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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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APR. 19, 2019

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ASIA PACIFIC

Changes we are proposing to make to the draft General Rules

2019-04-12

The National Industrial Chemicals Notification & Assessment Scheme (NICNAS) are seeking feedback on proposed changes to the draft General Rules for the new scheme. This consultation relates to certain General Rules that are either new or require significant change from the earlier exposure draft as a result of the passage of the IC Act (as amended). Stakeholder feedback on the categorisation criteria in the earlier draft of the General Rules was also considered in this process. Important: This consultation is not a further exposure draft of all the General Rules. NICNAS are continuing to develop the remainder of the General Rules, taking into account the stakeholder feedback received on the exposure drafts in 2018.

The focus of this consultation

The focus of this consultation is on amendments contained in the Industrial Chemicals Act 2019 that bring in new requirements for introducers. These requirements are that introducers will now need to make a one-off declaration for exempted introductions at the end of the registration year in which the introduction first occurs. In addition, during passage of the IC Act, the Government agreed to explore how the General Rules could limit the use of new animal test data for introductions where the chemical has multiple end uses, including in cosmetics. We are proposing new Rules in this area as well.

Have your say on this consultation

Submit this online form (preferred) if you wish to provide your comments on this consultation or email your submission to us at nicnas.reforms@nicnas.gov.au.

Further information on the consultation is available at: [Download our consultation paper on the draft General Rules \[PDF 897 KB\]](#)

NICNAS, 4 April 2019

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

The National Industrial Chemicals Notification & Assessment Scheme (NICNAS) are seeking feedback on proposed changes to the draft General Rules for the new scheme.

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Public Release Summary Belanty Fungicide

2019-04-12

The Australian Pesticides and Veterinary Medicine Authority (APVMA) is considering an application for the registration of Belanty Fungicide containing Mefentrifluconazole. The product is to be registered for control of Powdery mildew in grapevines and Black spot in apples. APVMA invite comment from 9 April 2019 until 7 May 2019 on whether the application for registration of the product should be granted. The APVMA is able to consider comments relating to the legislative grounds for registration, including:

- work health and safety
- public health
- chemistry and manufacture
- residues in food
- environmental safety
- trade
- efficacy and target crop safety

Download the [Public Release Summary on Belanty Fungicide](#).

More information is available at: [APVMA gazette 7, 9 April 2019](#)

APVMA, 9 April 2019

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

Hazard Class for Desensitized Explosives to be Incorporated into China GHS

2019-04-12

On 4 April 2019, China's Standardization Administration (SAC) announced on its website that 44 compulsory national standards (GB standard) were to be revised or formulated in one or two years. As scheduled, a new GB standard concerning the classification and labelling of desensitised explosives will be formulated by China's Ministry of Industry and Information Technology (MIIT) in 12 months. In 2015, an additional hazard class for desensitised explosives with new H statements H206 to H208 was incorporated into the [UN GHS Rev.6](#). The desensitised explosives were defined as solid or liquid explosive substances or mixtures which are phlegmatized to suppress their explosive properties in such a manner that they do not mass explode and do not burn too rapidly and therefore may be exempted from the hazard class "Explosives". China's current GHS

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classification and labelling criteria of chemicals, namely the GB 30000-2013 series, were formulated in line with the UN GHS Rev.4. MIIT in April 2018 consulted on its own schedule for drafting a classification and labelling standard of desensitised explosives and it was recently included in SAC's schedule. It will be a new GB 30000.XX standard named as "Rules for Classification and Labelling of Chemicals- Part XX: Desensitised Explosives". Further information is available at:

- [UN GHS Rev.6](#)
- [China GHS to Supplement New Physical Hazard Classification](#)
- [SAC notice](#)

Chemlinked, 10 April 2019

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

AMERICA

SDS Fail Exposes Food Processing Workers to Hazardous Chemicals

2019-04-12

Safety data sheets (SDSs) for several bulk flavourings failed to list hazardous substances, according to National Institute for Occupational Safety and Health (NIOSH) findings. Out of 26 bulk liquid flavourings obtained from two U.S. coffee roasting and packaging facilities, 21 contained diacetyl, and 15 contained 2,3-pentanedione. Inhalation of diacetyl may lead to obliterative bronchiolitis, a debilitating lung disease. Animal studies of 2,3-pentanedione, a common substitute, have found evidence of similar inhalational hazards. Of the 26 flavourings tested, 24 came from a single manufacturer. None of the SDSs listed diacetyl and 2,3-pentanedione.

SDS Exemptions

Chemical manufacturers, distributors, and importers must provide employers with SDSs under the Occupational Safety and Health Administration's (OSHA) hazard communication standard. SDSs notify employers of hazardous substances in the chemicals they purchase so they can implement appropriate controls to protect the health and safety of their employees. However, some substances may not be listed on an SDS for reasons that include:

Safety data sheets (SDSs) for several bulk flavourings failed to list hazardous substances, according to National Institute for Occupational Safety and Health (NIOSH) findings.

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- They are generally recognized as safe for ingestion by the Food and Drug Administration (however, they may present an inhalation hazard in the workplace);
- They are part of the manufacturer's trade secrets; or
- They make up less than 1% of all ingredients.

Employers at the two coffee-roasting and packaging facilities asked NIOSH to perform a Health Hazard Evaluation out of concern about occupational exposure to flavouring chemicals and possible risks for respiratory impairment. One facility representative told NIOSH investigators the manufacturer said there was no added diacetyl or 2,3-pentanedione in its flavourings. The manufacturer later clarified to the facility that diacetyl may occur as a natural by-product of acetoin, which is added to almost all coffee flavours used by the facility. Workers in food-processing facilities face respiratory hazards due to inhalation of diacetyl and 2,3-pentanedione, which are emitted from bulk materials, especially at elevated temperatures.

Food Industry Hazards Identified

In August 2000, NIOSH investigated cases of obliterative bronchiolitis among former workers of a microwave popcorn plant. The institute determined that artificial butter flavourings added to the popcorn were responsible for causing the disease. NIOSH later found that flavourings used to produce flavoured whole-bean and ground-roasted coffee led to the same lung disease among workers employed in coffee roasting and packaging. There are no OSHA permissible exposure limits for diacetyl and 2,3-pentanedione. NIOSH has recommended exposure limits be set at an 8-hour time-weighted average (TWA) of 5 parts per billion (ppb) for diacetyl and 9.3 ppb for 2,3-pentanedione in workplace air. It also has recommended 15-minute TWA short-term exposure limits of 25 ppb for diacetyl and 31 ppb for 2,3-pentanedione.

Recommended Precautions for Employers

NIOSH recommends a series of controls and practices for food-processing employers to prevent or limit diacetyl and 2,3-pentanedione exposures:

- Consider using less hazardous substances;
- Use engineering controls such as closed systems, isolation, or local exhaust ventilation;
- Institute administrative controls, such as good housekeeping, and work practices that limit the release of chemical vapours and dust, minimising exposure;

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- Provide personal protective equipment (respirators) where needed, in addition to engineering or administrative controls;
- Keep containers of flavourings tightly closed when not in use so their contents do not get into the workplace air;
- Isolate mixing and other high-exposure processes from the rest of the workplace, and maintain these work areas under negative air pressure;
- Use the lowest temperatures necessary if heated processes are used;
- Monitor air concentrations of flavouring ingredients;
- Provide breathing tests (spirometry) before the first exposure and on a regular basis to all workers at risk of hazardous exposure to flavourings or their ingredients;
- Monitor the status of workers' health, tracking potential symptoms or cases; *and*
- Refer workers for evaluation by a physician if they have abnormal breathing test results, an accelerated drop in test results over time, or persistent symptoms.

EHS Daily Advisor, 9 April 2019

<http://ehsdailyadvisor.blr.com/>

RCRA Waste Ignitability Testing Updates Could Be Coming

2019-04-12

The United States Environmental Protection Agency (EPA) is proposing to revise requirements regarding the test methods that must be used to determine if a liquid waste is a RCRA hazardous waste because it has the characteristic of ignitability. Under current regulations, one of two flash point test methods specified in the EPA's *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846)* must be used to make the ignitability determination. But the EPA notes that those methods were approved in regulations issued in 1980 and 1981. Since then the Agency has made preliminary moves to modify the requirements so that more modern methods may be used, but no regulatory change was completed. The new proposal would allow the use of consensus-based standards that reflect improvements and the modernization of flash point testing that have occurred since 1981. According to the Agency, the proposed changes would affect 217 commercial laboratories that conduct ignitability testing under the older SW-846 methods. "EPA understands that many generators and laboratories already have instrumentation capable of modern flash point testing," the Agency states. "Therefore,

The United States Environmental Protection Agency (EPA) is proposing to revise requirements regarding the test methods that must be used to determine if a liquid waste is a RCRA hazardous waste because it has the characteristic of ignitability.

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the proposed update adds the flexibility of using modern test methods, provides the potential for cost savings, and enhances the protection of human health and the environment while providing equivalent results." In the same proposal, the Agency is seeking to make additional revisions regarding the regulatory exclusion in the ignitable characteristic rules for aqueous liquids containing alcohols; sampling guidance applicable to waste mixtures with multiple phases when determining whether a waste exhibits the ignitability characteristic; and alternatives to the use of mercury thermometers in the air sampling and stack emissions methods in SW-846.

Existing Methods

Currently, to determine whether a liquid waste is an ignitable hazardous waste under RCRA (i.e., has a flash point less than 60°C (140 °F)), its flash point must be assessed according to either of the two following procedures:

- Method 1010A uses a procedure and instrumentation commonly referred to as the Pensky-Martens method, a closed-cup approach that aims to simulate a liquid spill in a closed environment. This method is appropriate for liquids that are nonhomogeneous, form films, have high viscosities, or are slurries because it uses an instrument that can mechanically mix wastes.
- Method 1020B employs a small-scale closed-cup device called a Setafish. This method provides the practical advantage of reduced sample size and, therefore, reduces lab waste generation when compared to the Pensky-Martens method.

Either method requires use of mercury thermometers, which are being phased out because of environmental, health, and safety concerns.

Proposed Updates

The EPA is proposing to update Method 1010A to Method 1010B and Method 1020B to Method 1020C. Both proposed updates include the allowance for an automatic method with electronic flash point detection, the option to use a flame ignition source or an electric ignition source, and use of nonmercury temperature devices. The proposed methods are identical to methods developed and maintained by ASTM International, a non-profit organisation comprising producers, users, consumers, government, and academia that develops and publishes consensus-based standards. Under the proposal, testing would still be allowed using the older methods.

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Other Proposed Revisions

In addition, the proposal would:

- Codify existing guidance regarding the regulatory exclusion in the ignitable characteristic for aqueous liquids containing alcohols. Currently, the exclusion applies to any aqueous solution containing less than 24 percent alcohol by volume. However, the EPA has provided guidance noting that the exclusion may inadvertently exclude certain wastes that have low amounts of alcohol but other components that result in the regulatory definition of ignitability. The proposed revision would incorporate the guidance into the regulations.
- Add new regulatory language to clarify that the EPA's existing sampling procedures for multiphase samples would be applicable to all liquid wastes tested for ignitability.
- Clarify how to properly test multiphase wastes containing multiple liquid(s) with or without solids for ignitability determinations.
- Finally, the proposal would update *SW-846* air sampling and stack emissions for Methods 0010, 0011, 0020, 0023A, and 0051, each of which uses mercury thermometers. The update would provide current users of these methods with the flexibility to use alternative temperature-measuring devices instead of the currently required mercury thermometers.

EHS Daily Advisor, 9 April 2019

<http://ehsdailyadvisor.blr.com/>

EPA Proposes Rule on Certain Confidential Business Information Claims, Reaching Another TSCA milestone

2019-04-12

The United States Environmental Protection Agency (EPA) is releasing a proposed rule for public comment on the procedures for companies to substantiate certain claims of confidentiality for chemical identities and how the agency will review those claims. The proposed rule is intended to ensure that when a company has claimed the identity of a chemical as confidential business information (CBI) it meets the criteria for that status under the Toxic Substances Control Act (TSCA). "We continue to be committed to fostering transparency about information on chemicals while protecting verified confidential information," said Assistant Administrator for EPA's Office of Chemical Safety and Pollution Prevention Alexandra Dapolito Dunn. "With this proposed rule, we are meeting

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another obligation under TSCA, as amended by the Frank R. Lautenberg Chemical Safety Act." The proposed rule outlines procedures for a very specific CBI review activity that is limited in focus. It covers only the universe of CBI claims made for specific chemical identities for chemicals reported as "active" in response to the TSCA Inventory Notification Rule. The TSCA Inventory Notification Rule required companies to notify EPA about which chemicals on the TSCA Inventory were active in U.S. commerce (defined as having been manufactured or processed during the 10-year period ending June 21, 2016) and permitted companies to claim confidentiality of a specific identify for those active chemicals. TSCA requires that persons who claimed confidentiality for "active" chemical substance identities must substantiate those claims using certain procedures including using an electronic reporting process. TSCA also requires the EPA to establish a final rule to review CBI claims by 19 February 2020, within one year of the publishing of the TSCA Inventory on 19 February 2019. The CBI reviews covered in this rule must occur by 19 February 2024, which is within five years of the date of the TSCA Inventory publication. The proposed rule describes requirements for EPA's review of these claims, including timeframes for EPA completing reviews and annual posting of results to date. Upon publication in the Federal Register of the proposed rule, the EPA will accept public comments for 60 days in docket EPA-HQ-OPPT-2018-0320 on www.regulations.gov. Further information is available at: <https://www.epa.gov/tsca-inventory/chemical-identity-cbi-claims-active-chemicals-tsca-inventory>

U.S EPA, 10 April 2019

<http://www.epa.gov>

New Hazardous Waste Pharmaceutical Rule Imposes New Obligations on Health Care Providers

2019-04-12

The United States Environmental Protection Agency (EPA) Acting Administrator Andrew Wheeler signed a new hazardous waste pharmaceutical rule on 8 December 2018. This rule will impose significant new obligations on certain health care providers, including pharmacies and long-term care providers, as well as forward and all reverse distributors of pharmaceuticals. The final proposed rule issued on 22 February 2019, will be codified in Subpart P of Part 266 (Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities) of the Resource Conservation and Recovery Act ("RCRA") and will govern qualifying healthcare sector

The final proposed rule issued on 22 February 2019, will be codified in Subpart P of Part 266 (Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities) of the Resource Conservation and Recovery Act ("RCRA") and will govern qualifying healthcare sector activities in lieu of the obligations contained in 40 CFR §262.

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activities in lieu of the obligations contained in 40 CFR §262. This new rule represents a noteworthy change from EPA's previous policy position that pharmaceuticals in the reverse distribution chain were not "discarded" under RCRA for purposes of waste designation until an affirmative decision was made to treat them as "waste" and discard them. A proposed rule under the Bush Administration would have treated unused prescription and over-the-counter ("OTC") drugs as "universal wastes" subject to less stringent management and disposal rules, but EPA never finalized the proposed regulation as concerns were raised regarding Drug Enforcement Agency regulated narcotics and medications. EPA also felt the need to address its concern that a substantial number of industry representatives were ignoring guidance and treating pharmaceuticals sent through reverse distribution as "not discarded" and therefore, not a regulated waste. While the rule does not add any pharmaceuticals to the hazardous waste listings or expand the hazardous waste characteristics to include additional pharmaceuticals, EPA outlines almost a dozen new definitions affecting the healthcare sector and its governance under the rule. This includes an expansive definition of "healthcare facility" that encompasses supermarket and other grocery stores, warehouse clubs and supercentres, mail order pharmacies, chiropractors and dentists' offices in addition to the more traditional doctors' offices, hospitals, nursing care facilities and other ambulatory health care services. In particular, long term care facilities, as specifically defined in the rule^[1], will be required to follow the new provisions of subpart P instead of benefiting from previously allowed household waste exclusion. The rule applies to all healthcare facilities that generate above the "very small quantity generators" (VSQGs) monthly quantity thresholds regardless of the amount of hazardous waste pharmaceuticals generated above those limits. Non-pharmaceutical hazardous waste still must be quantified and the appropriate generator category assigned for determination under part 262, but the calculation should not include any hazardous waste pharmaceuticals handled under subpart P. Healthcare facility VSQGs maintain their conditional exemption under 40 CFR §262.14 but may opt into subpart P. Healthcare facilities that dispose of prescription pharmaceuticals must register with U.S. EPA, provide training to staff, appropriately label containers and segregate listed or characteristically hazardous (toxic, flammable, reactive, or corrosive) pharmaceuticals from unlisted, non-hazardous materials. The rule also creates an exemption from certain existing requirements for discarded containers of medications that would be considered P-listed hazardous waste, such as drugs containing warfarin (e.g., Coumadin). The final rule also contains several critical requirements related to treatment of non-prescription pharmaceuticals (not considered solid waste at the

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healthcare facility) and prescription pharmaceuticals (considered “solid waste” at the healthcare facility) sent through reverse logistics and reverse distribution depending upon the “reasonable expectation” of legitimate reuse or recycling of the pharmaceuticals. EPA determined that there is no “reasonable expectation” of reuse or reclamation of prescription pharmaceuticals except in rare circumstances (e.g., in the case of lawful donation). Prescription drugs that are returned to the manufacturer for credit are almost always discarded. The rule also exempts from regulation, medications collected during drug take-back programs and events as falling within the Congressionally-created household hazardous waste exemption. Finally, the rule eliminates the dual regulation of hazardous waste pharmaceuticals under RCRA if they are also regulated by the DEA as “controlled substances.”

Of particular significance is the amendment of the P075 listing for nicotine products such that FDA-approved OTC nicotine replacement therapies (e.g., patches, gums and lozenges) will no longer be included under the P075 listing for hazardous waste and may be discarded as a non-hazardous solid waste. This is based upon EPA finding that such drugs do not meet the regulatory criteria for acute hazardous waste (P-code). However, other products, the primary ingredient of which is nicotine (e-cigarettes, prescription nicotine, nicotine used in legacy pesticides and in research and manufacturing), will continue to carry the P075 waste code. Subpart P takes effect six months after publication on 21 August 2019 only in non-authorized states, Indian Country and U.S. Territories (except Guam). In RCRA-authorized states, Subpart P is effective only after the state adopts Subpart P. However, Subpart P is considered more stringent than current regulations and, therefore, authorized states are required to adopt it by 1 July 2021, unless the state requires a statutory amendment for adoption, in which case, the deadline for adoption of Subpart P is 1 July 2022. The new rule also contains a sewerage ban that applies to all healthcare facilities, including VSQGs and is effective in ALL states on 21 August 2019 regardless of whether the state is RCRA-authorized or has adopted Subpart P, and effective on 21 August 2019. Since EPA’s promulgation on P075 is less stringent than the current federal standard, RCRA authorized states are not required to adopt its provision. This inevitably will result in a patchwork approach that may prove challenging for multi-state facilities focused on compliance. Because the final rule makes fundamental changes to long-held EPA policy regarding the point at which a pharmaceutical product is considered a solid waste under RCRA, it may create significant regulatory uncertainty, and potential liability, for entities in the pharmaceutical distribution chain that must evaluate their

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compliance with the new rule. Furthermore, the RCRA state authorization construct will add even more complexities. This alert provides an overview of the key provisions, timelines and implications, but a more detailed review will depend on specific facts or circumstances and can be provided upon request.

National Law Review, 5 April 2019

<http://www.natlawreview.com>

EUROPE

Draft reference values for sodium and chloride – have your say

2019-04-12

The European Food Safety Authority (EFSA) is publicly consulting on draft dietary reference values (DRVs) for sodium and chloride, the final two nutrients in its review of scientific advice on nutrient intakes for the EU population. Sodium and chloride are the two elements in salt, commonly used in the diet as an ingredient, condiment or preservative. The Panel on Nutrition, Novel Foods and Food Allergens provisionally considers for the general adult population (including pregnant and lactating women):

- An intake of 2g sodium per day to be safe and adequate, considering evidence on the risk of cardiovascular disease on the one hand and nutrition adequacy on the other;
- An intake of 3.1g chloride per day to be safe and adequate, taking account that the main source of chloride in EU diets is sodium chloride.

The panel also proposes age-specific values of both nutrients for children, adjusting for differences in energy requirement and including growth factors. Adequate intakes for infants above 6 months of age were derived from the intakes of breastfed infants below 6 months of age. EFSA's provisional reference values are neither nutrient goals nor recommendations for populations or individuals. They are meant to serve policy makers in the EU and its Member States to inform nutrition policies and issue dietary guidelines to help consumers make healthy dietary choices. If you would like to contribute to the discussion before finalisation of these scientific opinions, please provide comments online and register now for the [technical meeting](#) taking place in Brussels on 7 May as part of the consultation process.

The European Food Safety Authority (EFSA) is publicly consulting on draft dietary reference values (DRVs) for sodium and chloride, the final two nutrients in its review of scientific advice on nutrient intakes for the EU population.

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Copies of the consultation papers are available at:

- [Public consultation on draft dietary reference values for sodium](#)
- [Public consultation on draft dietary reference values for chloride](#)

EFSA, 3 April 2019

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

Men 23 times more likely to die in the workplace than women

2019-04-12

In 2017/18, the Health & Safety Executive (HSE) released its findings summarising statistics surrounding health and safety at work. While the report outlined a variety of insightful statistics, one of the most shocking relates to the locations in which workplace fatalities take place. Indeed, while accidents happen within different industries throughout the UK, the HSE's research found that fatalities are more likely to happen in more places than others. In fact, based on UK averages, workers are more likely to die due to an incident in the workplace in Wales than any other part of the UK, with Scotland coming in at a close second. On the other hand, research has shown that people that live and work in the South East of England are least likely to die due to an accident at work. 5 most common causes of work-based fatalities in the UK across the 2017/18 period:

- Falls from a height (31%);
- Struck by a moving vehicle (23%);
- Struck by a moving object (20.3%);
- Trapped by something collapsing/overturning (14.2%);
- Contact with moving machinery (11.5%).

Asbestos

Figures indicate that, on average, every 40 minutes someone in the UK dies from lung disease that can be linked to past workplace exposure. Shockingly, 20% of annual lung disease deaths occur as a direct result of Asbestos-related lung cancer. Although awareness has been introduced as a key part of workplace health and safety, Asbestos related fatalities still account for a high percentage of work-related deaths. Research also found a trend regarding work-related fatalities based on age. As to be expected, the older you are, the more likely you are to have an accident in the workplace. Specifically, figures indicate a significant increase in workplace fatalities from the age of 35, with the likelihood increasing up

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until retirement age, where workers who are 65 and over are 6x more likely to suffer from a fatal injury. The report also found that men are 23 times more likely to die in the workplace than women. While the cause of the findings could be attributed to the fact that men statistically occupy more physically intensive occupations (including construction and off-shore engineering) data was drawn from a wide array of occupations in which women also work in high volume. As a result, the statistic suggests that, on average, men are more at risk of suffering a fatal workplace injury across any industry or sector. In response to the rate of workplace fatalities, the UK government introduced increasingly legislation in late 2015/2016 in an effort to take a hard line against reduce health and safety violations and ensure that organisations adopt a proactive, rather than reactive, approach to health and safety.

Sentencing guidelines

As a result, for cases tried in a magistrate's court organisations can be expected to pay anywhere between £5,000 to £20,000. However, for cases that are tried in the Crown Court, fines are unlimited. Indeed, the new sentencing guidelines have caused the total amount in fines skyrocketed from around £40 million to £72 million in 2016/17. Increasing again to around £73 million in 2017/18.

Safety & Health Practitioner, 8 April 2019

<http://www.shponline.co.uk>

Presentations Available from EFSA Stakeholder Workshop on Nanoscience and Nanotechnology

2019-04-12

The European Food Safety Authority (EFSA) held a stakeholder workshop on April 1-2, 2019, on the implementation of its guidance on the risk assessment of applications of nanosciences and nanotechnologies in the food and feed chain. As reported in our July 5, 2018, blog item, "EFSA Publishes New Guidance on Nanotechnologies in Food and Feed," in July 2018, EFSA published new guidance on how to assess the safety of nanoscience and nanotechnology applications. The guidance covers novel foods, food contact materials, food and feed additives, and pesticides, taking into account new developments that have taken place since publication of the previous guidance in 2011. The workshop was an opportunity for stakeholders, EFSA, and its experts to have an open discussion and share their experiences on implementing the

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EFSA guidance, focusing on human and animal health. The workshop was attended by 60 participants, who discussed the challenges they have faced implementing the guidance and shared examples of good practice. Stakeholders made suggestions on some sections of the guidance, which were noted for consideration by EFSA's Working Group on Nanotechnologies. EFSA has posted the following presentations from the workshop:

- "The EFSA guidance on the risk assessment of the application of nanoscience and nanotechnologies in the food and feed chain," Reinhilde Schoonjans, EFSA;
- "Supporting applicants in the area of regulated products (REPRO)," Remigio Marano, EFSA;
- "Overview of the EFSA Guidance on risk assessment of the application of nanoscience and nanotechnologies in the food and feed chain," Francesco Cubadda, Consortium of Istituto Superiore di Sanità (ISS) (Italy), Working Group Member;
- "Validation and Implementation of an Analytical Methodology to Characterize the Fraction of Nano-Sized Particles in E171 and E174," Jan Mast, Sciensano;
- "Report on E171 (titanium dioxide) and E172 (iron oxide) – analytical perspectives from research," David Brizzolara, Titanium Dioxide Manufacturers Association (TDMA);
- "Implementation issues related to the EFSA GD: Questions received from stakeholders," Hubert Rauscher, Joint Research Center;
- "Characterisation and quantification in matrix: Focus on Chapters 4.3-4.4, including solubility and degradation/dissolution rate," Francesco Cubadda, ISS (Italy), WG Member;
- "Physical Chemical Characterization of Nanomaterials," Jürgen Nolde (presented by Bjoern Braun), Evonik Resource Efficiency GmbH (Germany);
- "Food and Feed Ingredient Submissions: The Importance of Particle Size — Understanding and Interpreting EFSA's Guidance on Nanotechnologies," Nigel Baldwin, Intertek (United Kingdom);
- "Focus on Chapters 5 & 6 covering Oral Exposure Assessment and Hazard identification/characterisation," Alicja Mortensen, National Research Center for the Working Environment (NRCWE) (Denmark);
- "Intestinal uptake of particles," Klaus Weber, AnaPath GmbH (Switzerland), and Nils Krueger, Evonik Resource Efficiency GmbH (Germany);

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- "Nanomaterials in the EU Food Regulations," Takis Daskaleros, European Commission (EC); and
- "Bottlenecks faced in the industry and multi-disciplinary approach in risk assessment of nanomaterials: A Regulatory perspective," Dr. David Carlander, Nanotechnology Industries Association (NIA) (Belgium).

Nano & Other Emerging Technologies Blog, 10 April 2019

<http://nanotech.lawbc.com>

REACH Update

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Poison Centres Notification format updated

2019-04-11

A revised version of the Poison Centres Notification (PCN) format is now available. It has been improved based on user feedback from industry, appointed bodies and poison centres. The PCN format structures the information on hazardous mixtures submitted to the Member State appointed bodies. A copy is available at: [PCN format](#)

ECHA News, 10 April 2019

<http://echa.europa.eu>

Authorisations granted for uses of three substances

2019-04-11

The European Commission has granted authorisations for five uses (review period expiry dates in brackets) for:

- two uses of sodium chromate (EC 231-889-5, CAS 7775-11-3) and two uses of potassium chromate (EC 232-140-5, CAS 7789-00-6) to Saes Getters S.p.A. (6 March 2026); and
- one use of dibutyl phthalate (EC 201-557-4, CAS 84-74-2) to AVX Limited (21 March 2026).

Adopted opinions

ECHA News, 10 April 2019

<http://echa.europa.eu>

Commission publishes 12th ATP to the CLP Regulation

2019-04-11

On 27 March 2019, the European Commission published the 12th adaptation to technical progress (ATP) to the CLP Regulation, implementing the sixth and seventh revised editions to the Globally Harmonised System (GHS) of Classification and Labelling. A copy of the revised CLP Regulation is available at: [Commission Regulation](#)

ECHA News, 10 April 2019

<http://echa.europa.eu>

A revised version of the Poison Centres Notification (PCN) format is now available.

REACH Update

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New intentions to harmonise classification and labelling

2019-04-11

The European Chemicals Agency has announced that 3 new intentions to harmonise classification and labelling have been received. New intentions have been received for:

- lavandulyl senecioate (EC 805-422-6, CAS 23960-07-8) by Italy;
- sodium chlorate (EC 231-887-4, CAS 7775-09-9) by Sweden; and
- potassium chlorate (EC 223-289-7, CAS 3811-04-9) by Sweden.

Further information is available at: [Registry of CLH intentions](#)

ECHA News, 10 April 2019

<http://echa.europa.eu>

Update to the list of substances registered only by UK companies

2019-04-11

The European Chemicals Agency have announced that the list of substances registered only by UK companies has been updated. It now contains 21 newly registered substances and 926 substances from the previous list published on 8 February. ECHA remind companies to initiate the transfer of their registrations and other assets through ECHA's IT tools before the UK withdrawal takes effect. Further advice is available on our web page. Further information is available at: [UK withdrawal from the EU](#)

ECHA News, 10 April 2019

<http://echa.europa.eu>

Court dismisses action against Commission decision concerning the authorisation of uses of DEHP

2019-04-11

On 4 April 2019, the General Court of the European Court of Justice issued a judgment dismissing action brought by Client Earth. Client Earth was seeking to annul a Commission decision rejecting its request to review a Commission authorisation decision for some uses of DEHP. The decision was based on opinions by ECHA's committees for risk assessment and for socio-economic analysis. The Court considered that the Commission did not err in its assessment of the conformity of the application for authorisation. Furthermore, Client Earth's claims that the Commission had

The European Chemicals Agency has announced that 3 new intentions to harmonise classification and labelling have been received.

REACH Update

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made errors in relation to the socio-economic assessment and the analysis of alternatives were considered to be unfounded. Further information in the judgement is available at: [Judgment](#)

ECHA News, 10 April 2019

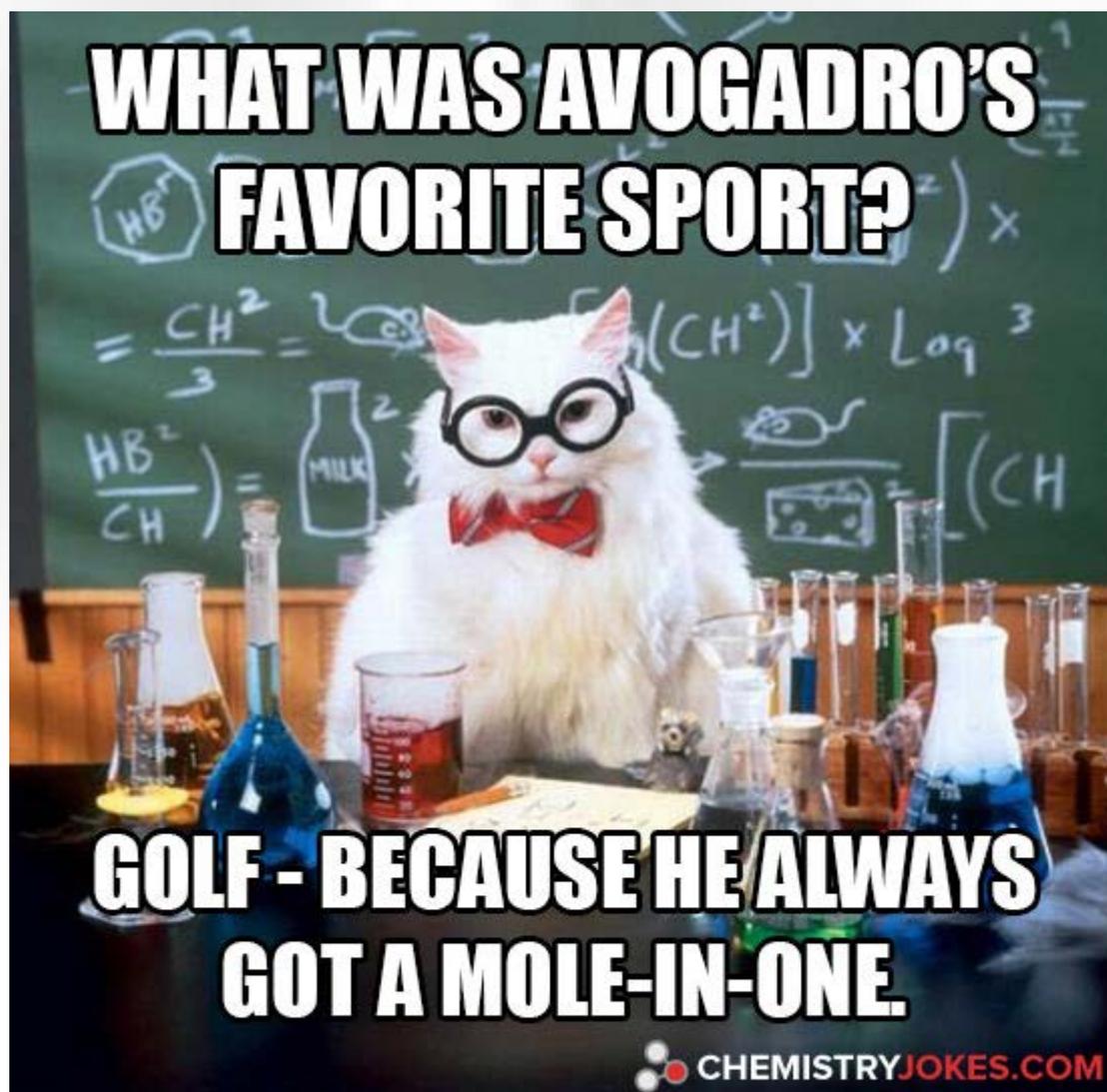
<http://echa.europa.eu>

Janet's Corner

CHEMWATCH

What Was Avogadro's Favourite Sport?

2019-04-12



Hazard Alert

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Benzidine

2019-03-25

Benzidine, (4,4'-diaminobiphenyl), is the solid organic compound with the formula $(C_6H_4NH_2)_2$. [1] It is a manufactured chemical that does not occur naturally. Benzidine is a crystalline (sandy or sugar-like) solid that may be greyish-yellow, white, or reddish-grey. It will evaporate slowly from water and soil. Its flammability, smell, and taste have not been described. In the environment, benzidine is found in either its "free" state (as an organic base), or as a salt (for example, benzidine dihydrochloride or benzidine sulphate). In air, benzidine is found attached to suspended particles or as a vapour. [2] Benzidine has been linked to bladder and pancreatic cancer. Since August 2010 benzidine dyes are included in the EPA's List of Chemicals of Concern.[1]

USES [2]

In the past, industry used large amounts of benzidine to produce dyes for cloth, paper, and leather. However, it has not been made for sale in the United States since the mid-1970s. Major U.S. dye companies no longer make benzidine-based dyes. Benzidine is no longer used in medical laboratories or in the rubber and plastics industries. However, small amounts of benzidine may still be manufactured or imported for scientific research in laboratories or for other specialised uses. Some benzidine-based dyes (or products dyed with them) may also still be brought into the United States.

IN THE ENVIRONMENT [2]

In the past, benzidine entered the environment largely when it was being made or used to produce dyes. Industry released it to waterways in the form of liquids and sludges, and transported benzidine-containing solids to storage or waste sites. Benzidine was sometimes accidentally spilled, and it was released to the air as dust or fumes. For the most part, companies no longer make or use benzidine, and the government strictly regulates these activities. Today, most benzidine still entering the environment probably comes from waste sites where it had been disposed. Some may also come from the chemical or biological breakdown of benzidine-based dyes or from other dyes where it may exist as an impurity. Only very small amounts of free benzidine will dissolve in water at moderate environmental temperatures. When released into waterways, it will sink and become part of the bottom sludge. Benzidine

Benzidine, (4,4'-diaminobiphenyl), is the solid organic compound with the formula $(C_6H_4NH_2)_2$.

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salts can dissolve more easily in water than free benzidine. Only a very small portion of dissolved benzidine will pass into the air. Benzidine exists in the air as very small particles or as a vapor, which may be brought back to the earth's surface by rain or gravity. In soil, most benzidine is likely to be strongly attached to soil particles, so it does not easily pass into underground water. Benzidine can slowly be destroyed by certain other chemicals, light, and some microorganisms (for example, bacteria). Certain fish, snails, algae, and other forms of water life may take up and store very small amounts of benzidine, but accumulation in the food chain is unlikely.

SOURCES & ROUTES OF EXPOSURE

Sources of Exposure [2]

The general population is not likely to be exposed to benzidine through contaminated air, water, soil, or food. Benzidine is a manufactured chemical that does not occur naturally in the environment. Currently, the United States industry makes and uses very little (if any) benzidine, and no releases to air, water, or soil are reported on the Toxic Release Inventory (TRI). Only rarely has benzidine been detected in areas other than waste sites, and it has not been found in food. Some dyes used to colour foods or drinks may contain impurities that can be broken down to benzidine once inside the body. If you live near a hazardous waste site, you could be exposed to benzidine by drinking contaminated water or by breathing or swallowing contaminated dust and soil. Benzidine can also enter the body by passing through the skin. Some quantities of dyes made from benzidine may still be brought into the United States. These may contain small amounts of benzidine as a contaminant, or chemicals that may be broken down in the body to benzidine. If you use such dyes to dye paper, cloth, leather, or other materials, you may be exposed by breathing or swallowing dust, or through skin contact with dust. You may be exposed in a similar way if you work at or near hazardous waste sites.

Routes of Exposure [2]

Benzidine can enter your body if you breathe air that has small particles of benzidine or dust to which benzidine is attached. It can also enter your body if you drink water or eat food that has become contaminated with benzidine. If your skin comes in contact with benzidine, it could also enter your body. Generally, it will take only a few hours for most of the benzidine to get into your body through the lungs and intestines. It may take several days for most of the benzidine to pass through your skin. Breathing, eating, or drinking benzidine-based dyes may also expose you

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to benzidine. Your intestines contain bacteria that can break down these dyes into benzidine. Once in your body, only a small portion of benzidine will leave as waste in your urine and feces. Your body will change most of the benzidine into many different chemical forms (called metabolites), which dissolve readily in your bodily fluids and are easy for your body to remove. Some of these changed forms of benzidine appear to cause many of the chemical's harmful effects. Studies show that after benzidine has entered your body, most of it (and its changed forms) will be removed within a week.

HEALTH EFFECTS [3]

Acute Effects

No information is available on the acute effects of benzidine in humans via inhalation exposure. Benzidine is considered to be very acutely toxic to humans by ingestion. Symptoms of acute ingestion exposure include cyanosis, headache, mental confusion, nausea, and vertigo. Dermal exposure may cause skin rashes and irritation. Tests involving acute exposure of rats and mice have shown benzidine to have high toxicity from oral exposure.

Chronic Effects (Noncancer)

Chronic exposure to benzidine in humans may result in bladder injury. The Reference Dose (RfD) for benzidine is 0.003 milligram per kilogram body weight per day (mg/kg/d) based on brain cell vacuolisation in mice and liver cell alterations in female mice. The California Environmental Protection Agency (CalEPA) has established a chronic reference exposure level of 0.01 milligrams per cubic metre (mg/m³) for benzidine based on neurological, liver, and spleen effects in mice.

Cancer Risk

- Numerous epidemiologic studies have demonstrated occupational exposure to benzidine to result in an increased risk of bladder cancer.
- Animal studies have reported various tumour types at multiple sites from benzidine exposure via oral, inhalation, and injection exposure.
- EPA has classified benzidine as a Group A, human carcinogen.

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SAFETY [4]

First Aid Measures

- Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.
- Skin Contact: In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.
- Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
- Ingestion: Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Exposure Control/Personal Protection

Engineering Controls

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

Personal Protective Equipment

The following personal protective equipment is recommended when handling benzidine:

- Splash goggles;
- lab coat;
- dust respirator (be sure to use an approved/certified respirator or equivalent); and
- gloves.

Personal Protection in Case of a Large Spill:

- Splash goggles;

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- full suit;
- dust respirator;
- boots; and
- gloves.
- A self-contained breathing apparatus should be used to avoid inhalation of the product.

REGULATION

United States

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

- General Industry: 29 CFR 1910.1010 requirements identical to 29 CFR 1910.1003 - 13 Carcinogens (4-Nitrobiphenyl, etc.) -- Cancer-Suspect Agent
- Construction Industry: 29 CFR 1926.1110 requirements identical to 29 CFR 1910.1003 - 13 Carcinogens (4-Nitrobiphenyl, etc.) -- Cancer-Suspect Agent
- Maritime: 29 CFR 1915.1010 requirements identical to 29 CFR 1910.1003 - 13 Carcinogens (4-Nitrobiphenyl, etc.) -- Cancer-Suspect Agent

ACGIH: The American Conference of Governmental Industrial Hygienists has set the following threshold Limit Value (TLV) for benzidine: Exposure by all routes should be carefully controlled to levels as low as possible; Skin; Appendix A1 - Confirmed Human Carcinogen

NIOSH: The National Institute for Occupational Safety and Health has set the following Recommended Exposure Limit (REL): Appendix A - NIOSH Potential Occupational Carcinogens; Appendix C - Supplementary Exposure Limits

REFERENCES

1. <http://en.wikipedia.org/wiki/Benzidine>
2. <http://www.atsdr.cdc.gov/phs/phs.asp?id=567&tid=105>
3. <http://www.epa.gov/ttn/atw/hlthef/benzidin.html>
4. <http://www.sciencelab.com/msds.php?msdsId=9923046>

Gossip

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~dGossip

~tMaterials could delay frost up to 300 times longer than existing anti-icing coatings

~w2019-03-27

~qPhase-switching liquids hold promise as next-generation anti-icing materials.

Most techniques to prevent frost and ice formation on surfaces rely heavily on heating or liquid chemicals that need to be repeatedly reapplied because they easily wash away. Even advanced anti-icing materials have problems functioning under conditions of high humidity and subzero conditions, when frost and ice formation go into overdrive. Now, researchers from the University of Illinois at Chicago College of Engineering describe for the first time several unique properties of materials known as phase-switching liquids, or PSLs, that hold promise as next-generation anti-icing materials. PSLs can delay ice and frost formation up to 300 times longer than state-of-the-art coatings being developed in laboratories. Their findings are published in the journal *Advanced Materials*. "Ice and frost pose hazards to people and can damage machines and reduce functionality of some technologies, especially those related to energy and transportation, so we have been interested in finding possible ways to overcome their harmful effects, and phase-switching liquids are very promising candidates," said Sushant Anand, assistant professor of mechanical and industrial engineering and corresponding author of the paper. PSLs are a subset of phase change materials that have melting points higher than the freezing point of water, which is 0 degrees Celsius, meaning that they would be solids at a range of temperatures close to that at which water freezes. Examples of such materials include cyclohexane, cyclooctane, dimethyl sulfoxide, glycerol, and more. "At sub-zero temperatures, all PSLs turn solid. So, on a winter day, you could coat a surface where you don't want icing with a PSL material and it would remain there much longer than most deicing liquids, which demand frequent reapplication," said Rukmava Chatterjee, a doctoral student in the UIC College of Engineering and the first author of the paper. While researchers have known about phase change materials for a long time, their unique anti-icing and anti-frosting properties have not been investigated before, Chatterjee explained. Decades ago, Daniel Beysens, research director of the physics and mechanics of heterogeneous media laboratory at Université de recherche Paris Sciences et Lettres

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and a co-author on the paper, had observed that when materials like cyclohexane were cooled just below their melting points, water droplets condensing on the surface would move around erratically. "We had looked into this erratic motion before, and we had shown that it originated from the melting of the cyclohexane induced by the heat released into these materials during water droplet condensation," Anand said. In their current research, Anand and Chatterjee cooled a range of PSLs to -15 degrees Celsius, rendering them all solid. Under high humidity conditions, they noticed that the solidified PSLs melted directly underneath and in the immediate vicinity of water droplets condensing on the PSLs. "We were expecting that the erratic droplet motion would stop upon cooling the surface to -15C. But to our surprise, we found that the droplets kept on showing the same hopping motion even at very low temperatures," Anand said. "It turns out that PSLs are extremely adept at trapping this released heat. "This quality, combined with the fact that condensed water droplets become extremely mobile on these cooled PSLs means that the formation of frost is significantly delayed. Yes, at a certain point, ice does eventually form and that is inevitable, but some of the PSLs we tested are water soluble, and this contributes to their anti-freezing properties and can help delay ice formation much longer than even the advanced anti-icing coatings." Anand and Chatterjee saw the same frost delaying effect with the PSLs even when they were applied as extremely thin layers to objects. "In our first set of experiments, the PSL coating we used was about 3 millimetres thick. But we also tested them as very thin coatings, like a film, and still saw the same freezing delay effect," Anand said. "This means that we can potentially use PSLs to coat objects like car windshields or turbine blades without compromising the object's functionality." In further experiments, the researchers found that PSLs have a wide range of optical transparencies, can self-repair after being scratched and can purge liquid-borne contaminants. "The unique properties of PSLs, which we describe for the first time in this paper, make them excellent candidates for next-generation materials to prevent frost and ice development on surfaces," Anand said. Because PSLs are solids at low temperatures, he anticipates that they wouldn't need to be applied as often as liquid anti-icing agents because they would have better staying power. "But, of course, we need to conduct additional experiments to determine their limits and figure out if there are ways we can further maximise their ice/frost-repelling abilities," he said.

~sPhys.org, 18 March 2019

~s http://phys.org

~tNew method to reduce uranium concentration in contaminated water

~w2019-03-27

~qResearchers from China have proposed a way to reduce Uranium concentration in contaminated water.

In a paper to be published in the forthcoming issue in NANO, researchers from China have proposed a way to reduce Uranium concentration in contaminated water. As an essential nuclear fuel, Uranium has been greatly used and inevitably released to the environment. Without proper disposal, exposure to uranium can result in serious harms to the ecology and health of humans. Mesoporous SBA-15 with ordered mesostructures, high surface areas and large pore sizes have been applied to concentrate U(VI) from aqueous solutions. The exploration of SBA-15 with higher performances also keeps developing. For instance, the synthesis of functional SBA-15 with organic ligands containing N, O, S and P elements, and with controllable morphologies (e.g., rods, plates, and fibres) and tunable mesostructures have also been reported. However, the comprehensive evaluation of structure-composition-function relationships, including the interconnected influence of textural characteristics of sorbents and the interaction mechanism of U(VI)-surface modified chemical groups, has not been fully studied yet. This paper investigates how the synergistic integration of pore mesochannels and surface functionalisation of SBA-15 enables high-performance U(VI) sorption. In this study, we report the rapid sorption of U(VI) with high capacities and selectivity by amidoxime functionalised ordered mesoporous SBA-15 with two typical morphologies (i.e., rods and plates) via a post-grafting method. The results show that the mesostructures including morphologies and pore length of SBA-15 perform the dominant function for the fast sorption kinetics (10 min for plates, 20 min for rods), while the modified amidoxime groups make excellent U(VI) sorption capacities (646.2 mg/g for plates, 499.8 mg/g for rods at pH 5.0 and T 298.15 K) and high selectivity possible. U(VI) adsorbed amidoxime-functionalised SBA-15 can also be effectively regenerated by HCl solutions and reused well after six cycles, exhibiting favourable potentials for the uptake of radionuclides in real environmental management.

~sEurekAlert, 14 March 2019

~shttp://www.eurekalert.org

~tNature-inspired antibacterial metals

~w2019-03-27

~qUsing the naturally occurring lotus effect concept, a team of scientists has taken a quantum leap towards the production of self-cleaning sheet metal on an industrial scale.

From aviation to medicine, various sectors are increasingly using materials that mimic the lotus plant, whose leaves have self-cleaning properties. Thanks to the bumpy surface structure covered with tube-shaped wax crystals, water falling on these leaves forms beads that roll off, carrying away dust and dirt. Using this naturally occurring lotus effect concept, a team of scientists has taken a quantum leap towards the production of self-cleaning sheet metal on an industrial scale. Supported by the EU-funded TresClean project, the team created a roughened surface on the metal that reduces wettability and prevents bacterial adhesion. A news item by the Science|Business Network of industry research and policy organisations summarises the technology: "TresClean has used high-power laser cutting devices to create microscopic 'spikes' and 'ridges' in sheet metal causing liquids to 'bounce off' the rough micro-topography that mimics the surface of the Lotus leaf."

Avoiding bacterial contamination

The same item notes that this particular structure "creates miniature pockets of air that minimises the contact area between the surface and a liquid, almost like standing on a bed of needles." TresClean project coordinator Prof. Luca Romoli explains: "In the same way that Lotus leaves keep themselves clean, without the need for cleaning products or chemicals, their jagged, rough surfaces enable water to stay as spherical droplets by preventing 'spreading.'" He adds: "Bacteria do not get a chance to stick because the contact with the metal surface and the liquid is reduced by over 80 percent. We are looking at an anti-bacterial metal." The techniques involved in TresClean "will be applied to produce self-cleaning and aseptic machine parts for food industry (e.g. components in contact with biological foods) and home appliances (e.g. dishwashers)," as stated on the project website.

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Reduced cleaning phases

In the news item, Prof. Romoli describes the project's impact: "Vats in milk factories need to be cleaned every 6-8 hours to avoid the exponential growth of bacteria. This hinders usage and therefore affects output." He goes on to say: "By saving hours per day in cleaning, it will yield an efficiency improvement stemming from fewer sterilisation cycles and less cleaning time within production as a whole. This will also reduce energy consumption as a result of fewer cleaning phases making food production quicker, safer and more profitable." TresClean could also be beneficial for medical cutting tools and sterile surfaces, among other applications, according to Prof. Romoli. The ongoing TresClean (High Throughput Laser texturing of Self-CLEANing and antibacterial surfaces) project was set up "to transform laser surface texturing from a low productivity process limited by a lack of power and restricted beam manipulation to a high-throughput process harnessing ultrashort pulsed high-power lasers and high-speed scanners" as stated on CORDIS. The project partners hope the upscaling of laser technology will be completed by mid-2019.

~sPhys.org, 14 March 2019

~s<http://phys.org>

~tMost styrofoam isn't recycled. Here's how 3 start-ups aim to fix that

~w2019-03-27

~qPyrowave, Polystyvert and GreenMantra using non-traditional 'chemical' recycling technologies

Virginie Bussières jokingly refers to styrofoam as "public enemy No. 6." That's because the polystyrene takeout containers, electronics packaging, coolers and other products we discard each year are more likely to pollute waterways or get buried in landfills than they are to be recycled. (The No. 6 is a reference to the plastic's identification number or resin code). And once in the environment, they can take decades or even centuries to break down. But Bussières and her colleagues at Montreal-based Pyrowave are hoping to reform styrofoam — literally — into a resource that everyone wants to recycle. And they're not the only ones. Montreal-based Polystyvert and Brantford, Ont., based GreenMantra have a similar vision, but different technological solutions. The material commonly called styrofoam is properly known as expanded polystyrene foam or EPS, which comes in a variety of colours (not to be confused with Styrofoam,

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a trademarked brand of extruded polystyrene foam or EPS used to make blue insulation boards.) A recent report from the Canadian Chamber of Commerce found that, in 2012, 80 per cent of styrofoam waste in Canada, more than 6,500 tonnes, ended up in landfills or waterways. That's because most communities don't recycle it — just 35 per cent accept polystyrene in their recycling programs, according to the Canadian Plastics Industry Association. It's even worse in the U.S., which recycled less than four per cent of its polystyrene containers and packaging in 2012, the Environmental Protection Agency reports. The main problem is it's not cost-effective to collect a material that's so bulky and light, and breaks apart so easily, contaminating other recyclables. And there aren't a lot of buyers once it's collected. Many jurisdictions, including the City of Toronto, have to effectively pay companies to take it.

Hot new tech

But the cost isn't the only issue with traditional, "mechanical" recycling. Bussières, vice-president of communications, marketing and government affairs for Pyrowave, says it also has trouble coping with contamination from things like food residues that are often found on food containers. And as with most plastics, traditional styrofoam recycling is not actually a cycle. After processing, it's no longer expandable or foam-like. Instead, it gets turned into hard plastic for things like crown mouldings, picture frames and park benches. That is, it can only be "recycled" once. That's the difference with Pyrowave's technology — it uses a "chemical recycling" process to take waste polystyrene and generate brand-new styrofoam. Microwaves heat up and break down polystyrene molecules, which are long chains, into their individual links — called styrene. That in turn can be chemically processed back into polystyrene. "All the contamination is taken away in the process," Bussières added. That means the process can start with dirtier styrofoam than traditional recycling can handle, and generate new styrofoam with 100 per cent recycled content that's identical to styrofoam made directly from petroleum.

Why products marked 'recyclable' sometimes aren't

"We can reduce our dependency on oil," Bussières said. "That's the vision behind the technology." She added that it's also the key to a so-called circular economy — based on resources being endlessly reused and recycled instead of extracted new and then landfilled at their end of life

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as they mostly are now. Pyrowave estimates its recycling process can produce polystyrene with a tenth of the energy and half the greenhouse gas emissions of polystyrene made directly from oil, and says it can sell its styrene at a price that's competitive with "virgin" styrene produced from crude oil. The product can also be recycled over and over again, although currently about 10 per cent is lost each time. Bussières says polystyrene is ideal for chemical recycling because every chain link is the same (in many polymers, there are different kinds of chain links): "Technology can bring something that was public enemy No. 6 to one of the easiest to recycle." The company launched a pilot test of its technology in November 2018 in Salaberry-de-Valleyfield, Que., near Montreal. Its plant can handle about 100 or 200 kilograms an hour. The resulting styrene oil is sold to Sarnia, Ont.-based chemical supplier INEOS Styrolution Canada. Bussières said the company is also in discussions with Health Canada to get food grade approval for polystyrene made through its process.

Dissolution solution

Not far from Pyrowave, another Montreal company says it can also make polystyrene from 100 per cent recycled materials. Polystyvert says its process also generates a material identical to new polystyrene. The difference is that instead of breaking the polystyrene down, Polystyvert simply dissolves it, in the essential oil cymene. "It's a change of state," said Solenne Brouard Gaillot, the company's founder and CEO, who likened it to the transition between snow and water. The company supplies solvent-containing concentrators to companies that can be placed on-site. By dissolving styrofoam before transportation, it says it can put 10 times more styrofoam in the same truck. Once dissolved, it can be resolidified with another solvent, and washed and filtered multiple times to remove contaminants before being reformed into polystyrene pellets. Those can be turned back into styrofoam. The solvents can be recycled and reused repeatedly, and so can the styrofoam itself. "Without any end. That's the point," Brouard Gaillot said. Because it doesn't need to be chemically broken down into styrene and then reprocessed into polystyrene, Brouard Gaillot says Polystyvert's process is cheaper and lower energy than Pyrowave's. She added that the polystyrene pellets it produces are cheaper than "virgin" polystyrene made from oil, and that's important because manufacturers aren't willing to pay a premium for a "greener" product. Polystyvert opened a Montreal demonstration plant in June 2018 that can process 125 kilograms of polystyrene per hour or 800 tonnes a year. It gets its polystyrene from both municipalities and companies such as

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fridge distributors. The polystyrene it produces is currently being sold to a company that makes insulation. But it, too, is trying to get food grade approval from Health Canada and U.S. FDA so it can make food containers.

And now for something completely different

But is turning discarded styrofoam takeout containers back into things like new styrofoam takeout containers the best solution? Jodie Morgan, CEO of Brantford, Ont.-based GreenMantra doesn't think so. "We believe that plastic in general is a fairly low-value product," she says. "And then we spend a lot of money collecting that product, sorting that product, processing that product all so it can go back into ... a relatively low-value end product." She thinks in order to boost plastic recycling rates around the world, recycling needs to be more worth the effort, and for that to happen, waste plastic needs to be worth more. GreenMantra's technology turns discarded styrofoam into something completely different. It's a form of chemical recycling, like Polystyvert's technology. But instead of breaking the styrofoam chains into their individual links, it only cuts them into smaller pieces. That generates a material completely different from styrofoam. "Through using this molecule, we can create products that can have much more value than the original plastic," Morgan said. Those include additives for inks and coatings for the printing industry that make them glossier, easier to print out and more durable. They replace similar additives made directly from fossil fuels, says Domenic di Mondo, GreenMantra's vice-president of technology. Another of the company's goals is to make it easier for styrofoam to be reused. Right now, that's tricky because so many different kinds of styrofoam are collected for recycling together, and they're hard to mix into a single product. GreenMantra's additive could help them mix evenly so they can be turned into more products like insulation boards. Morgan likened it to the emulsifier in bottled salad dressing that keeps the oil and water from separating. Di Mondo says the additive can also lower the density of the foam, boosting its performance as an insulator. The company has just built a Brantford, Ont., demonstration plant that it expects will open in a month or two and will be able to process thousands of tonnes of polystyrene a year. And unlike Pyrowave and Polystyvert, which are getting their raw materials for free, GreenMantra says it is choosing to actually pay money for some of the waste polystyrene it will be getting from companies and municipalities. "In part, why we're doing that is to drive more collection," Di Mondo explained.

Environmental impact

That's welcome news for cities struggling to find a home for their waste styrofoam. Nadine Kerr, manager of processing and resource management at the City of Toronto, says that's the city's biggest styrofoam recycling challenge right now. At the moment, Pyrowave, Polystyvert and GreenMantra are operating on a relatively small scale as they take measurements and tweak their technology. Polystyvert, for one, says it's getting more offers of free styrofoam waste than it can handle. Kerr said the City of Toronto has done trials with all three companies to test the new technology. "So, there is some hope for this material," she said. Andrea Hicks, an assistant professor of civil and environmental engineering at the University of Wisconsin, Madison published a recent study that looked at the environmental impact of polystyrene through its life cycle. It found extracting the raw materials for polystyrene is "environmentally taxing" because they need to be distilled from crude oil. From that perspective, Hicks thinks it's interesting that new styrofoam recycling technologies are displacing those raw ingredients. But she noted that the styrofoam needs to be re-expanded and shaped, and shaping and moulding alone consumes 30 per cent of the energy in the life cycle of styrofoam. She added that it's not a given that any new recycling technology is better for the environment. That depends on the amount and type of energy used to power the process, as well as the other materials, such as solvents, used in the process. "And the environmental impact of that." Hicks's study found that recycling reduced styrofoam's environmental footprint, but reusing did even more. "There's that whole reduce, reuse, recycle," she said. "And I think what people really miss is it's actually a hierarchy. We're supposed to reduce what we're using, then reuse, and the last case is recycling."

~sCBC, 25 March 2019

~s<http://www.cbc.ca/story/science>

~t'Forever chemicals' no more? These technologies aim to destroy PFAS in water

~w2019-03-27

~qResearchers are developing a battery of new treatments to better target and ultimately obliterate fluorinated contaminants in water supplies

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Nonpolymer per- and polyfluoroalkyl substances (PFAS), used to manufacture many non-stick and stain-repellent household products, have been detected in drinking water in hundreds of locations around the US and beyond. Exposure to some of these chemicals has been linked to harmful health effects. Because the molecules contain tough carbon-fluorine bonds, once they leak into the environment, they are persistent. Commonly used adsorbent technologies at water treatment facilities trap the chemicals, but they are vulnerable to clogging, and they collect the PFAS, which then need to be disposed of. Now, chemists are not only designing new adsorbents that better target PFAS and don't clog as often but also developing treatment methods to completely destroy the molecules rather than merely sequestering them. At the Sweeney Water Treatment Plant in North Carolina, engineers are finalising designs for a new system aimed at removing a mix of persistent industrial chemicals from their drinking water. These molecules are troublemakers—wily foes that have evaded capture by traditional water treatment methods. They're known collectively as PFAS, the family of nonpolymer per- and polyfluoroalkyl substances nicknamed "forever chemicals." The plant has been paying special attention to PFAS. The facility supplies water to roughly 200,000 customers, drawing the bulk of that water from the lower part of the Cape Fear River, which researchers in 2016 found to be contaminated with PFAS downstream from a fluorochemical-producing Chemours plant. The new facility will house four 12 m long beds of granular activated carbon, about 7 m wide and 3.7 m deep, to suck PFAS from the water. These beds are three times as deep as the plant's existing ones, which it uses to house bacteria that help disinfect the water. Water will trickle through the new beds over the course of 10–20 min before it is considered clean. Every 400 days, the activated carbon, having soaked up a maximum level of contaminants, will need to be replaced—baked in a commercial incinerator to drive out the contaminants, then topped up with fresh carbon before being put back into service. Officials estimate construction of the new system will cost \$46 million, with yearly operating costs of \$2.9 million. Until that project is completed, sometime in 2022, the plant is relying on its existing carbon beds to remove PFAS as well as to disinfect its water. After the new system is operational, those beds will go back to their original purpose. In the meantime, the added burden of cleaning PFAS from the water means that the plant will need to replace the activated carbon more frequently. Some of the existing beds had lasted for as many as 10 years; now, they'll be replaced every 12 months. Such measures, though they may seem extreme, are what many water utilities find necessary to treat the collection of notoriously persistent PFAS. And at the moment, they are the best methods we've got. PFAS have been

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detected in surface and groundwater in hundreds of locations in the US and around the world. Exposure to some of these chemicals is linked to harmful health effects in the liver, kidneys, blood, and immune system. The compounds are used in many non-stick and stain-repellent household products and can get into the environment when manufacturing waste is improperly disposed of. Although the long-chain PFAS molecules—perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS)—are no longer manufactured in the US, many smaller-chain PFAS are still in use. PFAS also get into the environment through the application of firefighting foams at airports and military bases. Each PFAS molecule has a hydrophilic “head” and a long, hydrophobic “tail” that contains carbon-fluorine bonds. The carbon-fluorine bond is one of the strongest single bonds in nature, giving the molecules their persistence in the environment and their “forever” moniker. PFOA and PFOS, which are the focus of most water treatment efforts, can, when broken down, form other, smaller-chain fluorinated molecules that persist in the environment and may still pose harm. “They’re just a completely different beast,” says Clarkson University’s Michelle Crimi about PFAS. She says removing PFAS is the hardest challenge she’s faced in her 20 years of studying water remediation methods. Today’s water utilities have limited options for removing PFAS. Reverse osmosis, ion-exchange resins, and granular activated carbon trap PFAS, either in a concentrated liquid, in the case of reverse osmosis, or in a solid, as in the case of the resins and carbon. And those liquids and solids then need to be disposed of. It’s from this list of options that water officials in North Carolina chose, running several tests in 2017 and 2018 and ultimately settling on the large carbon beds. The US Environmental Protection Agency’s health advisory level for PFOA and PFOS, separately or in combination, currently sits at 70 parts per trillion, a number that may change as regulators grapple with setting enforceable limits for the chemicals. North Carolina officials aimed not just to beat that level but to remove as much PFAS from the water as possible. They expect the new treatment system will be capable of capturing 90% of PFAS from their water. “There’s no technology that’s really going to remove 100%” of the PFAS, says Carel Vandermeijden, director of engineering at Cape Fear Public Utility Authority, which operates the Sweeney Water Treatment Plant. But no one knows exactly what the combined cumulative health effect is of all the PFAS, he says, “so our approach is to put in the best available technology.” But the best on the market still leaves room for improvement. Reverse osmosis, ion-exchange resins, and granular activated carbon, though capable of trapping PFAS, were not designed to specifically bind these newly scrutinised and little-understood pollutants. These technologies can also allow smaller PFAS molecules to slip through

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and are vulnerable to fouling from other substances in the water, causing them to lose efficiency. Plus, they create a concentrated waste stream. So now, researchers are not only designing adsorbents that specifically take up PFAS but are also developing treatment methods to completely destroy the molecules rather than merely sequestering them. And they're doing this with an eye toward making as little long-term waste as possible.

~sChemical & Engineering News, 25 March 2019

~shttp://pubs.acs.org/cen/news

~tCommercial hybrid-electric aircraft, reduced carbon emissions

~w2019-03-27

~qAlthough we're still a long way from commercial airplanes powered by a combination of fossil fuel and batteries, a recent feasibility study explored fuel/battery configurations and the energy lifecycle to learn the trade-offs needed to yield the greatest reductions in carbon dioxide emissions.

Although we're still a long way from commercial airplanes powered by a combination of fossil fuel and batteries, a recent feasibility study at the University of Illinois explored fuel/battery configurations and the energy lifecycle to learn the trade-offs needed to yield the greatest reductions in carbon dioxide emissions. "In the energy supply chain there's a phrase, from 'well to wake.' That is, fuel production begins at the oil well and ends at the wake of the airplane. Tracking costs and environmental implications across this entire lifecycle is important, because the implications for fuel and energy production can be substantially different, depending on the source. In this study, we looked at how technologies need to improve to make a hybridized configuration feasible, where feasibility is assessed based on a need to meet a certain range requirement and feature a large reduction in carbon emissions. The net carbon emissions were calculated from a combination of fuel burn and the carbon impact associated with recharging the batteries," said Phillip Ansell, assistant professor in the Department of Aerospace Engineering in the College of Engineering at the U of I. According to Ansell, that second part has been ignored. "You can get a fuel burn reduction, but if the cleanliness of the electrical grid that's being used to charge the battery system is not included, you're missing a significant part of the carbon emissions total," he said. The study compared the relative CO₂ emissions produced per kilowatt-hour for

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each individual state across the United States. It includes a map of the U.S. with values of how much carbon is produced per unit of energy. But, to be commercially acceptable, a hybrid-electric aircraft needs to be able to carry the same number of passengers and travel the same distances as current all-fossil fuel aircraft do, so the study used the parameters for a single-aisle airplane that can carry approximately 140 passengers as a model. They parametrically varied the proportion of power across the propulsion driveshaft that was electrically derived, using configurations where 12.5 percent, 25 percent, or 50 percent of the necessary power was produced by an electric motor. The study didn't consider cost in dollars, but rather the cost in CO₂ emissions -- the environmental cost. The most feasible configuration from the model was a propulsion system that uses a 50 percent electrical-power drivetrain and a battery specific energy density of 1,000 watt-hours per kilogram. This configuration was estimated to produce 49.6 percent less lifecycle CO₂ emissions than a modern conventional aircraft with a maximum range equivalent to that of the average of all global flights, making it a viable option for environmentally responsible aviation. However, current battery technologies are quite far from being able to achieve this configuration. Despite this fact, Ansell did say that improvements in batteries will continue to provide gains in capabilities. "Obviously, the 12.5 percent is the most near-term accessible configuration that was studied, because we'll need less battery technology progress to get to that point. However, we also see a non-linear relationship between CO₂ emissions produced and improvements in hybrid-electric propulsion concepts, where the most rapid proportional reductions in carbon emissions are produced across near-term improvements in technology," Ansell said. "Achieving the technology improvements for a 50% hybrid system certainly has a very long timetable to get to market, by a long shot, because it's entirely uncertain if or when that level of energy density of batteries will be manufactured. But at least in the interim, even small gains in component technologies can make a big difference." When will technology be able to manufacture a battery lightweight enough yet powerful enough to fly a commercial airplane? Ansell speculated, "Perhaps in the next 10 years we'll be able to have a battery that is 400 to 600 watt-hours per kilogram. If we project that out, the levels that we need for larger hybridization factors, or even fully electric commercial aircraft, might be within reach in the next 25 years."

~sScience Daily, 25 March 2019

~s<http://www.sciencedaily.com>

~tCatalyst advance removes pollutants at low temperatures

~w2019-03-27

~qResearchers have developed a catalyst that can both withstand high temperatures and convert pollutants at near room temperature -- an important advance for reducing pollution in modern cars.

Researchers at Washington State University, University of New Mexico, Eindhoven University of Technology, and Pacific Northwest National Laboratory have developed a catalyst that can both withstand high temperatures and convert pollutants at near room temperature -- an important advance for reducing pollution in modern cars. They report on their work in the journal, *Nature Communications*. Catalytic converters have been used in the U.S. since the 1970s as a way to clean up pollutants from vehicle exhaust. In the catalytic process, rare metals, such as platinum, are used in a chemical reaction to convert carbon monoxide and other pollutants to non-toxic carbon dioxide, nitrogen, and water. As cars have become more fuel-efficient, however, they use less energy and the temperature of the exhaust gases is lower, which makes it harder to clean up the pollutants. In fact, the U.S. Department of Energy has set a goal of removing 90 percent of harmful emissions at 150 degrees Celsius or lower. The catalysts have to perform at low temperatures but also must survive under the harsh conditions encountered during operation.

"The catalyst problem has increased paradoxically as cars have become better and more efficient," said Emiel Hensen, catalysis professor at Eindhoven University of Technology. Meanwhile, the industry also struggles with the high cost of the precious metals required for catalysis. Platinum, for instance, facilitates chemical reactions for many commonly used products and processes but costs more than \$800 per ounce. The catalyst the researchers developed is based on the activation of single atoms of platinum supported on cerium oxide. While their catalyst outperforms current technology, it also reduces the amount of platinum required, which would lower overall costs. "The industry wants to make use of every single atom of the precious metals, which is why single-atom catalysis has attracted increased attention," said Abhaya Datye, a distinguished professor at UNM's Department of Chemical and Biological Engineering. In their latest work, the researchers first ensured their catalysts were thermally stable, trapping platinum ions on a cerium oxide support at very high temperatures. Their synthesis method caused the platinum atoms to strongly bond to their support. They then activated the

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catalyst in carbon monoxide at about 275 degrees Celsius. "To our surprise, we discovered that the high temperature synthesis made the ceria more easily reducible, allowing it to provide a key ingredient -- oxygen -- to active sites," said Yong Wang, Voiland Distinguished Professor in the Gene and Linda Voiland School of Chemical Engineering and Bioengineering at WSU. The activated oxygen was then able to remove pollutants at near room temperature at the platinum sites. "This research directly addresses the 150-degree challenge identified by the U.S. Department of Energy and by automobile companies," said Wang. "The discovery of oxygen activation at near room temperature is extremely useful, and this finding could have a significant impact on the technology of exhaust emission control." The researchers now plan to study the performance of single-atom catalysts with other organic compounds and pollutants. The work was funded by the U.S. Department of Energy's Office of Basic Energy Sciences and Netherlands Research Centre for Multiscale Catalytic Energy Conversion.

~sScience Daily, 25 March 2019

~s<http://www.sciencedaily.com>

~tNew properties of perovskite solar cells

~w2019-03-27

~qA new study has discovered new properties of perovskite solar cells.

Employees of the Department of Electrophysics at the Institute of Physics and Technology, Ural Federal University, Ivan Zhidkov and Ernst Kurmaev in collaboration with colleagues from Skoltech, the Institute of Problems of Chemical Physics of the Russian Academy of Sciences and Moscow State University discovered new properties of perovskite solar cells. The properties revealed by scientists do not yet allow the use of batteries on spacecraft and satellites, since the hybrid bromide-iodide complex lead halides in their composition did not demonstrate the necessary resistance to high doses of γ -radiation. Due to strong irradiation, the efficiency of solar cells decrease by 32-41%. 'Solar batteries in space must withstand not only increased radiation, but also be resistant to relatively high doses of gamma rays, which is necessary for stable operation of devices in orbit for several years. In our work, we investigated the complex halide $\text{Cs}_{0.1}\text{5MA}_{0.10}\text{FA}_{0.75}\text{Pb}(\text{Br}_{0.17}\text{I}_{0.83})_3$ with a perovskite structure, also called triple-cation perovskite and considered the most stable in this group of

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materials. Perovskite films and solar cells were subjected to hard γ -ray irradiation with a dose of up to 5,000 Gy. Within 300 Gy, perovskite solar cells turned out to be quite stable, but with a further increase in dose, a rapid drop in short circuit current and light conversion efficiency in devices was found,' explained Skoltech post-graduate Alexandra Boldyreva. Now the efforts of scientists are aimed at finding more stable materials. Perovskite is the name of a rare mineral, calcium titanate. Perovskite solar cells are lighter and cheaper than silicon, their production is non-toxic. The elements can be made thin and flexible, which makes them promising for use in space.

~sEurekAlert, 25 March 2019

~shttp://www.eurekalert.org

~tEnergy monitor can find electrical failures before they happen

~w2019-03-27

~qSensor can monitor wiring in a building or ship, and signal when repairs are needed

A new system devised by researchers at MIT can monitor the behaviour of all electric devices within a building, ship, or factory, determining which ones are in use at any given time and whether any are showing signs of an imminent failure. When tested on a Coast Guard cutter, the system pinpointed a motor with burnt-out wiring that could have led to a serious onboard fire. The new sensor, whose readings can be monitored on an easy-to-use graphic display called a NILM (non-intrusive load monitoring) dashboard, is described in the March issue of IEEE Transactions on Industrial Informatics, in a paper by MIT professor of electrical engineering Steven Leeb, recent graduate Andre Abouljian MS '18, and seven others at MIT, the U.S. Coast Guard, and the U.S. Naval Academy. A second paper will appear in the April issue of Marine Technology, the publication of the Society of Naval Architects and Marine Engineers. The system uses a sensor that simply is attached to the outside of an electrical wire at a single point, without requiring any cutting or splicing of wires. From that single point, it can sense the flow of current in the adjacent wire, and detect the distinctive "signatures" of each motor, pump, or piece of equipment in the circuit by analysing tiny, unique fluctuations in the voltage and current whenever a device switches on or off. The system can also be used to monitor energy usage, to identify possible efficiency

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improvements and determine when and where devices are in use or sitting idle. The technology is especially well-suited for relatively small, contained electrical systems such as those serving a small ship, building, or factory with a limited number of devices to monitor. In a series of tests on a Coast Guard cutter based in Boston, the system provided a dramatic demonstration last year. About 20 different motors and devices were being tracked by a single dashboard, connected to two different sensors, on the cutter USCGC Spencer. The sensors, which in this case had a hard-wired connection, showed that an anomalous amount of power was being drawn by a component of the ship's main diesel engines called a jacket water heater. At that point, Leeb says, crewmembers were sceptical about the reading but went to check it anyway. The heaters are hidden under protective metal covers, but as soon as the cover was removed from the suspect device, smoke came pouring out, and severe corrosion and broken insulation were clearly revealed. "The ship is complicated," Leeb says. "It's magnificently run and maintained, but nobody is going to be able to spot everything." Lt. Col. Nicholas Galanti, engineer officer on the cutter, says "the advance warning from NILM enabled Spencer to procure and replace these heaters during our in-port maintenance period, and deploy with a fully mission-capable jacket water system. Furthermore, NILM detected a serious shock hazard and may have prevented a class Charlie [electrical] fire in our engine room." The system is designed to be easy to use with little training. The computer dashboard features dials for each device being monitored, with needles that will stay in the green zone when things are normal, but swing into the yellow or red zone when a problem is spotted. Detecting anomalies before they become serious hazards is the dashboard's primary task, but Leeb points out that it can also perform other useful functions. By constantly monitoring which devices are being used at what times, it could enable energy audits to find devices that were turned on unnecessarily when nobody was using them, or spot less-efficient motors that are drawing more current than their similar counterparts. It could also help ensure that proper maintenance and inspection procedures are being followed, by showing whether or not a device has been activated as scheduled for a given test. "It's a three-legged stool," Leeb says. The system allows for "energy scorekeeping, activity tracking, and condition-based monitoring." But it's that last capability that could be crucial, "especially for people with mission-critical systems," he says. In addition to the Coast Guard and the Navy, he says, that includes companies such as oil producers or chemical manufacturers, who need to monitor factories and field sites that include flammable and hazardous materials and thus require wide safety margins in their operation. One important characteristic of the system that is attractive for both military

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and industrial applications, Leeb says, is that all of its computation and analysis can be done locally, within the system itself, and does not require an internet connection at all, so the system can be physically and electronically isolated and thus highly resistant to any outside tampering or data theft. Although for testing purposes the team has installed both hard-wired and noncontact versions of the monitoring system -- both types were installed in different parts of the Coast Guard cutter -- the tests have shown that the noncontact version could likely produce sufficient information, making the installation process much simpler. While the anomaly they found on that cutter came from the wired version, Leeb says, "if the noncontact version was installed" in that part of the ship, "we would see almost the same thing." The research team also included graduate students Daisy Green, Jennifer Switzer, Thomas Kane, and Peer Lindahl at MIT; Gregory Bredariol of the U.S. Coast Guard; and John Donnal of the U.S. Naval Academy in Annapolis, Maryland. The research was funded by the U.S. Navy's Office of Naval Research NEPTUNE project, through the MIT Energy Initiative.

~sEurekAlert, 22 March 2019

~shttp://www.eurekalert.org

~tNew mechanism of action found for agricultural pesticide fludioxonil

~w2019-03-27

A fungicide commonly used by the agricultural industry to protect grains, fruit and vegetables from mould damage seems to kill fungi by a previously uncharacterised mechanism that delivers a metabolic shock to cells, new research finds. The fungicide, fludioxonil, was originally devised to protect seeds during storage but was so effective at limiting mould damage that it is now widely used to treat produce after harvest to extend its shelf life. While scientists have long known that a protein unique to fungi is required for fludioxonil to kill fungal cells, the exact mechanism by which fludioxonil works has remained unclear. New work by researchers at the University of Wisconsin-Madison shows that fungi exposed to fludioxonil experience a spike in the concentration of a reactive stress molecule that triggers a biochemical cascade in fungi that leads to cell death. The researchers created mutant strains of yeast resistant to the fungicide, which provided insight into how fungi sense the damage caused by fludioxonil and commit themselves to a metabolic pathway from which they cannot recover. Understanding this mechanism

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can help researchers assess the role fludioxonil plays in the agricultural system and may better illuminate how drugs kill fungal pathogens and how fungi develop resistance to anti-fungal chemicals. The research was published March 25 in the journal *Scientific Reports*. The work was led by Tristan Brandhorst and Iain Kean in the lab of Bruce Klein, a professor of paediatrics, internal medicine and medical microbiology and immunology at UW-Madison and the UW School of Medicine and Public Health. Since its introduction in 1993 by the progenitor of the agrochemical company Syngenta, fludioxonil was believed to directly target a protein in fungal cells known as a hybrid histidine kinase, or HHK for short. Syngenta hypothesised that fludioxonil bound directly to HHK in order to activate a biochemical pathway that causes fungal cells to inadvertently kill themselves. "HHK is a little bit unusual in that it's highly conserved throughout the fungal kingdom, and it's not present in humans," says Klein. "It also offered an opportunity for clarifying a drug target that might be selective for fungal microbes and therefore not toxic in humans." So, Klein's lab set out to understand how fludioxonil attacked HHK. But in 2016, they reported that, although fludioxonil requires the HHK protein to kill fungi, the pesticide and protein do not directly interact, leaving fludioxonil's true mechanism of action up in the air. In the current study, the researchers resolved to test alternative possibilities for how fludioxonil works. They found that fludioxonil caused a form of cellular stress in fungi called oxidative stress. Oxidative stress is fairly common and is caused by a combination of the oxygen in the air and cell damage from stressors like ultraviolet light. The researchers speculated that HHK acted as a sensor that was triggered by oxidative stress to promote cell death. Surprisingly, when Klein's team exposed fungi to various forms of oxidative stress, cells remained healthy. Clearly, while the pesticide produced oxidative stress, this stress alone wasn't enough to trigger cell death through HHK. While looking for evidence of oxidative stress damage, Kean supplied the fungal cells with dimedone, a chemical that can alleviate a different type of cellular stress called aldehydic stress. Aldehydic stress is caused by aldehydes, such as the preservative formaldehyde, which are highly reactive. With dimedone around to suppress aldehydic stress, the fungi became resistant to fludioxonil, suggesting that aldehydic stress might be the missing link between fludioxonil and HHK. Looking for aldehydes triggered by fludioxonil, the researchers identified a spike in the aldehyde methylglyoxal, a particularly reactive chemical that can damage both DNA and cellular proteins. Methylglyoxal is normally formed in small amounts as cells break down sugars, but cells possess catalytic enzymes to break it down before it becomes a problem. Klein's lab found that fludioxonil inhibited one of the enzymes involved in metabolizing sugars in a way

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that causes it to release extra methylglyoxal, which in turn activates the lethal HHK cascade. "The take home lesson is that fludioxonil is multifactorial. It's not compromising cells by one solitary mechanism. It has potential to damage cells in a variety of ways," says Brandhorst. "And aldehydic stress is particularly problematic because its damage is hard to detect." During the study, the researchers modified HHK to make it resistant to fludioxonil. HHK has several sulfur-containing amino acids within its protein structure, and these amino acids can use the sensitive sulfur atoms to sense and respond to environmental conditions like aldehydes. When the researchers removed the sulfur, HHK no longer responded to fludioxonil and the cells became resistant, pointing to the importance of these sensitive sulfur atoms in the detection of the aldehydes induced by fludioxonil. The researchers note that the ability of fludioxonil to act on a sugar-metabolising enzyme common to all cells, and to produce the damaging compound methylglyoxal, may mean that the pesticide has more potential to harm non-fungal cells than previously thought. Although fludioxonil has been deemed safe for use, the authors of the current study suggest that the effects this widely used pesticide has upon animals be re-examined. "There's more to be studied here," says Klein.

Phys.org, 25 March 2019

<http://phys.org>

Wood-based technology creates electricity from heat

2019-03-27

A University of Maryland-led team of researchers has created a heat-to-electricity device that runs on ions and which could someday harness the body's heat to provide energy. Led by UMD researchers Liangbing Hu, Robert Briber and Tian Li of the department of materials science, and Siddhartha Das of mechanical engineering, the team transformed a piece of wood into a flexible membrane that generates energy from the same type of electric current (ions) that the human body runs on. This energy is generated using charged channel walls and other unique properties of the wood's natural nanostructures. With this new wood-based technology, they can use a small temperature differential to efficiently generate ionic voltage, as demonstrated in a paper published March 25 in the journal Nature Materials. If you've ever been outside during a lightning storm, you've seen that generating charge between two very different temperatures is easy. But for small temperature differences, it is more difficult. However, the team says they have successfully tackled this

UMD-Led researchers' wood-based technology creates electricity from heat

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challenge. Hu said they now have “demonstrated their proof-of-concept device, to harvest low-grade heat using nanoionic behaviour of processed wood nanostructures”. Trees grow channels that move water between the roots and the leaves. These are made up of fractally-smaller channels, and at the level of a single cell, channels just nanometres or less across. The team has harnessed these channels to regulate ions. The researchers used basswood, which is a fast-growing tree with low environmental impact. They treated the wood and removed two components—lignin, that makes the wood brown and adds strength, and hemicellulose, which winds around the layers of cells binding them together. This gives the remaining cellulose its signature flexibility. This process also converts the structure of the cellulose from type I to type II which is a key to enhancing ion conductivity. A membrane, made of a thin slice of wood, was bordered by platinum electrodes, with sodium-based electrolyte infiltrated into the cellulose. The regulate the ion flow inside the tiny channels and generate electrical signal. “The charged channel walls can establish an electrical field that appears on the nanofibers and thus help effectively regulate ion movement under a thermal gradient,” said Tian Li, first author of the paper. Li—who was named as one of Forbes “30 Under 30” in Energy in 2018—said that the sodium ions in the electrolyte insert into the aligned channels, which is made possible by the crystal structure conversion of cellulose and by dissociation of the surface functional groups. “We are the first to show that, this type of membrane, with its expansive arrays of aligned cellulose, can be used as a high-performance ion selective membrane by nanofluidics and molecular streaming and greatly extends the applications of sustainable cellulose into nanoionics,” said Li summing up their paper.

Phys.org, 25 March 2019

<http://phys.org>

Chemicals induce dipoles to damp plasmons

2019-03-27

The light scattered by plasmonic nanoparticles is useful, but some of it gets lost at the surface and scientists are now starting to figure out why. In novel experiments at Rice University and the Johannes Gutenberg University of Mainz, along with theoretical work at Princeton University, researchers found that molecules placed on the surface of a single gold nanorod affect its plasmonic response by altering the electronic structure of the particle itself. The finding could enhance applications like catalysis that involve plasmon-driven chemistry. Plasmons are ripples of electrons

A new study discovers a mechanism by which molecules affect the plasmonic response of gold nanorods.

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that resonate across the surface of a metal nanoparticle when triggered by light. The light they receive at one wavelength, or colour, is radiated at the same wavelength, and that can inform researchers about the particle and its environment. Surface plasmons help sense the presence of chemicals, enable photochemistry and selectively catalyse chemical reactions. But light lost between the particle's surface and the researcher's eye can contain additional information previously not considered. It had been thought signal loss via plasmon damping was due to chemicals adsorbed to the nanoparticle surface, perhaps through charge transfer from the metal to the chemical substances. But Stephan Link, a professor of chemistry and of electrical and computer engineering at Rice, had doubts that just one explanation would fit all studies. They led Link, lead author Benjamin Förster and their colleagues to the discovery of an entirely different mechanism, reported this week in *Science Advances*. Their strategy was to put two types of identically sized molecules with different atomic arrangements onto single gold nanorods for analysis. These molecules, cage-like carborane thiols, induced surface dipoles in the metal that in turn scattered enough of the plasmons' energy to damp their signal. That let the researchers see and measure damping directly with no interference from other molecules or other nanorods. The proximity of the thiols, identical except for the placement of one carbon atom, to the nanorod induced unique dipole moments -- the molecules' positive and negative poles that change strength and move like the needle of a compass -- on the metal surface. Emily Carter, a theoretical-computational scientist and dean of the School of Engineering and Applied Science at Princeton, performed detailed quantum mechanical calculations to test mechanisms that could explain the experiments. "Plasmonic resonances have a spectral width that, together with resonance wavelengths, gives specific colours," Link said. "A narrow line gives you a truer colour. So, we looked at how the width of this resonance changes when we put molecules on the particle." Not just any molecules would do. The carborane thiols, molecules of the exact same size, stick to gold nanoparticles in equal measure but are chemically different enough to change the plasmons' spectral width. That let the researchers measure plasmon damping by each type of molecule without interference from other damping mechanisms. The plasmons that flow across a surface depend so heavily on the particle's size and shape that little attention had been paid to the effect of chemicals adsorbed to the surface, Förster said. "If you change the surface of the nanorod, the energy gets lost in different ways," he said. "We didn't understand this at all. But if something loses energy, it's not functioning as you want it to function." The refractive properties of the surrounding medium and averaging of signals from

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multiple particles of various size and shape can also affect the signal. That had also made it difficult to analyse the impact of adsorbed chemicals. "Several contributions determine the plasmon resonance width," Link said. "But there's a fudge factor everybody invokes that nobody had really tackled in a quantitative way. A lot of people blamed charge transfer, meaning excited hot electrons moved from the metal to the molecule. "We are saying that's not the case here," he said. "It may not be the same every time you put a molecule on a metal particle, but this gives us, for the first time, a complete quantitative study that also doesn't turn a blind eye to the chemistry at the interface. It lets us understand that the chemistry is important. "The work is fundamental and I think it's pretty because it's so simple," Link said. "We combined the right sample, the experiment and single-particle spectroscopy with advanced theory, and we put it all together."

Science Daily, 22 March 2019

<http://www.sciencedaily.com>

Plant scraps are the key ingredient in cheap, sustainable jet fuel

2019-03-27

Scientists in China have developed a process for converting plant waste from agriculture and timber harvesting into high-density aviation fuel. Their research, published March 21 in the journal *Joule*, may help reduce CO₂ emissions from airplanes and rockets. Cellulose, the main component in the biofuel, is a cheap, renewable, and highly abundant polymer that forms the cell walls of plants. While chain alkanes (such as branched octane, dodecane, and hexadecane) have previously been derived from cellulose for use in jet fuel, the researchers believe this is the first study to produce more complex polycycloalkane compounds that can be used as high-density aviation fuel. Ning Li, a research scientist at the Dalian Institute of Chemical Physics and an author of the study, believes this new biofuel could be instrumental in helping aviation "go green." "Our biofuel is important for mitigating CO₂ emissions because it is derived from biomass and it has higher density (or volumetric heat values) compared with conventional aviation fuels," says Li. "As we know, the utilization of high-density aviation fuel can significantly increase the range and payload of aircraft without changing the volume of oil in the tank." To produce this biofuel, Li and his team found that cellulose can be selectively converted to 2,5-hexanedione using the chemical reaction hydrogenolysis. They then developed a method of separating the compound 2,5-hexanedione

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by converting the 5-methylfurfural in hydrogenolysis product to 2,5-hexanedione, while keeping 2,5-hexanedione in the product unchanged. This resulted in a 71% isolated carbon yield -- a 5% increase from the product yield in their initial work. Finally, they reacted hydrogen with the 2,5-hexanedione from wheatgrass cellulose to obtain the final product: a mixture of C12 and C18 polycycloalkanes with a low freezing point and a density about 10% higher than that of conventional jet fuels. Much of the biofuel's magic lies in this high density -- it can be used as either a wholesale replacement fuel or as an additive to improve the efficiency of other jet fuels. "The aircraft using this fuel can fly farther and carry more than those using conventional jet fuel, which can decrease the flight number and decrease the CO2 emissions during the taking off (or launching) and landing," says Li. Although the researchers produced the biofuel at a laboratory scale in this study, Li and his team believe the process' cheap, abundant cellulose feedstock, fewer production steps, and lower energy cost and consumption mean it will soon be ready for commercial use. They also predict it will yield higher profits than conventional aviation fuel production because it requires lower costs to produce a higher-density fuel. The biggest issue holding the process back is its use of dichloromethane to break down cellulose into 2,5-hexanedione; the compound is traditionally used as a solvent in paint removers and is considered an environmental and health hazard. "In the future, we will go on to explore the environmentally friendly and renewable organic solvent that can replace the dichloromethane used in the hydrogenolysis of cellulose to 2,5-hexanedione," says Li. "At the same time, we will study the application of 2,5-hexanedione in the synthesis of other fuels and value-added chemicals."

Science Daily, 21 March 2019

<http://www.sciencedaily.com>

New research shows highest energy density all-solid-state batteries now possible

2019-03-27

Scientists from Tohoku University and the High Energy Accelerator Research Organisation have developed a new complex hydride lithium superionic conductor that could result in all-solid-state batteries with the highest energy density to date. The researchers say the new material, achieved by designing structures of hydrogen clusters (complex anions), shows markedly high stability against lithium metal, which would make it the ultimate anode material for all-solid-state batteries. All-solid-state

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batteries incorporating a lithium metal anode have the potential to address the energy density issues of conventional lithium-ion batteries. But until now, their use in practical cells has been limited by the high lithium ion transfer resistance, caused mainly by the instability of the solid electrolyte against lithium metal. This new solid electrolyte that exhibit high ionic conductivity and high stability against lithium metal can therefore be a real breakthrough for all-solid-state batteries that use a lithium metal anode. "We expect that this development will not only inspire future efforts to find lithium superionic conductors based on complex hydrides, but also open up a new trend in the field of solid electrolyte materials that may lead to the development of high-energy-density electrochemical devices," said Sangryun Kim of Shin-ichi Orimo's research group at Tohoku University. All-solid-state batteries are promising candidates for resolving the intrinsic drawbacks of current lithium-ion batteries, such as electrolyte leakage, flammability and limited energy density. Lithium metal is widely believed to be the ultimate anode material for all-solid-state batteries because it has the highest theoretical capacity (3860 mAh g⁻¹) and the lowest potential (-3.04 V vs. standard hydrogen electrode) among known anode materials. Lithium-ion-conducting solid electrolytes are a key component of all-solid-state batteries because the ionic conductivity and stability of the solid electrolyte determine battery performance. The problem is that most existing solid electrolytes have chemical/electrochemical instability and/or poor physical contact against lithium metal, inevitably causing unwanted side reactions at the interface. These side reactions result in an increase in interfacial resistance, greatly degrading battery performance during repeated cycling. As revealed by previous studies, which proposed strategies such as alloying the lithium metal and interface modification, this degradation process is very difficult to address because its origin is the high thermodynamic reactivity of the lithium metal anode with the electrolyte. The main challenges to using the lithium metal anode are high stability and high lithium ion conductivity of the solid electrolyte. "Complex hydrides have received a lot of attention in addressing the problems associated with the lithium metal anode because of their outstanding chemical and electrochemical stability against the lithium metal anode," said Kim. "But because of their low ionic conductivity, using complex hydrides with the lithium metal anode have never been attempted in practical batteries. So, we were very motivated to see if developing complex hydride that exhibit lithium superionic

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conductivity at room temperature can enable the use of lithium metal anode. And it worked.”

EurekaAlert, 22 March 2019

<http://www.eurekaalert.org>

4D-printed materials can be stiff as wood or soft as sponge

2019-03-27

Imagine smart materials that can morph from being stiff as wood to as soft as a sponge - and also change shape. Rutgers University-New Brunswick engineers have created flexible, lightweight materials with 4D printing that could lead to better shock absorption, morphing airplane or drone wings, soft robotics and tiny implantable biomedical devices. Their research is published in the journal *Materials Horizons*. 3D printing, also known as additive manufacturing, turns digital blueprints to physical objects by building them layer by layer. 4D printing is based on this technology, with one big difference: it uses special materials and sophisticated designs to print objects that change shape with environmental conditions such as temperature acting as a trigger, said senior author Howon Lee, an assistant professor in the Department of Mechanical and Aerospace Engineering. Time is the fourth dimension that allows them to morph into a new shape. “We believe this unprecedented interplay of materials science, mechanics and 3D printing will create a new pathway to a wide range of exciting applications that will improve technology, health, safety and quality of life,” Lee said. The engineers created a new class of “metamaterials” - materials engineered to have unusual and counterintuitive properties that are not found in nature. The word metamaterials is derived from the Greek word “meta,” which means “higher” or “beyond.” Previously, the shape and properties of metamaterials were irreversible once they were manufactured. But the Rutgers engineers can tune their plastic-like materials with heat, so they stay rigid when struck or become soft as a sponge to absorb shock. The stiffness can be adjusted more than 100-fold in temperatures between room temperature (73 degrees) and 194 degrees Fahrenheit, allowing great control of shock absorption. The materials can be reshaped for a wide variety of purposes. They can be temporarily transformed into any deformed shape and then returned to their original shape on demand when heated. This [YouTube video](#) shows how 4D-printed smart materials can morph from stiff to soft and also change shape. Video by Chen Yang/Rutgers University-New Brunswick. The materials could be used in airplane or drone wings that

Rutgers engineers’ unique smart materials change shape as temperatures

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change shape to improve performance, and in lightweight structures that are collapsed for space launches and reformed in space for a larger structure, such as a solar panel. Soft robots made of soft, flexible and rubbery materials inspired by the octopus could have variable flexibility or stiffness that is tailored to the environment and task at hand. Tiny devices inserted or implanted in people for diagnosis or treatment could be temporarily made soft and flexible for minimally invasive and less painful insertion into the body, Lee said.

EurekAlert, 22 March 2019

<http://www.eurekalert.org>

Toxin-spewing bacteria decoded

2019-03-27

Scientists at Emory University School of Medicine have identified a central regulator of toxin production in the bacterium *C. difficile*, the most common cause of healthcare-associated infections in the United States. *C. difficile* is a major cause of persistent diarrhoea, occurring most often after taking antibiotics. The results were published in the journal *mBio*. The laboratory of Shonna McBride, Ph.D. investigates how *C. difficile* regulates toxin production and spore formation, the production of dormant cells that can survive long-term in the environment and hospital settings. Understanding the conditions during infection that promote toxin production could provide targets for new antibiotics and insights regarding how the bacteria control toxin synthesis. *C. difficile* produces two toxins that damage intestinal cells and cause the symptoms of infection, but making these toxins requires a lot of energy. Environmental stress increases toxin production, but having an abundance of nutrients around, such as amino acids, peptides and certain sugars, suppresses the production of toxin. Working with McBride, instructor Adrienne Edwards, Ph.D. had previously spotted a gene that regulates both toxin production and spore formation. They named it *RstA*, for "Regulation of Sporulation and Toxins." In their current *mBio* paper, the researchers showed how the protein encoded by *RstA* controls toxin gene activity. "This one protein is critical for preventing toxin production by controlling multiple factors that are important for toxin expression," says McBride, assistant professor of microbiology and immunology. Edwards was able to pull the *RstA* protein out of bacterial cell extracts by using specific DNA fragments from toxin genes as bait. Using this pulldown method, Edwards also demonstrated that *RstA* binds to the DNA of other regulatory genes that control toxin production. By tracking the effects of mutating part of the protein, the

Scientists at Emory University School of Medicine have identified a central regulator of toxin production in the bacterium *C. difficile*

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scientists were able to confirm that RstA acts directly as a DNA clamp to control toxin expression. The predicted structure of RstA suggests that it is a “quorum-sensing” protein and is involved in sensing the presence of nearby bacteria by interacting with a small molecule produced by bacteria. Edwards showed that RstA likely interacts with a small molecule made only by *C. difficile* to allow it to bind DNA. However, the genome of *C. difficile* is organized in a way that is different from many closely related bacterial species, so it has been more difficult to find the signal. “Identification of the cofactor that controls RstA activity is a high priority, as this will likely provide insight into the physiological conditions and/or metabolites that influence *C. difficile* TcdA and TcdB [the toxin proteins] production,” the authors conclude.

Phys.org, 25 march 2019

<http://phys.org>

Cost-effective method for hydrogen fuel production process

2019-03-27

Nanoparticles composed of nickel and iron have been found to be more effective and efficient than other, more costly materials when used as catalysts in the production of hydrogen fuel through water electrolysis. The discovery was made by University of Arkansas researchers Jingyi Chen, associate professor of physical chemistry, and Lauren Greenlee, assistant professor of chemical engineering, as well as colleagues from Brookhaven National Lab and Argonne National Lab. The researchers demonstrated that using nanocatalysts composed of nickel and iron increases the efficiency of water electrolysis, the process of breaking water atoms apart to produce hydrogen and oxygen and combining them with electrons to create hydrogen gas. Chen and her colleagues discovered that when nanoparticles composed of an iron and nickel shell around a nickel core are applied to the process, they interact with the hydrogen and oxygen atoms to weaken the bonds, increasing the efficiency of the reaction by allowing the generation of oxygen more easily. Nickel and iron are also less expensive than other catalysts, which are made from scarce materials. This marks a step toward making water electrolysis a more practical and

Researchers have identified an inexpensive way to boost the efficiency of a process used to create hydrogen, a clean, renewable fuel.

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affordable method for producing hydrogen fuel. Current methods of water electrolysis are too energy-intensive to be effective.

Science Daily, 19 March 2019

<http://www.sciencedaily.com>

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~tLinking pollution and infectious disease

~w2019-03-28

~qChemicals and pathogens interact to weaken the immune system, reduce vaccine efficacy, and increase pathogen virulence

Environmental pollutants can interact with pathogens to change how people and wildlife respond to infectious diseases. Decades ago, researchers showed that persistent organic pollutants, such as polychlorinated biphenyls and dioxins, make mice less resistant to an influenza virus. New research suggests that other contaminants—including fluorochemicals, arsenic, and mercury—can also interfere with the immune response in laboratory animals, as well as in people. In some cases, pollutants decrease the immune response to vaccines, making people more susceptible to infectious diseases. In other cases, environmental pollutants increase the virulence of pathogens, such as making certain bacteria more resistant to antibiotics. Researchers are calling for more interdisciplinary work at the intersection between environmental health and infectious disease to help unravel some of the mechanisms behind these interactions. Such work is needed to fully understand how chemicals in the environment affect public health. Thousands of seals died along the coasts of the heavily polluted Baltic Sea in the late 1980s. Scientists traced the deaths to a virus similar to the one that causes distemper in dogs. Last year, the same virus struck hundreds of seals in Maine. In both instances, researchers believe that persistent organic pollutants, such as polychlorinated biphenyls (PCBs), dioxins, and furans, played an indirect role in the seals' demise. The seals are one example of a phenomenon of increasing importance to toxicologists: the interplay between exposure to environmental contaminants and infectious disease. More than two decades ago, researchers reported that exposure to low levels of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), the most toxic of the dioxins, decreases resistance to an influenza virus in mice (Fundam. Appl. Toxicol. 1996, DOI: 10.1006/faat.1996.0004). Scientists have since shown that exposure to other chemicals, including perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), mercury, and arsenic, can also alter the immune response and increase susceptibility to infectious diseases in multiple species of laboratory animals. Epidemiology studies in humans have linked exposure to various chemicals in the womb with reduced levels of antibodies triggered by

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childhood vaccines and increased risk of infectious diseases. Chemicals also affect pathogens, and in some cases can make them more dangerous. Researchers have shown a link between multidrug-resistant bacteria and exposure to zinc, lead, and disinfectants. Epidemiologists are investigating whether exposure to phthalates is also associated with multidrug-resistant bacteria. "Environmental pollutants affect how we are infected," Linda Birnbaum, director of the US National Institute of Environmental Health Sciences, said during opening remarks at a January workshop on the interactions between chemicals and pathogens sponsored by the US National Academies of Sciences, Engineering, and Medicine. Studies so far have revealed tantalizing clues about the scope and mechanisms of these interactions, but more work needs to be done to understand the full effects of chemical exposure on public health, said Birnbaum and other toxicologists, epidemiologists, and infectious disease experts who attended the workshop. Perfluoroalkyl substances used in firefighting foams contaminate many US military bases. These substances are associated with immunological effects. Birnbaum has been investigating the intersection between environmental pollution and infectious diseases for many years. She pioneered the work on exposure to TCDD and decreased resistance to an influenza virus in mice in the mid-1990s while working as a researcher for the US Environmental Protection Agency. Studies led by other scientists have linked perinatal exposure to PCBs (PLOS Med. 2006, DOI: 10.1371/journal.pmed.0030311) and to perfluoroalkyl substances (J. Immunotoxicol. 2017, DOI: 10.1080/1547691X.2017.1360968) with decreased immune responses to childhood vaccines in people living in the Faroe Islands in the North Atlantic Ocean. "Understanding environmental immunotoxicity will be critical to making successful vaccines," Birnbaum emphasised at the workshop. Researchers are now increasingly concerned about exposure to per- and polyfluoroalkyl substances (PFAS). These substances are widely used in consumer products because of their water- and oil-repellent properties. They are found in food packaging, non-stick products, stain-repellent clothing, cleaners, and many other household items. Firefighting foam is also a large source of PFAS groundwater contamination near military bases and airports. Perfluoroalkyl carboxylates, particularly PFOA, have received a lot of attention because of their potential to suppress the immune system, says Berit Granum, a senior scientist at the Norwegian Institute of Public Health. Even though industry has phased out the use of PFOA, blood serum levels of PFOA in humans "have decreased at a slower rate than predicted," she tells C&EN. Researchers attribute the slow decline to continuous exposure to perfluoroalkyl carboxylates from sources such as drinking water, milk and dairy products, meat, seafood, eggs, indoor air,

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house dust, and industrial emissions. From these same sources, people are also exposed to other compounds that get metabolized into perfluoroalkyl carboxylates, Granum says. Such precursors include polyfluoroalkyl phosphate monoesters and diesters that can metabolise into PFOA, perfluorononanoate, perfluorohexanoate, and perfluoroheptanoate, she notes.

Philippe Grandjean and colleagues at the Harvard T.H. Chan School of Public Health were among the first to find an association between elevated PFAS concentrations in mothers' blood and reduced response to vaccinations in their children, specifically how Faroese children responded to diphtheria vaccination (*JAMA, J. Am. Med. Assoc.* 2012, DOI: 10.1001/jama.2011.2034). Granum and colleagues subsequently also linked exposure to perfluoroalkyl substances with decreased antibody levels triggered by vaccines and altered immune-related health effects in early childhood (*J. Immunotoxicol.* 2013, DOI: 10.3109/1547691X.2012.755580). The researchers measured concentrations of PFOA, perfluorononanoate, perfluorohexane sulfonate, and PFOS in blood collected from pregnant women in Norway when they gave birth in 2007 and 2008, and in blood of the children at three years of age. They found that higher maternal levels of the four PFAS correlated with fewer antibodies against rubella in the vaccinated children. Granum and colleagues also observed a correlation between maternal levels of PFOA and perfluorononanoate and the number of common colds in the Norwegian children, and between maternal levels of PFOA and perfluorohexane sulfonate and gastroenteritis in the children. The scientists followed up with a study investigating gene expression associated with PFAS exposure in the Norwegian mother-child pairs (*J. Immunotoxicol.* 2015, DOI: 10.3109/1547691X.2015.1029147). They compared whole-genome transcriptomics data from umbilical cord blood with maternal blood concentrations of four PFAS. The team identified that PFAS exposure is associated with changes in expression of 52 genes involved in immunological and developmental functions. They discovered that expression of those same genes is also associated with decreased rubella antibodies and increased episodes of the common cold in children. In other work, Granum and colleagues reported that exposure to several PFAS is associated with an increased number of respiratory tract infections in the first 10 years of life (*Environ. Res.* 2017, DOI: 10.1016/j.envres.2017.10.012). On the flip side, the researchers also found an inverse association between maternal concentrations of perfluoroundecanoic acid and atopic eczema in girls. However, they did not see an association

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with asthma or allergy-related health effects for other PFAS. Most recently, they showed possible gender differences in respiratory infections and gastroenteritis associated with PFAS exposure, with the majority of correlations identified only in girls (Environ. Int. 2019, DOI: 10.1016/j.envint.2018.12.041). The work is important for regulators around the world who are grappling with setting limits for PFAS in drinking water, food, and hazardous waste sites. Interestingly, risk assessors in the US and European Union came to similar conclusions for PFOA and PFOS using different approaches, Granum says. The European Food Safety Authority (EFSA) published its assessment of the risks of PFOA and PFOS in food in December 2018. EFSA used human epidemiological studies to recommend a maximum limit of 13 ng/kg of body weight per week for PFOS and 6 ng/kg of body weight per week for PFOA. In the US, the Agency of Toxic Substances and Disease Registry (ATSDR) published a draft risk assessment of PFOS and PFOA in June 2018. ATSDR used animal studies to propose a minimum risk level of 14 ng/kg of body weight per week for PFOS and 21 ng/kg of body weight per week for PFOA. ATSDR is working with the US Centres for Disease Control and Prevention to conduct exposure assessments in communities near military bases that have PFAS in their drinking water. The regulatory agencies have yet to set limits for PFAS other than PFOA and PFOS.

Exposure to arsenic in drinking water has been associated with a decrease in response to the diphtheria vaccine in Bangladeshi children. Scientists have known for a long time that arsenic also affects the immune system. Case reports from the 1920s to 1940s show that arsenic given to patients at high doses to treat syphilis led to effects that sound like immunological responses, Molly Kile, an environmental epidemiologist at Oregon State University, said during the January workshop. Kile presented a study demonstrating an association between total arsenic levels in urine and a lack of serum antibodies against varicella zoster, the virus that causes chicken pox and shingles (Environmental Health Perspectives. 2015, DOI: 10.1289/ehp.1408731). She also showed that higher arsenic exposures were associated with higher odds of past hepatitis B infection (Environ. Res. 2018, DOI: 10.1016/j.envres.2018.06.023). Kile also presented preliminary, unpublished data showing that the timing of arsenic exposure appears to be important. Working with colleagues in Bangladesh, her group examined the effects of in utero exposure to arsenic from drinking water on the risk of infectious disease in Bangladeshi children. One of the studies found a strong association between arsenic levels and a decrease

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in serum antibodies for diphtheria in vaccinated children. The researchers did not find an association between arsenic and tetanus. Whenever there is an outbreak of infectious disease, people are quick to blame an unvaccinated child as the source of the infection. "But there are a lot of people who get caught up in these outbreaks who have been vaccinated," Kile noted. People's immunological responses to vaccines vary, and some vaccines are known to produce relatively short periods of protection—this is why adults should receive booster shots for tetanus and diphtheria every 10 years. But vaccine protection "may wane quicker if people are exposed to environmental pollutants," Kile said. Other studies looking at mother-child pairs in New Hampshire (Environ. Health Perspect. 2016, DOI: 10.1289/ehp.1409282) and Bangladesh (Environ. Health Perspect. 2011, DOI: 10.1289/ehp.1002265) found similar associations between developmental exposure to arsenic and increased risk of lower respiratory infections and diarrheal disease in children during the first year of life. Mercury exposure in artisanal gold miners in Brazil has been associated with increased autoantibody levels. Scientists know that mercury has neurotoxic effects, but evidence is growing that it also interferes with the immune system. People can be exposed to many different forms of mercury: elemental mercury from broken thermometers and small-scale artisanal gold mining, inorganic mercury from fluorescent light bulbs and dental amalgams, methylmercury from eating contaminated fish, and ethylmercury from the preservative thimerosal used in some vaccines. All forms of mercury produce some kind of effect on the immune response, says Jennifer Nyland, a professor of biology at Salisbury University. But they don't all affect the immune system in the same ways, and they don't have the same level of toxicity, she adds. They are also metabolised differently. Researchers have reported evidence of mercury altering immune function in animal studies, in vitro cell cultures, and human epidemiological studies. As a postdoc at the Johns Hopkins Bloomberg School of Public Health, Nyland demonstrated that exposure to low doses of inorganic mercury exacerbate an autoimmune disease triggered by the Coxsackievirus in mice (Toxicol. Sci. 2011, DOI: 10.1093/toxsci/kfr264).

Coxsackievirus causes hand, foot, and mouth disease, and nearly everyone is infected with the virus at some point in their lives, Nyland says. Most people clear the infection without long-term adverse effects. But some susceptible individuals develop an autoimmune disease that affects their heart long after they have cleared the infection, she says. Somehow the immune system gets triggered to send cells called macrophages

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back into the heart. Those cells initiate an inflammatory response that eventually damages the heart tissue, leading to a flabby heart that is unable to function properly. Nyland and colleagues showed that exposure to mercury followed by Coxsackievirus infection makes this particular autoimmune disease worse in mice. While at Hopkins, Nyland worked with others to investigate the effects of mercury on human immune cells in cell cultures (*Toxicol. Lett.* 2010, DOI: 10.1016/j.toxlet.2010.06.015). The researchers isolated the cells from blood samples and stimulated them with bacterial antigens to mimic an infection. They also dosed the cells with varying concentrations of mercuric chloride, methylmercury, and ethylmercury. All three forms of mercury affected the immune response by altering the release of signalling proteins called cytokines, but in different ways and to varying degrees. "The bottom line is that all of the different forms of mercury have the potential to be immunotoxic," Nyland says. The researchers also studied artisanal gold miners who use elemental mercury (*Environ. Res.* 2010, DOI: 10.1016/j.envres.2010.02.001) and people who eat contaminated fish downstream of gold mines in Brazil (*Environ. Health Perspect.* 2011, DOI: 10.1289/ehp.1103741). They showed an association between mercury levels in urine from the gold miners and levels of an autoantibody in their blood. That autoantibody is one that physicians use to help diagnose the autoimmune disease lupus, Nyland says. The scientists also found a correlation between total levels of mercury and methylmercury in hair or blood of people who consumed contaminated fish and levels of the autoantibody in their blood, although the correlation was not as strong as in the gold miners. At Salisbury, Nyland's work recently moved toward looking at the mechanism of how mercury is interacting with the immune response. The work is just beginning, Nyland says. Her group is investigating the pathways involved in the inflammasome—a multiprotein complex that detects pathogens and activates the release of proinflammatory cytokines. The team is investigating how the interplay of various doses of mercury species, co-exposure to other chemicals, and pathogen infections affects gene expression of inflammasome components. "Mercury could be interacting with one of the steps that helps to make that inflammasome form," Nyland says. "It could also be changing how that inflammasome does its job once it is formed." Researchers are investigating whether disinfectants, phthalates, and other chemicals contribute to multidrug-resistant strains of methicillin-resistant *Staphylococcus aureus*. In addition to changing the immune response in numerous species, some substances can also make pathogens more virulent or resistant to antibiotics. Meghan Davis, a professor of environmental health and engineering at the Johns Hopkins Bloomberg School of Public Health, is investigating how various

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chemicals that people encounter every day affect methicillin-resistant *Staphylococcus aureus* (MRSA), leading to multidrug-resistant strains. Unlike typical staph infections that respond well to antibiotics, MRSA infections are difficult to treat because the bacteria don't make a particular protein that binds to penicillin, methicillin, and cephalosporins. "None of the β -lactam antimicrobials bind" to MRSA, Davis says. These are the first-tier drugs used for treating skin and soft-tissue infections, which is where MRSA arises most commonly, Davis says. Researchers like Davis get concerned when multidrug-resistant strains of MRSA pop up. These strains resist other antibiotics in addition to β -lactams, making it even more challenging to treat infections. Scientists in the Netherlands discovered one of these superstrains of MRSA in pigs in 2005. This particular strain had the gene for tetracycline resistance and, in some cases, a gene for zinc resistance, Davis says. It spread throughout Europe, Canada, and the midwestern US. Danish scientists later reported a link between the bacteria in pigs and feed supplemented with tetracycline or zinc (Vet. Microbiol. 2011, DOI: 10.1016/j.vetmic.2011.05.025). Both tetracycline and zinc in feed may have contributed to the strain's surviving in animals and therefore being available to infect exposed people—who can then transmit it to other people, Davis says. Zinc is not the only metal associated with more virulent strains of *S. aureus*. Researchers recently reported a correlation between exposure to lead and greater detection of MRSA (Environ. Health 2018, DOI: 10.1186/s12940-017-0349-7). Davis and colleagues are investigating how disinfectants and other chemicals found in the home can affect MRSA. The work is starting to show that disinfectants might exert selective pressure on *S. aureus*, leading to multidrug-resistant strains. Next on Davis's list are phthalates, which are used as plasticizers in many plastics, inks, paints, and other consumer products and have been linked to respiratory diseases such as asthma. *S. aureus*, too, is a driver of inflammatory, noncommunicable disease in people; some strains of the bacteria produce superantigens that affect the immune system. Davis plans to analyse bacterial, fungal, and chemical elements in archived dust samples from several studies related to asthma. "I'm trying to explore the potential for phthalates to exert selective pressure on the microbial communities in the home and in the child" to promote disease, she says.

Complex Interactions

The interplay between exposure to chemicals in the environment and disease is complicated. Chemicals can affect both pathogens and the

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infected person. And they can influence the person directly or indirectly through the microbiome—the bacteria, fungi, viruses, and other microorganisms living in and on an individual or other environments. Studies have shown alterations in the microbiomes of mice exposed to arsenic, lead, manganese, PCBs, or the pesticide diazinon, Birnbaum noted at the January workshop. Some of the studies suggest that those microbiome changes induce metabolic effects that could lead to obesity, atherosclerosis, and neurological diseases, she said. Environmental contaminants may also play a role in emerging public health threats. The National Toxicology Program (NTP) is currently investigating why so many pregnant women in Brazil infected with the Zika virus in 2015 and 2016 gave birth to babies with microcephaly, a birth defect in which the baby's head is smaller than expected. "The severity of the brain effects of Zika in Brazil may have been related to co-exposure to environmental pesticides in use there," Birnbaum said. Birnbaum serves as director of the NTP as well as the National Institute of Environmental Health Sciences. NTP scientists are investigating the larvicide pyriproxyfen, which is used in drinking water in Brazil, Birnbaum noted. They did not see any effects in standard developmental, reproductive studies in rats and rabbits, but there might be an effect on the developing brain in studies in zebrafish, she said. The next step will be for the NTP to look at what happens when pyriproxyfen and the Zika virus are combined. Evidence is growing that chemicals in the environment can alter how people and wildlife respond to pathogens. Wildlife, such as the seals in the Baltic and off the coast of Maine, serve as sentinels of exposure to toxic chemicals in the environment. "If we don't learn from the critters around us, whether domestic or wildlife, even the plants, we are bound to ignore warning signs," Birnbaum said. Birnbaum and other participants at the workshop emphasized the need for more research on the effects of the environment combined with infectious diseases on human health. One particular challenge is finding funding for this type of research, which spans multiple disciplines. But such work is urgently needed, Birnbaum said, to inform public health policy.

~sChemical & Engineering News, 18 March 2019

~shttp://pubs.acs.org/cen/news

~tThere's Mounting Evidence That Parkinson's Starts in The Gut - Not The Brain

~w2019-03-28

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Scientists have found mounting evidence that Parkinson's could start in the gut before spreading to the brain, with one study in 2017 observing lower rates of the disease in patients who had undergone a procedure called a truncal vagotomy. The operation removes sections of the vagus nerve - which links the digestive tract with the brain - and over the course of a five-year study, patients who had this link completely removed were 40 percent less likely to develop Parkinson's than those who hadn't. According to the team led by Bojing Liu from the Karolinska Institutet in Sweden, that's a significant difference, and it backs up earlier work linking the development of the brain disease to something happening inside our bellies. If we can understand more about how this link operates, we might be better able to stop it. "These results provide preliminary evidence that Parkinson's disease may start in the gut," said Liu. "Other evidence for this hypothesis is that people with Parkinson's disease often have gastrointestinal problems such as constipation, that can start decades before they develop the disease." The vagus nerve helps control various unconscious processes like heart rate and digestion, and resecting parts of it in a vagotomy is usually done to remove an ulcer if the stomach is producing a dangerous level of acid. For this study, the researchers looked at 40 years of data from Swedish national registers, to compare 9,430 people who had a vagotomy against 377,200 people from the general population who hadn't. The likelihood of people in these two groups to develop Parkinson's was statistically similar at first - until the researchers looked at the type of vagotomy that had been carried out on the smaller group. In total, 19 people (just 0.78 percent of the sample) developed Parkinson's more than five years after a truncal (complete) vagotomy, compared to 60 people (1.08 percent) who had a selective vagotomy. Compare that to the 3,932 (1.15 percent) of people who had no surgery and developed Parkinson's after being monitored for at least five years, and it seems clear that the vagus nerve is playing some kind of role here. So, what's going on here? One hypothesis the scientists put forward is that gut proteins start folding in the wrong way, and that genetic 'mistake' gets carried up to the brain somehow, with the mistake being spread from cell to cell. Parkinson's develops as neurons in the brain get killed off, leading to tremors, stiffness, and difficulty with movement - but scientists aren't sure how it's caused in the first place. The new study gives them a helpful tip about where to look. The Swedish research isn't alone in its conclusions. In 2016, tests on mice showed links between certain mixes of gut bacteria and a greater likelihood of developing Parkinson's. What's more, earlier in 2017 a study in the US identified differences between the gut bacteria of those with Parkinson's compared with those who didn't have the condition. All of this is useful for scientists looking to prevent Parkinson's,

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because if we know where it starts, we can block off the source. But we shouldn't get ahead of ourselves - as the researchers behind the new study point out, Parkinson's is complex condition, and they weren't able to include controls for all potential factors, including caffeine intake and smoking. It's also worth noting that Parkinson's is classed as a syndrome: a collection of different but related symptoms that may have multiple causes. "Much more research is needed to test this theory and to help us understand the role this may play in the development of Parkinson's," said Lui.

~sScience Alert, 17 March 2019

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

~tIs It More Efficient to Stand or Walk on an Escalator? This Scientist Has The Answer

~w2019-03-28

Love them or hate them, traffic laws exist to keep people safe and to help vehicles flow smoothly. And while they aren't legally enforceable, pedestrian traffic also tends to follow its own set of unwritten rules. Most pedestrians use walking etiquette as a way to minimise discomfort – "Oops! Sorry to bump you!" – and to improve efficiency – "I want to get there faster!" Without even thinking about it, you probably abide by the common pedestrian traffic rule that faster walkers should move to the inside of a path while slower walkers gravitate to the outside. In the United States, this aligns with street traffic rules, where vehicles pass on the left, while slower vehicles stay in the right lane of the road. This approach to passing leads to the formation of pedestrian lanes of traffic. While they're not painted on sidewalks like they are on roadways, these functional lanes can help pedestrians move more comfortably and quickly. Human systems engineers like me know that pedestrian lanes emerge naturally in crowded environments. Within the built environment, designers have used different techniques to encourage particular pedestrian traffic patterns. One example is signs that encourage pedestrians to "stand to the right" on escalators. Riders will use the right half of the step if they are standing and the left half if they're walking (or running!) to reach the end of the escalator. But do two lanes of pedestrian traffic on an escalator actually help you reach your destination more quickly? Should there be a walking lane and a standing lane, or should both lanes be used for standing only?

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One study reported that 74.9 percent of pedestrians choose to stand on the escalator instead of walking. Should an entire lane of the escalator be left open for a small, impatient proportion of the crowd? When designers plan spaces such as roads, buildings and corridors, they consider the space needed for each person in the environment. The space needed changes depending on how the space will be used. For a pedestrian, the “buffer zone” describes how much space a person needs to feel comfortable, and varies by activity. Someone standing needs, on average, a little over three square feet (0.3m^2) of space, whereas a walking pedestrian needs more than eight square feet (0.75m^2). That means a constrained space such as an escalator can comfortably hold more than twice the number of standing pedestrians as walking pedestrians. In London, planners reaped a 27 percent increase in the hourly capacity by switching to a “standing only” policy on a typically congested escalator at a subway station. No walking was allowed on the crammed escalator, which allowed more people to move through the station in the same amount of time as before. A highly efficient escalator is one that has the most output – that is, carries the most people to the destination. But the change was contentious. Social convention in transport has often favoured the individual traveller. For example, allowing people to walk up the left does allow some individuals to move faster, even though it reduces the capacity of the escalator and slows down the overall travel time for others. While using one of the escalator lanes for walking can help the walking pedestrian exit more quickly, walkers’ varied speeds relative to the rest of the traffic hinders overall efficiency. To improve the overall system, the system-level efficiency is what should be considered. Engineers consider a lot of pedestrians in one area a high-density crowd. In these situations, pedestrians tend to walk much slower than when in a low-density or open space. This slower pace is caused by both a lack of space, as well as the need for each pedestrian to make more decisions – should I speed up? Slow down? Pass this person? Just wait? The overwhelming number of small decisions can lead to pedestrians behaving like those around them. This literally go-with-the-flow mentality makes walking less mentally fatiguing. So, when people approach an escalator, they’ll often just do what the person immediately ahead of them is doing. If the person in front of them walks, they walk. If the person in front of them stands, they stand. All it takes is someone to start the trend. Stand on both sides of the escalator. The others will follow. Counterintuitive as it may seem, this one change will help everyone get to the destination faster, especially when things are crowded.

~sScience Alert, 16 March 2019

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~shttp://www.sciencealert.com.au

~tToo much sunscreen? Why avoiding the sun could damage your health?

~w2019-03-28

~qFor years we have been told to slather up or seek shade to avoid skin cancer. But now it is becoming clear that shunning the sun comes with its own health perils

SLIP! Slop! Slap! As public-health campaigns go, Cancer Council Australia's dancing seagull telling people to slip on a shirt, slop on some sunscreen and slap on a hat must rank among the stickiest in history. Launched in 1981, it prompted many a devoted sun worshipper to reconsider whether a "healthy tan" was virtuous, or a herald of premature skin ageing and cancer. It seems to have been effective: after increasing in the general population for decades, rates of the deadliest form of skin cancer, melanoma, are now falling among Australians under the age of 40. "These are people who will have been exposed to the [Slip, Slop, Slap] message for pretty much their whole lives," says Heather Walker of Cancer Council Australia. But has this come at a cost? In Australia and worldwide, the prevalence of vitamin D deficiency is increasing – and sunscreen has taken much of the blame. Low levels of vitamin D are associated with weaker bones and teeth, infections, cardiovascular disease and autoimmune and inflammatory diseases including multiple sclerosis. And although vitamin D supplements have been touted as a solution, so far, they don't seem to have the effect that was expected. Now evidence is accumulating that sun exposure has benefits beyond vitamin D. All of this has prompted some to label sunscreen "the new margarine" – a reference to health advice in the 1980s and 90s to switch from butter to hydrogenated vegetable oil to protect heart health, only to discover that the trans-fats found in many margarines were potentially more harmful. Could sunscreen face a similar fate? And if sun exposure is necessary, how do we reap the benefits without getting skin cancer? The Ancient Babylonians, Egyptians, Greeks and Romans all recognised that sunlight could be harnessed to promote health. Hippocrates, for instance, believed that it was beneficial in the treatment of most ailments. But medical interest in sunlight truly took hold at the turn of the 20th century, following observations that it kills bacteria and that a deficiency is associated with rickets, a condition that affects bone development during childhood. By the late-1920s, sunlight was

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being touted as a cure for pretty much every illness under the sun, and a suntan had become an emblem of health and status.

Soaking up rays

It was also around this time that scientists identified one of the key mechanisms by which sunlight promotes health. When the ultraviolet (UV) B rays in sunlight hit the skin, they spur the synthesis of vitamin D₃. This circulates in the blood before being further metabolised into the active form of vitamin D elsewhere in the body. Bone and muscle cells use vitamin D to regulate levels of calcium and phosphorus, keeping them strong and healthy – but it is also important for certain immune cells, which spew out an antimicrobial in response to it. Indeed, last month a study found that giving vitamin D supplements alongside antibiotics could speed up treatment of multidrug-resistant tuberculosis in the lungs. Of course, sunlight also has a dark side. This was recognised in 1928 by British researcher George Findlay, who exposed mice to regular irradiation with UV light and observed that tumours developed on their skin. Since then, many more studies have shown that UV light triggers DNA mutations in our skin cells, potentially leading to cancer. Sunscreen, in combination with other sun avoidance measures, reduces that risk. Today, the sunscreen industry is booming. Global sales of sun-care products totalled around \$15.8 billion in 2015 and are projected to reach \$24.9 billion by 2024. There is also a trend towards ever higher sun protection factors, even SPF100, although they don't necessarily provide much extra protection (see "Sunscreen myths"). Combined with the fact that most Westerners spend a lot of time indoors – in the US it is, on average, 90 per cent of their lives – this has prompted concerns that, at least at high latitudes, many people aren't storing enough vitamin D to see them through winter. The fear is that their bones, muscles and possibly other tissues are suffering as a result. About 10 per cent of people in the UK have insufficient levels of vitamin D during the summer, rising to nearly 40 per cent during the winter months. For this reason, in 2016, the UK's Scientific Advisory Committee on Nutrition recommended that everyone should consider taking vitamin D supplements during winter, because there is good evidence that they can make a difference to bone and muscle health. The trouble is, in recent years the list of illnesses associated with vitamin D deficiency has grown to include cardiovascular disease, infections and even infertility, but for many of these, supplements don't seem to lead to better health. Several recent studies actually associated high doses of vitamin D with an increased risk of falls in older people.

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According to a recent review of trials, apart from bone-related conditions, there is good evidence for only two things: that vitamin D can prevent upper respiratory tract infections and stop existing asthma from getting worse. Ongoing trials may yet find additional benefits, but it is unlikely vitamin D will be a panacea for our many modern health challenges. Vitamin D isn't the only way sunlight affects our health, however. UV light itself may also help marshal our immune system via the largest organ in the body: our skin. Long thought to be simply a protective barrier that provides a way to sense our environment, it turns out our skin may also be a vital part of the immune system. The outermost layer contains cells called keratinocytes that absorb UV light, then send signals to regulatory cells that help to keep the immune system in check. If there is plenty of UV light, these dampening signals are transmitted to the rest of the body, suppressing its immune responses. One idea for why, as daytime creatures on this sunny planet, we evolved this response to the sun is that it is a way to tolerate our own cells, rather than misidentifying them as "foreign" and destroying them. By getting sunlight, we boost that tolerance of self, which is essential for preventing autoimmune diseases, says Scott Byrne, an immunologist at the University of Sydney.

Protection factor

Byrne has been working with Prue Hart at the University of Western Australia to investigate whether UV light could help people with multiple sclerosis (MS), an autoimmune condition that is more common at higher latitudes. Hart has shown that exposing mice to UV doses equivalent to a brief stint in the midday sun can prevent them from developing a form of MS. Now she and Byrne are looking into whether UV exposure from specialised lamps could slow, or even prevent, the development of MS in people. However, sunlight's effect on immune suppression also has a big downside: "Probably the reason why skin cancers grow is because the immune system is dampened and less efficient," says Hart. Even so, immune suppression can't explain all the effects of sunlight on health that we have seen. Consider the perplexing finding that people with high sun exposures have higher life expectancies, on average, than sun avoiders – despite facing an increased risk of skin cancer. That was the discovery of a large Swedish study into the risks associated with melanoma and breast cancer. In 1990, nearly 30,000 women were interviewed about their health and behaviour – including their sun habits. They were then interviewed again 20 years later. When Pelle Lindqvist at the Karolinska Institute and his colleagues crunched that data, they found that, on average, women

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who spent more time in the sun lived one to two years longer than sun avoiders, even after adjusting for factors such as disposable income, education level and exercise. That suggests it wasn't simply about having a more healthy lifestyle overall. The researchers found this reduced life expectancy among sun avoiders was mostly due to a greater risk of death from cardiovascular disease and other non-cancer-related illnesses, such as type 2 diabetes, autoimmune disease or chronic lung disease. What could be going on? Richard Weller at the University of Edinburgh, UK, thinks he has the answer. Like most dermatologists, Weller started his career believing that sunlight is terribly bad for you. He still wouldn't dispute that it is a major risk factor for skin cancer. However, his discovery that we produce and stockpile vast quantities of nitric oxide – a potent dilator of blood vessels – in our skin, which can be activated by sunlight, made him think again.

He wondered if this UV-activated nitric oxide was why people's blood pressure readings are lower in summer than in winter, and whether it may help to explain why cardiovascular disease is more prevalent at higher latitudes. If that were the case, it would also help to explain the puzzling results of the Swedish study. What he found pointed in that direction: his experiments showed that if you expose somebody to the equivalent of about 20 minutes of UK noontime summer sunlight, they experience a drop in blood pressure that continues even after they step indoors. This sunlight-activated nitric oxide may have other functions as well. Separate studies have revealed that mice fed a high-fat diet that has been shown to promote weight gain and metabolic dysfunction can be protected against these effects through regular exposure to UV light, but not if nitric oxide production is blocked. Nitric oxide is implicated in wound healing, not to mention achieving and maintaining an erection. It also seems to be another substance to which regulatory immune cells respond. More evidence will be needed to convince the wider dermatology community to step back into the sunlight. "The only established benefit of solar exposure is vitamin D production; others are still controversial," says Antony Young, who studies the effect of solar UV on the skin at King's College London. Even so, he believes there may be something to Weller's findings: "UV has an awful lot of effects at a cellular and a molecular level, and it would certainly not be surprising if these had been exploited by evolution to get some advantages." All of this leaves health policy-makers with a dilemma. Most still believe that the need to protect skin from sun damage outweighs the risk of vitamin D deficiency, given repeated findings about

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skin cancer. For example, getting sunburnt once every two years has been found to triple a person's risk of developing melanoma. Cancer Council Australia now emphasises the importance of the UV index – a measure of how strong the sun's UV rays are on a scale of 1 to 11 – in dictating when sunlight should be avoided. Together with other Australian medical bodies, it recommends staying indoors when the UV index is 3 or above, or following the modified Slip, Slop, Slap, Seek and Slide message if you are outdoors for more than a few minutes (the latter two were added in 2007, to emphasise the importance of seeking shade and sliding on sunglasses). Sunscreen is a last resort. "You should use clothing to cover up," says Walker. "That offers the most reliable protection. Only use sunscreen on the parts of your skin that are uncovered." During autumn and winter, though, the council encourages people living in Southern Australia, where vitamin D deficiency is more of a risk, to head outside with some skin uncovered in the middle of the day, when the UVB rays needed to synthesise vitamin D are at their strongest. That won't work in countries at higher latitudes, such as the UK, because the sun doesn't rise high enough during winter for the UVB rays to reach ground level. Populations in these countries are dependent on the vitamin D they stockpile during sunnier months, supplemented by that obtained from foods such as oily fish, egg yolks and some breakfast cereals, or taking vitamin D tablets. You don't need to spend hours sizzling in the summer sun to ensure you synthesise adequate vitamin D for the year (see diagram, below). "We still don't know the minimal dose requirement [of sunlight] for adequate vitamin D production, but whatever it is, it is very much lower than is necessary to have a sunburn," says Young. You can even manufacture some vitamin D while wearing sunscreen – although the amount you make will be reduced. But preliminary studies by Weller suggest that sunscreen inhibits both the release of nitric oxide and vitamin D. So, what does he tell his patients? "I am conflicted," Weller says. "Sunlight is good and bad." Both he and Young stress the importance of knowing your skin type: people with darker skin will need to spend longer in the sun to generate vitamin D and nitric oxide, and it also takes longer for them to burn. Possibly, though, there is a way of getting the best of both worlds. Weller and his colleagues have recently patented an ingredient that could be added to sunscreen, and which releases nitric oxide into the skin when sunlight hits it. He has had little interest from sunscreen manufacturers, though, possibly because it makes things more complicated. "They have spent years and years – as has the dermatology community – saying sunlight is bad: avoid it," says Weller. "Now we're coming along with a more nuanced message."

~sNew Scientist, 13 March 2019

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

~tScientists identify compounds in coffee which may inhibit prostate cancer

~w2019-03-28

For the first time, scientists have identified compounds found in coffee which may inhibit the growth of prostate cancer. This is a pilot study, carried out on drug-resistant cancer cells in cell culture and in a mouse model; it has not yet been tested in humans. This work is presented at the European Association of Urology congress in Barcelona, after publication in the peer-reviewed journal *The Prostate*. Coffee is a complex mixture of compounds which has been shown to influence human health in both positive and negative ways. There is increasing evidence that drinking certain types of coffee is associated with a reduction in incidence of some cancers, including prostate cancers. Now Japanese scientists have studied the effects of two compounds found in coffee, kahweol acetate and cafestol, on prostate cancer cells and in animals, where they were able to inhibit growth in cells which are resistant to common anti-cancer drugs such as Cabazitaxel. The researchers initially tested six compounds, naturally found in coffee, on the proliferation of human prostate cancer cells in vitro (i.e. in a petri-dish). They found that cells treated with kahweol acetate and cafestol grew more slowly than controls. They then tested these compounds on prostate cancer cells which had been transplanted to mice (16 mice). 4 mice were controls, 4 were treated with kahweol acetate, 4 with cafestol, with the remaining mice being treated with a combination of kahweol acetate and cafestol. Study leader, Dr Hiroaki Iwamoto (Department of Integrative Cancer Therapy and Urology, Kanazawa University Graduate School of Medical Science, Japan, first author of the study) said: "We found that kahweol acetate and cafestol inhibited the growth of the cancer cells in mice, but the combination seemed to work synergistically, leading to a significantly slower tumour growth than in untreated mice. After 11 days, the untreated tumours had grown by around 3 and a half times the original volume (342%), whereas the tumours in the mice treated with both compounds had grown by around just over one and a half (167%) times the original size. It is important to keep these findings in perspective. This is a pilot study, so this work shows that the use of these compounds is scientifically feasible, but needs further investigation; it does not mean that the findings can yet be applied to

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humans. We also found the growth reduction in transplanted tumour cells, rather than in native tumour cells. What it does show is that these compounds appear to have an effect on drug resistant cells prostate cancer cells in the right circumstances, and that they too need further investigation. We are currently considering how we might test these findings in a larger sample, and then in humans." Kahweol acetate and cafestol are hydrocarbons, naturally found in Arabica coffee. The coffee-making process has been found to affect whether these compounds remain in coffee after brewing (as with espresso), or whether they are stripped out (as when filtered). Professor Atsushi Mizokami (Department of Integrative Cancer Therapy and Urology, Kanazawa University Graduate School of Medical Science, Japan) added: "These are promising findings, but they should not make people change their coffee consumption. Coffee can have both positive and negative effects (for example it can increase hypertension), so we need to find out more about the mechanisms behind these findings before we can think about clinical applications. However, if we can confirm these results, we may have candidates to treat drug-resistant prostate cancer." In an independent comment, Professor Zoran Culig (Professor of Experimental Urology, Medical University of Innsbruck) said: "These are interesting findings. I would expect that those initial results will motivate researchers to use more recently developed models, such as patient-derived xenografts which express the androgen receptor. Such experiments will likely provide a definitive answer as to future perspective of this kind of treatment."

~sEurekAlert, 17 March 2019

~shttp://www.eurekalert.org

~tThis chemical has been polluting N.J. for decades. Now, 5 companies have to pay big to clean it up.

~w2019-03-28

~qFive chemical companies polluted New Jersey's water for years with a long-lasting, cancer-causing family of chemicals. Now, the state is directing those companies to clean up the mess.

Recently, the New Jersey Department of Environmental Protection issued a directive to five companies -- Chemours, Dow DuPont, DuPont, Solvay and 3M -- aimed at addressing the contamination of what are known as "PFAS" chemicals (short for polyfluoroalkyl and perfluoroalkyl substances). The

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chemicals, which are used for products ranging from non-stick cookware to firefighting foam, have been linked to cancer and other health effects, according to the Centres for Disease Control and Prevention. Under the new directive, which the NJDEP called “groundbreaking,” the named companies are required to disclose all information related to their use and discharge of PFAS chemicals in New Jersey. The companies will also be held financially responsible for the remediation and treatment of PFAS-related contamination in the state. “The PFAS group of chemicals are ubiquitous in our environment and pose significant health risks to the public,” NJDEP Commissioner Catherine McCabe said. “In issuing this directive, we are putting these five companies on notice that many years of contaminating New Jersey’s precious drinking water and other natural resources will not go unchecked. On behalf of all New Jerseyans, we will hold these companies accountable and insist that they step up to address the problem they have created.” Under the new directive, McCabe said that Solvay will be expected to pay more than \$3 million for remediation work that was already done in West Deptford, where the company used perfluorononanoic acid (PFNA) from 1985 to 2010. McCabe said she was unsure at this point how much more money the companies will need to commit to clean up. “We have already spent over \$3 million in responding to the contamination in West Deptford,” McCabe said. “So, we’re asking Solvay to cut us a check, to reimburse us for our costs.” According to company spokesman David Klucsik, Solvay is reviewing the new directive and will respond “appropriately.” “Solvay has been responding to the presence of compounds in the vicinity of its West Deptford plant and has implemented remedial activities,” Klucsik said. “Solvay shares the information it gathers with the NJDEP, and Solvay maintains an ongoing dialogue with the Department and other stakeholders around its West Deptford site.” In a statement, Chemours said it was reviewing the NJDEP directive and that it is in regular communication with the state. The company stressed that it does not use two prominent PFAS chemicals, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA,) for its products. “Chemours is committed to taking a leadership role in environmental stewardship and supports the development of a science and risk-based approach to establish standards and guidelines for PFAS compounds,” the company said. “We believe collaboration and transparency are critical to achieving this.” Dow DuPont, which is the parent company of DuPont, also said that it was reviewing the new directive, and that it is in communication with the NJDEP. 3M did not respond to requests for comment. The chemicals in the PFAS family have been produced and used commercially and industrially for more than 60 years, but regulatory agencies around the world are only recently

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starting to understand the health effects, according to the NJDEP. The state said that PFAS chemicals are discovered on a near-daily basis in the state's water, soils, air, fish, plants and other natural resources. The chemicals are widespread in New Jersey, according to the NJDEP, with the highest concentrations being found in traditionally industrial areas. West Deptford, where the Solvay plant used PFNA, is home to some of the highest levels of PFNA contamination in the world. Military bases like Joint Base McGuire-Dix-Lakehurst and Naval Weapons Station Earle also have high levels of PFAS contamination, particularly PFOS which is a common ingredient in firefighting foam. "The Department of Defence, yes, is responsible for the PFOS contamination that you'll find around the military bases, and so far, they've been stepping up to do the monitoring and to look at the work that's needed to get those under control around those bases," McCabe said. Among the most well-studied PFAS chemicals, according to the NJDEP, are PFOS, PFNA, PFOA and GenX, a separate family of chemicals developed to replace PFOA. None of the chemicals are naturally occurring, according to the NJDEP, and the chemicals do not break down in the environment. According to the CDC, PFAS chemicals can increase the risk of cancer, lower a woman's chance of getting pregnant and interfere with natural hormones. The New Jersey Sierra Club, a leading environmental advocacy group in the state, praised the state's action. "This is a really important step forward in enforcing New Jersey's clean-up laws against polluters," said Jeff Tittel the director of the New Jersey Sierra Club. The NJDEP's directive comes as the federal government lags behind in regulating PFAS chemicals. In February, the U.S. Environmental Protection Agency unveiled a nationwide action plan for the problem, but stopped short of setting a national drinking water standard for PFAS chemicals.

NJ.com, 25 March 2019

<https://www.nj.com>

Scent of Danger: Are There Toxic Ingredients in Perfumes and Colognes?

2019-03-28

Yes, the sweet smell of perfumes, even the most expensive ones you invest in, can leave you bewildered with dangerous reactions. The fragrances are not always natural oils, they can also contain toxic chemicals which have effects which can never be negated. However, you can save yourself by opting for organic and botanical variants as shown on Fragrance 365's website. Here, we are going to give you some insight into the chemicals

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which are embedded in these perfumes and why are they harmful. Various studies have discovered a huge number of malicious chemical ingredients such as camphor, acetone, benzaldehyde, benzyl acetate, benzyl alcohol, ethanol, ethyl acetate, limonene, linalool, and methylene chloride in some combination or the other in the fragrances. Though, not all the above fragrances can cause huge damages, regular use of these on body can lead to severe nervous, respiratory, and kidney damages which are at times irreversible. Inflammation, irritation, itching, and dizziness are some side-effects which are common amongst the people who are particularly allergic to one of these chemicals. To top it all, the labels of these fragrances do not even disclose what the chemicals hidden under the rosy smell are, making it difficult for allergic people to save themselves from reactions. Here are the chemicals that different studies have discovered in a small section of brands. Endocrine disruptors and phthalates were discovered as ingredients of many famous perfumes which can cause severe drop in the IQ of a baby if the mother uses the fragrances during pregnancy. Plus, the diethyl phthalates result in sperm damage. Over 24 chemicals in the perfumes are known to cause allergy triggers such as headaches, runny noses, rashes, hyperpigmentation, coughing, skin inflammation and more. The lack of regulation is also a serious concern here because it is only the banned substances which the manufacturers are barred from using. Apart from those, they use many other petrochemicals which are not even assessed until after they were busted under studies.

Musk Ketone, which is a dangerous skin irritant was discovered in the scents which is certainly not permissible when most of the people use them directly on their skin. Certain 'Obesogens' were also discovered by scientists which are known to make people gain weight just by application of perfumes. Well, now you know that fragrances can contain chemicals and that too harmful ones which can cause hormonal imbalances, allergic reactions, and weight gain. Plus, there are many other hidden substances which are seen unfit for human use. And they are conveniently hidden because companies are not bound by regulations to reveal the chemicals that they've used. All said, the question is how you can protect you family from these toxins. Here are some tips to avoid toxins and still smell pleasant:

- Avoid all packaging which come without full chemical disclosure.
- Look up the complicated ingredients on the internet and check if they are safe or not.

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- Opt for products which use essential oils for scents and you can always switch to essential oils instead of scents yourself.
- Organic scents, though expensive, are a great way to escape several toxic chemicals.

There you have it! There are chances that your eau de parfum has toxic substances in it, you need to be more careful to be safe.

Kerala News, 25 March 2019

<http://www.keralanews247.com>

These 5 Common Habits Could Be Slowly Killing You

2019-03-28

Even when they're truly detrimental to your health, certain activities can be difficult to give up. Whether it's smoking, regularly indulging in sugary beverages, or binge drinking, there are a handful of practices that experts have linked to an early death. Before suggesting that these activities were harmful, researchers studied big groups of people over long periods of time. In one of those studies, published this week in the American Heart Association journal *Circulation*, scientists found troubling links between high intakes of soda and an early death. And in a large review of two studies published in the same journal last year, researchers pinpointed five habits that appeared to be tied with a significantly shorter lifespan. Here's an overall look at what scientists have concluded are the most harmful habits for your health:

Drinking sugary beverages and eating processed foods

Drinking soda, juice, and other heavily sweetened beverages appears to take a heavy toll on our bodies. In fact, a new 34-year study of more than 118,000 people suggested that the more sugar people drank, the more likely they were to die from problems such as heart trouble. However, as with many nutrition studies, this one merely involved observing people over time. That means the research could not definitively conclude that sugary drinks are bad – it could suggest only that they might be. If you're worried about your drinking and eating habits, there's plenty you can do to counteract the problems tied with sugary drinks. Aside from simply avoiding soda and juice, a growing body of research suggests that a meal plan focusing on vegetables, protein, and healthy fats has key benefits. Those include losing weight, keeping the mind sharp, and protecting the heart and brain as you age. The best diets (and the ones linked with the longest life) involved high intakes of vegetables, nuts, whole grains,

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healthy fats (such as those from fish and olive oil), and low intakes of sugary beverages, such as soda and juice, processed sweets and breads, red and processed meats, and trans fats and salt.

Smoking

Smoking kills. No other habit has been so strongly tied to death. In addition to cancer, smoking causes heart disease, stroke, lung diseases, diabetes, and chronic obstructive pulmonary disease, which includes emphysema and chronic bronchitis, according to the Centres for Disease Control and Prevention (CDC). Smokers inhale burned tobacco and tar along with toxic metals, such as cadmium and beryllium, and elements such as nickel and chromium – all of which accumulate naturally in the leaves of the tobacco plant. So, it's no surprise that studies find that abstaining from cigarette smoking for life is linked with living longer. If you've already smoked, the research still has good news: Both quitting and cutting back have also been linked with positive outcomes related to life expectancy. "Smoking is a strong independent risk factor of cancer, diabetes, cardiovascular diseases, and mortality," researchers wrote in one study. "And smoking cessation has been associated with a reduction of these excess risks."

Sitting for long periods of time

In general, staying sedentary for lengthy periods of time seems to be awful for your health. But getting up every once in a while to do regular cardio exercise is an all-natural way to lift your mood, improve your memory, and protect your brain against age-related cognitive decline. In other words, it's the closest thing to a miracle drug that we have. A wealth of research suggests that cardio – any type of exercise that raises your heart rate and gets you moving and sweating for a sustained period of time – has a significant and beneficial effect on the brain. "Aerobic exercise is the key for your head, just as it is for your heart," according to a recent article in the Harvard Medical School blog Mind and Mood. Most research suggests that the best type of aerobic exercise for your mind is anything you can do consistently for 30 to 45 minutes at a time.

Being overweight or underweight

People who weigh above or below average appear to face a slightly higher risk of death from a range of causes, according to a large recent study that assessed peoples' weight using a measure called the body mass index (BMI). Researchers like to use BMI for quick assessments of large groups of people. Generally speaking, a BMI of between 18.5 and 24.9 is considered

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within the “healthy range” for adults over age 20, according to CDC. And people who fell within that BMI range tended to outlive their peers who fell outside it, the study found. In other words, people who had BMIs that were either above or below the “healthy range” lived shorter lives than people with BMIs that fell within that range. That said, BMI is far from a perfect means of gauging your overall health. The 1830s-era measure does not take into account a number of key health factors, including overall body fat, gender, muscle composition, or the amount of fat you’re carrying around your middle. This measure, also known as abdominal fat, is emerging as a key alternative to BMI because of its strong links with heart health and diabetes.

Drinking heavily

It’s been tough to pin down the precise relationship between drinking and overall health. A little bit of alcohol (such as one or two drinks per day) seems to be OK. More than that, however, and the benefits appear to vanish. The most dangerous types of drinking are heavy drinking and binge drinking. Defined by the CDC as eight drinks or more per week for women and 15 drinks or more per week for men, heavy drinking has been tied to a host of negative outcomes, including an overall shorter life expectancy. Binge drinking, or having four drinks if you’re a woman and five drinks if you’re a man within two hours, may be equally or even more harmful, studies suggest. Other problems tied to heavy drinking and binge drinking include cancer, heart disease, respiratory disease, and injury.

Science Alert, 24 March 2019

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

There’s Evidence Coffee Acts on Your Brain Like Cannabis, But in Reverse

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Coffee, the world’s most common recreational drug, affects our metabolism far more deeply than we realised, according to a recent study. The results describe a number of knock-on effects that impact upon several important body systems, suggesting our daily coffee habit might have a complex range of benefits and risks to our health. It seems hardly a month goes by when there’s a new discovery that coffee is either good for our health and helps you live a longer life, or a potential danger and cancer risk. In between the hype and the headlines, the truth is always more complicated. And this 2018 study points to why – it turns out the

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compounds in our daily cup of joe change more metabolites in our blood than previously known. The investigation entailed 47 coffee drinkers to give up the habit for a month before throwing back four cups of coffee each day for the next 30 days. Following that, they upped their coffee intake to eight cups. All the while, researchers were taking blood samples to analyse changes in biochemistry that result from consuming food and drink. The resulting profile revealed 115 metabolites were impacted by the consumption of coffee. A total of 82 of those chemicals were already known, and could be mapped to 33 metabolic pathways, a number of which were completely new relationships. The exact consequences of these changes weren't explored, but what is apparent is that we really should be paying attention. "These are entirely new pathways by which coffee might affect health," said the study's lead author Marilyn Cornelis from Northwestern University Feinberg School of Medicine at the time. "Now we want to delve deeper and study how these changes affect the body." For example, drinking around eight cups of coffee a day has a knock-on effect causing a drop in the kinds of neurotransmitters mimicked by cannabis. In other words, where cannabis ramps up our body's endocannabinoid system, something in coffee seems to drive down the system's neurotransmitters, putting it into low gear. Our body tends to decrease its production of endocannabinoids in times of stress, making the researchers question the relationship between coffee and how our body adapts to change. "The increased coffee consumption over the two-month span of the trial may have created enough stress to trigger a decrease in metabolites in this system," said Cornelis. "It could be our bodies' adaptation to try to get stress levels back to equilibrium." That's not all the endocannabinoid system does, though. It has a hand in everything from cognition, to sleep, to appetite. "The endocannabinoid pathways might impact eating behaviours," said Cornelis, referring to the classic link between cannabis and 'the munchies'. Another metabolic pathway worth further investigation is the one responsible for keeping our steroids in check. Steroids cover a variety of chemical messengers that zip around through our blood, controlling everything from growth to sexual characteristics. In particular, the researchers found metabolites associated with the excretion of steroids went up with coffee consumption, hinting at a connection between the beverage and elimination of steroid compounds from our body. Exactly what components of coffee are responsible for these kinds of changes is not yet clear. The findings might go some way to explain why coffee seems to have so many health benefits, such as helping in weight management and reducing the risk of type 2 diabetes. "This is often thought to be due to caffeine's ability to boost fat metabolism or the glucose-regulating effects of polyphenols

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(plant-derived chemicals)," said Cornelis. "Our new findings linking coffee to endocannabinoids offer alternative explanations worthy of further study." Given how popular coffee is all over the globe, it's strange to think there is so much we still don't know about its impact on our health. Hopefully more studies like this one will help us fine tune its benefits and help us determine how to get the most out of our frequent cappuccinos. This research was published in the Journal of Internal Medicine.

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Spread of cancers halted by smart bacteria that trigger immune attack

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Genetically modified "smart" bacteria injected into tumours can shrink growths and trigger an immune response that stops cancer spreading, tests in animals show. The engineered bacteria exploit the vulnerability of solid tumours to infections. This vulnerability comes about because tumours evolve all kinds of tricks for evading immune system attack, from physically keeping out immune cells to releasing chemicals that tell the cells not to attack. But this leaves tumours open to infection by bacteria and viruses that would be rapidly wiped out elsewhere in the body. The smart bacteria, created by Sreyan Chowdhury at Columbia University in New York and his colleagues take advantage of this, infecting a tumour and multiplying. Once the number of bacteria reaches a critical level, they are designed to self-destruct and release an antibody in the heart of the cancerous growth. This antibody then encourages the immune system to attack the tumour. The team started with a harmless strain of *E. coli*. This was engineered to produce an antibody, which binds to a protein called CD47 found on the surface of some cancer cells, triggering their destruction. However, CD47 is also found on the surface of healthy red blood cells, so injecting high levels of the antibody straight into the blood would be dangerous. By instead injecting the bacteria directly into tumours, high levels of the antibody are produced only where needed. In tests in mice, several kinds of tumours shrank after being injected with the smart bacteria. What's more, the growth of tumours elsewhere in the body of the mice also slowed, while the chances of cancer spreading to new sites in the body was greatly reduced (bioRxiv, doi.org/c3k5). The research shows that the modified bacteria can be used to trigger body-wide immune system targeting of untreated tumours, says cancer biologist Graham Dellaire of Dalhousie University in Canada. "Harnessing

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this effect could well be the key to curing metastatic disease – the major cause of cancer-related death,” he says. Whether this approach will work in people remains to be seen, but Dellaire points out that the live bacteria used to immunise against TB, in the BCG vaccine, have long been used to treat bladder cancer. This is also thought to work by triggering an immune response.

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

Exposure to dirty city air reduces sperm quality and quantity in mice

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Dirty air in urban areas may be having an impact on sperm. Tests on mice showed that those exposed to tiny pollution particles had worse sperm quality and smaller quantities than mice who were not. Many health problems are linked to pollution emitted by petrol and diesel cars, including respiratory issues, cancer and stunting child development. However, whether the smallest of these air pollutants, PM2.5, could also be contributing to increasing male infertility rates around the world is still unclear. Elaine Costa at the University of Sao Paulo and her colleagues studied four groups of mice. They exposed three of the groups to PM2.5 for different lengths of time before and after birth, and the fourth was only exposed to filtered air. They then analysed sperm development when they became adults and the exposed mice showed a deterioration in the tubes in the testes that produce sperm. The quality of sperm was significantly worse in mice exposed to pollution before and after birth, compared to the control group. Exposure to air pollution after birth appeared to have the most serious impact on sperm. DNA tests also showed changes in the levels of genes related to testicular cell function. “These findings provide more evidence that governments need to implement public policies to control air pollution in big cities,” said Costa in a press release. The work, which is not yet peer-reviewed, will be presented at the Endocrine Society conference in New Orleans on Sunday.

New Scientist, 24 March 2019

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

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Restoring this enzyme's function protects against heart disease in lupus and beyond

2019-03-28

Patients with lupus, an inflammatory disease in which the body's immune system attacks its own tissues, are on average seven to nine times more likely to develop heart disease than the general population. Younger women with lupus are 50 times as likely to develop the disease as young women without the disease. The endothelium—the single layer of cells lining blood vessel walls—is thought to protect against heart disease. It does so in part by producing nitric oxide. A research team at the Medical University of South Carolina has shown that the enzyme responsible for nitric oxide production stops working properly when exposed to serum from lupus patients. They also showed that its ability to produce nitric oxide can be restored by administration of L-sepiapterin. Their findings are published in an article published ahead of print by *Lupus Science & Medicine*. The article provides proof of concept that the enzyme could be a therapeutic target for heart disease in lupus. Restoring the enzyme's function could also help protect lupus patients against kidney disease. The same inflammatory forces are at work there but the damage occurs much more quickly. The findings also suggest that restoring the protective function of endothelial cells could be a strategy for treating heart disease more broadly. "Our study demonstrates that therapies directed towards restoring the function of the enzyme that makes nitric oxide might be effective in restoring the function of the endothelium," explains Jim C. Oates, M.D., senior author on the article. Oates is director of the Division of Rheumatology & Immunology and vice chair for research at MUSC. "So, it's a proof of concept that allows us to move forward in studying the enzyme, nitric oxide synthase, or restoring its function as a target for vascular disease in lupus," continues Oates. "This is a first step in a long process of trying to identify therapeutics that might be useful for preventing this accelerated phenotype of cardiovascular disease in lupus patients," says Joy Buie, Ph.D., MSCR, a postdoctoral fellow at MUSC and the first author on the article. For the study, the team collected serum samples from a cohort of African American patients, specifically Gullah patients, with lupus who have been followed since 2003. The South Carolina Clinical & Translational Research Institute at MUSC helped the research team collect study samples from control volunteers, process study samples from both study patients and control volunteers, and securely store collected data. The MUSC team showed that exposing endothelial cells to serum from patients with lupus caused the enzyme that produced nitric oxide to quit working properly. That enzyme is known as endothelial nitric

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oxide synthase. Instead of producing the protective nitric oxide, it began producing superoxide, which promoted damaging inflammation. In essence, the enzyme lost its power to protect against heart disease and instead promoted conditions that could lead to it. A co-factor needed for the proper function of the enzyme had been rendered unusable by exposure of the endothelial cells to the serum of lupus patients. Administering L-sepiapterin to the cells restored the enzyme's ability to produce nitric oxide by providing a new and more reliable source of that co-factor. "If you try to give the co-factor itself, it's rapidly oxidized by the same process that leads to the dysfunction of the enzyme," explains Oates. "So, giving L-sepiapterin, a precursor to the co-factor, makes it less susceptible to that rapid breakdown." L-sepiapterin is not currently approved for administration in humans. However, it is under investigation for the treatment of a number of diseases, including diabetic gastroparesis. Before it can be administered to patients, much further testing, both in animal models and in clinical trials, will be necessary to confirm its efficacy and safety profile. But these findings point to a whole new way of understanding, preventing, and treating heart disease, one that is not limited only to patients with lupus. "Many people focus on controlling cholesterol to protect against heart disease," explains Buie. "Our study focuses the attention on making endothelial cells happy and functional. It identifies therapeutic targets on endothelial cells as being important." That's not to say that controlling cholesterol and other lifestyle changes aren't important. They too can affect how well the endothelium protects against heart disease. "Lifestyle modifications can affect the endothelium. The Western diet—characterised by highly processed foods that are high in saturated and trans-fat and low in good oils like omega-3 fatty acids—contributes to heart disease in everybody, not just lupus patients," explains Oates. "So, changing to a healthy diet and becoming more active goes a long way." But these findings suggest that pharmaceutically restoring endothelial function deserves further study as an additional therapeutic approach for patients with lupus and others at high risk of heart disease.

Medical Xpress, 25 March 2019

<http://medicalxpress.com>

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