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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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## Regulatory Update

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### ASIA PACIFIC

#### **APVMA proposed decision to remove home and garden uses of chlorpyrifos products**

2019-08-02

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has proposed to remove all remaining uses of the insecticide chlorpyrifos in domestic and home garden settings, and certain public spaces. APVMA Chief Executive Officer, Dr Chris Parker, said the Proposed Regulatory Decision (PRD) to suspend all domestic and home garden products with chlorpyrifos after 28 days is the result of a comprehensive review of the chemical's environmental and health impacts. "We make decisions based on credible scientific evidence and have been taking progressive action on chlorpyrifos for many years. "In our assessments, we have considered all populations and factored in exposure to uses in home garden and domestic settings, as well as certain public spaces. "As a result of our regulatory decision today, it is proposed that no chlorpyrifos products used in domestic and home garden situations will be available for sale in Australia after 28 days." The APVMA is currently consulting on agricultural, biosecurity, and permitted use patterns, and chlorpyrifos products can continue to be used in agricultural settings or under permit only if used according to label instructions. More information about the PRD, including the list of affected products, disposal advice, alternatives, and consultation details, can be found on the APVMA website.

APVMA, 24 July 2019

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

#### **Cancellation of Product Label Approvals at the Request of the Holder**

2019-08-02

On 30 July, the Australian Pesticides and Veterinary Medicine Authority (APVMA) published details of products that have had their label approvals cancelled at the request of the holder.

**The Australian Pesticides and Veterinary Medicines Authority (APVMA) has proposed to remove all remaining uses of the insecticide chlorpyrifos in domestic and home garden settings, and certain public spaces.**

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Product no. (A)	Product name (B)	Registrant (C)	Product label approval number (D)	Date of effect (E)
69416	Titan Diflufenican 25 + Bromoxynil 250 Selective Herbicide	Titan Ag Pty Ltd	69416/60746	16 July 2019
62641	Titan Bromoxynil MA Selective Herbicide	Titan Ag Pty Ltd	62641/1207	18 July 2019
61796	Titan Bromoxynil 200 Selective Herbicide	Titan Ag Pty Ltd	61796/0407	16 July 2019
65074	Accensi Triple Shot Herbicide	Accensi Pty Ltd	65074/50066	18 July 2019
62747	Accensi Bromoxynil 200 Selective Herbicide	Accensi Pty Ltd	62747/0108	18 July 2019
81792	Reylon Apex Herbicide	RuralCo Holdings Limited	81792/104061	18 July 2019
82951	Reylon Bolt 200EC Herbicide	RuralCo Holdings Limited	82951/107201	18 July 2019
59666	Imtrade Bromox 200 Selective Herbicide	Imtrade Australia Pty Ltd	59666/0909 59666/1005	16 July 2019 16 July 2019
61593	Imtrade Bromox MA Selective Herbicide	Imtrade Australia Pty Ltd	61593/0909 61593/1007 61593/102994	18 July 2019 18 July 2019 18 July 2019

The following instructions set out how a person can deal with the product bearing the cancelled product label.

### SUPPLY

## Regulatory Update

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A person may supply or cause to be supplied the above product(s) bearing the cancelled label manufactured prior to the date listed in Column E of Table 1, at wholesale and retail level, until 12 months after the date listed in Column 1 of Table E. 12 months after the date listed in Column E of Table 1, it will be an offence against the Agvet Codes to have possession or custody of the product(s) bearing the cancelled label with the intention to supply, or to supply the product.

### USE

A person may continue to use the product(s) bearing the cancelled label according to its label instructions until 12 months after the date listed in Column E of Table 1. Any person who possesses, has custody of, uses, or otherwise deals with the listed product bearing the cancelled label in accordance with the above instructions is taken to have been issued with a permit under the Agvet Codes to so possess, have custody of, use or otherwise deal with the product(s) bearing the cancelled label until 12 months after the date listed in Column E of Table 1. The supply and use of the product(s) bearing the cancelled label must be in accordance with the conditions of registration or approval, including any conditions relating to the shelf life or expiry date. It is an offence to possess, have custody of, use, or deal with the product(s) bearing the cancelled label listed in the table in a manner that contravenes the above instructions.

APVMA Gazette, 30 July 2019

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

### **New fees and charges from 1 August 2019**

2019-08-02

The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has published details of the new fees that now apply. New fees apply for all registration levels, new chemical assessments, certificate and permit applications, Inventory services and Prior Informed Consent (Rotterdam Convention) applications. Further information is available at the NICNAS website.

NICNAS, 30 July 2019

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

**The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has published details of the new fees that now apply.**

## Regulatory Update

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### Database of section 19A approvals to import and supply medicines to address medicine shortages

2019-08-02

The Therapeutic Goods Administration (TGA) have announced that the Section 19A database has been updated to include new approvals. This database provides information on medicines not on the Australian Register of Therapeutic Goods (ARTG) that are approved for import and supply in Australia because:

- there is a shortage of a medicine registered in Australia; and
- the medicine is needed in the interest of public health.

The database holds information on approvals current on or after 21 February 2018. Consumers can use medicines accessed under section 19A until the medicines expire. The 'Import and supply approved until' date applies to the approval holder importing and supplying the medicine. The [Medicines Shortages Information Initiative](#) lists medicines that are unavailable or in short supply. If you are having difficulty obtaining a treatment that has been prescribed to you, talk to your doctor or pharmacist. Section 19A approvals are granted for a specified period, which usually coincides with the period that the medicine on the ARTG is unavailable or in short supply. However, approval may lapse early if:

- a decision has been made about whether or not to register the medicine in Australia;
- any of the specific criteria for approval no longer apply (for example, the registered medicine is no longer in short supply);
- a condition of approval has been breached.

Section 19A approvals are subject to a number of conditions specified by the TGA including the following (though additional conditions can be imposed where the circumstances warrant it):

- the approval applies only to the medicine specified in the approval;
- the approval is only for importation into and supply within Australia;
- the medicine is sourced from manufacturers with acceptable evidence of Good Manufacturing Practice (GMP);
- a letter to health professionals who will be prescribing the medicine is usually required
- the goods must be labelled with the name and address of the approval holder to ensure that adverse events can be reported.

**The Therapeutic Goods Administration (TGA) have announced that the Section 19A database has been updated to include new approvals.**

## Regulatory Update

CHEMWATCH

The database can be found at: <https://www.tga.gov.au/ws-s19a-index>

TGA, 24 July 2019

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

### China's Hainan Province Plans to Bid Farewell to Single-use Non-biodegradable Plastics

2019-08-02

On 23 July 2019, Hainan Province issued a Notice to seek public feedback on the *Inventory of Single-use Non-biodegradable Plastics Prohibited from Production, Sale and Use (Batch 1)*. The Inventory comprises two parts, i.e. single-use films and bags which contain non-biodegradable polymer materials like PE, PP, PS, PVC, EVA and PET, and single-use tableware containing non-biodegradable polymer materials. The Inventory is developed in accordance with the *Program of Hainan Province for Comprehensively Prohibiting Production, Sale and Use of Single-use Non-biodegradable Plastics*, which was introduced earlier this year in a bid to ease pollution. According to preliminary statistics, Hainan uses around 120,000 tonnes of single-use non-biodegradable plastics each year, of which 65,000 tonnes are produced within its jurisdiction. The Program makes a commitment that the province will impose a total ban on production, sale and use of single-use non-biodegradable plastic bags and tableware by the end of 2020, and prohibit production, sale and use of all plastics included in the trial Inventory by the end of 2025. Hainan is not the first region in China to officially vow to phase out single-use non-biodegradable plastics. Following the introduction of the *Notice of the State Council on Restricting Production, Sale and Use of Plastic Bags* in 2007, several regional governments have gone further to enhance local regulation in this regard to shrink the plastics problem. Earlier in 2014, Jilin Province published the *Regulations of Jilin Province on Prohibiting Production, Sale and Provision of Single-use Non-biodegradable Plastic Bags and Tableware*, proposing a plastic ban which is just narrower than that of Hainan. In September 2015, Jiangsu Province passed the *Regulations of Jiangsu Province on Promotion of Circular Economy*, stating that retail establishments must not sell non-degradable plastic bags or provide such bags free of charge starting from 1 January 2017. Due to existing and impending government regulations against single-use plastics, many Chinese businesses are ramping up biodegradable plastic production. Moreover, after China initiated its foreign waste ban, the plastic recycling sector is gaining stronger support from the authorities. It can be expected

**On 23 July 2019, Hainan Province issued a Notice to seek public feedback on the Inventory of Single-use Non-biodegradable Plastics Prohibited from Production, Sale and Use (Batch 1).**

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that the years to come may witness a dramatic change in China's plastics industry. Further information is available at:

- [Hainan's Inventory of Single-use Non-biodegradable Plastics Prohibited from Production, Sale and Use \(Batch1\)](#)
- [Program of Hainan Province for Comprehensively Prohibiting Production, Sale and Use of Single-use Non-biodegradable Plastics](#)
- [Notice of the State Council on Restricting Production, Sale and Use of Plastic Bags](#)
- [Regulations of Jilin Province on Prohibiting Production, Sale and Provision of Single-use Non-biodegradable Plastic Bags and Tableware](#)
- [Regulations of Jiangsu Province on Promotion of Circular Economy](#)

Chemlinked, 26 July 2019

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

### South Korea Launches K-REACH Late Pre-registration

2019-08-02

South Korea's pre-registration of existing chemical substances ended on 30 June 2019. Registrants that missed the pre-registration deadline, are in principle ineligible for follow-up manufacture or import in South Korea. However, the IT system for pre-registration is still open and technically speaking still accepting applications. According to the authority, the current system should only be used for late pre-registration. Although the data requirements in the system are the same as the pre-registration, the registrants should self-check in advance if they fit the eligibility criteria for late pre-registration. Late pre-registration is only applicable to existing chemical substances manufactured or imported over 1 tonne per year for the first time after 30 June 2019 and before the corresponding phase-in registration deadline. Average annual manufacture/import volume for the previous three-years (2016, 2017, 2018) should be below 1 tonne per year. Relevant materials, e.g. customs evidentiary documentation, contract, etc.) shall be retained to substantiate eligibility and for later review by the authority. Enterprises that meet the criteria for pre-registration but missed the deadline, can still try to submit their data since no additional proof is required in the IT system to define whether it is an application for pre-registration or late pre-registration at current stage. But there is a possibility that they will face punishment in the future.

Chemlinked, 26 July 2019

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

**South Korea's pre-registration of existing chemical substances ended on 30 June 2019.**

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### AMERICA

#### **EPA funding to Maryland will support regulation of pesticides use, worker protections**

2019-08-02

The United States Environmental Protection Agency (EPA) announced a \$359,870 Pesticides Performance Partnership grant to the Maryland Department of Agriculture (MDA). The funding will support the state's enforcement of pesticide regulations, implement programs for certifying and training pesticide applicators, and improving agricultural worker protections. "This funding strengthens the partnership and collaboration between Maryland and EPA in ensuring the safe use of pesticides, protecting the health of workers who are integral to the state's agricultural economy, and improving the environment," said EPA Regional Administrator Cosmo Servidio. MDA will also use the funding to implement programs to protect endangered species, prevent pesticide contamination of ground and surface water, and implement pesticide container and containment regulations. For more information about the regulation of pesticides <https://www.epa.gov/regulatory-information-topic/regulatory-information-topic-pesticides>

U.S EPA, 24 July 2019

<http://www.epa.gov>

#### **EPA Registers Long-Term Uses for Sulfoxaflor**

2019-08-02

On 12 July 2019, the United States Environmental Protection Agency (EPA) announced in a Decision Memorandum that it has registered new uses and restored previously registered uses for sulfoxaflor. EPA has approved the use of sulfoxaflor on alfalfa, corn, cacao, grains (millet, oats), pineapple, sorghum, teff, teosinte, tree plantations, and restored the uses on citrus cotton, cucurbits (squash, cucumbers, watermelons, some gourds), soybeans, and strawberries. EPA states that substantial data show that when sulfoxaflor is used according to the label, it poses no significant risk to human health and poses a lower risk to non-target wildlife, including pollinators, than other registered alternative products. EPA's registration decision is available at [www.regulations.gov](http://www.regulations.gov) in Docket Number EPA-HQ-OPP-2010-0889-0570. EPA's decision follows an opinion issued on 10 September 2015, by the U.S. Court of Appeals for the Ninth Circuit vacating EPA's 2013 unconditional registration for the pesticide

**The United States Environmental Protection Agency (EPA) announced a \$359,870 Pesticides Performance Partnership grant to the Maryland Department of Agriculture (MDA).**

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sulfoxaflor, and remanding the matter to EPA to obtain further studies and data regarding the effects of sulfoxaflor on bees and bee colonies. That decision is discussed in our blog item available here. In response to that decision, EPA also issued a cancellation order that included provisions for the disposition of existing stocks of sulfoxaflor products. After the decision of the Ninth Circuit Court of Appeals, EPA re-evaluated the data and on 14 October 2016, approved sulfoxaflor end-use registrations for limited uses that did not include crops that attract bees. EPA also has been granting emergency exemptions for sulfoxaflor since 2012, with the most recent emergency exemptions granted on 17 June 2019, for the use of sulfoxaflor to control tarnished plant bugs on cotton in 12 states, and to control sugarcane aphids on sorghum in 14 states. In the 12 July 2019, decision adding new uses, restoring previous uses, and removing certain application restrictions, EPA states an unconditional registration under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 3(c)(5) for new uses of sulfoxaflor is backed by substantial data, including numerous pollinator studies submitted by the registrant, Dow AgroSciences (DAS). With specific regard to sulfoxaflor's impact on bees, EPA states the following: Since the vacatur in 2015, DAS has submitted numerous additional pollinator studies. The pollinator data requirements listed in 40 CFR 158.630 have all been submitted or waived. EPA's risk assessment process for pollinators has evolved since those data requirements were promulgated and now EPA generally assesses risks to bees using a three-tier process based on a more robust data set as described in two guidance documents: "Guidance for Assessing the Risks of Pesticides to Bees" (USEPA 2014) and "Guidance on Exposure and Effects Testing for Assessing Risks to Bees" (USEPA 2016). For sulfoxaflor, all Tier I data have been submitted. Three additional Tier II semi-field (tunnel) studies and two colony feeding studies have been submitted. Pollen and nectar residue data have been submitted for multiple crops. The submitted data covers all of the requested use patterns. For those crops that did not have data specific to pollen and nectar residues, data was extrapolated as appropriate from other crops. All regulatory data requirements for assessing pollinators have now been addressed and the EPA has adequate data to demonstrate that there will be no unreasonable adverse effects to honey bees resulting from the expanded registration of sulfoxaflor. EPA's decision also removes previously imposed application restrictions:

- Removed the prohibition of use on crops grown for seed because EPA believes pollinator protection restrictions, including low use rates,

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will be in place regardless of whether the crop is grown for seed or for commodity harvest;

- Removed the restriction to post-bloom application for bee-attractive crops only when there is low risk or limited potential for exposure to bees;
- Removed the 12-foot buffer requirement because EPA believes the spray drift mitigation requirements on labels are adequate to limit drift; and
- Removed the 2016 restriction against tank mixing because EPA states data show that there is no additional risk when sulfoxaflor is tank mixed with other compounds.

EPA's decision includes the following crop specific restrictions:

- Citrus: Only one application is allowed per year between 3 days before bloom and until after petal fall.
- Ornamentals: Only one application is allowed during bloom, and that bloom must not exceed a rate of 0.071 lb ai/acre.
- Pome Fruit, Stone Fruit, Tree Nuts and Pistachio: No application is allowed any time between 3 days prior to bloom and until after petal fall.
- Small Fruit Vine Climbing and Low Growing Berry, Tree Plantations: No application is allowed any time between 3 days prior to bloom and until after petal fall.

EPA found that the FIFRA standard for registration is met for the registration of sulfoxaflor on the uses approved, and that the benefits of these uses outweigh the risks, but also set specific label requirements including restrictions to minimise potential exposure to bees:

- Worker Protection: "Applicators and other handlers must wear: Long-sleeved shirt and long pants, shoes plus socks, protective eyewear" and "Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of" 24 hours (for Transform WG label) and 12 hours (for Closer SC label).
- Environmental Hazards Statement: "This product is highly toxic to bees and other pollinating insects exposed to direct treatment or to residues in/on blooming crops or weeds. Protect pollinating insects by following label directions intended to minimise drift and reduce pesticide risk to these organisms."
- The RT25 (how long foliar residues of sulfoxaflor exhibit toxicity to honey bees): "The RT25 for this product is less than or equal to 3 hours."

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- Directions for Use: "Notifying known beekeepers within 1 mile of the treatment area 48 hours before the product is applied will allow them to take additional steps to protect their bees. Also, limiting application to times when managed bees and native pollinators are least active, e.g. 2 hours prior to sunset or when the temperature is below 50°F at the site of application will minimize risk to bees."

### Commentary

This new decision by EPA may finally be the culmination of a long and convoluted process to register sulfoxaflor. The litigation that resulted in vacatur of the initial registrations began in 2013. At the time the Ninth Circuit issued its decision in 2015, vacatur was viewed by many observers as a novel and radical response to an EPA decision to register a new pesticide. Since that time, registrants and users of newly approved active ingredients have encountered more aggressive litigation in which vacatur is often cited as a possible remedy. This has created more uncertainty and concern about product availability, even after EPA approves an eagerly anticipated new product to meet a pressing pest control need. In the case of sulfoxaflor, EPA has clearly determined that the data submitted by DAS demonstrate that any risks to pollinators presented by sulfoxaflor will be less than the risks presented by currently registered insecticides sulfoxaflor is likely to replace. This determination concerning relative risk based on review of additional data should address the deficiencies in the EPA rationale found by the Court when it vacated the 2013 sulfoxaflor registrations. Interestingly, the current EPA decision may raise a similar issue concerning the sufficiency of EPA's rationale concerning the effects of sulfoxaflor on endangered species. EPA states the following in its Decision Memorandum:

### Endangered Species

EPA has not made an effects determination for sulfoxaflor. EPA is currently focusing most of its resources for assessing impacts to listed species on its registration review program for currently registered pesticides. EPA believes that, as a general matter, older pesticides present a greater degree of risk to listed species than most new chemistries, including sulfoxaflor, and that it is therefore environmentally preferable in most circumstances for EPA to assess the impacts of existing pesticides sooner in the process than newer pesticides that are designed to compete with more risky alternatives. EPA believes that is especially true for sulfoxaflor, where the alternatives include organophosphates, neonicotinoids and pyrethroids. As a result, EPA does not believe the environment or the public would be best served by delaying the registration of new uses for sulfoxaflor to

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complete consultation. Focusing the limited resources of EPA, the Fish and Wildlife Service and the National Marine Fisheries Service on completing a consultation on the effects of sulfoxaflor would by necessity come at the expense of putting more resources into evaluating – and consequently regulating, where appropriate – what EPA believes to be more toxic compounds, that, among other things, pose greater risk, to endangered species than does sulfoxaflor. While it is clearly sensible for EPA and the Services to prioritize the limited resources available to make and to consult concerning effects determinations for endangered species by addressing existing pesticide classes that are likely to present the greatest risk before products with new chemistries that are intended to be more selective, it remains to be seen whether reviewing courts will be inclined to accept this type of rationale. In particular, it will be interesting to see whether the sufficiency of this approach to endangered species determinations becomes an issue in any future litigation regarding sulfoxaflor or other newly registered active ingredients.

National Law Review, 27 July 2019

<http://www.natlawreview.com>

### **Cal/OSHA Standards Board Adopts New Emergency Regulation to Protect Outdoor Workers from Wildfire Smoke**

2019-08-02

California's Department of Industrial Relations' Occupational Health & Safety Standards Board adopted an emergency regulation to protect workers from hazards associated with wildfire smoke. The regulation is expected to go into effect in early August. The emergency regulation will be effective for one year and applies to workplaces where the current Air Quality Index (AQI) for airborne particulate matter is 151 or greater, and where employers should reasonably anticipate that employees could be exposed to wildfire smoke. Under the new regulation, employers must take the following steps to protect workers, according to a [news release](#):

- Identify harmful exposure to airborne particulate matter from wildfire smoke before each shift and periodically thereafter by checking the AQI for PM 2.5 in regions where workers are located.
- Reduce harmful exposure to wildfire smoke if feasible, for example, by relocating work to an enclosed building with filtered air or to an outdoor location where the AQI for PM 2.5 is 150 or lower.

**California's Department of Industrial Relations' Occupational Health & Safety Standards Board adopted an emergency regulation to protect workers from hazards associated with wildfire smoke.**

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If employers cannot reduce workers' harmful exposure to wildfire smoke so that the AQI for PM 2.5 is 150 or lower, they must provide:

- Respirators such as N95 masks to all employees for voluntary use.
- Training on the new regulation, the health effects of wildfire smoke, and the safe use and maintenance of respirators.

The Standards Board has also requested that Cal/OSHA conduct a follow-up comprehensive review of the regulation with an advisory committee using the regular rule making process in order to adopt permanent regulations. The emergency regulation will remain in effect during that process.

Occupational Health & Safety News, 24 July 2019

<http://www.ohsonline.com>

### Notification Requirements for Methylene Chloride Paint Removers Will Take Effect 26 August

2019-08-02

In the 27 March 2019, *Federal Register*, the U.S. Environmental Protection Agency (EPA) issued its final regulatory rulemaking that prohibits the manufacture (including import), processing, and distribution of methylene chloride for consumer paint and coating removal. 84 Fed. Reg. 11420 starting on 26 August 2019, which is 90 days after the effective date of the final rule, a company that manufactures, processes, or distributes in commerce methylene chloride is required to provide notification to downstream users of the consumer use paint remover restrictions via Safety Data Sheets (SDS). This notification requirement applies to all manufacturers, processors, or distributors of methylene chloride and is not limited only to those companies engaged with paint remover products. The EPA rulemaking provides the following specific text that must be included in the SDS:

- SDS Section 1.(c): "This chemical/product is not and cannot be distributed in commerce (as defined in TSCA section 3(5)) or processed (as defined in TSCA section 3(13)) for consumer paint or coating removal."
- SDS Section 15: "This chemical/product is not and cannot be distributed in commerce (as defined in TSCA section 3(5)) or processed (as defined in TSCA section 3(13)) for consumer paint or coating removal."

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More information is available at: "[Communication and Recordkeeping Requirements Related to EPA Ban on Consumer Use Paint Removers Containing Methylene Chloride Go in Effect on August 26, 2019.](#)"

National Law Review, 25 July 2019

<http://www.natlawreview.com>

### EUROPE

#### U.K. Announces Open Consultation Call For Evidence To Develop Standards For Compostable, And Biobased Plastics

2019-08-02

On 22 July 2019, the United Kingdom (U.K.) Department for Business, Energy and Industrial Strategy and Department for Environment, Food and Rural Affairs announced an open consultation for the development of standards for biodegradable, compostable, and biobased plastics. The consultation welcomes views from any interested parties to identify gaps and provide expert advice on:

- The overall sustainability of biobased and biodegradable plastic products in comparison with other materials;
- Existing relevant plastic degradation standards and how they are promoted without adverse environmental effects; and
- The design and implementation of standards for biodegradable plastics to ensure they are fully biodegradable in a reasonable timeframe.

With a focus on obtaining robust evidence backed by scientific theory, direct practical experience, or analysis, rather than opinion, views from environmental scientists, bioscience or biotechnology practitioners, standards authorities, manufacturers, waste processors, consumers, producers, and certification authority experts are welcome. Consultation responses must be submitted by 14 October 2019. For further details, the call for evidence can be accessed [here](#).

National Law Review, 27 July 2019

<http://www.natlawreview.com>

**On 22 July 2019, the United Kingdom (U.K.) Department for Business, Energy and Industrial Strategy and Department for Environment, Food and Rural Affairs announced an open consultation for the development of standards for biodegradable, compostable, and biobased plastics.**

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### Sugars opinion rescheduled to assess wealth of data

2019-08-02

The European Food Safety Authority (EFSA) has updated the timeline for its scientific advice on dietary sugars due to the high volume of datasets and studies to be collected, analysed and assessed. EFSA has agreed a deadline extension with the five European countries that requested this scientific advice and aims to have a draft ready for public consultation in late 2020, with a view to finalising the work in 2021. EFSA was asked to provide scientific advice on added sugars in 2017 and developed a scientific protocol – a detailed plan for the conduct of the assessment. Following a public consultation on the protocol in 2018, the breadth of studies to include in the assessment was expanded. Significant progress has been made, but numerous additional studies require assessing and some data owners are being contacted to request additional information. EFSA's nutrition experts will attempt to set a tolerable upper intake level for total/added/free sugars if the available data allow it. Otherwise, other values could be used to characterise the risk. This will help national authorities to establish recommendations on the consumption of dietary sugars and to plan food-based dietary guidelines. Mandate for a scientific opinion on the Tolerable Upper Intake Level of dietary sugars

EFSA, 19 July 2019

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

### NIOSH Report on Occupational Exposure Banding Process for Chemical Management Addresses Nanofibers and Nanoparticles

2019-08-02

On 10 July 2019, the National Institute for Occupational Safety and Health (NIOSH) announced the availability of a new Technical Report, The NIOSH Occupational Exposure Banding Process for Chemical Risk Management. NIOSH describes occupational exposure banding as “a voluntary process that assigns each chemical to a category based on its toxicity and any negative health outcomes associated with exposure to that chemical.” The Technical Report “provides a process with easy procedures and clear rules for assignment and can be used in a broad spectrum of workplace settings.” Section 3.14, “Consideration of Special Categories of Aerosols,” includes recommendations for liquid aerosols; fibres, including nanofibers; and nanoparticles:

**The European Food Safety Authority (EFSA) has updated the timeline for its scientific advice on dietary sugars due to the high volume of datasets and studies to be collected, analysed and assessed.**

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- **Fibres:** The Report notes that fibres and other high-aspect-ratio particles “have unique aerodynamic features that are dependent on their geometry (dimensions) and that influence their deposition in the respiratory tract.” In addition, the physical shape and size of fibres can directly influence their toxicological properties and the nature of their interactions with target cells. The Report states: “These complexities require using a Tier 3 assessment for fibres, and the [occupational exposure band (OEB)] Tier 1 and Tier 2 criteria are not recommended. Some hazard banding frameworks for nanomaterials recommend assigning the most stringent band for bio-persistent, rigid nanofibres.”
- **Nanoscale solid-phase particles:** The Report describes empirical data and mechanistic hypotheses that have been used to support application of the hazard banding procedures within control banding schemes for engineered nanoparticles (*g.*, as applied in various national standards). Using the same rationale, NIOSH recommends that the occupational exposure banding process be modified as follows when applied to nanoparticles:
  - **Poorly-soluble nanoscale particles:** If the toxicity data include no observed adverse effect levels (NOAEL) that were developed specifically for the nanoscale form of the chemical substance, then the NIOSH occupational exposure banding process can be used with no modifications;
  - If data are available for only the microscale form of the chemical substance, then the band assignment should be shifted to the next more stringent band, on the assumption that poorly soluble nanoscale substances will likely be more toxic than their microscale equivalents (*g.*, by an order of magnitude). The Report notes that some other banding schemes also recommend a more stringent band (to reduce exposure by an order of magnitude) when data are available on only the microscale form of the substance; and
- **Soluble nanoscale particles:** The Report states that data support an association between increased total particle surface area and increased toxicity for poorly soluble nanoscale particles. As particle solubility increases, there may be less need for the OEB to account for enhanced toxicity due to the nanoparticle-specific characteristics. The Report notes that in the French Agency for Food, Environmental and Occupational Health and Safety (ANSES) and International Organisation for Standardisation (ISO) control banding schemes, soluble particles are addressed with regard to the toxicity of the solute, without consideration of nanoparticle-specific toxicity. Given the uncertainties in the relationship of solubility to particle

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toxicity, however, NIOSH “recommends that in the absence of data to the contrary, all nanoscale particles should be treated in the same manner without regard to solubility.” If data are available only for the microscale form of the agent, NIOSH recommends shifting the banding assignment to the next more stringent band.

The Report cautions that because the toxicity of nanoscale fibres and nanoscale tubes may differ substantially from other forms of the compound, the occupational exposure banding process described “may not fully and accurately capture the toxicity of these chemical substances.” NIOSH states that Tier 1 and Tier 2 should not be used and instead a Tier 3 assessment is required as described for other fibres. According to the Report, NIOSH is currently evaluating the state of the science for deriving occupational exposure limits (OEL) and OEBs for nanomaterials and is also examining the process and data for developing hazard categories for nanomaterials based on biological mode of action and physical-chemical properties.

Nano & Other Emerging Technologies Blog, 24 July 2019

<http://nanotech.lawbc.com>

### **BPC issues opinion on 1 active substance approval**

2019-08-02

The Biocidal Products Committee has issued an opinion on active substance approval for the following substance: 2,2-Dibromo-2-cyanoacetamide (DBNPA) Product type 4 (food and feed area)

Yorda's Hive, 29 July 2019

<https://www.yordasgroup.com/hive/news>

### **Substances added to Annex II of Germany Betäubungsmittelgesetz (BtMG) Narcotics Act**

2019-08-02

On 12 July 2019, the Betäubungsmittelgesetz (BtMG) Narcotics Act was updated. The following substances were added to Annex II:

- Cumyl 4CN Binaca
- Cumyl-5F-PeGaClone
- Cyclopropylfentanyl
- 4-fluoroisobutyrfentanyl

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- Methoxyacetylfentanyl
- Ocfentanil
- Tetrahydrofuranylfentanyl
- 2-(2,4-dichlorophenyl)-N-[2-(dimethylamino)cyclohexyl]-N-methylacetamide

Yorda's Hive, 25 July 2019

<https://www.yordasgroup.com/hive/news>

## REACH Update

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### Advice on how to comply with NMP restriction

2019-08-02

A new guideline is available for industrial users of 1-methyl-2-pyrrolidone (NMP) to help them comply with the substance's restriction requirements. The guideline is needed because this is the first restriction of its kind that is based on Derived no Effect Levels (DNEL). NMP is used as a solvent or surface deposition medium during manufacturing and is therefore a critical substance for various industries producing batteries, semiconductors, fibres, pharmaceuticals and wire coatings. NMP users in these sectors will have to comply with the restriction by 9 May 2020. For NMP used in wire coatings, the deadline is 9 May 2024. In close cooperation with stakeholders, ECHA has prepared the guideline to help companies, including SMEs, to manage the risks when using NMP at industrial sites. NMP is a reproductive toxicant (may damage the unborn child), it causes serious eye and skin irritation and it may cause respiratory irritation. Several consultations and round table workshops have been organised to identify good practice and find illustrative examples on how users of NMP can control exposure to NMP and comply with the restriction. The general approach described in this guideline can also be applied to other aprotic solvents similar to NMP, such as DMF and DMAC, if similar REACH restrictions are introduced for other aprotic solvents at a later stage. The guideline will be published in 23 EU languages. The translations will be available in autumn 2019. Further information is available at:

- [How to comply with REACH Restriction 71, guideline for users of NMP \(1-methyl-2-pyrrolidone\)](#)
- [Restriction](#)
- You can express your views on the NMP Guideline [here](#).

ECHA, 17 July 2019

<http://echa.europa.eu>

### Restriction proposal for intentionally added microplastics in the EU – update

2019-08-02

The European Chemicals Agency (ECHA) nor the European Commission are proposing to close down artificial turf pitches. Several media have recently reported that proposals to restrict the intentional use of microplastics under the REACH regulation will result in the closure of thousands

**A new guideline is available for industrial users of 1-methyl-2-pyrrolidone (NMP) to help them comply with the substance's restriction requirements.**

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of artificial turf pitches across the EU, with profound implications for sports clubs and the users of these facilities. The granular infill material that is typically used in artificial turf pitches is understood to be an 'intentionally-added microplastic', but neither ECHA nor the European Commission are proposing that these pitches should be closed. The European Commission has requested ECHA in 2018 to prepare a proposal for restriction of intentionally added microplastics in the framework of the REACH regulation. This is done in the wider context of the EU plastics strategy. In March of this year, ECHA has published their proposal and opened a public consultation that will be open until 20 September 2019. The restrictions proposal addresses a wide range of uses of intentionally added microplastics. In the framework of the public consultation, further information has been requested on the use of granular infill material in synthetic turf in order to assess the implications and the possible need for a derogation. As these pitches are a substantial source of microplastics to the environment (estimated loss of between 18 000 and 72 000 tonnes of microplastics per year in the EU), ECHA is gathering information on the socio-economic impacts (costs and benefits) of phasing out microplastic infill material. Socio-economic costs could arise, for example, from the need to use alternative infill material on existing pitches such as cork, coconut fibre, olive cores or other alternative materials. ECHA is also gathering information on the effectiveness of technical measures to prevent the loss of infill material from artificial turf pitches into the environment. ECHA's scientific committees for Risk Assessment (RAC) and Socio-economic Analysis (SEAC) will consider the information received as they consider their opinions on the restriction proposal, which will include their evaluation of the costs and benefits of the proposal and the need for transitional arrangements. The committees' opinions are planned to be finalised in early 2020, after which they will be sent to the Commission for decision-making. All factors, including the important role that sport fields play in promoting physical exercise, health and social inclusion, are taken into account in the decision-making process. ECHA's scientific committees also recently adopted opinions on a proposal to further reduce the maximum permissible content of certain polycyclic aromatic hydrocarbons (PAHs) in infill material, because of the potential risk to human health. This proposal is not thought to have significant impacts on existing fields as the new limit is only applicable to new infill material and can be readily achieved. Further information is available at:

- [Public consultation – give comments](#)

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- Proposal for a restriction of eight polycyclic aromatic hydrocarbons (PAHs) in granules and mulches used as infill material in synthetic turf pitches and in loose form on playgrounds and in sport applications

ECHA, 25 July 2019

<http://echa.europa.eu>

### Options to address non-extractable residues (NER) in regulatory persistence assessment

2019-08-02

This background note informs of the approach development concerning NER, and about general possibilities to refine the persistence assessment by the quantification and characterisation of NER. Options described are based on recent scientific developments summarised in a discussion paper - also published on the ECHA website in June 2018. ECHA guidance update is foreseen to include more information on the available methodologies. Further information is available at:

- Addressing non-extractable residues in regulatory persistence assessment
- Discussion paper
- Managing PBT substances under REACH

ECHA News, 31 July 2019

<http://echa.europa.eu>

### Authorisations granted for uses of four substances

2019-08-02

The European Commission has granted authorisations for six uses. Review periods expire on the dates given in brackets:

- for two uses of ammonium dichromate (EC 232-143-1, CAS 7789-09-5) - BAE Systems (Operations) Limited; Qioptiq Ltd and Display Technologies Limited (21 September 2029; 21 September 2021);
- for a use of chromium trioxide (EC 215-607-8, CAS 1333-82-0) - ZF Friedrichshafen AG (10 July 2031);
- for two uses of pentazinc chromate octahydroxide (EC 256-418-0, CAS 49663-84-5) - Indestructible Paint Ltd (22 January 2031); and
- for a use of bis(2-methoxyethyl) ether (diglyme) (EC 203-924-4, CAS 111-96-6) - PMC ISO-CHEM (22 August 2024).

**The European Commission has granted authorisations for six uses.**

## REACH Update

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Further information is available at: [Official Journal summaries](#)

ECHA News, 31 July 2019

<http://echa.europa.eu>

### Commission public consultation on postponing harmonised rules for poison centre notifications

2019-08-02

The European Commission has launched a public consultation on postponing the compliance date to submit information on hazardous chemical mixtures for consumer use. Companies have to notify national poison centres to facilitate an adequate emergency health response. The draft regulation proposes to postpone the first compliance date from 1 January 2020 to 1 January 2021. The deadline for the public consultation is 18 August 2019. ECHA will update its web pages and other material accordingly once a formal decision has been made. Further information is available at:

- [Public consultation and draft regulation](#)
- [Poison Centres website](#)

ECHA News, 31 July 2019

<http://echa.europa.eu>

**The European Commission has launched a public consultation on postponing the compliance date to submit information on hazardous chemical mixtures for consumer use.**

## Janet's Corner

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### Black Hole

2019-08-02



## Hazard Alert

CHEMWATCH

### Nickel carbonyl

2019-07-22

Nickel carbonyl is the organonickel compound with the formula  $\text{Ni}(\text{CO})_4$ . [1] It is a volatile, yellow liquid with a musty odour. Nickel carbonyl is flammable and explosive. It is slightly soluble in water, but soluble in other organic solvents. [2] Nickel carbonyl is formed when metallic nickel combines with carbon monoxide. It is considered to be one of the most toxic chemicals used industrially and the magnitude of its morbidity and mortality has been compared to that of hydrogen cyanide. [3]

### USES [2]

Nickel carbonyl is used in refining nickel ore, forming nickel films and coatings, as a catalyst in various chemical reactions, and in glass plating.

### SOURCES OF EMISSION & ROUTES OF EXPOSURE

#### Sources of Emission [2]

- Industry sources: The primary sources of nickel carbonyl are the industries that manufacture it or use it in production, such as nickel mining and refining, the chemical industry, glass and metal plating companies.
- Diffuse sources: Sub-threshold facilities in the industries that use the substance.
- Natural sources: Nickel carbonyl is not expected to be found occurring naturally.
- Transport sources: There are no known sources of mobile emissions of nickel carbonyl.
- Consumer products: There are no known consumer products containing nickel carbonyl.

#### Routes of Exposure [4]

Nickel carbonyl enters the body via:

- inhalation,
- ingestion,
- skin absorption,
- skin and/or eye contact

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### HEALTH EFFECTS

#### Acute Effects [4]

- Initial exposure to nickel carbonyl can cause headache, chest tightness, dizziness, weakness, sweating, cough, nausea and vomiting.
- These may improve, but hours later (12 hours to five days) following a severe exposure, lung (pulmonary) symptoms may appear including fever, pneumonia, respiratory failure, cerebral oedema and death.
- At lower concentrations these vapours cause irritation, congestion, and oedema of the lung.

#### Chronic Effects [5]

- Dermatitis is the most common effect in humans from chronic dermal exposure to nickel. Cases of nickel dermatitis have been reported following occupational and non-occupational exposure, with symptoms of eczema (rash, itching) of the fingers, hands, wrists, and forearms.
- Chronic inhalation exposure to nickel in humans also results in respiratory effects, including a type of asthma specific to nickel, decreased lung function, and bronchitis.

#### Reproductive/Developmental Effects [2]

- Nickel carbonyl may be a teratogen (cause harm to a foetus).

#### Cancer Risk [5]

- Nickel carbonyl has been reported to produce lung tumours in rats exposed via inhalation.
- EPA has classified nickel carbonyl as a Group B2, probable human carcinogen.

### SAFETY [6]

#### First Aid Measures

- Inhalation: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.
- Skin Contact: Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical

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attention, if needed. Thoroughly clean and dry contaminated clothing and shoes before reuse.

- Eye Contact: Flush eyes with plenty of water for at least 15 minutes. Then get immediate medical attention.
- Ingestion: If vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.
- Antidote: dimercaprol/oil, intramuscular.
- Note to Physician: For inhalation, consider oxygen. For ingestion, consider gastric lavage.

### Fire Hazard Information

- Nickel carbonyl poses a severe fire and explosion hazard.
- As the vapour is heavier than air, it may ignite at distant ignition sources and flash back.
- Vapour/air mixtures are explosive.
- Alcohol-resistant foam, carbon dioxide, regular dry chemical and water should be used to extinguish a nickel carbonyl fire.
- For large fires, use alcohol-resistant foam or flood with fine water spray.
- Thermal decomposition or combustion products of nickel carbonyl include oxides of carbon, oxides of nickel.

### Exposure Controls & Personal Protection

#### Engineering Controls

- Ventilation: Ventilation equipment should be explosion-resistant if explosive concentrations of material are present.
- Provide local exhaust or process enclosure ventilation system. Ensure compliance with applicable exposure limits.

#### Personal Protective Equipment

The following personal protective equipment is recommended when handling nickel carbonyl:

- Eye protection: Wear splash resistant safety goggles with a face-shield. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.
- Clothing: Wear appropriate chemical resistant clothing.
- Gloves: Wear appropriate chemical resistant gloves.

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- Respirator: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.

### At any detectable concentration

- Any self-contained breathing apparatus that has a full-face piece and is operated in a pressure-demand or other positive-pressure mode.
- Any supplied-air respirator with a full-face piece that is operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure demand or other positive-pressure mode.

### Escape

- Any air-purifying full-face piece respirator (gas mask) with a chin-style, front-mounted or back-mounted canister providing protection against the compound of concern.
- Any appropriate escape-type, self-contained breathing apparatus.

### For Unknown Concentrations or Immediately Dangerous to Life or Health

- Any supplied-air respirator with a full-face piece that is operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure demand or other positive-pressure mode.
- Any self-contained breathing apparatus that has a full-face piece and is operated in a pressure-demand or other positive-pressure mode.

## REGULATION

### United States [7]

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

- General Industry: 29 CFR 1910.1000 Z-1 Table -- 0.001 ppm, 0.007 mg/m<sup>3</sup> TWA (PEL listed under Nickel carbonyl (as Ni))
- Construction Industry: 29 CFR 1926.55 Appendix A -- 0.001 ppm, 0.007 mg/m<sup>3</sup> TWA (PEL listed under Nickel carbonyl (as Ni))
- Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 0.001 ppm, 0.007 mg/m<sup>3</sup> TWA (PEL listed under Nickel carbonyl (as Ni))

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for nickel carbonyl of 0.05 ppm, 0.12 mg/m<sup>3</sup> TWA (TLV listed under Nickel carbonyl, as Ni)

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NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for nickel carbonyl of 0.001 ppm, 0.007 mg/m<sup>3</sup> TWA; Appendix A - NIOSH Potential Occupational Carcinogens

### Australia [4]

Safe Work Australia: Safe Work Australia has set an eight hour time weighted average (TWA) exposure limit of 0.05 parts per million for nickel carbonyl.

Australian Drinking Water Guidelines (NHMRC and ARMCANZ, 1996):

For nickel: Maximum of 0.02 mg/L (i.e. 0.00002 g/L).

### REFERENCES

1. [https://en.wikipedia.org/wiki/Nickel\\_tetracarbonyl](https://en.wikipedia.org/wiki/Nickel_tetracarbonyl)
2. <http://www.npi.gov.au/resource/nickel-carbonyl>
3. <http://www.ncbi.nlm.nih.gov/pubmed/8383493>
4. <http://www.cdc.gov/niosh/npg/npgd0444.html>
5. <http://www.epa.gov/ttn/atw/hlthef/nickel.html>
6. <https://www.mathesongas.com/pdfs/msds/MAT16290.pdf>
7. [https://www.osha.gov/dts/chemicalsampling/data/CH\\_256150.html](https://www.osha.gov/dts/chemicalsampling/data/CH_256150.html)

## Gossip

## CHEMWATCH

### Scientists create predictive model for hydrogen-nanovoid interaction in metals

2019-07-15

A five-year collaborative study by Chinese and Canadian scientists has produced a theoretical model via computer simulation to predict properties of hydrogen nanobubbles in metal. The international team was composed of Chinese scientists from the Institute of Solid State Physics of the Hefei Institute of Physical Science along with their Canadian partners from McGill University. The results will be published in Nature Materials on July 15. The researchers believe their study may enable quantitative understanding and evaluation of hydrogen-induced damage in hydrogen-rich environments such as fusion reactor cores. Hydrogen, the most abundant element in the known universe, is a highly anticipated fuel for fusion reactions and thus an important focus of study. In certain hydrogen-enriched environments, e.g., tungsten armour in the core of a fusion reactor, metallic material may be seriously and irreparably damaged by extensive exposure to hydrogen. Being the smallest element, hydrogen can easily penetrate metal surfaces through gaps between metal atoms. These hydrogen atoms can be readily trapped inside nanoscale voids ("nanovoids") in metals created either during manufacturing or by neutron irradiation in the fusion reactor. These nanobubbles get bigger and bigger under internal hydrogen pressure and finally lead to metal failure. Not surprisingly, the interplay between hydrogen and nanovoids that promote the formation and growth of bubbles is considered the key to such failure. Yet, the basic properties of hydrogen nanobubbles, such as their number and the strength of the hydrogen entrapped in the bubbles, has largely been unknown. Furthermore, available experimental techniques make it practically impossible to directly observe nanoscale hydrogen bubbles. To tackle this problem, the research team proposed instead using computer simulations based on fundamental quantum mechanics. However, the structural complexity of hydrogen nanobubbles made numerical simulation extremely complicated. As a result, the researchers needed five years to produce enough computer simulations to answer their questions. In the end, however, they discovered that hydrogen trapping behaviour in nanovoids - although apparently complicated - actually follows simple rules. First, individual hydrogen atoms are adsorbed, in a mutually exclusive way, by the inner surface of nanovoids with distinct energy levels. Second, after a period of surface adsorption, hydrogen is pushed - due to limited space - to the nanovoid core where molecular hydrogen gas then accumulates. Following these rules, the team created a model that accurately predicts properties of hydrogen nanobubbles and accords well

**A five-year collaborative study by Chinese and Canadian scientists has produced a theoretical model via computer simulation to predict properties of hydrogen nanobubbles in metal.**

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with recent experimental observations. Just as hydrogen fills nanovoids in metals, this research fills a long-standing void in understanding how hydrogen nanobubbles form in metals. The model provides a powerful tool for evaluating hydrogen-induced damage in fusion reactors, thus paving the way for harvesting fusion energy in the future.

EurekaAlert, 15 July 2019

<http://www.eurekaalert.org>

### Using building materials to monitor for high enriched uranium

2019-07-24

A new paper details how small samples of ubiquitous building materials, such as tile or brick, can be used to test whether a facility has ever stored high enriched uranium (HEU), which can be used to create nuclear weapons. The technique could serve as a valuable forensic tool for national or international efforts related to nuclear non-proliferation and security. "We can now use the housing structure itself as part of any non-proliferation monitoring efforts," says Robert Hayes, an associate professor of nuclear engineering at North Carolina State University and author of the paper. "This work details the theory to test building material samples to differentiate between the forms of uranium used in nuclear power and the HEU that's used to develop nuclear weapons." The technique builds on previous work done by Hayes and his research team. The method requires testing a relatively small core sample of the relevant building material, about the size of your pinkie finger. The testing is done using hardware somewhat similar to that used to assess radiation exposure of dosimeter badges worn by workers in the nuclear power industry. In a sense, a small piece of any wall effectively becomes a dosimeter badge. "Our technique allows us to determine how much radiation a material has been exposed to, in addition to the very types of radiation a material has been exposed to," Hayes says. "Because different radionuclides have different radiation fields, these measurements allow us to determine which nuclear materials were stored near whatever building material we're sampling." While this technique is new, there is already interest in it among the agencies responsible for nuclear monitoring - and Hayes is working to improve the technique further. "We're optimistic that this will be a valuable tool in the non-proliferation monitoring toolbox, but we need to address some existing questions," Hayes says. "For example, the radiation signature will vary depending on where the nuclear material was stored in relation to whatever sample we're testing. If our sample was from brick that was right

**A new paper details how small samples of ubiquitous building materials, such as tile or brick, can be used to test whether a facility has ever stored high enriched uranium (HEU), which can be used to create nuclear weapons.**

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under a uranium storage container, the signature will be different than if the container was located 20 feet away, horizontally. Theoretically, these properties of the signature would be consistent over any gridded array of the same building material. Sampling such an array would then allow us to reconstruct not only what material was stored at a site, but precisely where it was stored. That's something we're working on now."

EurekaAlert, 15 July 2019

<http://www.eurekaalert.org>

### 30 shades of steel: Scientists develop 'cheat sheet' for the creation of new steels

2019-07-24

Researchers from the National University of Science and Technology "MISIS" developed a database that will help create new grades of steels. This will speed up the process of creating innovative steel grades with specified strength and ductility allow at least 10 times, which will allow manufacturing car bodies of the most complex shapes. The research is published in "Calphad". In modern Materials Science, the basis for the synthesis of new materials is the so-called phase state diagrams, which show the interaction of chemical elements at different temperatures. Based on this information, it is possible to predict the physical properties and microstructure of alloys, and, most importantly, the conditions and technology for their production. By studying and collecting thermodynamic parameters, scientists create a database for use in specialised programs that allow modelling new materials. For the developers it is a kind of "cheat sheet", according to which they develop a technology for creating new materials with the required properties. Today, the production of flexible steels for car bodies, capable of bending into the most complex shapes, but at the same time withstands the load on impact, is very topical for the industry. It is known that the strength and ductility of steel can be increased by adding lanthanum. However, the overall mechanism of rare earth elements' influence on steel properties remained unknown until recent times. Thermodynamic database which describes the interaction of iron and carbon with lanthanum additives makes it possible to accurately assume the phase composition, crystallisation temperature and microstructure of the material. Such a database is created by researchers from NUST MISIS. This data allows optimising the development of new steels, as it significantly reduces the time to search for new compositions and conduct the necessary experiments. With the database, the period of development of new

**Researchers from the National University of Science and Technology "MISIS" developed a database that will help create new grades of steels.**

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steel grades can be reduced from 1 year to 1-2 months. "In our work, we managed to experimentally confirm all the thermodynamic data of the La-Fe-C (lanthanum-iron-carbon) system. For instance, to clarify the chemical reactions between the elements of the system we obtained about 30 alloys with different chemical compositions", Vladimir Cheverikin, paper co-author, senior researcher at NUST MISIS Centre "Materials Thermochemistry", explains. According to the results of the research, scientists managed to calculate the exact crystallisation temperature of steel-based alloys and various changes in their heat treatment. Thus, now, if it is necessary to create new steel grades, it is enough to load the resulting database into the appropriate software and get a list of conditions that will optimise the processes, including heat treatment and pressure treatment.

EurekaAlert, 11 July 2019

<http://www.eurekaalert.org>

### **It's time to get serious about recycling lithium-ion batteries**

2019-07-24

Lithium-ion batteries have made portable electronics ubiquitous, and they are about to do the same for electric vehicles. That success story is setting the world on track to generate a multimillion-metric-ton heap of used Li-ion batteries that could end up in the trash. The batteries are valuable and recyclable, but because of technical, economic, and other factors, less than 5% are recycled today. The enormity of the impending spent-battery situation is driving researchers to search for cost-effective, environmentally sustainable strategies for dealing with the vast stockpile of Li-ion batteries looming on the horizon. As the popularity of electric vehicles starts to grow explosively, so does the pile of spent lithium-ion batteries that once powered those cars. Industry analysts predict that by 2020, China alone will generate some 500,000 metric tons of used Li-ion batteries and that by 2030, the worldwide number will hit 2 million metric tons per year. If current trends for handling these spent batteries hold, most of those batteries may end up in landfills even though Li-ion batteries can be recycled. These popular power packs contain valuable metals and other materials that can be recovered, processed, and reused. But very little recycling goes on today. In Australia, for example, only 2–3% of Li-ion batteries are collected and sent offshore for recycling, according to Naomi J. Boxall, an environmental scientist at Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO). The recycling rates in the

**A projected surge in electric-vehicle sales means that researchers must think about conserving natural resources and addressing battery end-of-life issues**

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European Union and the US—less than 5%—aren't much higher. "There are many reasons why Li-ion battery recycling is not yet a universally well-established practice," says Linda L. Gaines of Argonne National Laboratory. A specialist in materials and life-cycle analysis, Gaines says the reasons include technical constraints, economic barriers, logistic issues, and regulatory gaps. All those issues feed into a classic chicken-and-egg problem. Because the Li-ion battery industry lacks a clear path to large-scale economical recycling, battery researchers and manufacturers have traditionally not focused on improving recyclability. Instead, they have worked to lower costs and increase battery longevity and charge capacity. And because researchers have made only modest progress improving recyclability, relatively few Li-ion batteries end up being recycled. Most of the batteries that do get recycled undergo a high-temperature melting-and-extraction, or smelting, process similar to ones used in the mining industry. Those operations, which are carried out in large commercial facilities—for example, in Asia, Europe, and Canada—are energy intensive. The plants are also costly to build and operate and require sophisticated equipment to treat harmful emissions generated by the smelting process. And despite the high costs, these plants don't recover all valuable battery materials. Until now, most of the effort to improve Li-ion battery recycling has been concentrated in a relatively small number of academic research groups, generally working independently. But things are starting to change. Driven by the enormous quantity of spent Li-ion batteries expected soon from aging electric vehicles and ubiquitous portable electronics, start-up companies are commercialising new battery-recycling technology. And more scientists have started to study the problem, expanding the pool of graduate students and postdocs newly trained in battery recycling. In addition, some battery, manufacturing, and recycling experts have begun forming large, multifaceted collaborations to tackle the impending problem. In January, for example, US Department of Energy secretary Rick Perry announced the creation of the DOE's first Li-ion battery recycling R&D centre, the ReCell Centre. According to Jeffrey S. Spangenberg, the program's director, ReCell's key goals include making Li-ion battery recycling competitive and profitable and using recycling to help reduce US dependence on foreign sources of cobalt and other battery materials. Launched with a \$15 million investment and headquartered at Argonne National Laboratory, ReCell includes some 50 researchers based at six national laboratories and universities. The program also includes battery and automotive equipment manufacturers, materials suppliers, and other industry partners. At the same time, the DOE also launched the \$5.5 million Battery Recycling Prize. The program's goal is to encourage entrepreneurs to find innovative solutions for collecting and storing

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discarded Li-ion batteries and transporting them to recycling centres, which are the first steps in turning old batteries into new ones. And last year, researchers in the UK formed a large consortium dedicated to improving Li-ion battery recycling, specifically from electric vehicles. Led by the University of Birmingham, the Reuse and Recycling of Lithium Ion Batteries (ReLiB) project brings together some 50 scientists and engineers at eight academic institutions, and it includes 14 industry partners.

Battery specialists and environmentalists give a long list of reasons to recycle Li-ion batteries. The materials recovered could be used to make new batteries, lowering manufacturing costs. Currently, those materials account for more than half of a battery's cost. The prices of two common cathode metals, cobalt and nickel, the most expensive components, have fluctuated substantially in recent years. Current market prices for cobalt and nickel stand at roughly \$27,500 per metric ton and \$12,600 per metric ton, respectively. In 2018, cobalt's price exceeded \$90,000 per metric ton. In many types of Li-ion batteries, the concentrations of these metals, along with those of lithium and manganese, exceed the concentrations in natural ores, making spent batteries akin to highly enriched ore. If those metals can be recovered from used batteries at a large scale and more economically than from natural ore, the price of batteries and electric vehicles should drop. In addition to potential economic benefits, recycling could reduce the quantity of material going into landfills. Cobalt, nickel, manganese, and other metals found in batteries can readily leak from the casing of buried batteries and contaminate soil and groundwater, threatening ecosystems and human health, says Zhi Sun, a specialist in pollution control at the Chinese Academy of Sciences. The same is true of the solution of lithium fluoride salts (LiPF<sub>6</sub> is common) in organic solvents that are used in a battery's electrolyte. Batteries can have negative environmental effects not just at the end of their lives but also long before they are manufactured. As Argonne's Gaines points out, more recycling means less mining of virgin material and less of the associated environmental harm. For example, mining for some battery metals requires processing metal-sulfide ore, which is energy intensive and emits SO<sub>x</sub> that can lead to acid rain. Less reliance on mining for battery materials could also slow the depletion of these raw materials. Gaines and Argonne co-workers studied this issue using computational methods to model how growing battery production could affect the geological reserves of a number of metals through 2050. Acknowledging that these predictions are "complicated and uncertain," the researchers found that world reserves of lithium and nickel are adequate to sustain rapid growth of battery production. But battery manufacturing could

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decrease global cobalt reserves by more than 10%. There are also political costs and downsides that recycling Li-ion batteries could help address. According to a CSIRO report, 50% of the world's production of cobalt comes from the Democratic Republic of the Congo and is tied to armed conflict, illegal mining, human rights abuses, and harmful environmental practices. Recycling batteries and formulating cathodes with a reduced concentration of cobalt could help lower the dependence on such problematic foreign sources and raise the security of the supply chain. Just as economic factors can make the case for recycling batteries, they also make the case against it. Large fluctuations in the prices of raw battery materials, for example, cast uncertainty on the economics of recycling. In particular, the recent large drop in cobalt's price raises questions about whether recycling Li-ion batteries or repurposing them is a good business choice compared with manufacturing new batteries with fresh materials. Basically, if the price of cobalt drops, recycled cobalt would struggle to compete with mined cobalt in terms of price, and manufacturers would choose mined material over recycled, forcing recyclers out of business. Another long-term financial concern for companies considering stepping into battery recycling is whether a different type of battery, such as Li air, or a different vehicle propulsion system, like hydrogen-powered fuel cells, will gain a major foothold on the electric-vehicle market in coming years, lowering the demand for recycling Li-ion batteries. Battery chemistry also complicates recycling. Since the early 1990s when Sony commercialised Li-ion batteries, researchers have repeatedly tailored the cathode's composition to reduce cost and to enhance charge capacity, longevity, recharge time, and other performance parameters. Some Li-ion batteries use cathodes made of lithium cobalt oxide (LCO). Others use lithium nickel manganese cobalt oxide (NMC), lithium nickel cobalt aluminium oxide, lithium iron phosphate, or other materials. And the proportions of the components within one type of cathode—for example, NMC—can vary substantially among manufacturers. The upshot is that Li-ion batteries contain "a wide diversity of ever-evolving materials, which makes recycling challenging," says Liang An, a battery-recycling specialist at Hong Kong Polytechnic University. Recyclers may need to sort and separate batteries by composition to meet the specifications of people buying the recycled materials, making the process more complicated and raising costs. Battery structure further complicates recycling efforts. Li-ion batteries are compact, complex devices, come in a variety of sizes and shapes, and are not designed to be disassembled. Each cell contains a cathode, anode, separator, and electrolyte.

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Cathodes generally consist of an electrochemically active powder (LCO, NMC, etc.) mixed with carbon black and glued to an aluminium-foil current collector with a polymeric compound such as poly(vinylidene fluoride) (PVDF). Anodes usually contain graphite, PVDF, and copper foil. Separators, which insulate the electrodes to prevent short circuiting, are thin, porous plastic films, often polyethylene or polypropylene. The electrolyte is typically a solution of LiPF<sub>6</sub> dissolved in a mixture of ethylene carbonate and dimethyl carbonate. The components are tightly wound or stacked and packed securely in a plastic or aluminium case. Large battery packs that power electric vehicles may contain several thousand cells grouped in modules. The packs also include sensors, safety devices, and circuitry that controls battery operation, all of which add yet another layer of complexity and additional costs to dismantling and recycling. All these battery components and materials need to be dealt with by a recycler to get at the valuable metals and other materials. In stark contrast, lead-acid car batteries are easily disassembled, and the lead, which accounts for about 60% of a battery's weight, can be separated quickly from the other components. As a result, nearly 100% of the lead in these batteries is recycled in the US, far surpassing recycling rates for glass, paper, and other materials. Several large pyrometallurgy, or smelting, facilities recycle Li-ion batteries today. These units, which often run near 1,500 °C, recover cobalt, nickel, and copper but not lithium, aluminium, or any organic compounds, which get burned. The facilities are capital intensive, in part because of the need to treat the emission of toxic fluorine compounds released during smelting. Hydrometallurgy processing, or chemical leaching, which is practiced commercially in China, for example, offers a less energy-intensive alternative and lower capital costs. These processes for extracting and separating cathode metals generally run below 100 °C and can recover lithium and copper in addition to the other transition metals. One downside of traditional leaching methods is the need for caustic reagents such as hydrochloric, nitric, and sulfuric acids and hydrogen peroxide. Researchers running bench-scale studies have identified potential improvements to these recycling methods, but only a handful of companies run recycling tests on the methods at the pilot-plant scale. In the Vancouver, British Columbia, area, an American Manganese facility converts 1 kg/h of cathode scrap to a precursor that manufacturers can use to synthesise fresh cathode material. Scrap refers to off-spec cathode powder, trimmings, and other waste collected from battery manufacturing. Zarko Meseldzija, the company's chief technical officer, describes the scrap as "low-hanging fruit," a convenient material to use for experiments before boosting the scale of operations and moving on to actual spent batteries. He explains that the company's process

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relies on sulfur dioxide for leaching cathode metals and does not use hydrochloric acid or hydrogen peroxide. Battery Resourcers in Worcester, Massachusetts, runs a pilot plant that processes Li-ion batteries at a rate of up to roughly 0.5 metric tons per day and is actively working to increase capacity by a factor of 10, according to CEO Eric Gratz. Many current recycling methods yield multiple single-metal compounds that must be combined to make new cathode material. Battery Resourcers' process precipitates a mixture of nickel, manganese, and cobalt hydroxides. This mixed-metal cathode precursor simplifies battery preparation and could lower manufacturing costs.

Meanwhile, the DOE's ReCell team is pursuing so-called direct recycling methods for recovering and reusing battery materials without costly processing. One approach calls for removing the electrolyte with supercritical carbon dioxide, then crushing the cell and separating the components physically—for example, on the basis of density differences. In principle, nearly all the components can be reused after this simple processing. In particular, because the method does not use acids or other harsh reagents, the morphology and crystal structure of the cathode materials remain intact, and the materials retain the electrochemical properties that make them valuable. Gaines says more work is needed to implement this cost-saving approach. At the University of Birmingham's ReLiB project, principal investigator Paul Anderson says the team sees a clear opportunity to boost the economic efficiency of battery recycling through automation. To that end, the team is developing robotic procedures for sorting, disassembling, and recovering valuable materials from Li-ion batteries. Birmingham's Allan Walton, a coinvestigator, adds that using robotic devices to disassemble batteries could eliminate human workers' risk of electrical and chemical injury. Automation could also lead to enhanced separation of battery components, increasing their purity and value, he says. Although most of these strategies remain at an early stage of development, the need for them is growing. Currently, the number of end-of-life electric-vehicle batteries is low, but it's about to skyrocket. Numerous impediments stand in the way of large-scale recycling, but "opportunities always coexist with challenges," says An of Hong Kong Polytechnic. It's time to take the bull by the horns and get serious about recycling Li-ion batteries.

Chemical & Engineering News, 14 July 2019

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

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### Physicists Have Reversed Time on The Smallest Scale by Using a Quantum Computer

2019-07-24

It's easy to take time's arrow for granted - but the gears of physics actually work just as smoothly in reverse. Maybe that time machine is possible after all? An experiment earlier this year shows just how much wiggle room we can expect when it comes to distinguishing the past from the future, at least on a quantum scale. It might not allow us to relive the 1960s, but it could help us better understand why not. Researchers from Russia and the US teamed up to find a way to break, or at least bend, one of physics' most fundamental laws on energy. The second law of thermodynamics is less a hard rule and more of a guiding principle for the Universe. It says hot things get colder over time as energy transforms and spreads out from areas where it's most intense. It's a principle that explains why your coffee won't stay hot in a cold room, why it's easier to scramble an egg than unscramble it, and why nobody will ever let you patent a perpetual motion machine. It's also the closest we can get to a rule that tells us why we can remember what we had for dinner last night, but have no memory of next Christmas. "That law is closely related to the notion of the arrow of time that posits the one-way direction of time from the past to the future," says quantum physicist Gordey Lesovik from the Moscow Institute of Physics and Technology. Virtually every other rule in physics can be flipped and still make sense. For example, you could zoom in on a game of pool, and a single collision between any two balls won't look weird if you happened to see it in reverse. On the other hand, if you watched balls roll out of pockets and reform the starting pyramid, it would be a sobering experience. That's the second law at work for you. On the macro scale of omelettes and games of pool, we shouldn't expect a lot of give in the laws of thermodynamics. But as we focus in on the tiny gears of reality - in this case, solitary electrons - loopholes appear. Electrons aren't like tiny billiard balls, they're more akin to information that occupies a space. Their details are defined by something called the Schrödinger equation, which represents the possibilities of an electron's characteristics as a wave of chance. If this is a bit confusing, let's go back to imagining a game of pool, but this time the lights are off. You start with the information - a cue ball - in your hand, and then send it rolling across the table. The Schrödinger equation tells you that ball is somewhere on the pool table moving around at a certain speed. In quantum terms, the ball is everywhere at a bunch of speeds ... some just more likely than others. You can stick your hand out and grab it to pinpoint its location, but now you're not sure of how fast it was going. You could also gently

**An experiment earlier this year shows just how much wiggle room we can expect when it comes to distinguishing the past from the future, at least on a quantum scale.**

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brush your finger against it and confidently know its velocity, but where it went... who knows? There's one other trick you could use, though. A split second after you send that ball rolling, you can be fairly sure it's still near your hand moving at a high rate. In one sense, the Schrödinger equation predicts the same thing for quantum particles. Over time, the possibilities of a particle's positions and velocities expands. "However, Schrödinger's equation is reversible," says materials scientist Valerii Vinokur from the Argonne National Laboratory in the US. "Mathematically, it means that under a certain transformation called complex conjugation, the equation will describe a 'smeared' electron localising back into a small region of space over the same time period." It's as if your cue ball was no longer spreading out in a wave of infinite possible positions across the dark table, but rewinding back into your hand. In theory, there's nothing stopping it from occurring spontaneously. You'd need to stare at 10 billion electron-sized pool tables every second and the lifetime of our Universe to see it happen once, though. Rather than patiently wait around and watch funding trickle away, the team used the undetermined states of particles in a quantum computer as their pool ball, and some clever manipulation of the computer as their 'time machine'. Each of these states, or qubits, was arranged into a simple state which corresponded to a hand holding the ball. Once the quantum computer was set into action, these states rolled out into a range of possibilities. By tweaking certain conditions in the computer's setup, those possibilities were confined in a way that effectively rewound the Schrödinger equation deliberately. To test this, the team launched the set-up again, as if kicking a pool table and watching the scattered balls rearrange into the initial pyramid shape. In about 85 percent of trials based on just two qubits, this is exactly what happened. On a practical level, the algorithms they used to manipulate the Schrödinger equation into rewinding in this way could help improve the accuracy of quantum computers. It's not the first time this team has given the second law of thermodynamics a good shake. A couple of years ago they entangled some particles and managed to heat and cool them in such a way they effectively behaved like a perpetual motion machine. Finding ways to push the limits of such physical laws on the quantum scale just might help us better understand why the Universe 'flows' like it does. This research was published in Scientific Reports.

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

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### The super fly that could feed us, end waste and make plastic and fuel

2019-07-24

BZZZZZZZ. Most people would find working next to the noise of thousands of flies a little irritating, and perhaps reach for a rolled-up newspaper. But to Keiran Whitaker, it is the soundtrack of a more sustainable future. That, and the promise of hard cash: Whitaker's company Entocycle is farming the flies in a specialised lab a short walk from Tower Bridge in central London. Within a year, he wants to be shipping them around the country. As food. These are no ordinary insects. They are bigger than the average housefly but far more sluggish. They don't eat anything, so they don't need mouths or digestive systems, which means they can't bite. They aren't pests and they can't carry disease. And as flies go, they don't even fly that much. When they do, it is like they can't really be bothered. It is easy to reach out and just grab one. They are black soldier flies. And if they sound amazing – which they are – then wait until you meet the kids. The larvae of these flies are the next big thing in sustainability. They can be dried and fed to pets. They can replace fishmeal in the diet of farmed fish and animals, and so help protect the oceans from over-exploitation. They can be swapped for the mountain of soya used in animal feed, so saving the rainforests. They can digest all manner of human wastes without generating a lot of greenhouse gases. They can be processed into a kind of plastic. They have been baked into bread and biscuits and mixed into ice cream. They taste, if you were wondering, a bit like peanuts. "These are the most hipster insects in the world," says Whitaker, referring to their diet, as he shows me around. As larvae, his flies dine on only the finest leftovers from a local microbrewery and the neighbouring coffee shops. While trains rumble in and out of London Bridge station overhead, the insects are busy in a computer-controlled environment that counts them and works out how much food they need. Which, as it happens, is an awful lot. You might have seen a viral video of a scrum of maggots devouring a pizza – it is quite something. Those are black soldier fly larvae, doing what they do best, eating what we throw away. And they do so in a fascinating, if admittedly grotesque, way by forming a living fountain in which those larvae that have temporarily had their fill are pushed up and away by hungry replacements. Because the adult flies don't eat, the larvae need to stock up on food before they pupate, an intermediate stage to their final form. That means, after less than two solid weeks of munching, each larva has grown to 2.5 centimetres long and weighs more than 200 milligrams. Almost a third of that is fat and more than 40 per cent is protein. That makes them a

**The black soldier fly is the next big thing in sustainability, digesting waste products with minimal greenhouse gas emission. Farming them could save the world**

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valuable commodity. "I think we are going to see insect farming on a massive scale," says Åsa Berggren of the Swedish University of Agricultural Sciences in Uppsala. "It has lots of things going for it compared with how we get protein today." Global demand for protein is soaring and could double by 2050. Yet much of what we produce at the moment we don't eat, at least not directly. We feed it to farmed animals instead. By weight, about a quarter of all wild fish caught globally are made into fishmeal. For soya – a crop long blamed for driving deforestation in the tropics – some 80 per cent goes to animal feed. Most protein for animal food is sourced from the cheapest providers internationally. That means the farmed salmon you buy in a UK or US supermarket probably ate soya grown in Brazil, while the chickens were raised on ground-up anchovies hoovered from the seas off Peru. "Food production is the most destructive industry ever invented," says Whitaker. "And most people have two ways to make change: who you vote for and what you buy." Pet owners are among the first to have an insect-based choice. In January this year, UK start-up Yora started to mix black soldier fly larvae into its dry dog food. It can do so because regulations on pet food are fairly loose. It is a different story for feeding animals destined for human consumption, especially in places like Europe where the BSE scandal of the 1980s focused attention on what protein animals were eating. Insect protein was caught in the subsequent bans, but those laws are starting to change. In 2017, the European Union said fish farmers could use insect protein, and by 2020 it is expected to allow it in food for chickens and pigs. The US is moving too: late last year, the Food and Drug Administration signalled its approval for the use of insects in chicken feed. There are no restrictions on the use of fat from insects, which is already mixed into pig food made by a company called Protix in the Netherlands – which also supplies black soldier fly protein for Yora dog food. Elaine Fitches, an applied entomologist at Durham University, UK, who wrote a report on insect protein sources for the EU in 2016, says companies are queuing up to take advantage of the revised laws. "Everywhere you look, there are investments in this area," she says. "It is now moving from start-up to transition to commercial scale." US firm EnviroFlight opened a large-scale black soldier fly farm in Kentucky in November. And South Africa-based AgriProtein, which farms maggots reared on food waste, raised \$100 million last year to fund expansion. France has already said it wants to be a world leader in the production of protein by 2030, and sees massive insect farms as one way to achieve that. And it isn't just focusing on the black soldier fly. French firm Ynsect is building a factory in Amiens that it says will rear enough mealworm beetles to produce 20,000 tonnes of larval protein a year, mostly for fish farming. "That is a hell of a lot of little maggots," Fitches says. Is it

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all as good as it sounds? Berggren says would-be insect farmers should remember they are often using non-native species. The black soldier fly, for example, isn't yet settled in the UK. It is probably too cold for any that escape. Entocycle's London lab is kept at 30°C. But Berggren says species tend to find a way. "We really don't know enough to be sure what would happen."

The picture is clearer when it comes to sustainability. Alexander Mathys at the Swiss Federal Institute of Technology in Zurich has just finished a full life-cycle assessment of the environmental impact of Protix's pilot plant in Dongen, the Netherlands, which grows its black soldier fly larvae on waste from the food industry. By measuring land and water use, energy demand and greenhouse gas production, he found that insect fats and proteins for both animal fodder and human consumption were more sustainable than animal-based sources, and that, while vegetable fodder still scored better overall, insect farming had the edge when it came to water and land use. One way to make insect fat and protein a more sustainable food ingredient is for us to eat more of it directly – instead of feeding it first to fish, chickens and pigs. "I tried to convince the Swiss chocolate industry to replace palm oil with oil made from black soldier fly larvae," says Mathys. "They didn't like it." (One South African company, Gourmet Grubb, has taken the plunge and uses fat from the insects in its ice cream.) Despite the strict rules on what animals in the human food chain eat, there are few controls on using protein from insects in food we eat directly, and insect-based snacks are appearing on supermarket shelves. Food scientists have baked insect flour from black soldier fly larvae, mealworms and even cockroaches into bread. The results, they say, can be dense and a bit chewy – and some give off an unpleasant smell during baking – but taste pretty similar to a regular loaf. Already, a Finnish bakery in Helsinki has started to sell bread made with flour from ground-up crickets. Customers say they don't notice the difference, although each loaf is about 50 per cent more expensive. Whitaker says Entocycle is aiming beyond animal feed too: "I didn't start this to feed animals. I started it to feed people." He is a vegan, but is happy to tuck into a shared plate of his dried whole larvae. It is ethical, he says, because insects don't have feelings. His business plan is to license farmers to install rows of hundreds of automated trays to fatten up the larvae, which he would then reclaim, separate into protein and fat, and sell as premium ingredients. Several farmers, keen to diversify their production to stay in business, are already on the waiting list, he says. Just don't use the M-word. "We don't like to use the word maggot. We call it a larva. We call it what it is." It might sound yucky to some, but then most of us – including vegetarians and vegans –

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unknowingly eat fats and proteins from insects all the time, because the animals are collected when crops are harvested. Under FDA rules, frozen broccoli can include up to 60 whole aphids or mites per 100g and the same amount of chocolate is allowed to contain up to 60 insect fragments. An average can of tinned tomatoes? One fruit fly maggot allowed. Fitches says the easiest way to make foods processed with insect ingredients more sustainable is to expand what the larvae themselves are allowed to eat. If destined for farm animals, regulations in many developed countries restrict the menu to what is called pre-consumer waste – the by-products of existing food production – and no meat. That is why Whitaker's black soldier flies get the brewing and coffee leftovers. There is only so much of that to go around, though, so truly sustainable insect farming on a massive scale requires finding something else to feed them. Something like that pizza in the video, perhaps. Colossal amounts of food are thrown away every day – which wastes valuable resources and generates the powerful greenhouse gas methane as it rots in compost and landfill sites. By some estimates, if food waste were a country, it would be the world's third biggest carbon emitter, behind only the US and China. Black soldier flies and other insects have already proved themselves adept at breaking down everything from dead fish (another hit video worthy of your time) and surplus fruit and vegetables from supermarkets, to the mess left behind by Ugandan bootleggers who make a gin-like drink called waragi by distilling ingredients including molasses. And the larvae do so without producing methane – they convert the carbon in the feedstock into the proteins and oils of their wriggly bodies, with some released as carbon dioxide. An assessment by Swiss scientists late last year showed that, when disposing of organic matter, black soldier flies produce greenhouse gas emissions 47 times lower than composting does. Organic matter doesn't have to mean food waste, though. "To me using manure [to farm insects] is a no-brainer," says Fitches. "Some people don't like the idea but we buy farmed mushrooms and they're covered in manure." To use flies to turn excrement into fat and protein for our food would require quite a shift in thinking in many societies – and significant changes to regulations. But even if the work of the flies doesn't ultimately produce food, it could still steer us to a more sustainable future. At one end of the life cycle of what we consume, these insects can help us dispose of what we throw away with less impact on the environment – the Swiss analysis was of a dedicated insect-biowaste treatment plant in Indonesia. At the other, the protein and especially the fat they contain can be put to good use elsewhere. As studies show that insects are disappearing from the natural world, it could be that we realise we need them more than ever. "This is a really exciting

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time to work in this science as the results are immediately relevant to industry and that's really cool," says Mathys. "The topic is really flying."

New Scientist, 17 July 2019

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

### Bloom's Mission to Turn Toxic Algae into Shoes

2019-07-24

On a morning in November 2017, while the residents of Lakeland, Florida, headed off to work, a small team of engineers parked what looked like an enormous lava lamp on the banks of Lake Bonnet. The ten-by-eight-foot water tank sat on a trailer fitted with a generator-powered pump. As the trailer gurgled to life, a hose pumped a swirling stream of green, algae-choked water into the tank. Like many Florida waters, Lake Bonnet had become overrun with plant slime. In fact, all 50 states and many countries worldwide are struggling with epidemic levels of algae that can prove toxic to people and ecosystems. "Red tides" of algae along Florida's Gulf Coast have killed tons of fish and marine mammals. Chinese lakes have turned into electric-green sludge. Beaches in Southern California are also experiencing explosions of algae and its related toxins: domoic acid and microcystin are among the algae-produced poisons that can kill off wildlife and cause illness in humans. Gulping it, swimming in it, or inhaling it (via sea mist) causes vomiting and diarrhea; extended contact can lead to cancer and liver failure. In Florida, lifeguards have reported higher incidence of respiratory illness, and many marina workers have taken to wearing air masks. Battling the algae hasn't been easy or practical, but at Lake Bonnet, engineers from a multinational firm called Aecom tested a brand-new technology that they think just might offer a solution to the global algae crisis. The water tank filters algae from water and then turns it into plastic foam like the kind used by footwear companies to make billions of pairs of shoes each year. That cushiony underfoot feeling you get from running shoes, sneakers, and hiking boots? It's typically provided by ethylene-vinyl acetate (EVA) foam, which is made from toxic petrochemicals. But a handful of outdoor footwear companies, such as Bogs and Altra, in conjunction with Aecom, have begun making shoes with an EVA-algae-based hybrid called Bloom. As this new material gains traction, algae could help clean up an industry that's notorious for harmful environmental impacts. You might start thanking algae for that spring in your step—and you might see cleaner waterways. "It's pretty amazing to watch," says Laurie Smith, lakes and stormwater manager for the City of Lakeland. Smith and a number of other Florida water specialists attended

**One company thinks it can solve the global algae crisis by making sneakers from sludge**

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the Lake Bonnet test to learn about the process and evaluate its potential for their districts. She witnessed how a pump drew water via a hose into the tank, where the slimy water mixed with a coagulant that caused the algae to clump together. (The tank can run from one location on the shore, although it's set up on a portable trailer that can be easily relocated.) Then, air bubbles were pumped into the water. As they rose, they carried the algae to the tank's surface, where it floated like foamed milk on a cappuccino. Engineers skimmed off the clumped algae, and a stream of crystal-clear water poured back into the lake. The system processed 125 to 175 gallons of lake water per minute and netted more than 300 pounds of algae in just one day. "That's an incredible amount of algae," Smith says. "With most water-quality projects, we don't see immediate impacts. But with this, we saw pollution coming out and clean water going back in, which is amazing. I'm very hopeful that as this technology gets refined, it could present a real solution [to the algae epidemic]." Algae isn't like an oil spill, which introduces foreign chemicals to waterways. The tiny, free-floating plants naturally occur in both marine and freshwater environments, and they occasionally explode to pestilential levels. In recent years, those blooms have become bigger, more frequent, and longer lasting. Climate change may be a factor: the earth's water temperatures are creeping up. Plus, nitrogen and phosphorus—naturally present in most waterways—are now appearing at unprecedented levels in many lakes and coastlines. Rainwater flushes the nitrogen- and phosphorus-rich fertilizers from our lawns and farms into watersheds, where they stimulate algae production. Turns out, overstimulated algae can cause big problems for communities and the waters they rely on. For four days in August 2014, some 500,000 residents of Toledo, Ohio, couldn't drink or even shower with their tap water because of an algae bloom in Lake Erie. In July 2018, Governor Rick Scott declared a state of emergency in seven South Florida counties after Lake Okeechobee became a cesspool of photosynthesizing microorganisms. Algae covered 90 percent of the lake's 730 square miles and crippled the many businesses that rely on Okeechobee's tourism and outdoor recreation for most of midsummer. Plus, these blooms stink like rotting food. So, although "attack of the green slime" may sound like a C-grade horror movie, in some areas, the crisis is real. So far, the available remedies have proven to be inadequate, impractical, or both. Adding copper sulfate or alum to the water causes a quick die-off, but the chemicals also kill fish. And they don't remove the algae itself, so the phosphorus and nitrogen embedded in the cell walls of algae persist in the waterway and make subsequent blooms more likely, because algae feeds off phosphorus and nitrogen. Dredging removes the offending nutrients but is wildly expensive—about \$6 million for an 80-

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acre lake, Smith says—and there's no good way to dispose of the dredged gunk. Other proposals include building stormwater reservoirs where pollutants can settle before the (slightly cleaner) water is allowed to rejoin streams and lakes. But such systems are also expensive—in Florida, just buying the required land is likely to top \$1 billion—and the environmental payoff isn't proven.

Then, in 2014, a surfer and inventor named Rob Falken began investigating a novel solution to the algae problem. With a background in materials development and a passion for sustainability, Falken thought algae's high protein content could allow the plants to stand in for petroleum in the production of certain plastics, like the foam used to make yoga mats and springy soles. He connected with Algix, a company that had developed a small-scale method for vacuuming slime out of catfish farms. Algix provided Falken with some algae, and after a month of experimentation, he developed a recipe for plant-based foam: pulverise solar-dried algae into powder, turn that into a pellet, then injection-mould those pellets into sheets of flexible bioplastic. With that formula, roughly half algae, half EVA by weight, Algix and Falken partnered to form Bloom in 2015. Bloom's small-scale production of algae-based foam initially attracted boutique brands making niche products. Vivobarefoot used it to make an amphibious sneaker. Kelly Slater applied Bloom traction pads to his Slater Designs surfboards. The algae was collected from China's Lake Taihu, which is even larger than Lake Okechobee and provided millions of pounds of biomass. But to supply the biggest gear brands, Bloom would need to Hoover up even more green goop. So, in 2016, the company partnered with Aecom, a global engineering firm that builds and operates massive infrastructure projects like wind farms, bridges, and New York's One World Trade Centre. The partnership emboldened some areas in the United States to give algae sucking a try. In the summer of 2018, Aecom executed its first official algae-removal projects in North Fort Myers, Cape Coral, and Lee County, Florida. And now one of footwear's biggest players is knocking on Bloom's door. Adidas confirmed that it's currently testing Bloom foam for potential use in future products. Already, some 15 outdoor brands are using Bloom in items ranging from shoes to stand-up paddleboards. (Surftech uses Bloom for its deck pads.) This past spring, Bogs slid Bloom footbeds into its shoes and boots, and Altra built Bloom into its new line of casual kicks. Saola, a sustainably made sneaker company, debuted its first-ever line last fall with Bloom insoles and outsoles. "Bloom is just a cleaner, better material," says Guillaume Linossier, founder of Saola. "And its production results in cleaner waterways. To me, it's a double benefit." Plus, says Golden Harper, founder of Altra, Bloom is crazy comfortable.

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“That slip-on feel is so key, because how [a shoe] feels when you try it on makes a big impact on how it will sell,” Harper says. “It doesn’t do you any good to build something that’s sustainable but isn’t comfortable, because people won’t buy it.” But just how well Bloom sells remains to be seen. You’d think EVA foam would be an easy target for a takedown. Made from non-renewable petrochemicals, it’s technically recyclable, though in practice, that’s rarely done. Instead, it’s trashed—and as EVA decomposes, it releases volatile organic compounds that pollute air and water. So, although EVA may be a devil, it’s the devil footwear companies already know. And that makes it a tough incumbent to unseat, despite the algae foam’s environmental advantages, which are compelling. Bloom hired a third-party consulting firm called Earth Shift to assess its foam’s environmental impact from creation to afterlife. The analysis found that Bloom, with its algae-EVA blend, was 20 to 41 percent less environmentally harmful than pure EVA. That’s despite the fact that Bloom isn’t currently recyclable. (Bloom isn’t recyclable for the same reason standard EVA foam isn’t recyclable: it can’t be melted and reprocessed into new material.) But Bloom probably costs more than straight EVA, and just how much more is still being determined. “It’s a little too early to know,” Linossier admits. “We think it will be a little more expensive, but not a lot, because the raw material doesn’t cost anything,” he explains. But even a few pennies’ difference could deter mass-market brands from switching, says Andy Polk, senior vice president of Footwear Distributors and Retailers of America. “Americans buy a lot of basic \$20 to \$40 footwear,” he says. “And can Bloom compete with EVA foam costs in lower price-point shoes?” he asks. If it can’t, Bloom is likely to remain in the realm of \$80 to \$100 shoes made by companies that want to impress customers with their innovation and sustainability. “Bloom may not work for every product,” Polk admits, “but I think it can find a good niche in the footwear marketplace as long as the material stands up to what the shoe is designed to do: deliver breathability, flexibility, comfort, stability, et cetera.” Even if Bloom doesn’t win over the mainstream Famous Footwear labels, it still stands to make a measurable impact on the overall shoe industry. Cleaning up even a fraction of the 23 billion pairs worldwide that the industry produces every year could make this category less oil dependent. And Bloom’s influence seems likely to spread beyond shoes to yoga mats and other products that currently rely on EVA. (Tentree floated a backpack that uses Bloom on Kickstarter.) “I do think [Bloom] will become fairly omnipresent,” says Altra’s Harper. “A lot of companies want to be sustainable, and this is comparable [to EVA] in cost and comfort, so it’s not giving brands a lot of excuses not to use it.” Plus, says Smith, turning a pestilential natural substance into a high-demand commercial material is “truly in the spirit of recycling.” If

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Aecom's algae filtration proves to be less expensive than dredging, Smith could clean her area's waterways and save taxpayers' money. "We want good water quality, but we live and die by cost benefit, so I can't tell you how impressed I was by the pilot project I saw," she says. Panaceas are rare in water restoration work, but even if this is just one tool in the shed, says Smith, "I'm hoping it could be a super-duper tool."

Outside, 22 July 2019

<https://www.outsideonline.com>

### Sawdust Might Be One Answer to the World's Plastic Problem

2019-07-24

A technology start-up near Ontario's leafy border with Michigan says it has the answer to the world's plastic pollution problem: sawdust. Origin Materials is getting ready to pay sawmills in the area \$20 a ton for the scraps left over in the process of turning logs into lumber, which it will use to make recyclable plastic bottles that remove carbon-dioxide from the sky because they're made from sustainably sourced wood waste. Nestle SA, Danone SA and PepsiCo Inc. plan to sell water in Origin's recyclable plant-based bottles in early 2022. It's one of the many unconventional ways conceived by scientists to reduce the world's reliance on plastics made from petroleum, which emit as much climate-damaging pollutants as 189 coal plants each year from production to incineration. Other so-called bio-based plastics are being developed from sugar, corn, algae, seaweed, sewage and even dead beetles. "Consumers are caring about plastic in a way that they haven't in a long time, maybe ever," said John Bissell, 34, who founded Origin Materials in 2008 and has spent 10 years working as an engineer developing alternative plastics that don't contribute to climate change. "Everyday things like bottles and clothing can now become carbon negative, but remain otherwise functionally identical." That may be true in theory, but phasing out petroleum-based plastics will be an uphill battle. Use of the material has become so ingrained for societies around the world that about half of all new oil demand through 2040 will come from petrochemicals, an industry that relies on plastics for most of its business, according to BloombergNEF. The \$500 billion global plastics market is responsible for 5% of greenhouse gas emissions, Friends of the Earth data show. Some projections see that ratio tripling in the next 30 years. Plant-based plastics, especially varieties made from sugar cane, are starting to seep into the mainstream as companies try to respond to consumers who are increasingly angry about the ecologically devastating

**Beverage giants Pepsi, Danone and Nestle plan to sell water in recyclable plastic bottles made from lumber scraps.**

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impact of plastics. London-based Bulldog sells its male skincare products in plastic tubes made from sugar cane. Last year, Danish toymaker Lego A/S started including botanical pieces, like leaves, bushes and trees, made entirely of plant-based plastics in its box sets. It'll take getting big food and beverage companies on board to really alter the equation. Nestle alone produces 1.7 million tons of plastic packaging a year, according to the Ellen MacArthur Foundation, enough to make over 51 billion bottles. Beverage makers like Coca-Cola Co. and Pepsi use a lot more than that. Coca-Cola rolled out its so-called plantbottle in 2009, but it's still 70% petroleum based. "There is no doubt that awareness around plastic waste has become more prominent in the last two years," said Simon Lowden, president of PepsiCo's global snacks group, which announced in 2016 it would seek to reduce absolute greenhouse gas emissions by 20% by 2030. As part of a strategy to find more sustainable packaging, Pepsi last year joined Nestle and Danone's NaturALL Bottle Alliance to find ways to reduce the carbon footprint of beverage bottles. All three plan to buy 100% plant-derived bottles from Origin Materials when its Ontario plant gets up and running at the end of 2020 with a starting capacity of 300 million bottles a year. Origin Materials developed a way to extract cellulose from wood waste to make para-xylene, a hydrocarbon usually derived from oil used to manufacture PET, one of the most common plastics today. Since trees and plants naturally capture CO<sub>2</sub> through photosynthesis, using sustainably sourced sawdust and wood chips more than offsets any pollutants released in the manufacturing process, according to Bissell. However ingenious the techniques to make plant-based bottles may get, though, they're still plastic. Not all varieties are recyclable or biodegradable. And ultimately unless they are recycled — and worldwide only one out of every five bottles is — plastic bottles inevitably end up in landfills where they may spew pollutants into the air, or worse, find their way into the oceans where most could take hundreds of years to degrade, killing birds, fish and whales in the process. When incinerating, bio-based plastics may be little better than oil-based ones because the carbon stored in them is released. Since David Attenborough's Blue Planet 2 documentary in 2017 showed albatrosses feeding their chicks plastic by accident, plastic's environmental impact has "gone from a niche topic of conversation and engagement to something that features in all our conversations," said Mark Lancelott, a sustainability expert at PA Consulting Group Ltd. The London-based consultancy has seen a "significant increase" in requests from food and beverage companies on how to manage plastic waste. After the European Union and New York announced bans this year on certain single-use plastics, many companies are getting nervous about how far those regulations could go, added Katherine Lampen, a London-

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based partner in Deloitte's sustainability advisory team, which advises big consumer packaged good companies. "They are concerned that the future viability of their business could be reduced due to a heavy reliance on the material," she said. Sceptics of the bioplastic push say they're not resolving the underlying problem. It would be better to focus on improving rates of reuse of plastic or glass packaging, with waste collected by the producer, according to Juliet Phillips, an ocean campaigner at the Environmental Investigation Agency, a non-governmental organisation. If production of plant-based plastics were to be scaled up, "land-use demands could bring about competition with agriculture, accelerating deforestation concerns and biodiversity loss," she said. For Bissell at Origin Materials, the plastic industry has become too important for global commerce to work on only one front to improve sustainability, especially considering soaring demand in emerging markets where reuse programs tend to be underdeveloped. "The end of life of plastics is really important. I'm not too sure that I'd argue that it's more important than climate change. That feels like maybe not the right trade off to make," he said.

Bloomberg, 22 July 2019

<http://www.bloomberg.com>

### This New Liquid Is Magnetic, and Mesmerising

2019-07-24

Lodestone, a naturally-occurring iron oxide, was the first persistently magnetic material known to humans. The Han Chinese used it for divining boards 2,200 years ago; ancient Greeks puzzled over why iron was attracted to it; and, Arab merchants placed it in bowls of water to watch the magnet point the way to Mecca. In modern times, scientists have used magnets to read and record data on hard drives and form detailed images of bones, cells and even atoms. Throughout this history, one thing has remained constant: Our magnets have been made from solid materials. But what if scientists could make magnetic devices out of liquids? In a recent study published in *Science*, researchers managed to do exactly that. "We've made a new material that has all the characteristics of an ordinary magnet, but we can change its shape, and conform it to different applications because it is a liquid," said Thomas Russell, a polymer scientist at the University of Massachusetts, Amherst, and the study's lead author. "It's very unique." Using a special 3D printer, Dr. Russell and his colleagues at the Lawrence Berkeley National Laboratory injected iron oxide nanoparticles into millimetre-scale droplets of toluene, a colourless liquid that does not dissolve in water. The team also added a soap-like

**Scientists have created "soft" magnets that can flow and change shape, and that could be a boon to medicine and robotics.**

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material to the droplets, and then suspended them in water. The soap-like material caused the iron oxide nanoparticles to crowd together on the surface of the droplets and form a semisolid shell. "The particles get stuck in place, like a traffic jam at 5 o'clock," Dr. Russell said. Next, the scientists placed the droplets on a stirring plate with a spinning bar magnet, and observed something extraordinary: The solid magnet caused the positive and negative poles of the liquid magnets to follow the external magnetic field, making the droplets dance on the plate. When the solid magnet was removed, the droplets remained magnetised. "We almost couldn't believe it," Dr. Russell said. In the 1960s, scientists at NASA discovered that some liquids could become magnetized in the presence of a strong magnetic field. But these liquids, known as ferrofluids, always lost their magnetism as soon as the stronger, external magnetic field was removed. In contrast, the droplets created by Dr. Russell and his team become magnetic and stay that way, thanks to the nanoparticle shell that forms within the soapy emulsion. As a result, the droplets can be made to change shape with just a small application of force, as if a traffic cop came upon that rush-hour traffic jam and started moving things along, Dr. Russell said. The motion of liquid droplets can also be guided with external magnets. Thus employed, liquid magnets could be useful for delivering drugs to specific locations in a person's body, and for creating "soft" robots that can move, change shape or grab things. "We hope these findings will enable people to step back and think of new applications for liquid magnets," Dr. Russell said. "Because until now, people in material sciences haven't thought this was possible at all."

New York Times, 18 July 2019

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

## New record in lead-free halide double perovskites

2019-07-24

Illumination consumes more than 20 percent of electricity. Thus, finding an efficient, stable, single-phase warm white-light material is very important. Lead hybrid perovskites have drawn interest for excellent photoelectric performance and simple synthesis. Lead perovskites with white-light emission have been studied, but photoluminescence quantum efficiencies (PLQEs) are low. However, the large-scale application of lead perovskites is hindered by toxicity and instability. Therefore, the substitution of Pb with less toxic or non-toxic elements and the replacement of organic cations with relatively stable inorganic cations is being investigated. Very recently, Keli Han's group at the State Key Laboratory of Molecular

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Reaction Dynamics, Dalian Institute of Chemical Physics, Chinese Academy of Science, reports a series of bulk lead-free double perovskites:  $\text{Cs}_2\text{AgBi}_{1-x}\text{In}_x\text{Cl}_6$  ( $0 < x < 1$ ). They demonstrate the existence of the parity-forbidden transition by photophysical characterisation in  $\text{Cs}_2\text{AgInCl}_6$  bulk crystal. The  $\text{Cs}_2\text{AgBi}_{0.125}\text{In}_{0.875}\text{Cl}_6$  breaks the parity-forbidden transition and shows warm white-light emission with broad emission across the entire visible spectrum, with the highest PLQE of 70.3%. The  $\text{Cs}_2\text{AgBi}_{0.125}\text{In}_{0.875}\text{Cl}_6$  nanocrystals and microcrystals are synthesised. They reveal that the PLQE decreases with the size decreasing, due to the enhancement of PL quenching effect caused by the increase of permanent defects. Furthermore, the  $\text{Cs}_2\text{AgBi}_{0.125}\text{In}_{0.875}\text{Cl}_6$  bulk crystal possesses excellent stability, and therefore, seems promising as a new highly efficient warm white-light emitting material in applications of LEDs.

Phys.org, 22 July 2019

<http://phys.org>

### An air-stable and waterproof lithium metal anode

2019-07-24

Lithium metal anode offers a promising pathway to upgrade the energy density of lithium ion batteries for its high specific capacity (3800 mAh g<sup>-1</sup>) and low voltage (-3.04 V vs. Li/Li<sup>+</sup>). But the safety issues caused by dendrite growth and instability in air caused by its high chemical activity limit its large-scale use as an electrode material. Lithium metal is highly sensitive to moisture and oxidative components in the air, leading to the generation of insulating products like lithium hydroxides on its surface and the resultant deterioration of the electrochemical performance. Moreover, when lithium contacts water, combustion and explosion can occur due to the production of hydrogen and heat. The sensitivity of lithium metal therefore necessitates demanding requirements for the transport, storage and process of lithium metal anode. It is hence highly desirable to develop an air-stable and waterproof lithium metal anode for potential use in the future. In the electronics field, packaging technologies protect electronic components from physical damage and corrosion in humid air and water with a coating, which provides design impetus for the protection of lithium metal. Recently, a research team led by Prof. Quan-Hong Yang in Tianjin University and Prof. Wei Lv in Tsinghua University developed a wax-PEO coating for lithium metal surfaces utilising a simple dip coating method to realise an air-stable and waterproof lithium metal anode. Wax as a commonly-used inert sealing material is easily coated on the surface of lithium metal. This wax-based composite coating prevents

**Lithium metal anode offers a promising pathway to upgrade the energy density of lithium ion batteries for its high specific capacity (3800 mAh g<sup>-1</sup>) and low voltage (-3.04 V vs.**

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adverse reactions of lithium metal in air and water. In batteries, the coating retards the etching of electrolyte to the surface of lithium metal anodes while the homogeneously distributed PEO guarantees uniform lithium ion conduction at the interface and inhibits the growth of lithium dendrites. Under the protection of wax-PEO coating, lithium surfaces remain unchanged in air with high relative humidity of 70% for 24 hours, and high capacity retention of 85% is achieved. Even contacting lithium with water immediately, no combustion or capacity decay occurred. The coated lithium metal anode remains stable for as long as 500 hours in symmetric cells, and lithium sulfur batteries assembled with the coated lithium metal anode show a low capacity decay rate of 0.075% per cycle for 300 cycles. This work demonstrates an efficient packaging technology for air-stable and waterproof lithium metal anodes. It is also easily scalable and applicable to other sensitive electrode materials.

Phys.org, 22 July 2019

<http://phys.org>

### **Living components: Programmable structural dynamics successful in self-organising fibre structures**

2019-07-22

Cells assemble dynamically: their components are continuously exchanging and being replaced. This enables the structures to adapt easily to different situations, and by rearranging the components to respond to stimuli faster, to renew or to form just on demand. The microtubules, a scaffold structure made of protein fibres that can be found in the cytoplasm of the cells of algae, plants, fungi, animals and humans, are one such dynamic mesh. Because of their self-organising structure, these fibres constantly form and degrade at the same time, thereby actively supporting the cell in complex tasks such as cell division or locomotion. The fibres require energy to form and maintain such dynamic states. Now, for the first time, Prof. Dr. Andreas Walther and Dr. Laura Heinen from the Institute for Macromolecular Chemistry and the Centre of Interactive Materials and Bioinspired Technologies (FIT) at the University of Freiburg have succeeded in programming the dynamics of such dissipative, i.e. energy-consuming, structures in an artificial chemical system on the basis of DNA components. The researchers present their results in the latest edition of the journal *Science Advances*. The difficulty of programmable structural dynamics in synthetic dissipative systems is the synchronisation of the energetic deactivation and activation with the structural build-up and degradation of the components. The Freiburg researchers were

**Scientists have succeeded in programming the dynamics of structures in an artificial chemical system on the basis of DNA components.**

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able to solve the problem by using an energy-driven, dynamic covalent bond, that is responsible for the firm cohesion of atoms, in the backbone of the DNA sequences. The covalent bond is herein formed through the catalytic activity of the enzyme T4 DNA ligase, and simultaneously split at the very same site by a restriction enzyme, which can recognize and cut DNA at specific positions. This newly-formed system is reversible and results directly in structural dynamics, which distinguishes it from previous artificially-generated dissipative structures. The study, which took place with the aid of Walther's ERC Starting Grant "TimeProSAMat," uses the dynamic synthesis of a polymer of DNA fragments, to show scientists how the lifetime, exchange frequency, or relative bond fraction of the DNA polymers can be controlled in dependence of the chemical fuel adenosine triphosphate and the enzyme concentrations. The Freiburg researchers were able to sustain these dynamic steady states for several days. The chemical modifications of DNA to use it as a construction material are versatile and there are also many available restriction enzymes, explains Heinen, "So our concept enables wide-ranging access to innovative functional materials, which act outside thermodynamic equilibrium. And it does so with so far unique programming possibilities in its dynamic structural characteristics."

Science Daily, 22 July 2019

<http://www.sciencedaily.com>

### **Eco-friendly composite catalyst and ultrasound removes pollutants from water**

2019-07-24

The research team of Dr. Jae-woo Choi and Dr. Kyung-won Jung of the Korea Institute of Science and Technology's (KIST, president: Byung-gwon Lee) Water Cycle Research Centre announced that it has developed a wastewater treatment process that uses a common agricultural by-product to effectively remove pollutants and environmental hormones, which are known to be endocrine disruptors. The sewage and wastewater that are inevitably produced at any industrial worksite often contain large quantities of pollutants and environmental hormones (endocrine disruptors). Because environmental hormones do not break down easily, they can have a significant negative effect on not only the environment but also the human body. To prevent this, a means of removing environmental hormones is required. The performance of the catalyst that is currently being used to process sewage and wastewater drops significantly with time. Because high efficiency is difficult to achieve

**Scientists have developed a wastewater treatment process that uses a common agricultural by-product to effectively remove pollutants and environmental hormones, which are known to be endocrine disruptors.**

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given the conditions, the biggest disadvantage of the existing process is the high cost involved. Furthermore, the research done thus far has mostly focused on the development of single-substance catalysts and the enhancement of their performance. Little research has been done on the development of eco-friendly nanocomposite catalysts that are capable of removing environmental hormones from sewage and wastewater. The KIST research team, led by Dr. Jae-woo Choi and Dr. Kyung-won Jung, utilised biochar, which is eco-friendly and made from agricultural by-products, to develop a wastewater treatment process that effectively removes pollutants and environmental hormones. The team used rice hulls, which are discarded during rice harvesting, to create a biochar\*\* that is both eco-friendly and economical. The surface of the biochar was coated with nano-sized manganese dioxide to create a nanocomposite. The high efficiency and low cost of the biochar-nanocomposite catalyst is based on the combination of the advantages of the biochar and manganese dioxide. The KIST team used the hydrothermal method, which is a type of mineral synthesis that uses high heat and pressure, when synthesising the nanocomposite in order to create a catalyst that is highly active, easily replicable, and stable. It was confirmed that giving the catalyst a three-dimensional stratified structure resulted in the high effectiveness of the advanced oxidation process (AOP), due to the large surface area created. When used under the same conditions in which the existing catalyst can remove only 80 percent of Bisphenol A (BPA), an environmental hormone, the catalyst developed by the KIST team removed over 95 percent in less than one hour. In particular, when combined with ultrasound (20kHz), it was confirmed that all traces of BPA were completely removed in less than 20 minutes. Even after many repeated tests, the BPA removal rate remained consistently at around 93 percent. Dr. Kyung-won Jung of KIST's Water Cycle Research Centre said, "The catalyst developed through this study makes use of a common agricultural by-product. Therefore, we expect that additional research on alternative substances will lead to the development of catalysts derived from various types of organic waste biomass." Dr. Jae-woo Choi, also of KIST's Water Cycle Research Centre, said, "We have high hopes that future studies aimed at achieving process optimization and increasing removal rates will allow for the development an environmental hormone removal system that is both eco-friendly and low-cost." \*\*Biochar: a term that collectively refers to substances that

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can be created through the thermal decomposition of diverse types of biomass or wood under oxygen-limited conditions

Science Daily, 19 July 2019

<http://www.sciencedaily.com>

## Curiosities

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#### **Defective potassium channels cause headache, not body pain**

2019-07-25

Defective potassium channels involved in pain detection can increase the chance of developing a headache and could be implicated in migraines, according to research in mice published in *eNeuro*. A type of potassium channel called TRESK is thought to control the excitability of peripheral sensory neurons that detect pain, heat, cold, and touch. Even though these channels are found throughout the neurons sensing both body and facial pain, channel mutations are linked only with headaches and not body pain. Yu-Qing Cao and colleagues at Washington University in St. Louis analysed a knock-out mouse with defective TRESK channels and measured the resulting neural activity. The researchers found that only facial pain receptors were more excitable, and that the sensory neurons had more spontaneous activity. Using behavioural tests, the scientists observed that the knock-out mice showed increased sensitivity to temperature and touch stimuli on their faces, as well as more headache-related behaviours, but no body pain behaviours. These results indicate that TRESK channels have cell-specific roles and are responsible for regulating pain in facial sensory neurons, making them a target for migraine treatment research

Medical Xpress, 15 July 2019

<http://medicalxpress.com>

#### **Cigarette Butts Are a Huge Trash Issue, And Now We Know They're Harming Plant Growth**

2019-07-25

Cigarette butts left in grass and soil can harm nearby plant growth, according to a new study. The study led by Anglia Ruskin University in Cambridge, England found that a cigarette butt can cut down the germination, or development, of plants, adding to concerns about discarded cigarette remnants as an under-acknowledged, but widespread, pollutant. Cigarette butts cut down the germination success of grass by 10 percent and clover by 27 percent, and the shoot length by 13 percent and 28 percent, respectively, according to the study, which was published in the journal *Ecotoxicology and Environmental Safety*. Though plastic straws have dominated conversations for those looking to cut down on pollutants, cigarette butts are the most pervasive human-made contaminant. The BBC reports that the study says an estimated

**Defective potassium channels involved in pain detection can increase the chance of developing a headache and could be implicated in migraines, according to research in mice published in *eNeuro*.**

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4.5 trillion butts are littered globally each year. Though it's difficult to determine the amount of discarded cigarettes, estimates come from the 5.6 trillion cigarettes that are manufactured worldwide each year, most of which are "dumped irresponsibly," according to NBC News. The common ingredient in filters that spells danger for the environment comes in the form of cellulose acetate, a kind of plastic that takes at least a decade to decompose. Researchers reportedly took samples within the city of Cambridge, including some locations that had as many as 128 discarded cigarette butts per square metre. The study reportedly found no difference between harm caused by smoked cigarettes and unsmoked cigarettes. Due to the cigarette's inherent harm to the environment that is in addition to any smoke it gives off, some environmental activists have pushed for cigarette filters to be banned all together. Since the filters on cigarettes don't provide any health benefit and act exclusively as a "marketing tool," they should be banned to cut down on harm to the environment, Thomas Novotny, a professor of public health at San Diego State University told NBC News in 2018 about the push. However, a proposal for such a ban failed after being introduced by a California assemblyman and increasingly strict laws on cigarette littering have struggled to make a mark on pollution in recent years.

Science Alert, 22 July 2019

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

## These Incredible Real Tattoos Change Colour as Biomarkers Like Glucose Levels Shift

2019-07-25

Enough of biosensor "tattoos" that are just a wearable sticker. Scientists in Germany have developed an actual, intradermal tattoo that can change colour in response to changing levels of glucose, albumin, or pH. They haven't yet been tested in humans, but on pieces of pig skin the tattoos shifted across a range of hues as scientists tweaked the concentrations of the key biomarkers. It's an exciting first step that could lead to real tattoos that let patients and doctors monitor chronic diseases such as diabetes and kidney disease in real-time. The team, led by chemical engineer Ali Yetisen of the Technical University of Munich, was then able to accurately estimate the concentrations based on smartphone photos of the tattoos. While not all the dyes are yet reversible, this could be a transformative technology for personalised medicine - based on decorative body modification practices humans have been performing for thousands of years. "Body modification by injecting pigments into the dermis layer is

**Enough of biosensor "tattoos" that are just a wearable sticker.**

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a custom more than 4000 years old," the researchers wrote in their paper. "Here, a functional cosmetic technology was developed by combining tattoo artistry and colorimetric biosensors... Dermal tattoo sensors functioned as diagnostic displays by exhibiting colour changes within the visible spectrum in response to variations in pH, glucose, and albumin concentrations." The three biomarkers were chosen because they are often indicators that something is wrong. Albumin is a protein in blood plasma, and low levels can indicate kidney or liver problems, while high levels can indicate heart problems. Glucose needs to be closely monitored for the management of diabetes, which impairs the body's ability to metabolise sugars. And changes in the pH level of your blood - acidosis for low pH, alkalosis for high - can be caused by a range of issues which should be investigated by medical professionals. The team created a different colour-changing dye that could detect changes in each of these biomarkers in the interstitial fluid. That's the stuff that leaks out of your capillaries and fills the spaces between the cells, transporting things like oxygen and glucose. The albumin sensor is a yellow dye that turns green in the presence of albumin - the more albumin, the more green it becomes (although in these images it looks quite blue in colour). The glucose sensor took advantage of the enzymatic reactions of glucose oxidase and peroxidase; the changing concentration of glucose produces a structural change in the pigment from yellow to dark green. And the pH sensor consisted of the dyes methyl red, bromothymol blue, and phenolphthalein. At a pH range from 5 to 9 - normal human blood pH hovers around 7.4 - the sensor ranges from yellow to blue. When the levels of these biomarkers were changed in the interstitial fluid in the pieces of pig skin (which is a common medium for tattoo artists to practice on), the colours changed too. It's not yet ready for human use; for one thing, as we mentioned earlier, it's only been tested on pig skin so far. In addition, only the colour of the pH sensor was reversible - and it's not much help if the tattoo only works for one reading. The others could, the researchers said, be made reversible with synthetic receptors, but they've yet to test these out - that's for future research. The next step, they said, is probably to test the tattoos in living animals, to see if the inks cause adverse reactions. As researchers from MIT said when they developed similar colour-changing tattoo inks in 2017, this process could take a while. But looking into it further could definitely be worth it. "The applications of the sensors can be extended to the detection of electrolytes, proteins, pathogenic microorganisms, gases, and dehydration status," the researchers wrote. "The developed dermal sensors may have an application in medical diagnostics to monitor a broad

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range of metabolite biomarkers." All while looking badass as heck. The research has been published in *Angewandte Chemie International Edition*.

Science Alert, 22 July 2019

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

### People Are Keeping Parasitic Leeches as Pets, And Letting Them Drink Their Blood

2019-07-25

To the disgust of many of our readers, we recently discovered that keeping leeches as pets is actually a thing. And yeah, it's certainly... a bit different. But in light of humanity's disconnect with nature, and our concerning lack of knowledge about parasitic creatures, the idea that some of us are nurturing these parasites is also, uh, fascinating. "They're amazing, curious creatures that grow like crazy and make wonderful pets," leech keeper Ariane Khomjani told ScienceAlert. He explained how individual leeches have their own unique personalities, with some being more adventurous and others more shy. "Some like to try and sneak a feed more often than others, haha! But once they're full, they're content to sit and rest for a bit out of water if handled gently," he said. Khomjani has four of these squishy vampires. The species he keeps is one of the larger types: buffalo leeches (*Hirudinaria manillensis*) from Asia. There are over 600 leech species worldwide and most, but not all of them, are blood suckers. Others, like worm leeches (*Pharyngobdellida*), are predators that swallow their invertebrate prey whole, while some species are detritivores that eat organic debris. These wriggly sausages can have up to eight pairs of ocelli (eye spots), which they use to detect the shadows of potential prey. Their brain bits are spread across 32 body segments, and they are hermaphrodites, so each individual leech has both male and female organs, although they still require a mate to breed. If a hungry parasitic leech senses your body heat or the CO<sub>2</sub> in your breath, it can loop its way towards you by using its mouth and butt suckers. Yes, you read that right, their butts suck, too. If it finds a suitable bit of host, the leech will inject its saliva - which contains anaesthetic and anti-blood clotting compounds - before biting down with two- or three-pronged serrated jaws. "Once they get feeding you don't even feel it, even with the large buffalo leeches," explained Khomjani, although the initial bite can hurt a bit. They can go up to a year between feeds, but leech sellers recommend feeding the larger species every 3-6 months. Of course, as with anything involving direct contact with your bloodstream, feeding a leech your own blood should not be attempted without first seeking advice from a doctor. Some people

**To the disgust of many of our readers, we recently discovered that keeping leeches as pets is actually a thing.**

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are allergic to leech saliva and there's always a risk of catching an infection from them. Khomjani told us that while most bite wounds heal without a scar, due to the anti-coagulants in the leech saliva, it can sometimes take several days for a bite to stop bleeding. But it's exactly these saliva properties that have long made leeches of interest to humans. "Leeches have been linked with human culture, particularly in Europe, for centuries," parasitologist Mackenzie Kwak from National University of Singapore told ScienceAlert. In fact, we have been keeping leeches, primarily for medical purposes, for around 3,000 years. During the Victorian era (in the 1800s) they were recommended for treating everything from headaches to nymphomania. This craze led to a rather absurd battle between rival pharmacies, who produced increasingly elaborate leech jars in order to entice customers to choose their product. They were ridiculous, huge, over the top, and not really even practical for storing the escape artist leeches at all. But ultimately it was all about appearances, and a more eye-catching display meant more customers. This historic use of leeches severely reduced medicinal leech (*Hirudo medicinalis*) populations across Eurasia, so this species is now protected. Today, leeches are still kept for use in both human and animal medicine around the world and are approved by the US Food and Drug Administration (FDA) as "medical devices". "Leeches are used post-operatively in patients who have had digit reattachment or muscle or flap surgery," nurse Julie Smolders from South Western Sydney Local Health District told ScienceAlert. "The leeches are applied to the site and suck away the congested blood to allow for blood flow to the peripheries to keep the surgical site viable." The hospitals keep 100-200 leeches to make use of this blood-vessel clearing ability. These leeches are sourced from captive bred populations raised in controlled environments, to help minimise the potential risk of infection. If the idea of keeping one of these little Draculas intrigues you, but you've no interest of offering yourself up as a meal, there are various accounts online of pet leeches being fed raw liver or heated blood from the butcher. "Provided the blood [is] fresh and not treated with any preservatives or anything like that, I could see that sort of thing potentially working," Kwak told ScienceAlert, pointing out that parasitologists and medical entomologists have been using similar techniques to maintain parasites in laboratories for decades now. He believes "pet leeches are a marvellous way to learn about parasites, and on a broader level, to appreciate how intricate and bizarre the natural world can be." When asked about people's negative reactions

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to his pets, Khomjani replied, "could you imagine the outrage if someone talked about dogs and cats the way you see them talk about leeches?"

Science Alert, 21 July 2019

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

## Here's Why Instagram Getting Rid of Likes Could Be a Big Deal For Our Mental Health

2019-07-25

Instagram is running a social media experiment in Australia and elsewhere to see what happens when it hides the number of likes on photos and other posts. If you have an Instagram account, you'll get to see the numbers but your followers won't – at least, not automatically. They will be able to click and see who liked your post, but will have to count the list of names themselves. The trial is taking place right now in six countries: Australia, Brazil, Canada, Ireland, Italy, Japan and New Zealand. Canada has just finished its trial. It's a bold move by Instagram, but arguably a necessary one. There is growing concern about the effect of social media on young people's mental health and self-esteem. Instagram explained: We want your friends to focus on the photos and videos you share, not how many likes they get. Likes, and their public tallying, have become the heart of Instagram and many other social media platforms. By hiding them, does Instagram risk devaluing a crucial currency? Receiving loads of likes can feel like getting a gold star. It's a public affirmation that you're doing good work – a useful bit of quantitative feedback on your photographic skills or creativity. Under the new trial you'll still get the gold star, but in private, and without broader recognition. Nevertheless, the mental health repercussions of counting likes cannot be ignored. The design of social media promotes social comparison. You don't have to spend long on Instagram to find a plethora of people who are evidently better-looking, more successful, and more glamorous than you. As a result, young people can be left feeling inadequate and unworthy. Teens report that social media makes them feel closer to friends (78%), more informed (49%), and connected to family (42%). Yet many teens also report feeling pressure to always show the best versions of themselves (15%), overloaded with information (10%), overwhelmed (9%), or the dreaded "fear of missing out" (9%). These positive and negative reactions can see-saw, depending on a person's particular mindset at the time.

Will comments become the new likes?

**Instagram is running a social media experiment in Australia and elsewhere to see what happens when it hides the number of likes on photos and other posts.**

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Without a public tally of likes, it is likely that comments will become an even stronger indicator of how people are interacting with a particular Instagram post. Of course, comments can consist of anything from an emoji to an essay, and are therefore much more varied and adaptable than likes. Yet they can still affect users' emotions and self-worth, particularly because (unlike likes), comments can be negative as well as positive. The reaction among Australian Instagram users has so far been mixed. Many are disgruntled about the change, feel manipulated by the platform, and argue that the change will reduce Instagram's appeal, particularly among those who use it to support their business. But others have applauded the move on mental health grounds, while others still have reported that they are already feeling the difference that the experiment is designed to deliver. Nevertheless, people could potentially move away from Instagram if they don't feel it benefits them in the way they want. This could conceivably leave the market open for new social media platforms that unabashedly count likes for all to see. Finally, there is the question of whether this is nothing but a PR stunt by a global mega-brand. It's perhaps natural to be sceptical where the social media industry is concerned. But if this is a genuine move by Instagram to ameliorate the negative mental health effects of social media, then it's a valuable experiment, and the results may be very beneficial for some. Let's hope so.

Science Alert, 20 July 2019

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

### Using smart watches to monitor your heart could do more harm than good

2019-07-25

Self-empowered, self-motivated, self-aware: we have got used to the idea that more knowledge about our health is good for us. This ethos has fuelled an explosion in wearable technologies – fitness trackers, step counters and other gizmos – that give us real-time feedback on key physiological stats such as heart rate. Recently, the makers of the bestselling fitness tracker, the Apple Watch, began to roll out a new feature: the ability to monitor heart rhythm, and specifically to detect atrial fibrillation. Atrial fibrillation is a relatively common heart condition in which the two atria of the heart – the upper chambers – don't contract regularly. It can be constant, or intermittent, and becomes more common with age. It increases the risk of blood clots forming and causing a stroke. Those with the condition may need medication to thin their blood and allow their hearts to work efficiently. So why wouldn't you want to know

**Fitness trackers like the Apple Watch now allow you to detect heart conditions such as atrial fibrillation. That's not always a good thing, says doctor Margaret McCartney**

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if you had it? Certainly, some doctors I have spoken to welcome the diagnostic possibilities that wearables bring; many are enthusiastic users themselves. The problem is that this is mass screening via the back door, with all the associated positives and negatives. At its best, screening finds diseases at an early stage so that adverse consequences can be avoided. At its worst, it causes far more damage than the disease itself through false positives and unnecessary worry and treatment. In the UK, the National Health Service follows evidence-based recommendations made by the National Screening Committee. Its current advice is clear: don't screen for atrial fibrillation. That is because we have evidence that treatment works for people with symptoms, or those found to have the condition while being assessed for another condition. There is no evidence that treatment benefits outweigh the risks for a wider, asymptomatic population. A recent US paper suggests that 10,000 asymptomatic older people would have to be screened to detect 50 people with atrial fibrillation, and all those 50 would have to be treated to prevent one stroke. Meanwhile preliminary results of one study, funded by Apple, find that diagnoses of atrial fibrillation could be confirmed by a subsequent electrocardiogram only in about a third of cases. All this matters because the side effects of the blood thinners used to treat atrial fibrillation can be severe, ranging up to bleeding into the brain or gut. Such treatment would of course only be prescribed after consultation with a doctor. But if you are already finding it difficult to get a doctor's appointment, think of the impact of a lot of false positives landing on their desk. In the UK, the SAFER (Screening for Atrial Fibrillation with ECG to Reduce stroke) study is getting under way to test whether mass screening for atrial fibrillation is useful, with ethics committee oversight and informed consent. In the meantime, if you have symptoms – breathlessness, chest pain – you should see a doctor. If you want to be screened, enter a trial. Just because early detection sounds sensible doesn't mean it is good for us.

New Scientist, 17 July 2019

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

## “Forever chemical” replacements on the rise in the Great Lakes

2019-07-25

As industry phases out certain toxic PFAS chemicals, the compounds are decreasing in and around the Great Lakes, but replacement chemicals—which some argue also pose serious health concerns—are increasing, according to new research from Canada. This study, which contains the

**Phased-out compounds are decreasing in the Great Lakes, but replacements keep showing up.**

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longest, consistent record of PFAS in Great Lakes precipitation, confirms that environmental practices and regulation can reduce these toxic “forever chemicals” in the environment, but raises questions about whether or not the same will hold true for their replacements. PFAS (per- and polyfluoroalkyl substances) are a large class of chemicals used in firefighting foam, flame retardants and non-stick and waterproof materials that have recently come under scrutiny for building up to toxic levels in humans and their lack of regulation. They are linked to multiple health problems including cholesterol, fertility and thyroid problems and kidney and testicular cancers. At the same time, PFAS are showing up in drinking water supplies across the country, especially near old industrial sites, where they were used in manufacturing textiles, paper products, plastics and metals. Michigan, which is bordered by four Great Lakes, is one of the most PFAS contaminated states: 62 sites have confirmed PFAS pollution and state officials have created a PFAS response team and are ramping up monitoring at municipal water systems and schools. In the early 2000s, major PFAS manufacturers began phasing out longer chain PFAS molecules for shorter ones, which perform similar functions, but don't accumulate as readily in the bloodstream. “If you phase out chemicals and implement regulations, that will be reflected in our environment,” Sarah Gewurtz, a co-author of the new study and a physical scientist with Environment and Climate Change Canada, told EHN. While some argue these short-chain PFAS are safer for that reason, growing research casts doubt on those claims. Since 2006, the team of Canadian researchers have looked for perfluoroalkyl acids (PFAAs) in precipitation at three locations across Lakes Superior, Huron and Ontario. Each month for more than a decade, the team collected precipitation and compared levels of PFAAs to periodic samples of surface water. They found that long-chain PFAAs are decreasing in the Great Lakes as they are phased out, while their short-chain replacements are increasing. PFAAs are a class of PFAS, many of which are the end result of other PFAS breaking down in the environment. They are often the end point for degradation—like a stable isotope at the end of radioactive decay—which means they'll stick around for a long time. They're also mobile—moving around in water and in the air—and build up in animal and human blood and tissues. As a result of their research the scientists suggested that local levels of short-chain PFAAs might respond slower to any bans or regulation because they easily travel long distances through the atmosphere, according to their study published in June in the journal *Environmental Science and Technology*. Starting in the early 2000s, concern over several long-chain PFAS pushed industry to phase out those chemicals for short-chain alternatives that function similarly. Touted as safer alternatives, these

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short-chain replacements have one distinct benefit: they don't build up in bloodstreams in the same way their longer counterparts do. Because of this difference, some argue that short-chain PFAS wouldn't harm humans. That theory is starting to show some holes, Tom Bruton, senior scientist at the Green Science Policy Institute, told EHN. First, a chemical that's less toxic than its alternative isn't necessarily safe. And second, ongoing research is raising some questions about the safety of short-chain PFAS. There is some evidence that they can cause similar health issues as their long-chain forbearers.

Bruton said people should think twice about releasing large amounts of a poorly understood chemical into the environment. Even if a substance causes little harm at low levels, it could prove harmful at greater concentrations. He pointed to emerging research that showed short-chain PFAS accumulating not in the bloodstream, but elsewhere in the body, though industry and other researchers dispute its findings. "They're going to accumulate somewhere," Bruton said. Even if they don't accumulate in humans, they are accumulating, in some cases, in drinking water and agricultural land. Because short-chain PFAAs are new and poorly understood, it's unwise to increase the dose people are exposed to, Bruton said. Bruton likens it to aspirin. Taking one a day for blood pressure isn't going to hurt but taking too many at once could cause problems, even though aspirin doesn't accumulate in the body. PFAS moves from water bodies to humans through public water systems, but can also move through food. Michigan has also issued 13 do not eat advisories for fish throughout the state and 37 others to limit consumption because of PFAS. It has also told hunters not to eat deer killed within five miles of a former Air Force base on the Lake Huron shore. Groundwater at 62 sites in Michigan have PFAS levels more than 10 parts per trillion but less than the EPA lifetime health advisory of 70 parts per trillion. Nearly all have identifiable, local sources: often current or former military, industrial or landfill sites. Short-chain PFAAs are also harder to filter out of water than their long-chain counterparts. That could mean expensive upgrades for municipal water treatment systems. "At large scale short-chain PFAAs can only hardly, if at all, be removed from the environment with the main methods available today," wrote the authors of a 2018 study that outlined the environmental concerns of the short-chain chemicals. In 2018, Grand Rapids, Michigan, tested for and found low levels of two common long-chain PFAS: PFOA and PFOS. If high concentrations of short-chain PFAS appeared in Lake Michigan, where Grand Rapids gets its water, it would cost a lot to address the problem, Dave Harran, water system manager for Grand Rapids, told EHN. "It would certainly require a hefty change

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on our part to remove the contaminants,” he said. “We had run some rough numbers and we were looking at double-digit million dollars to revamp the treatment system.” Harran said that because PFAS levels are low in Grand Rapids drinking water, huge investments in new filtration aren’t being considered at this time. More effort is being made to take PFAS out of Grand Rapids wastewater, which would eventually get into the surrounding rivers and lakes. Although long-chain PFAS in the lakes decreased with their levels of production, amounts of short-chain PFAS might not drop quickly following a similar decrease. Many short-chain PFAS move more freely through the atmosphere and drop out of the sky wherever they’re caught up in precipitation. They’re a global pollutant. The Canadian research team speculated that, unlike long-chain PFAAs, which responded to local regulation, short-chain PFAAs could continue to rain into the Great Lakes long after local sources have been stopped. Stopping release of the short-chain chemicals in and around Lake Ontario wouldn’t stop them from blowing in from sources on the other side of the world, Gewurtz said. It’s the same phenomenon that led to elevated levels of PFAS at the poles. “Because they’re smaller, they’re lighter, so they’ll travel farther,” Gewurtz said. The mobile and persistent nature of short-chain PFAS makes understanding their effect on and movement in the environment difficult. Where they show up is a complicated matter because they are both released into the environment themselves—say, as firefighting foam—and show up after their precursors degrade. Add their ability to travel long distances through the air and it’s difficult to predict where they’ll be. “They don’t behave like other contaminants, such as PCBs,” Gewurtz said. For predictable contaminants like PCBs (polychlorinated biphenyls), researchers can rely on models to predict how and where they’ll move in the environment. Some models have been built but aren’t as accurate as those for other toxics. The fact that models don’t work for PFAAs makes long-term data sets like the one Gewurtz and her colleagues gathered the best path for understanding them and how they respond to any eventual regulation. “We really need these data sets,” she said.

Environmental Health News, 22 July 2019

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

**The agency says the widely used chemical chlorpyrifos is an important tool for the nation’s farmers.**

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#### **EPA will not ban use of controversial pesticide linked to children's health problems**

2019-07-25

The United States Environmental Protection Agency rejected a petition by environmental and public health groups to ban a widely used pesticide that has been linked to neurological damage in children, even though a federal court said last year there was “no justification” for such a decision. In a notice to the Federal Register on Thursday, the agency wrote that “critical questions remained regarding the significance of the data” that suggests that chlorpyrifos causes neurological damage in young children. The agency said that the Obama administration’s decision to ban the product — used on more than 50 crops, including grapes, broccoli and strawberries — was based on epidemiological studies rather than direct tests on animals, which have historically been used by the EPA to determine a pesticide’s safety. The EPA’s decision, which represented a win for industry, drew swift condemnation from groups that have pushed for years to remove the pesticide from the market. “By allowing chlorpyrifos to stay in our fruits and vegetables, Trump’s EPA is breaking the law and neglecting the overwhelming scientific evidence that this pesticide harms children’s brains,” Patti Goldman, an attorney for the environmental law organisation Earthjustice, said in a statement. “It is a tragedy that this administration sides with corporations instead of children’s health.” Still, the decision to deny the petition could bring the country closer to final resolution of a decades-long battle over a pesticide used on fruits, vegetables and cereals that Americans eat every day. Kevin Minoli, a partner at the Alston & Bird law firm, said agency critics can now challenge the EPA’s conclusion that the pesticide is safe. He noted that judges on the U.S. Court of Appeals for the 9th Circuit have already indicated “they have significant concerns about the safety of chlorpyrifos.” “This is the entry ticket to the actual main event,” said Minoli, who served in the EPA’s Office of General Counsel under multiple Republican and Democratic administrations. “This is the end of the road.” The Obama administration had proposed in 2015 to revoke all uses of chlorpyrifos after EPA scientists determined that existing evidence did not meet the agency’s threshold of a “reasonable certainty of no harm,” given exposure levels in Americans’ food supply and drinking water. EPA staffers cited studies of families exposed to it in apartment buildings and agricultural communities that found lower birth weight and reduced IQ, among other effects. But before the ban was finalised, President Trump took office and reversed course. In March 2017, then-EPA Administrator Scott Pruitt rejected the agency’s own analysis, saying the agency would reassess the science underpinning that

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decision and make a final determination in 2022. That action, welcomed by the pesticide industry and Agriculture Department officials who had questioned the EPA's findings, led to the latest court fight. Farmers have pressed to keep chlorpyrifos, which has long been banned from indoor use, available for use on crops. John Chandler, a fourth-generation farmer in Selma, Calif., grows peaches, plums, almonds, citrus and grapes for raisins and wine on his property. He said his operation uses chlorpyrifos on rare occasions, such as during an outbreak of the vine mealybug on grape crops. "It's kind of the last resort," Chandler said, adding that his family works to minimize their employees' exposure to the pesticide. "We train our workers very diligently on proper procedures." The industry welcomed the EPA's decision Thursday, even as manufacturers of the pesticide acknowledged that its approved uses could change over time as researchers gather more data. Gregg Schmidt, a spokesman for Corteva Agriscience, the pesticide's main manufacturer, said the company supports "critical uses of chlorpyrifos" while the EPA continues to review the pesticide and the scientific data around it. "We are committed to working with the agency as it seeks to make an accurate assessment and, if necessary, reduce potential exposures, while also ensuring that growers for whom chlorpyrifos is a critical tool can continue to use the product safely," Schmidt said in a statement.

Chris Novak, chief executive of the industry group CropLife America, said farmers and public health officials still rely on chlorpyrifos to control a number of "deadly and debilitating" pests, including mosquitoes. He added that the group supports funding to ensure that the EPA has adequate resources to test and regulate chlorpyrifos and other pesticides. The EPA said in a statement Thursday that it plans to expedite a review of chlorpyrifos, "which should be completed well before the 2022 statutory deadline." The agency also acknowledged it was in discussions with makers of the pesticide that "could result in further use limitations." The Trump administration's decision to keep the pesticide on the market comes as some major states — including California and New York — have taken steps to ban chlorpyrifos outright. California health officials said in May that their decision came amid growing evidence that the pesticide "causes serious health effects in children and other sensitive populations at lower levels of exposure than previously understood." California Gov. Gavin Newsom (D) proposed \$5.7 million to support the transition to "safer, more sustainable alternatives," according to the California Environmental Protection Agency. California's proposed ban is expected to take six months to two years to take full effect and comes as other states have started taking similar action. Last year, Hawaii became the first state

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to ban pesticides containing chlorpyrifos, though that ban will not take effect until 2022. New York state lawmakers recently approved legislation to ban the pesticide by Dec. 1, 2021. Oregon, Connecticut and New Jersey also are considering measures to take chlorpyrifos off the market. Chlorpyrifos has been used for a half-century on a wide array of crops and in virtually every corner of the country. But as evidence has grown over time about its potential health risks, the government has scaled back its use. Beginning in 2000, companies making chlorpyrifos entered into an agreement with the EPA to phase out residential use of the chemical, aside from a handful of exceptions, such as in ant and roach baits sold in child-resistant packaging. Two years later, the EPA put in place additional label changes aimed at protecting agricultural workers, as well as fish, other wildlife and water sources near where it is sprayed. But all that stopped short of banning chlorpyrifos in agriculture altogether — an outcome that advocates argue is long overdue. “Today’s decision is shameful,” Kristin Schafer, executive director of the Pesticide Action Network, said in an email. “It flies in the face of decades of strong scientific evidence, and the recommendations of the agency’s own scientists. This administration is putting children, workers and rural families across the country at continued risk for no good reason, and we will continue to press for a full federal ban of this dangerous chemical. This administration has made perfectly clear who they are working for.”

The Washington Post, 18 July 2019

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

### Plant-based diets tied to lower risk of type 2 diabetes

2019-07-25

People who tend to eat mostly plants may be less likely to develop type 2 diabetes, a research review suggests. Researchers examined data from nine previously published studies with a total of 307,099 participants, including 23,544 people who developed type 2 diabetes. The length of the studies ranged from 2 to 28 years. All of the studies used food frequency questionnaires to assess participants’ diets. Overall, people who most closely adhered to a vegan, vegetarian or other type of plant-based diet were 23% less likely to develop type 2 diabetes than people who consumed the least amount of plant-based meals, researchers report in *JAMA Internal Medicine*. “Plant-based diets can promote metabolic health and reduce diabetes risk through many pathways, including preventing excess weight gain, improving insulin sensitivity, reducing inflammation, and other mechanisms,” said Dr. Qi Sun, senior author of the study and a

**People who tend to eat mostly plants may be less likely to develop type 2 diabetes, a research review suggests.**

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researcher at the Harvard T.H. Chan School of Public Health and Brigham and Women's Hospital in Boston. People who eat a healthy variety of plant-based meals can lower their diabetes risk even when they're not strict vegetarians - avoiding meat, poultry and fish - or vegans - also avoiding animal products like milk and eggs. But they may not benefit as much if their plant-based diet is full of foods like French fries, white bread, and white rice, Sun said by email. "It does matter what veggies people eat and how the veggies are processed," Sun said. "Therefore, consuming healthy plant foods that are not or minimally processed, such as fresh fruits and vegetables, legumes, nuts, and whole grains, should be emphasised." People in the study who followed this advice - with the healthiest mix of fruits, vegetables and whole grains in their plant-based diets, were 30% less likely to develop type 2 diabetes than participants who tended to ignore this idea. Type 2 diabetes, the most common form, is linked to obesity and aging and happens when the body can't properly use or make enough of the hormone insulin to convert blood sugar into energy. Left unchecked, diabetes can lead to serious complications like nerve damage, blindness, amputations, kidney damage and heart problems. Doctors typically advise patients with type 2 diabetes to follow a low-calorie, low-fat and low-carbohydrate diet that includes lots of fresh fruits, vegetables and whole grains as well as lean poultry and fish. Fatty, sugary foods are discouraged along with consuming too much red or processed meat. None of the smaller studies in the current analysis were controlled experiments designed to prove whether a plant-based diet helps prevent diabetes or serious complications from the disease. Still, the results offer fresh evidence of the potential for good eating habits to help prevent and manage diabetes, said Samantha Heller, a nutritionist at New York University Langone Medical Centre in New York City. "Adding more whole plants such as broccoli, edamame, quinoa, extra virgin olive oil, almonds, and berries, to our diet is a great way to help manage type 2 diabetes and weight," Heller, who wasn't involved in the study, said by email. "Higher fibre foods are healthy for the gut microbiome, improve gastrointestinal function, improve insulin sensitivity, and help manage blood sugar," Heller added. "However, it is important to remember that even (portion sizes) of healthy foods matter."

Reuters Health, 23 July 2019

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

**"The hotter it gets, the more the stuff in plastic can move into food or drinking water."**

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#### Exposed to extreme heat, plastic bottles may ultimately become unsafe

2019-07-25

In hot environments, before you reach for a plastic water bottle to keep hydrated, you might think twice about whether it too has been wilting under a hot sun. "The hotter it gets, the more the stuff in plastic can move into food or drinking water," says Rolf Halden, director of the Centre for Environmental Health Engineering at Arizona State University's Biodesign Institute. Most plastic items release a tiny amount of chemicals into the beverages or food they contain. As temperature and time increase, the chemical bonds in the plastic increasingly break down and chemicals are more likely to leach. According to the FDA, the amounts of the chemicals are too minuscule to cause health problems, but scientists looking at the long-term effects of filling our lives with plastic say all those small doses could add up in a big way.

#### A single-use bottle on a hot summer day

Most of the water bottles you find on supermarket shelves are made of a plastic called polyethylene terephthalate, or PET. It's recognisable by the recycling number one and accepted by most curbside recycling programs. A study conducted by scientists at Arizona State University in 2008 looked at how heat sped up the release of antimony in PET bottles. Antimony is used to manufacture the plastic and can be toxic in high doses, the NIH reports. In mild, 21-degree centigrade weather, the researchers measured safe levels of the chemical in the bottled water. But the hotter the day, the less time it took for water to become contaminated. A hot car can reach temperatures over 65 degrees centigrade in the summer. In experiments, it took 38 days for water bottles heated to that temperature in a lab to show levels of antimony that exceeded safety recommendations. "As a general rule, yes, heat helps break down chemical bonds in plastics like plastic bottles, and those chemicals can migrate into beverages they contain," emails Julia Taylor, a scientist who researched plastic at the University of Missouri. In 2014 scientists found high traces of antimony and a toxic compound called BPA in water sold in Chinese water bottles. In 2016 scientists found high antimony levels in bottled water sold in Mexico. Both studies tested water under conditions that exceeded 150 degrees Fahrenheit, representing worst-case scenarios. According to industry group the International Bottled Water Association, bottled water should be kept in the same conditions that consumers keep other groceries. "Bottled water has an important role in emergency situations. If you're at risk of dehydration, it doesn't matter what container that comes in. But for

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the average consumer," says Halden, "there is really no benefit for using all these bottles."

#### What about reusable containers?

Water bottles that can be used repeatedly are most often made from high-density polyethylene (HDPE) or polycarbonate. HDPE is largely accepted by recycling programs (recycling code number two), but polycarbonate is more difficult to recycle (recycling code number seven). To make those bottles hard and shiny, manufacturers often use bisphenol-A or BPA, a compound that has come under fire for its toxicity. BPA is an endocrine disrupter, which means it can disrupt normal hormone function and lead to a slew of dangerous health issues. Studies have linked the compound to breast cancer. The FDA bans BPA from baby bottles and sippy cups, but has found no evidence to support additional restrictions. Regardless, many manufacturers have responded to consumer concerns by making their products BPA free. "'BPA free' does not necessarily mean 'safe,'" says Taylor. She notes that bisphenol-S is often used as an alternative even though it's "structurally similar to BPA and turns out to have very similar properties." Fewer studies have been done on what happens to water when left in reusable water containers in high temperatures, but research done by pouring boiling water into polycarbonate indicated that more BPA leached out as a result. "The bottom line is that glass is better than plastic, wherever possible," says Taylor. "Otherwise, the message should be to keep the water bottle in a bag or covered when not in use (not exposed to bright sunlight for long periods of time) and not to leave plastic bottles in a hot car as temperatures rise fast at this time of year."

#### What's the big picture?

Ultimately, the amount of trace chemicals a person might consume from a plastic food or drink containers left in the heat won't derail their health. But Halden says we should be concerned about how much plastic we surround ourselves with on a daily basis. "If you drink water from one PET bottle, will that hurt your health? Probably not," he says. "But if you go through 20 bottles a day, then the question of safety is an entirely different one." He notes that the cumulative effect of being surrounded by plastics in the goods we buy or microplastics in our water has the biggest potential health impact. Personally, Halden opts for a metal water bottle instead of a reusable plastic one when trying to stay hydrated on the go.

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"If you don't want it in your body, don't increase the material flow of it into society," he says.

National Geographic, 21 July 2019

[www.nationalgeographic.com.au](http://www.nationalgeographic.com.au)

### Where you grew up, what you ate—your bones record your life

2019-07-25

What's on your plate? The answer doesn't just matter for your next dinner—it's an issue of critical importance to archaeologists, who can infer everything from individual diets to large-scale population movements based on the chemistry of an ancient bone sample. Stable isotope analysis, the study of the nuances of elements in archaeological materials, can unlock all sorts of secrets about climate, diet, and the geographical origins of bones and other materials. Stable isotopic analysis looks at the isotopes—atoms with extra or missing neutrons—of different elements. Unlike unstable isotopes such as carbon-14, which degrades over time, stable isotopes never decay. There are over 250 known stable isotopes, and 80 of the periodic table's first 82 elements have them. Both organic and inorganic compounds contain these isotopes, and their ratios relative to one another act like a signature. (Learn how carbon isotopes help date ancient objects.) Carbon dating isn't a silver bullet for dating – but it can help archaeologists unpick the mysteries of past diets, climate conditions and lifestyles, as well as date remains.

#### Solving ancient mysteries

In the 1970s, archaeologist Nikolaas van der Merwe uncovered a skeleton that did not look like the others at the South African site he was excavating. Together with isotope physicist John Vogel and palaeoanthropologist Philip Rightmire, he decided to apply new scientific techniques with isotopes to the skeleton. The analysis revealed the ancient human had a different diet from others discovered during the excavation, which suggested previously unsuspected interactions between hunter gatherers like the people uncovered at the site and farmers in the region. Van der Merwe and Vogel went on to use stable isotope analysis on archaeological materials from the United States to show that maize had been introduced in the Eastern Woodland region of North America around 1,000 A.D. Isotope signatures are extremely useful for researchers. For example, plants absorb stable carbon-12 and carbon-13 isotopes, which

**Archaeologists use isotopic analysis to determine population movements and diets from chemical signatures in ancient human remains.**

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have a consistent ratio to one another in Earth's atmosphere. That ratio is passed on to plants through the soil and water they absorb. During photosynthesis, the amount of water, sun, and other factors changes the plants' carbon isotope ratio. There are three categories of carbon ratios for plant photosynthesis: C3, C4, and CAM. Each tells researchers something about where the plants were cultivated and what kinds of environmental conditions they endured. As plants are ingested by animals, they become part of their bodies. In turn, analysing the amount of carbon in animal hair, teeth, and bones shows the ratio of carbon isotopes contained in the plants they consumed. That can reveal their photosynthesis types, which points to what kinds of plants an organism ate and which environmental conditions created them. Isotopes can also point to weather conditions sustained by an individual (people who live in arid environments, for example, contain more nitrogen-15) or suggest how populations moved.

#### Snapshots in time

Other isotopes reveal all sorts of information about archaeological materials. Strontium isotopes are absorbed into teeth during their creation, creating a snapshot of sorts of where an individual lived during their childhood. But bone cells turn over constantly, gathering strontium signatures that reflect where individuals lived later. Comparing the two can reveal movement over an individual's lifespan or show that an individual wasn't born at the site at which they were recovered. And nitrogen isotopes can reveal how old a child was when he or she started eating solid foods. Stable isotopes are now used to study everything from bones to food residues on pots. They can also be used to identify the source of different metals. But isotope analysis isn't a silver bullet—it's expensive, the technique does not work on materials that have been burned, and contamination must be carefully avoided. And the older the specimen, the less that can be inferred from it, since bone collagen breaks down after about 50,000 years. Still, atoms can tell plenty about the origins and behaviours of the people whose burial sites have become archaeological digs.

National Geographic, 19 July 2019

[www.nationalgeographic.com.au](http://www.nationalgeographic.com.au)

**Heart attack rates dropped among older adults in Scotland in the decade after a nationwide indoor smoking ban took effect, a new study suggests.**

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#### Indoor smoking ban tied to heart attack decline in older adults

2019-07-25

Heart attack rates dropped among older adults in Scotland in the decade after a nationwide indoor smoking ban took effect, a new study suggests. Scotland banned smoking in all enclosed public spaces and workplaces in 2006. There was a 17% reduction in heart attacks in the first year after the ban took effect, compared to just a 4% decline over the same period in England, where public smoking rules didn't change, the study team notes. In Scotland between 2000 and 2016, there were a total of 117,161 heart attacks. Among men and women aged 60 and older, the smoking ban was followed by a roughly 13% reduction in heart attacks over the study period. The ban didn't appear to impact heart attacks for younger people, however. "People tend to start smoking when they are young, many years before they reach the age at which heart attacks tend to occur," said Dr. Jill Pell, director of the Institute of Health and Wellbeing at the University of Glasgow in the UK and co-author of the study. "Therefore, any effect from discouraging people from starting to smoke is likely to take more time to become apparent," Pell said by email. Even before the smoking ban, heart attack rates were declining in Scotland, the study team notes in *Circulation: Cardiovascular Quality and Outcomes*. But the legislation contributed to additional reductions, they conclude. In a previous study of the smoking ban, Pell and colleagues found a reduction in heart attacks among both smokers and non-smokers, she said. In a separate study, they also found that the number of smokers trying to quit increased immediately prior to the ban. While these studies were not designed to prove whether or how the ban directly prevented heart attacks, "there is likely to be a contribution from both encouraging smokers to quit and from protecting both non-smokers and smokers from other people's second-hand smoke," Pell said. Heart attack rates dropped slightly more for women over 60: 14% versus 13.2% for men. "In younger people overall, there appeared to be less of an impact across the 10-year period," said Stephanie Mayne, a researcher at the Children's Hospital of Philadelphia and the Perelman School of Medicine at the University of Pennsylvania who wasn't involved in the study. "This might be due to changes in other heart disease risk factors, like obesity and diabetes, during the same time period," Mayne said by email. Even so, the results offer fresh evidence of the benefits of avoiding second-hand smoke and living in places where it's not as easy to start or continue smoking, said Judith Prochaska, a researcher at Stanford University in California who wasn't involved in the study. "As much as feasibly possible, avoid exposure to second-hand

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smoke,” said Prochaska, who has received funding from Pfizer and Achieve, companies that make smoking cessation drugs. “If you live with someone who smokes, work to set up a policy to limit smoking to outside of the home and not in the car,” Prochaska said by email. “And if you live in an apartment complex that allows smoking, advocate for a change in policy.”

Reuters Health, 20 July 2019

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

### Paint makers reach \$305 million settlement in California, ending marathon lead poisoning lawsuit

2019-07-25

After a 19-year legal struggle, three former makers of lead paint have agreed to a \$305 million settlement with California county and city governments to mitigate poisoning dangers still present in old housing. Under the deal, disclosed in a filing in Santa Clara County Superior Court recently, defendants Sherwin-Williams, ConAgra Grocery Products Co. and NL Industries agreed to pay out the sum over six years, starting with a \$75 million payment later this year. The defendant paint companies did not admit any wrongdoing under the settlement. Most of the money will go toward a remediation program to eliminate lead paint hazards in older homes across the 10 jurisdictions that participated in the suit. These include Los Angeles, San Francisco, Alameda, and Santa Clara counties, as well as individual cities such as Oakland and San Diego. During the litigation, the plaintiffs had sought a far larger judgment mandating removal of lead paint from hundreds of thousands of older homes. Just how many homes can be made safer with the settlement funds isn't clear. Last year, Santa Clara County Superior Court estimated that inspecting one housing unit would cost around \$140 on average, while lead paint remediation would cost around \$1,500 per unit. Some of the settlement money - 17% - is also due to outside counsel hired by local governments during the case. The home clean-up program will be free for property owners who qualify to participate, and officials have said the remediation efforts could prevent thousands of new lead exposure cases. “This landmark settlement will allow thousands of homes to be remediated, and as a result current and future generations of California children will no longer face the threat of lead poisoning,” said James Williams, Santa Clara County Counsel. Sherwin-Williams said the settlement was favourable, limiting its liability. It pledged to fight other lawsuits over its legal advertising or sales of lead paint many decades ago, before U.S. sales were banned. “Sherwin-Williams is pleased to have reached an agreement

**After a 19-year legal struggle, three former makers of lead paint have agreed to a \$305 million settlement with California county and city governments to mitigate poisoning dangers still present in old housing.**

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to resolve this litigation, and it will continue to vigorously and aggressively defend against any similar current or future litigation,” the company said in a statement. Michael Cummins, a spokesman for ConAgra, said the company is “pleased to have reached a resolution to put this nearly 20-year old litigation behind us.” The local governments first brought the lawsuit in 2000 with the aim of making the companies pay billions for the clean-up. They claimed the companies knew of the toxic dangers of lead paint when they marketed it for decades before the U.S. government banned its use in homes in 1978. The companies contended they did not continue marketing leaded paints once the risks were known. They also argued that private property owners were responsible for the upkeep of homes to ensure potential paint hazards would not harm residents. The settlement represents a rare success for plaintiffs suing paint companies under the so-called public nuisance doctrine, which allows public entities to sue parties whose activities negatively impact broad communities by infringing upon a public right. Public nuisance cases against former lead paint makers have failed in other states, including Rhode Island, Illinois and Missouri. Still, the \$305 million falls far short of what the plaintiffs had counted on until recently. In a 2014 trial verdict, the companies were ordered to pay \$1.15 billion, but in 2017 an appeals court decision led to the judgment being reduced to \$409 million. Taken together, the court decisions also restricted how the money could be spent. For instance, the funds could only be used to fix paint hazards in the interior of homes built before 1951, though lead paint continued to be sold into the 1970s and exterior paint also harms children. The plaintiffs had also faced a short, four-year window to complete the clean-up program, after which unspent funds would be returned to the companies. In striking a compromise for a lesser amount, the California jurisdictions managed to get those terms lifted, giving them more leeway and no time constraint on using the remediation funds, the court filing showed.

Reuters Health, 18 July 2019

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

### **Evolutionary gene loss may help explain why only humans are prone to heart attacks**

2019-07-25

Researchers at University of California San Diego School of Medicine say the loss of a single gene two to three million years ago in our ancestors may have resulted in a heightened risk of cardiovascular disease in all humans as a species, while also setting up a further risk for red meat-

**Researchers at University of California San Diego School of Medicine say the loss of a single gene two to three million years ago in our ancestors may have resulted in a heightened risk of cardiovascular disease in all humans as a species, while also setting up a further risk for red meat-eating humans.**

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eating humans. The findings are published July 22, 2019 in PNAS. Atherosclerosis—the clogging of arteries with fatty deposits—is the cause of one-third of deaths worldwide due to cardiovascular disease. There are many known risk factors, including blood cholesterol, physical inactivity, age, hypertension, obesity and smoking, but in roughly 15 percent of first-time cardiovascular disease events (CVD) due to atherosclerosis, none of these factors apply. A decade ago, Nissi Varki, MD, professor of pathology at UC San Diego School of Medicine, with co-author Ajit Varki, MD, Distinguished Professor Of Medicine and Cellular And Molecular Medicine, and colleagues noted that naturally occurring coronary heart attacks due to atherosclerosis are virtually non-existent in other mammals, including closely related chimpanzees in captivity which share human-like risk factors, such as high blood lipids, hypertension and physical inactivity. Instead, chimp “heart attacks” were due to an as-yet unexplained scarring of the heart muscle. In the new study, the Varkis, and Philip Gordts, Ph.D., assistant professor of medicine, and others report that mice modified to be deficient (like humans) in a sialic acid sugar molecule called Neu5Gc showed a significant increase in atherogenesis compared to control mice, who retain the CMAH gene that produces Neu5Gc. The researchers—members of the Glycobiology Research and Training Centre and/or the Centre for Academic Research and Training in Anthropogeny at UC San Diego—believe a mutation that inactivated the CMAH gene occurred a few million years ago in hominin ancestors, an event possibly linked to a malarial parasite that recognised Neu5Gc. In their findings, the research team said human-like elimination of CMAH and Neu5Gc in mice caused an almost 2-fold increase in severity of atherosclerosis compared to unmodified mice. “The increased risk appears to be driven by multiple factors, including hyperactive white cells and a tendency to diabetes in the human-like mice,” said Ajit Varki. “This may help explain why even vegetarian humans without any other obvious cardiovascular risk factors are still very prone to heart attacks and strokes, while other evolutionary relatives are not.” But in consuming red meat, humans are also repeatedly exposed to Neu5Gc, which researchers said prompts an immune response and chronic inflammation they call “xenosialitis.” In their tests, human-like mice modified to lack the CMAH gene were fed a Neu5Gc-rich, high-fat diet and subsequently suffered a further 2.4-fold increase in atherosclerosis, which could not be explained by changes in blood fats or sugars. “The human evolutionary loss of CMAH likely contributes to a predisposition to atherosclerosis by both intrinsic and extrinsic (dietary) factors,” wrote the authors, “and future studies could consider using this more human-like model.” In previous work, the Varkis and colleagues have shown that dietary Neu5Gc also promotes inflammation and cancer

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progression in Neu5Gc-deficient mice, suggesting that the non-human sugar molecule, which is abundant in red meat, may at least partially explain the link between high consumption of red meat and certain cancers. Interestingly, the evolutionary loss of the CMAH gene appears to have produced other significant changes in human physiology, including reduced human fertility and enhanced ability to run long distances.

Science Daily, 22 July 2019

<http://www.sciencedaily.com>

### Genes linked to death from sepsis identified in mice

2019-07-25

Sepsis is a life-threatening condition that occurs when the body's immune response to infection spirals out of control. Bacteria in the bloodstream trigger immune cells to release powerful molecules called cytokines to quickly activate the body's defences. Sometimes, the response goes overboard, creating a so-called "cytokine storm" that leaves people feverish or chilled, disoriented and in pain. In severe cases, it can lead to multi-organ failure and death. Now, researchers at Washington University School of Medicine in St. Louis have found a set of genes that help cells survive exposure to cytokines. The genes are involved in disposing of cellular waste, a process known as autophagy. Mice that lack key autophagy genes are more likely to die from sepsis, the study shows. The findings raise the possibility that enhancing autophagy could potentially lead to treatments for the deadly condition. "When we recognise signs of sepsis in patients, we prescribe antibiotics and fluids, but we lack therapies to protect patients from the direct effects of the cytokine storm," said first author Anthony Orvedahl, MD, Ph.D., an instructor in paediatric infectious diseases. "Our research indicates that if we could modulate autophagy levels in cells, we might be able to promote cell survival and resistance to the cytokine storm, which may ultimately help people survive sepsis." The study is published online the week of July 22 in Proceedings of the National Academy of Sciences. Sepsis is a medical emergency and even with prompt medical care, about 15 percent of people do not survive, while many survivors experience longstanding complications. Orvedahl—along with colleagues including senior author Herbert "Skip" Virgin, IV, MD, Ph.D., now at Vir Biotechnology, and co-author Gary A. Silverman, MD, Ph.D., the Harriet B. Spoehrer Professor and head of the Department of Paediatrics—set out to find what protects cells from dying during a cytokine storm. The researchers looked at the effects of interferon gamma, a cytokine that activates immune cells' ability to kill bacteria but can also

**Researchers at Washington University School of Medicine have found a set of genes that help cells survive exposure to cytokines.**

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trigger cell death. By systematically inactivating one gene at a time from immune cells in a dish before treating them with interferon gamma, the researchers discovered that cells need a full complement of autophagy genes to survive exposure to the potent cytokine. Further experiments revealed that a second cytokine, called tumour necrosis factor, was also critical for the accelerated cell death in this system. "Autophagy is like cleaning the house, getting rid of all the junk inside the cell," Orvedahl said. "If unwanted things start to accumulate via a defect in this recycling system, it's like a tinderbox waiting for a spark. We don't yet know the exact material involved, but we think something builds up and makes cells more vulnerable to dying when they encounter these inflammatory cytokines." The importance of autophagy on cell survival suggests that the process may also be crucial for the survival of animals—and people—in the midst of a cytokine storm. To find out, the researchers studied four strains of genetically modified mice that lacked one of four autophagy genes in their immune cells, as well as mice with intact autophagy genes. They injected mice with tumour necrosis factor, which is thought to drive the cytokine storm in people. The mice whose autophagy systems were crippled by the absence of important autophagy genes got sick faster and were more likely to die. Chemical compounds that enhance or block autophagy are already being studied by researchers focused on cancer, cardiovascular disease and other conditions. Therapies that suppress autophagy may increase the risk of sepsis, Orvedahl said. Further, he cautioned that more research is needed before doctors can evaluate whether boosting autophagy is a viable strategy for treating sepsis. "We can't say for sure that autophagy activation would be protective," Orvedahl said. "We just showed that if mice lack autophagy, they are sicker and more likely to die. But we think that a better understanding of these processes could lead to attractive targets for developing more effective ways to treat sepsis."

Medical Xpress, 22 July 2019

<http://medicalxpress.com>

### **New study explains the molecular mechanism for the therapeutic effects of cilantro**

2019-07-25

Herbs, including cilantro, have a long history of use as folk medicine anticonvulsants. Until now, many of the underlying mechanisms of how the herbs worked remained unknown. In a new study, researchers uncovered the molecular action that enables cilantro to effectively delay

**In a new study, researchers uncovered the molecular action that enables cilantro to effectively delay certain seizures common in epilepsy and other diseases.**

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certain seizures common in epilepsy and other diseases. The study, published in *FASEB Journal*, explains the molecular action of cilantro (*Coriandrum sativum*) as a highly potent KCNQ channel activator. This new understanding may lead to improvements in therapeutics and the development of more efficacious drugs. "We discovered that cilantro, which has been used as a traditional anticonvulsant medicine, activates a class of potassium channels in the brain to reduce seizure activity," said Geoff Abbott, PhD, professor of physiology and biophysics at the UCI School of Medicine and principal investigator on the study. "Specifically, we found one component of cilantro, called dodecenal, binds to a specific part of the potassium channels to open them, reducing cellular excitability. This specific discovery is important as it may lead to more effective use of cilantro as an anticonvulsant, or to modifications of dodecenal to develop safer and more effective anticonvulsant drugs." Researchers screened cilantro leaf metabolites, revealing that one -- the long-chain fatty aldehyde (E)-2-dodecenal -- activates multiple potassium channels including the predominant neuronal isoform and the predominant cardiac isoform, which are responsible for regulating electrical activity in the brain and heart. This metabolite was also found to recapitulate the anticonvulsant action of cilantro, delaying certain chemically-induced seizures. The results provide a molecular basis for the therapeutic actions of cilantro and indicate that this ubiquitous culinary herb is surprisingly influential upon clinically important potassium channels. Documented use of botanical folk medicines stretches back as far as recorded human history. There is DNA evidence, dating back 48,000 years, that suggests the consumption of plants for medicinal use by *Homo neanderthalensis*. Archaeological evidence, dating back 800,000 years, suggests a non-food use of plants by *Homo erectus* or similar species. Today, evidence of the efficacy of botanical folk medicines ranges from anecdotal to clinical trials. In many cases, these "medicines" are currently consumed, often on a large scale, as foodstuffs or food flavouring. Cilantro, known as coriander in the UK, is one example. Cilantro has been consumed by human beings for at least 8,000 years. It was found in the tomb of Tutankhamen and is thought to have been cultivated by the ancient Egyptians. "In addition to the anticonvulsant properties, cilantro also has reported anti-cancer, anti-inflammatory, anti-fungal, antibacterial, cardioprotective, gastric health and analgesic effects," said Abbott. "And, the best part is it tastes good!"

Science Daily, 22 July 2019

<http://www.sciencedaily.com>

**Researchers have found the naturally occurring mineral can speed up the production of lead dioxide under certain circumstances**

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#### Lots of lead in the water? Maybe manganese is to blame

2019-07-25

Manganese is not a particularly toxic mineral. In fact, people need a little in their diets to remain healthy. Research at Washington University in St. Louis has shown however, that in conjunction with certain other chemicals, naturally occurring manganese can lead to big changes in the water in lead pipes. Depending on what disinfectants are used in the water, those changes can have significant -- even dangerous -- consequences. The results were recently published in *Environmental Science and Technology*. The research focuses on a unique form of lead,  $PbO_2$  or lead dioxide (lead in the plus-4 oxidation state). Lead dioxide has a very low water solubility -- it does not easily dissolve in water alone. It is also uncommon in nature, unlike the more familiar  $PbCO_3$ , the lead carbonate that makes up the scales that tend to form on pipes. "You don't find  $PbO_2$  in the environment because there is no strong oxidizing agent," said Daniel Giammar, the Walter E. Browne Professor of Environmental Engineering at the McKelvey School of Engineering. "But good disinfectants are often good oxidizing agents." Chlorine is a great disinfectant, so much so that it's used commonly in drinking water in America and across the world. It is also good oxidising agent and promotes the transformation of lead carbonate to lead dioxide. It turns out, however, that the process isn't particularly speedy, a fact that jibes with some real-world systems, but, seemingly, not with others. "If you look at a system that has lead pipes and free chlorine, then you do the calculations, you'd expect that every single one would have lead dioxide on the pipes," Giammar said. "But we don't see that. It makes us think: Something else is influencing whether or not a particular system ends up with lead dioxide on its inner surface. "That's where manganese comes in." In the presence of oxidants, manganese can easily change oxidation states; if the manganese comes into contact with chlorine, it's oxidized, turning into manganese oxide. Both in computer models and in experiments that mimicked water pipes -- complete with artificial tap water -- Giammar's lab found the manganese oxide acted as a catalyst, increasing the rate of conversion from lead carbonate to lead dioxide by two orders of magnitude. "The chlorine is still the reactant that's driving the lead conversion, but the manganese oxide acts as a catalyst to make it faster," Giammar said. This research may well help inform the way other chemical interactions affect rates of lead transformation. "What other things that aren't lead may be affecting these rates?" Giammar asked. "Do iron oxides do it? Aluminium is something we'll study, too." Further research into understanding what reactions influence lead transformation

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rates and otherwise affect the availability of lead in water will lead to more than breakthroughs in the lab. They will have real implications on health. Take Washington, D.C. in 2000, for example. The District's Water and Sewer Authority changed from a chlorine disinfectant to a less strong one called chloramine because the chlorine was creating some unpleasant by-products. But there was an unforeseen consequence. "When the water authority switched the disinfectant, the lead dioxide in the pipe scale was no longer stable," he said. "It dissolved rapidly and generated high concentrations of lead in the tap water." The events in D.C. made other systems using free chlorine start asking questions about whether or not they should be concerned about lead dioxide if they were to change to chloramine. Interestingly many systems observe lead dioxide in the scales on lead service lines, but other systems do not. Varying concentrations of manganese among public water systems could potentially explain these differences. "How you're going to treat your water depends on the source and its composition, also your infrastructure," Giammar said. "There's no one size fits all." This discovery was an accident. The lab was running another experiment with artificial tap water in lead pipes and treated it with chlorine to see if they could create lead dioxide. They included substances commonly found in tap water: calcium, magnesium, sodium and chloride. "There was a new student working on the project and, instead of adding magnesium, she added manganese," Giammar said. Then things got weird. "The water had been clear, all of a sudden it was cloudy and black." There was a lot of lead precipitation for a few weeks, but then it died down. "We opened up the pipes and looked," Giammar said. "Oh, we have the lead dioxide we were trying to make." The manganese just accelerated the process.

Science Daily, 22 July 2019

<http://www.sciencedaily.com>

## Technical Notes

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

### ENVIRONMENTAL RESEARCH

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[Monsanto, PCBs, and the creation of a “world-wide ecological problem”](#)

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[A fugacity model assessment of ibuprofen, diclofenac, carbamazepine, and their transformation product concentrations in an aquatic environment](#)

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### MEDICAL RESEARCH

[UK clinical experience up to 52 weeks with linaclotide for irritable bowel syndrome with constipation](#)

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### OCCUPATIONAL HEALTH RESEARCH

[Association of occupational exposures with cardiovascular disease among US Hispanics/Latinos](#)

[Occupational manganese exposure, reproductive hormones, and semen quality in male workers: A cross-sectional study](#)

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Monitoring early cell damage in physicians who are occupationally exposed to inhalational anaesthetics

Blue-yellow dyschromatopsia in toluene-exposed workers

Urinary hydroxypyrene determination for biomonitoring of firefighters deployed at the Fort McMurray wildfire: an inter-laboratory method comparison

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Overview of known plastic packaging-associated chemicals and their hazards

Different exposure profile of heavy metal and health risk between residents near a Pb-Zn mine and a Mn mine in Huayuan county, South China

Emerging contaminants of high concern and their enzyme-assisted biodegradation - A review.

Occurrence of legacy and alternative plasticisers in indoor dust from various EU countries and implications for human exposure via dust ingestion and dermal absorption

Understanding skin absorption of common aldehyde vapours from exposure during hazardous material incidents