re in that moment when the first lawsuits exposed the truth about cigarettes,” Wisner told Bartlett. “40 years from now, we’re going to look back at this time and go, what fools we were. Of course, it causes cancer. How did it take us so long to figure it

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out?" But farmers across Australia are reluctant to accept Australia's most popular weed killer could be lethal. They argue Roundup is fundamental to farming and revolutionised Australian agriculture when it was first introduced 40 years ago. They also point to the hundreds of studies that find no link between Roundup's key ingredient glyphosate and cancer. "Farmers across Australia at the moment really are incredibly worried about this hype that's going on worldwide," President of the National Farmers Federation, Fiona Simpson, tells 60 Minutes. "We have to stay with the science, we have to stay with the facts: there is no link."

Nine News, 7 September 2019

<http://9news.com.au>

Marine plastic pollution hides a neurological toxin in our food

2019-09-11

In the mid-1950s, domesticated cats in Minamata, Japan mysteriously began to convulse and fall into the bay. The people of Minamata took on similar symptoms shortly after, losing their ability to speak, move, and think. Chisso Corp., a Japanese chemical company, had dumped more than 600 tons of mercury into the bay between 1932 and 1968 via the company's wastewater. 1,784 people were slowly killed over the years while doctors scrambled to find the cause of the deaths that shared uncanny symptoms. The Minamata Bay disease is a neurological illness where methylmercury poisoning causes long-term impairment of the central nervous system. The Minamata Convention on Mercury emerged in early 2013 as an international environmental treaty aiming to limit global mercury pollution, with 112 countries as current parties. Although the Environmental Protection Agency and other government organisations worldwide have since limited mercury that enters surface waters from power utilities and other corporations, this toxin has a new and powerful avenue to the human brain: marine plastic pollution. "The concentration of mercury in the surface level of the ocean is probably three or four times higher today than it was 500 years ago," said Dr. Carl Lamborg, an associate professor from the ocean sciences department at the University of California Santa Cruz. Methylmercury makes its journey to our dinner plate up the food chain from the marine ecosystem's smallest organisms—phytoplankton and zooplankton—to fish and humans. Dr. Katlin Bowman, a postdoctoral research scholar at UCSC, is researching how mercury enters the food chain. Through methylation, mercury in the ocean becomes methylmercury, an organic form of the element. It

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is far more dangerous because it easily concentrates while traveling up the food chain. Heavy metal toxins naturally adhere to plastics in the water, contributing to the mercury pollution issue by creating extremely concentrated “fish food” bombs of dangerous chemicals, she said. “Plastic has a negative charge, mercury has a positive charge. Opposites attract so the mercury sticks,” Bowman said. Microplastics are more concentrated in methylmercury as a result of their greater surface area, trapping toxic particles in the many folds and tight spaces. “Microplastics are defined as a piece of plastic that’s less than five millimetres in size,” said Abigail Barrows, a marine research scientist from College of the Atlantic. “They cover a whole suite of things.” These include microbeads in personal care products and microfibers that break off of clothing. As plastic bags, bottles, and utensils degrade over time, they become microplastics. “If microplastics increase the rate of methylmercury production, then microplastics in the environment could indirectly be increasing the amount of mercury that accumulates in fish,” Bowman said.

Two key concepts worsen methylmercury’s impact: bioaccumulation and biomagnification. With bioaccumulation, methylmercury never leaves the body, instead building up over time. “The longer the fish lives, it just keeps eating mercury in its diet, and it doesn’t lose it, so it ends up concentrating very high levels of mercury in its tissues,” said Dr. Nicholas Fisher, distinguished professor at State University of New York Stony Brook. “The methylmercury also biomagnifies, which means that the concentration is higher in the predator than it is in the prey.” According to the European Commission’s Mercury Issue Briefing of 2012, top-level predators have more than 100,000 times more methylmercury stored in their system compared to their surrounding waters. However, our focus should be on the plastic pollution issue rather than mercury discharge. “The mercury bounces back and forth between the air and the ocean very easily,” Lamborg said. While this toxin cycles through the environment in regular cycles, plastics serve as a magnet for mercury, prolonging its lifetime in the ocean and funnelling it into the mouths of plankton and fish. When people eat affected seafood, they eat the concentrated methylmercury as well. The Minamata Bay Disaster has already spelled out the horrific effects of mercury poisoning in all of its nitty-gritty glory. The EPA and other international agencies have passed regulations since the 1970s, such as the Clean Water Act and the Safe Water Drinking Act, that have significantly driven surface water mercury emissions downward. However, according to a report published by Science in 2015, the eight million metric tons of plastic that enter the ocean each year ensure that the problem will only swell. “The plastic produced is on trend to double in

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the next 20 years," Barrows said. "So, I think that's where we need to focus on in terms of worrying about our environment."

Phys.org, 6 September 2019

<http://phys.org>

New York State Suspects Vitamin E May Have Played a Role in Vaping Illnesses

2019-09-12

Health officials in New York State said that they are investigating a possible cause of a recent surge in severe vaping-related illnesses: a compound called vitamin E acetate. The state Department of Health said in a news release that "very high levels" of the compound had been found in 13 samples from eight of 34 patients who have gotten ill in New York. The samples were analysed as part of an investigation by the Wadsworth Centre, a state laboratory. This finding by no means ends the search for what is causing the illnesses, particularly given that vitamin E acetate has not been confirmed as a factor in the majority of cases in which patients have gotten sick in New York. "That's the best theory, or hypothesis, we have right now," Dr. Howard Zucker, the New York State health commissioner, said in an interview. "We haven't ruled out there isn't something else in the vaping material." Michael Felberbaum, a spokesman for the Food and Drug Administration, said in a statement that "more information is needed to better understand whether there's a relationship between any specific products or substances and the reported illnesses." The agency is testing 100 samples for a "broad range" of chemicals, he added. "No one substance, including vitamin E acetate, has been identified in all of the samples tested," he said. "Importantly, identifying any compounds that are present in the samples will be one piece of the puzzle but will not necessarily answer questions about causality." Since mid-June, there have been about 215 illnesses nationwide, and two deaths, mostly in otherwise healthy people whose severe lung inflammation appeared linked to vaping. The complexity of the products and the geographic spread of the patients across two dozen states has left health officials puzzled and searching for answers. Gary Ginsberg, a New York State toxicologist, said that during recent calls with investigators from various states, federal officials from the Centres for Disease Control and Prevention and the Food and Drug Administration said that the vitamin E acetate is one of the substances they are exploring. Dr. Ginsberg said the illness seems to come from some "adulterant" in vaping devices. Dr. Zucker, the health commissioner, said that all of the products containing

Health officials around the country are still investigating numerous possible causes and have tested only some of the devices used by ill patients.

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vitamin E acetate were “on the black market” and not part of New York State’s medical marijuana program. New York has had 34 reported cases of severe illnesses, in patients ranging in age 15 to 46; in each case, the patient had used “at least one” cannabis-related product, the state news release said. However, the statement also said that patients reported using more than one vaping product, suggesting that the focus on vitamin E acetate may point to one cause, but not an exclusive one. The state said that the vitamin E compound was found in tests of cannabis products, but not in the nicotine-based products it tested, a finding consistent with reports from doctors that many illnesses have been linked to people using a vaping device for marijuana. “As a result, vitamin E acetate is now a key focus of the Department’s investigation of potential causes of vaping-associated pulmonary illnesses,” New York State said in its release. “Vitamin E acetate is a commonly available nutritional supplement that is not known to cause harm when ingested as a vitamin supplement or applied to the skin. However, the Department continues to investigate its health effects when inhaled because its oil-like properties could be associated with the observed symptoms.”

New York Times, 5 September 2019

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

Toyota diesel emissions expose broader problem with car pollution in Australia

2019-09-12

Australia’s state and territory environment protection authorities have sent more than 1,200 warning notices to drivers in the past year about their polluting cars, including hundreds of Toyotas with excessive smoke issues. It was revealed recently that Toyota is being sued as part of a class action over faulty diesel particulate filters (DPFs) in the Hilux, Fortuner and Prado vehicles sold in Australia between October 2015 and July 2019. Scores of drivers have told the ABC their faulty DPFs cause the cars to spew out smelly white smoke and use more fuel. Suzanne Harter, a clean energy campaigner for the Australian Conservation Foundation, said Australia needed to tighten standards to stop it from becoming a dumping ground for less-efficient, more-polluting cars. “Australia is currently lagging behind the rest of the world on vehicle-emissions standards,” Ms Harter said. “I think it speaks to a larger problem in Australia that we need to improve our standards, improve our testing regimes ... and make sure the vehicles that are coming into our country are both fuel efficient and are able to protect public health better.” Ms Harter said the lack of standards can put

Problems with diesel particulate filters in top-selling Toyota cars have exposed Australia’s ‘lagging’ vehicle-emissions standards, public health and environmental advocates say.

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motorists who have recently purchased a vehicle with a failing system in a difficult position. The DPFs are supposed to trap and burn off diesel particulates, stopping pollutants and particulates from going into the air. Instead, mechanics and drivers familiar with the Toyota issue said the malfunctioning DPFs are clogging up, causing the excessive smoke and impacting on fuel efficiency. Some Toyota drivers contacted the ABC after they were hit with notices warning them, they could be fined if they didn't stop excessive smoke coming out of their vehicles. Sydney woman Kyle Kinchela, who runs a hydraulic repair business with her husband, was shocked when she received a notice from the NSW Environment Protection Authority (EPA) in June last year. Their 2015 Toyota Hilux had excessive smoke issues, and the notice told her to fix her car or face a fine of up to \$2,000 — even though her car had just been serviced. "I obviously knew that it was blowing smoke at that particular time and it was quite bad, but it was not something I expected to receive," she said. "I called the EPA and I was quite surprised by their response, they stated that they were aware of issues with Toyota vehicles. "If I did not get the problem seen to within their time frame then they would fine us." "I called Toyota and tried to get in for a service and I couldn't get an appointment that suited within the EPA's time frame, so I had to get the next best thing and call the EPA for an extension." The notice reads similar to a speeding fine, with a time, date and place the offending vehicle was spotted by authorities. "You are advised that if an authorised officer reports your vehicle emitting smoke after Friday 29 June 2018, a Penalty Notice ranging from \$300 to \$2,000 can be imposed," the notice said. "Exhaust emissions from vehicles are the biggest cause of air pollution in urban areas and can cause health problems."

EPAs and police monitoring car emissions

In most states and territories, the EPA or an equivalent department receives and records reports of polluting cars. The ABC contacted all state and territory authorities to ascertain how many cars are being reported for expelling excess smoke. A report of a smoky car is at least 10 consecutive seconds of smoke coming out of an exhaust. The reporting of the issue varies between locations. Victoria has the most comprehensive data, but does not breakdown the reports into much detail. For example, it does not specify whether the smoke is black or white. Faulty DPFs are known to cause white smoke, while black smoke is an indicator of other problems. Victoria's EPA received 5,271 reports of excessive smoke from vehicles in 2018-19, an increase of 445 reports from the previous year. Last year, 339 of those reports were for people driving a Toyota Hilux — the most of any

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car — although the data does not specify if it was white smoke. Victoria's EPA did not tell the ABC how many notices it sent, warning drivers to fix their cars. The NSW EPA received 1,963 reports last financial year, an increase of almost 40 per cent, and issued a record number of 834 notices to drivers with smoky vehicles. NSW did not break the figures down by car model. The number of smoky vehicle reports in Queensland almost doubled in the past financial year to 3,169 reports, a 45 per cent increase on the previous year. Western Australia had 454 reports of smoky vehicles and issued 398 notices to drivers. In the ACT, there were 38 complaints about smoky vehicles last financial year, up from 21 complaints in the previous year. There was no data available from South Australia and the Northern Territory, and Tasmania had fewer than 10 reports. Adelaide driver Mike Stone was given a defect notice by South Australian police in November 2017 for excessive smoke coming out of his Hilux. He has been back to the Toyota dealership four times to have the issue fixed. "The first time was after receiving a defect warning from SAPOL [police] after leaving a smoke trail up the southern expressway," he said. "This so-called fix lasted about five months before heading back to the dealership again." Mr Stone said his fuel economy fluctuates and his car regularly leaves a big cloud of smoke when he takes off at the lights. The ABC asked Toyota to comment on the notices sent to drivers, and the issue of emissions. "We encourage any Toyota owners with questions or concerns about their DPF to contact their closest or preferred Toyota dealer," it said in a statement. "Alternatively, customers can find out more via a comprehensive DPF FAQ on the Toyota website. "We are unable to comment on matters before the courts but reiterate our commitment, as always, to helping our customers with any questions or concerns they have about their vehicle."

Excessive diesel emissions 'harmful' to health

Dr Vicki Kotsirilos from Doctors for the Environment said there was "no safe level" for diesel pollutants, and any cars expelling higher than normal emissions were of major concern. "Diesel emissions are particularly toxic chemicals that are released into the air," Dr Kotsirilos told the ABC. "When we inhale these chemicals, they can irritate the nasal passages, cause allergies and irritations, they can cause lung disease, trigger asthma in people who have asthma." Dr Kotsirilos said all vehicle emissions are harmful, but diesel emissions are worse. "They are a class one carcinogen that can cause lung cancer and can contribute to heart and lung disease," she said. "Vehicles that rely on diesel, that don't have proper filters, are more likely to emit diesel particulates into the air, and this would contribute to part of the air pollution problem." Dr Kotsirilos said the

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emissions are most harmful to people who live, work or attend school or child care near pollution “hotspots” like busy roads or intersections. Australia has the “Euro 5” vehicle emissions standard, which limits the amount of noxious pollutants cars can emit. However, Europe and most developed nations have tightened emissions standards to comply with what’s called Euro 6, or the more-stringent Euro 6d. “When the Euro 5 was put in place, the diesel filters were part of that requirement,” the ACF’s Suzanne Harter said. “Those filters are required for a really important reason, and that is to protect public health. “If those filters aren’t working as they should, that means that there could be greater health impacts that we would want to accept from those vehicles.” Dozens of drivers have told the ABC the faulty Toyota filters cause excessive smoke and impact fuel efficiency by up to 30 per cent. That means more particulates are going into the air, and more CO₂ is being produced because more fuel is being used.

No progress on vehicle emissions standards

Progress on changing car emissions and efficiency standards in Australia has stalled. A range of issues are at stake, including the accuracy of emissions testing, which is performed in a laboratory before a car is sold to market. Bodies such as the Australian Automobile Association (AAA) have argued for real-world testing, which would see cars driven over a 90km loop in a range of conditions to more accurately estimate a car’s emissions. There is no follow-up testing once a car is on the road, even if parts designed to comply with emissions allegedly fail to do the job. A ministerial forum set up in 2015 has failed to progress Australia’s emissions levels. Ms Harter said as a result, Australia has become an “outlier” in the vehicles market. “Some of the vehicles that are sold here are actually less efficient or more polluting than that same vehicle that would be sold overseas,” she said. Michael Bradley from the Australian Automobile Association would not comment on Toyota’s DPF problems, but said the AAA has been supportive of a tighter emissions standards for years. “The AAA has called for a comprehensive package of measures which address fuel standards, CO₂ standards, noxious-emissions standards and real-world testing. These issues are intertwined and have to be addressed in one package,” he said. A spokeswoman for Deputy Prime Minister and Minister for Infrastructure, Transport and Regional Development Michael McCormack responded to the ABC’s request for an interview in a statement. “The Liberal and Nationals Government is currently considering the case for introducing the latest international noxious-emission standards for light and heavy vehicles [Euro 6d and Euro VI respectively],

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but has not made a decision on how or when these standards may be implemented and will continue to consult with stakeholders," she said. "The Government is committed to developing a sensible framework that places savings for motorists and health benefits for the community front and centre, while ensuring that the vehicles that Australians value remain in the market."

ABC News, 5 September 2019

<http://www.abc.net.au/news/>

Technical Notes

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

ENVIRONMENTAL RESEARCH

[Virucidal effects of common disinfectants against tilapia lake virus.](#)

[Acute and chronic effects of perfluoroalkyl substance mixtures on larval American bullfrogs \(*Rana catesbeiana*\)](#)

[Methods to Test Endocrine Disruption in *Drosophila melanogaster*](#)

[Investigation of inflammation inducing substances in PM2.5 particles by an elimination method using thermal decomposition](#)

[Effect of Cu, Fe, Mn, Ni, and Zn and Bioaccessibilities in the Hazelnuts Growing in Sakarya, Turkey using In-Vitro Gastrointestinal Extraction Method](#)

MEDICAL RESEARCH

[Interdisciplinary-driven hypotheses on spatial associations of mixtures of industrial air pollutants with adverse birth outcomes](#)

[Validation of the \$\gamma\$ H2AX biomarker for genotoxicity assessment: a review](#)

[Assessing Toxicity and in Vitro Bioactivity of Smoked Cigarette Leachate Using Cell-Based Assays and Chemical Analysis](#)

[Regulation of cytochrome P450 expression by microRNAs and long noncoding RNAs: Epigenetic mechanisms in environmental toxicology and carcinogenesis](#)

[Bystander activation and autoimmunity](#)

OCCUPATIONAL RESEARCH

[Preliminary Evidence for a Hormetic Effect on DNA Nucleotide Excision Repair in Veterans with Gulf War Illness](#)

[An Online Survey of Occupational Hazards in Brazilian Aquaculture](#)

[Setting up a collaborative European human biological monitoring study on occupational exposure to hexavalent chromium](#)

[Dermatitis among workers in Ontario: results from the Occupational Disease Surveillance System](#)

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Do Gulf War veterans with high levels of deployment-related exposures display symptoms suggestive of Parkinson's disease?

PUBLIC HEALTH RESEARCH

Toxicity trends in E-Waste: A comparative analysis of metals in discarded mobile phones

Construction of a flexible electrochemiluminescence platform for sweat detection

Population-based incidence of lymphomas in the French Nord-Pas-de-Calais region between 2001 and 2005: Annual estimations and spatial analysis

Prenatal exposure to Polychlorinated Biphenyls and body fatness in girls

Determination of chemical-disease risk values to prioritise connections between environmental factors, genetic variants, and human diseases