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

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### ASIA PACIFIC

#### Safe Work Australia is seeking feedback on moving from GHS 3 to GHS 7 under the model WHS laws

2019-06-07

Over the coming months, Safe Work Australia will be consulting on the proposal to adopt an updated edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) for workplace hazardous chemicals. Since 1 January 2017, the 3rd revised edition of the GHS (GHS 3) has been implemented under the model Work Health and Safety laws. As Australia's transition to the GHS is now complete, it is time to move beyond GHS 3 to ensure Australia's classification and labelling requirements for workplace chemicals are aligned with our key trading partners, as they move to the 7th revised edition of the GHS (GHS 7). Safe Work Australia values the engagement of its stakeholders and is seeking feedback to help ensure any changes to Australia's classification and hazard communication requirements for workplace hazardous chemicals are implemented in a way which minimises impacts to the industry. Further information is available on the consultation platform, [Engage](#).

Safe Work Australia, 6 June 2019

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

**Over the coming months, Safe Work Australia will be consulting on the proposal to adopt an updated edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) for workplace hazardous chemicals.**

#### New chemicals full public reports

2019-06-07

The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has published the following list of manufactured or imported new industrial chemicals in Australia in the June Chemical Gazette.

*List of new manufactured or imported industrial chemicals*

Reference number	Applicant	Chemical or trade name	Hazardous substances	Introduction volume (kg)	Use
<a href="#">SAPLC/216</a> <a href="#">[PDF 228 KB]</a>	Akzo Nobel Pty Ltd	Polymer in PUMA 155	No	< 1,000 tonnes per annum	Component of industrial coatings
<a href="#">LTD/2063</a> <a href="#">[PDF 292 KB]</a>	Qenos Pty Ltd	Chemical in ExpBMC-1801	Yes	< 1 tonne per annum	Component of catalyst for polyethylene production

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*List of new manufactured or imported industrial chemicals*

Reference number	Applicant	Chemical or trade name	Hazardous substances	Introduction volume (kg)	Use
<a href="#">LTD/2069</a> <a href="#">[PDF 338 KB]</a>	Afton Chemical Asia Pacific LLC	X-18257	Yes	≤ 20 tonnes per annum	Component of fuel additives
<a href="#">LTD/2064</a> <a href="#">[PDF 288 KB]</a>	Qenos Pty Ltd	Chemical in ExpTR-1801	Yes	< 1 tonne per annum	Component of catalyst for polyethylene production
<a href="#">LTD/2071</a> <a href="#">[PDF 589 KB]</a>	Evonik Australia Pty Ltd	Photoinitiator A18	ND	< 1 tonne per annum	Component of pressure sensitive adhesive tape
<a href="#">LTD/2071</a> <a href="#">[PDF 589 KB]</a>	Brenntag Australia Pty Ltd	Photoinitiator A18	ND	< 1 tonne per annum	Component of pressure sensitive adhesive tape
<a href="#">PLC/1537</a> <a href="#">[PDF 209 KB]</a>	Cintox Australia Pty Ltd	Polymer in 80207 ALKYD	No	< 1 tonne per annum	A component of paints
<a href="#">LTD/2075</a> <a href="#">[PDF 275 KB]</a>	PPG Industries Australia Pty Ltd	Polymer in CA 7233A Base Component	ND	≤ 5 tonnes per annum	Component of industrial coatings
<a href="#">EX/219</a> <a href="#">[PDF 500 KB]</a>	Hempel (Australia) Pty Ltd	Polymer in ECOS® ND 15	ND	< 1 tonne per annum	Component of industrial paints and coatings
<a href="#">EX/222</a> <a href="#">[PDF 499 KB]</a>	Flint CPS Inks Australia Pty Ltd	Polymer in ECOS® ND 15	ND	≤ 0.05 tonne per annum	Component of industrial paints and coatings
<a href="#">LTD/2074</a> <a href="#">[PDF 381 KB]</a>	Clariant (Australia) Pty Ltd	Polymer in Hostaperm Yellow H3G 50	ND	≤ 10 tonne per annum	Component of paints and coatings
<a href="#">PLC/1526</a> <a href="#">[PDF 221 KB]</a>	BASF Australia Ltd	P92-1433	No	≤ 5 tonnes per annum	Component of automotive coatings
<a href="#">LTD/1934</a> <a href="#">[PDF 626 KB]</a>	Firmenich Limited	4-Penten-1-one, 1-(5-ethyl-5-methyl-1-cyclohexen-1-yl)-	Yes	≤ 1 tonne per annum	Fragrance ingredient
<a href="#">PLC/1521</a> <a href="#">[PDF 256 KB]</a>	Dow Performance Materials (Australia) Pty Ltd	Dimethicone/ Vinyl Dimethicone Crosspolymer (INCI Name)	No	≤ 100 tonnes per annum	Cosmetic ingredient

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*List of new manufactured or imported industrial chemicals*

Reference number	Applicant	Chemical or trade name	Hazardous substances	Introduction volume (kg)	Use
<a href="#">PLC/1521</a> <a href="#">[PDF 256 KB]</a>	L'Oreal Australia Pty Ltd	Dimethicone/ Vinyl Dimethicone Crosspolymer (INCI Name)	No	≤ 100 tonnes per annum	Cosmetic ingredient
<a href="#">PLC/1521</a> <a href="#">[PDF 256 KB]</a>	Dow Chemical (Australia) Pty Ltd	Dimethicone/ Vinyl Dimethicone Crosspolymer (INCI Name)	No	≤ 100 tonnes per annum	Cosmetic ingredient
<a href="#">PLC/1521</a> <a href="#">[PDF 256 KB]</a>	Connell Bros Company Australasia Pty Ltd	Dimethicone/ Vinyl Dimethicone Crosspolymer (INCI Name)	No	≤ 100 tonnes per annum	Cosmetic ingredient
<a href="#">PLC/1521</a> <a href="#">[PDF 256 KB]</a>	Ingredients Plus Pty Ltd	Dimethicone/ Vinyl Dimethicone Crosspolymer (INCI Name)	No	≤ 100 tonnes per annum	Cosmetic ingredient
<a href="#">PLC/1521</a> <a href="#">[PDF 256 KB]</a>	TULP Operations Australia Pty Ltd	Dimethicone/ Vinyl Dimethicone Crosspolymer (INCI Name)	No	≤ 100 tonnes per annum	Cosmetic ingredient
<a href="#">PLC/1532</a> <a href="#">[PDF 206 KB]</a>	Dow Performance Materials (Australia) Pty Ltd	Polymer in TPSiV 3011- 70A Natural Thermoplastic Elastomer	No	< 30 tonnes per annum	Electrical industry and electronics construction materials additive
<a href="#">PLC/1532</a> <a href="#">[PDF 206 KB]</a>	Dow Chemical (Australia) Pty Ltd	Polymer in TPSiV 3011- 70A Natural Thermoplastic Elastomer	No	< 30 tonnes per annum	Electrical industry and electronics construction materials additive
<a href="#">PLC/1532</a> <a href="#">[PDF 206 KB]</a>	Carst & Walker (Australia) Pty Ltd	Polymer in TPSiV 3011- 70A Natural Thermoplastic Elastomer	No	< 30 tonnes per annum	Electrical industry and electronics construction materials additive

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### List of new manufactured or imported industrial chemicals

Reference number	Applicant	Chemical or trade name	Hazardous substances	Introduction volume (kg)	Use
<a href="#">PLC/1532</a> <a href="#">[PDF 206 KB]</a>	Polymers International Australia Pty Ltd	Polymer in TPSiV 3011-70A Natural Thermoplastic Elastomer	No	< 30 tonnes per annum	Electrical industry and electronics construction materials additive
<a href="#">PLC/1532</a> <a href="#">[PDF 206 KB]</a>	APN Plastics Pty Ltd	Polymer in TPSiV 3011-70A Natural Thermoplastic Elastomer	No	< 30 tonnes per annum	Electrical industry and electronics construction materials additive
<a href="#">PLC/1532</a> <a href="#">[PDF 206 KB]</a>	TULP Operations Australia Pty Ltd	Polymer in TPSiV 3011-70A Natural Thermoplastic Elastomer	No	< 30 tonnes per annum	Electrical industry and electronics construction materials additive
<a href="#">LTD/2077</a> <a href="#">[PDF 349 KB]</a>	Allnex Resins Australia Pty Ltd	RESYDROL VAL 5547w	ND	≤ 220 tonnes per annum	Component of coatings
<a href="#">LTD/2047</a> <a href="#">[PDF 381 KB]</a>	ResChem Technologies	Fluoropolymer in BYK-1798	ND	≤ 1 tonne per annum	Component of industrial coatings

Not determined (ND): Based on the information available, the notified chemical cannot be classified according to the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), as adopted for industrial chemicals in Australia.

NICNAS Chemical Gazette, 4 June 2019

[http://www.nicnas.gov.au/Publications/Chemical\\_Gazette](http://www.nicnas.gov.au/Publications/Chemical_Gazette)

### Testing of Alkyl Nitrite 'Poppers'

2019-06-07

Products containing alkyl nitrites, some of which have a street name of 'poppers', are inhaled and are used to produce a muscle relaxant effect. There is some, incomplete, evidence that particular members of the family of alkyl nitrite substances may be more toxic than others. The TGA has tested a range of alkyl nitrite-containing products to confirm the identity of the type of alkyl nitrite present. The alkyl nitrites suspected or known to have been used in 'poppers' include propyl, isopropyl, butyl, isobutyl, amyl

**The TGA has tested a range of alkyl nitrite-containing products to confirm the identity of the type of alkyl nitrite present.**

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(aka pentyl), isoamyl (aka isopentyl), and octyl nitrites. To inform the recent discussion around rescheduling of alkyl nitrites, the TGA Laboratories have analysed samples of alkyl nitrite 'poppers' available for purchase both within Australia and from overseas. The purpose of this testing was to confirm the identity of the alkyl nitrites being used in the products and to compare the results to the labelled ingredients. Eight samples of alkyl nitrite 'poppers', labelled as 'leather cleaners', and obtained from local adult stores, were analysed for the presence of alkyl nitrites. The scheduled (S4) substance isobutyl nitrite was identified as the single major ingredient in all eight products. The product labels all claimed to contain 'alkyl nitrite' but did not specify which one.

The products tested were:

- RUSH Original with Power Pak Pellet 10 ml Bottle
- SUPER RUSH - Black Label with Power Pellet 10 ml Bottle
- Blue Boy Leather Cleaner 30 ml Bottle
- Colt Leather Cleaner 30 ml Bottle
- Jungle Juice Black Label Extreme Formula Leather Cleaner 30 ml Bottle
- Jungle Juice Platinum Leather Cleaner 30 ml Bottle
- Premium Iron Horse Leather Cleaner 30 ml Bottle
- Amsterdam Special Leather Cleaner 30 ml Bottle

Two of the products also contained a small white tablet suspended in the liquid referred to on the labelling as a 'power pellet' or 'power pak pellet'. These tablets were found to consist of aluminium oxide, possibly intended to absorb any moisture and help prevent degradation of the isobutyl nitrite. Samples of a further ten products obtained from overseas websites were also tested. A single major alkyl nitrite ingredient was found in each of these samples. Five of the samples were found to contain isopropyl nitrite while the remaining five samples were found to contain isoamyl nitrite (aka isopentyl nitrite). Eight of the samples contained the type of alkyl nitrite claimed on the label. Two of the samples stated the ingredient as 'Pentyl nitrite' but instead contained isopentyl nitrite (aka isoamyl nitrite). Two of the samples containing isopropyl nitrite incorrectly stated CAS registry numbers<sup>[1]</sup> for isoamyl nitrite on their labels although the ingredient naming was correct on each product.

The results for products obtained from overseas websites are as follows:



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Product Name	Label Claims	Identified alkyl nitrite compound
LIQUID GOLD Room Odorisor	Isopropyl Nitrite	Isopropyl nitrite
GATE!, Poppers amyl	Isoamyl Nitrite (CAS 110-46-3)	Isoamyl nitrite
LADY Room Odorisor	Isopropyl nitrite (cas-110-46-3)*	Isopropyl nitrite
TRIP	Isopropyl Nitrite (CAS 541-42-4)	Isopropyl nitrite
EVEREST PREMIUM	Isoamyl Nitrite (CAS 110-46-3)	Isoamyl nitrite
SCREAM Room Deodorisor	Isopropyl nitrite (cas 110-46-3)*	Isopropyl nitrite
EVEREST ENJOY IT!	Isopropyl Nitrite (CAS 541-42-4)	Isopropyl nitrite
ADLER	Pentyl Nitrite CAS 463-04-7	Isoamyl nitrite
VERITABLE POPPERS Nitrite D'Amyle	NITRITE D'AMYLE Nitrite d'isoamyle	Isoamyl nitrite
FIST Room Odoriser	Pentyl Nitrite CAS 110-46-3*	Isoamyl nitrite

\* CAS number quoted on labelling corresponds to isoamyl nitrite

The samples obtained from the Australian market were not registered on the ARTG (Australian Register of Therapeutic Goods), and were found to lack appropriate details on the label regarding ingredients. This lack of detailed information, such as ingredient identity and content, does not allow consumers to make informed decisions about the product they are using. While products from overseas generally contained the compounds identified on the label, there were examples of labelling that could be considered misleading, and none of the products stated the content amounts.

TGA, 6 June 2019

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

**The Poisons Standard is a Legislative Instrument for the purposes of the Legislative Instruments Act 2003.**

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### **The Poisons Standard (the SUSMP)**

2019-06-07

The Poisons Standard is a Legislative Instrument for the purposes of the *Legislative Instruments Act 2003*. The Poisons Standard consists of decisions regarding the classification of medicines and poisons into Schedules for inclusion in the relevant legislation of the States and Territories. The Poisons Standard also includes model provisions about containers and labels, a list of products recommended to be exempt from these provisions, and recommendations about other controls on drugs and poisons. The Poisons Standard has been presented with a view to promoting uniform scheduling of substances and uniform labelling and packaging requirements throughout Australia. The Poisons Standard is the legal title of the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

[Electronic version of the Poisons Standard: SUSMP No. 243 \(Poisons Standard June 2019\)](#)

The SUSMP is available in electronic form, free of charge, on the Federal Register of Legislation (FRL) website. The FRL is a repository and authoritative source of Commonwealth Acts, legislative and notifiable instruments, explanatory statements for legislative instruments, and other relevant documents and information. Please note that on the FRL the SUSMP goes by its legal title, the Poisons Standard. Additionally, rather than referring to the edition number, the publication will be named according to the month and year of publication (i.e. the month and year it is published on the FRL). For example, SUSMP No.7 is known as Poisons Standard June 2015 on FRL. SUSMP No.9 and all future editions of the Poisons Standard will only be available online.

### The SUSMP

The Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP):

- is a record of decisions regarding the classification of medicines and chemicals into Schedules for inclusion in relevant legislation of the states and territories;
- includes model provisions about containers and labels, and recommendations about other controls on medicines and chemicals; and
- is registered on the Federal Register of Legislation as the Poisons Standard.

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### Recent changes

The Poisons Standard June 2019 (No. 24) is the current edition. This supersedes the Poisons Standard February 2019 (No. 23). The Poisons Standard June 2019 incorporates numerous changes to the Poisons Standard February 2019. These changes are detailed in the explanatory statement supporting SUSMP 24 (Poisons Standard June 2019).

TGA, 31 May 2019

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

### **Differences between EU REACH Pre-registration and K-REACH Pre-registration**

2019-06-07

From 1 July 2019, existing chemical substances cannot be manufactured/imported/used in Korea unless they have been pre-registered under K-REACH. This article summarises the main differences between EU REACH pre-registration and K-REACH pre-registration to help you comply with the K-REACH pre-registration requirement.

#### Volume Calculation

Under K-REACH, volume trigger 1t/y is based on the maximum volume manufactured or imported in any given year from 2016 to 2018. Under EU REACH, the volume trigger is based on the average volume of three consecutive years.

#### Polymer

For a polymer, you calculate the estimated quantity of monomers contained and pre-register the monomers under EU REACH. Under K-REACH, you need to pre-register the polymer substance itself. For polymers which meet the criteria for polymer of low concern, it is recommended that you directly apply for confirmation on registration exemption to avoid full registration in the future.

#### Raw Materials for Cosmetic Use

Under K-REACH, raw materials for cosmetics use are fully exempt from K-REACH pre-registration and registration. Under EU REACH, they are not.

#### Fertilisers

**From 1 July 2019, existing chemical substances cannot be manufactured/imported/used in Korea unless they have been pre-registered under K-REACH.**

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Under K-REACH, fertilisers are fully exempt from K-REACH pre-registration and registration. Under EU REACH, they are not.

### Non-isolated Intermediates

Under both K-REACH and EU REACH, non-isolated intermediates are exempt from pre-registration/registration. However, under K-REACH, you also need to apply for confirmation on exemptions for non-isolated intermediates (A very unwise requirement). Otherwise, the non-isolated intermediates are not exempt.

**Priority Existing Chemical Substances (PECs)** For substances on the first list of 510 priority existing chemical substances subject to K-REACH registration, their pre-registration under K-REACH is forbidden since their grace periods have expired in July 2018. There is no such limitation under EU REACH.

### Info Requirement

For EU REACH pre-registration, you only need to provide substance identification, legal entity info and estimated tonnage band. Under K-REACH, you need to provide more info for pre-registration:

- Substance identity info: name, CAS no.
- Estimated annual import/manufacture volume band
- GHS classification and labelling
- Identified uses (using K-REACH use descriptor system to describe uses)
- Legal entity info: name, address, contact info of Korean legal entity
- In case of using OR: OR appointment letter and names of importers

It should be noted that one applicant shall update their pre-registration within one month if there are changes with:

- Annual volume
- GHS classification and labelling
- Uses
- Contact info or change of OR
- Recommendation?

There are many existing chemicals substances which qualify for exemptions from pre-registration/registrations. You shall apply for confirmation on exemptions first rather than submit pre-registrations since pre-registration is a only a temporary thing.

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Substances exempt from registration (application of confirmation on exemption required)

Chemical substance imported/ manufactured for export-only use, including substance imported/ manufactured to make export-only products.  
Chemical reagents  
Substances for R&D use  
Surface treated substances  
Non-isolated intermediates  
Isolated intermediates (which can be technically blocked from leakage or exposure)  
Polymer of low concern.

Further information is available at:

- [How to comply with amended K-REACH regulation](#)
- [Everything you need to know about K-REACH pre-notification](#)

Chem Safety Pro, 17 May 2019

<https://www.chemsafetypro.com>

## AMERICA

### New federal rules are supposed to make biosimilars more accessible. Will they work?

2019-06-07

In a long-awaited move, the United States Food and Drug Administration has released a set of guidelines intended to stoke the market for biosimilars, generic versions of complex biological drugs, frequently proteins, that are used to treat diseases like cancer and autoimmunity. The FDA has already approved 19 biosimilars. However, none of those drugs can be substituted—or interchanged by a pharmacist—for the reference biological drug from which they are derived. The new guidelines set testing standards for a biosimilar to be declared interchangeable, allowing pharmacists to replace a branded drug with a generic biologic in the same way they currently do for small-molecule drugs, without having to talk with a doctor first. Both patient advocates and the FDA hope that bringing more biosimilars to market will improve access to these ground-breaking drugs by giving consumers more choices and by lowering prices. In one study of patient costs for biologics to treat autoimmune disorders, annual out-of-pocket costs ranged from \$22,000 to \$29,000.

**The FDA's new guidance defines interchangeability and will use insulin as a test case**

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The wholesale prices of the biologics examined in the study ranged from about \$700 to more than \$7,000 per dose. The FDA plans to use insulin as a test case of the new guidance. Generics versions are rare in the US, and increasing costs of the drug in recent years have led to reports of people with diabetes rationing supplies or skipping doses. But not everyone is convinced the new guidance will make a big difference for consumers. The rules appear to apply to only a narrow subset of biologics that can be sold through a pharmacy directly to consumers rather than treatments that are given by a doctor through infusion or injection. Development costs for biologics are high. New interchangeable biosimilars might get stuck in patent litigation, which has been the fate of many biosimilars already approved. And in Europe, where more biosimilars are used, prices haven't dropped as drastically as some people anticipated. "Anything the FDA can do to encourage competition in this space is very useful to the consumer," says Michael Carrier, a professor at Rutgers Law School who specialises in pharmaceutical patent law. "As helpful as it is, though, there are still many hurdles to biosimilar competition," he warns. One of those hurdles for a biosimilar maker is in recreating the manufacturing process of a reference biologic. Unlike the fairly straightforward steps required to synthesise a small-molecule drug, biologics are typically made in living cells. Cell culture conditions have to be just right to create a properly folded therapeutic in good quantity. Biologic proteins may need chemical modifications to function properly in humans. These modifications can include the addition of carbohydrate groups or the removal of amino acids to make a protein more soluble. And all this must be scaled up for manufacturing. Meeting these challenges has already proved to slow the introduction of some biosimilars to the market. FDA approval of Celltrion's biosimilars of cancer treatments Rituxan and Herceptin has been held up because of manufacturing issues. And then there are the testing requirements. To be fully interchangeable, per the FDA guidance, a company developing a biosimilar that it wants to be interchangeable might have to perform pharmacological tests to show how the body uses and metabolises the protein and that providers can switch between drugs for the same illness without any safety and efficacy issues; the company may also need immunological tests to show that the protein isn't inadvertently setting off the body's defences.

For some candidate biosimilars, this testing might be a bit like reinventing the wheel, says Gillian Woollett, an industry analyst at Avalere Health. In Europe, where dozens of biosimilars have been approved and are in use, and many are assumed to be interchangeable with their reference drugs. In addition, US and European doctors also switch patients between

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different brand-name biologics with similar modes of action to treat the same disease. For example, several brand-name biologics attack the tumour necrosis factor pathway to thwart the inflammation seen in diseases like psoriatic arthritis. Evidence from Europe, she says, shows that such substitutions have little cause for concern. "The FDA knows the science better than anyone," Woollett says about the process of making and testing biologics and biosimilars. Information from Europe and from doctors who prescribe biologics should be enough to show that a biosimilar would probably be just as good as the reference therapeutic; the FDA's new guidance does not represent a higher standard, Woollett argues. The testing "is just additional data on a product that is already biosimilar. So, you're not polishing and making it better—it's exactly the same product." Overall, it takes more time and money to reproduce a biologic than it does a small molecule, [according to a report](#) from the Centre for Health Policy and Outcomes at Memorial Sloan Kettering Cancer Centre. "A biosimilar manufacturer must recoup its development costs, which are much higher" than for small-molecule generics, Carrier says. As for the FDA's test case for its interchangeability rules, a quirk of history means that insulin—a peptide hormone made of 51 amino acids—is not currently considered a biologic, but a small molecule. The FDA must first reclassify the drug, which FDA acting Commissioner Ned Sharpless says will happen in March 2020. [At a recent hearing](#), Sharpless said the guidance should affect the market for and availability of insulin, the cost of which has skyrocketed. He said that the maker of one insulin formulation has raised the price of the drug some 600% from 2012 to 2016. "As a physician, I find this intolerable. No patient should have to choose between paying for medicine and paying for their rent," Sharpless said. Abhijit Barve, head of global clinical research at Mylan, noted during the hearing that Mylan's biosimilar insulin glargine is already available in Europe. Insulin is more like a small molecule than a complex biologic, he said, and researchers already know a lot about how insulin behaves in the body. Barve conceded that there could be questions about biosimilar insulin's effect on the immune system, but he emphasized that requiring a bunch of additional testing "would only be a barrier to development." Even if more biosimilars make it to market and become broadly used, prices might not drop that much. The biosimilar version of Janssen's Remicade for chronic inflammation is only 15% cheaper than the branded product, according to the Centre for Health Policy and Outcomes report. The researchers predict that, as in Europe, US prices for biosimilars won't go much lower than 30% below the brand-name therapeutic. But brand-name-biologics manufacturers are already testing that prediction, at least in the case of insulin. Eli Lilly and Company [recently undercut itself](#),

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releasing a generic version of Humalog, its multibillion-dollar-per-year insulin, at half the price. And another challenge to making biosimilars broadly accessible is patent protection. Of the 19 FDA-approved biosimilars, not all are on the market. Some are tied up in patent and other litigation, Rutgers's Carrier says, noting that AbbVie, the maker of the industry's top-selling biologic, Humira, has more than 130 patents on nearly every aspect of making the antibody. As part of a settlement with AbbVie, companies creating generics of the drug have agreed to stay out of the US market until 2023.

But the US market is key, Woollett says. About 60% of biologics spending happens in the US. The availability of biosimilars worldwide hinges on success in the US market. "If we fail in the US when we are the single biggest market in the world, we have to ask whether this impacts the ability of the rest of the world to have economically viable biosimilars either," she says.

Chemical & Engineering News, 3 June 2019

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

### **EPA Hazardous Waste Pharmaceuticals Rule Mandates Changes for Health Care Facilities**

2019-06-07

The United States Environmental Protection Agency (EPA) has issued a new rule that will impact the operations of a wide-range of health care facilities and the manner in which those facilities manage hazardous waste pharmaceuticals. The "Management Standards for Hazardous Waste Pharmaceuticals and Amendment to the P075 Listing for Nicotine" applies to health care facilities that distribute, sell, or dispense pharmaceuticals, including hospitals, ambulatory surgical centres, physicians' offices, optical and dental providers, chiropractors, long-term care facilities (excluding assisted living facilities), and pharmacies. Prior to the issuance of this rule, the existing regulatory structure failed to account for differences between health care facilities and manufacturing facilities in the generation and management of hazardous waste pharmaceuticals, making it difficult for health care facilities to comply with the applicable regulations. EPA has issued this final rule, in part, to address these difficulties and to streamline the hazardous waste management obligations imposed on health care facilities. One of the more impactful provisions of the new rule prohibits health care facilities from disposing of hazardous waste pharmaceuticals down the toilet or drain. Also known as "sewering," this

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commonly used method of disposal will be banned nationwide effective 21 August 2019. In addition to the ban on sewerage, the new rule regulates hazardous waste pharmaceuticals in the reverse distribution process as hazardous wastes while still at the health care facility, triggering regulatory obligations that were previously shifted to reverse distributors thus, largely inapplicable to health care facilities. However, the new rule does not consider over-the-counter and non-prescription drugs processed by reverse logistics providers to be hazardous waste, unless the product is discarded by the health care facility. Health care facilities will also be required to implement and document training programs for employees who handle pharmaceutical waste, comply with accumulation standards and labelling requirements, submit reports, and maintain records related to the management of hazardous waste pharmaceuticals. Additionally, the new rule contains a conditional exemption to EPA's disposal standards for hazardous waste pharmaceuticals that are also Drug Enforcement Administration (DEA) regulated controlled substances. To qualify for the exemption, a health care facility must: (i) manage the DEA controlled substance in accordance with DEA regulations; (ii) ensure the product is incinerated or destroyed by a DEA approved method; and (iii) not sewer the controlled substance. Further, health care providers that operate a DEA "take back program" collection receptacle are expressly prohibited from depositing any hazardous waste pharmaceuticals into the receptacles except for household wastes deposited by ultimate users. While some provisions of the new rule will go into effect on 21 August 2019 (including the ban on sewerage), many of the requirements will not become effective until states adopt the new rule or implement regulations that are at least as stringent as those contained in the new rule. Most states will have until July 1, 2021 to adopt the new rule or implement their own regulations. More information on the final rule can be obtained [here](#). In light of the new regulatory framework and significant monetary penalties for violations, health care facilities should consult with legal counsel to better understand the applicable obligations. Please contact a member of Dinsmore's health care group for assistance in complying with EPA's new rule.

National Law Review, 5 June 2019

<http://www.natlawreview.com>

## Regulatory Update

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### Draft Document Summarising the Toxicity and Derivation of Reference Exposure Levels (RELs) for Toluene

2019-06-07

California's Office of Environmental Health Hazard Assessment (OEHHA) is releasing a draft document summarising the toxicity and derivation of Reference Exposure Levels (RELs) for Toluene. This document will be reviewed and discussed by the Scientific Review Panel on Toxic Air Contaminants (SRP) at its meeting on 28 June 2019 in Sacramento, CA. RELs are airborne concentrations of a chemical that are not anticipated to result in adverse noncancer health effects for specified exposure durations in the general population, including sensitive subpopulations. OEHHA is required to develop guidelines for conducting health risk assessments under the Air Toxics Hot Spots Program (Health and Safety Code Section 44360(b)(2)). In response to this statutory requirement, OEHHA develops RELs for many air pollutants. The Toluene RELs were developed using the most recent "Air Toxics Hot Spots Program Technical Support Document for the Derivation of Noncancer Reference Exposure Levels," finalized by OEHHA in 2008. A draft of the Toluene REL document was released for a 75-day public review and comment period on 1 December 2017. One set of comments was received. The received comments and OEHHA's responses to those comments are also available at this time. OEHHA are not seeking further comments from the public on the draft document. The Toluene REL values proposed are as follows:

- Acute REL (for a 1-hour exposure): 5000 micrograms per cubic metre ( $\mu\text{g}/\text{m}^3$ );
- 8-Hour REL (for repeated 8-hour exposures):  $830 \mu\text{g}/\text{m}^3$ ;
- Chronic REL (for long-term exposures):  $420 \mu\text{g}/\text{m}^3$

Further information is available at:

- [Toluene Reference Exposure Levels Technical Support Document](#)
- [Responses to Public Comment on the Draft Reference Exposure Levels for Toluene](#)
- [American Chemistry Council Comments on Draft Proposed Reference Exposure Levels \(RELs\) for Toluene CAS #108-88-3](#)
- [Toluene](#)

OEHHA, 31 May 2019

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

**California's Office of Environmental Health Hazard Assessment (OEHHA) is releasing a draft document summarising the toxicity and derivation of Reference Exposure Levels (RELs) for Toluene.**

## Regulatory Update

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### EUROPE

#### EU to quadruple REACH compliance checks

2019-06-07

The European Chemicals Agency (ECHA) says it intends to quadruple the number of checks it undertakes on the registrations of thousands of chemical substances used in the bloc. The move is part of an effort to improve compliance with the EU's Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation. ECHA also intends to streamline its systems for checking registrations, improve law enforcement, and clarify information requirements for industry, says Ofelia Bercaru, head of dossier evaluation at ECHA.

#### REACH compliance falls short

ECHA admits that of the 2,700 REACH registration dossiers pertaining to 700 chemical substances filed by industry that it has assessed in the past 10 years that two thirds are noncompliant due to missing or inaccurate data. Until now, ECHA has been required to undertake compliance checks on just 5% of the registrations for substances used in the EU. The agency is proposing that it will increase compliance checks to 20% of all registrations and 35–40% of registrations for the largest volume chemical substances. ECHA's planned policy shift comes within a few weeks of the publication of a report by the European Environment Bureau (EEB), a collection of more than 150 environmental organizations across Europe, in which the EEB claims there is widespread breaking of chemical safety law and lax official enforcement. A study by BUND, a German environmental group and member of the EEB, completed in April and cited in the EEB's report, asserts that five of the world's largest chemical companies are among 654 firms that are failing to comply with REACH. The EEB is calling for increased transparency of information associated with REACH registrations, along with the imposition of tougher sanctions, including fines and the naming and shaming of noncompliant companies, without delay. "ECHA has sat on this problem for years. We see the agency moving in the right direction, but why all the secrecy?" says EEB Chemicals Policy Manager Tatiana Santos. CEFIC, Europe's largest chemical industry association, says it will do what it takes to remedy the situation. "We take ECHA's findings—that the quality of data in a number of REACH dossiers

**Chemical industry  
safety data failings  
exposed by envi-  
ronmentalists**

## Regulatory Update

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needs improvement—seriously,” says Marco Mensink, director general for CEFIC.

Chemical & Engineering News, 29 May 2019

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

### EU Poison Centre Notification

2019-06-07

A wide variety of chemical products are available on the EU market for use by professionals and the general public. These products can pose hazards due to unintentional exposure in cases of misuse or accidents. It is crucial that emergency responders have immediate access to accurate and relevant information about the chemical product in question when an accidental exposure takes place. According to Article 45 of the CLP (Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures), importers and downstream users placing hazardous mixtures on the market are responsible for complying with the requirements established in Annex VIII to the CLP. According to Annex VIII, information must be submitted for mixtures that are placed on the EU market and classified as hazards based on their health or physical effects. Required information must be provided to the appropriate appointed body in the Member States where the mixture is placed on the market. Submission information includes the GHS hazard classification, toxicological information, as well as information about the composition of the product. Poison centres have reported experiencing problems correctly identifying a mixture in case of accidental exposure in up to 40% of the calls they receive. In order to improve emergency response, labels for hazardous mixtures placed on the market will be required to carry a 16-digit Unique Formula Identifier (UFI). The UFI will enable rapid and unambiguous identification of the information submitted on the mixture by any poison centre called upon to provide advice on dealing with a poisoning incident. If you have obligations under Annex VIII to CLP, its recommend downloading a copy of the ECHA Guidance document which provides details on the obligation to submit relevant information on hazardous mixtures to the Member States' appointed bodies.

#### ECHA Submission portal now available

The first release of the ECHA submission portal is now available for poison centre notifications. The portal is a secure way to centrally manage notifications for hazardous mixtures and is available for use by industry and Member States' appointed bodies.

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### Member state variation in implementation

Notification is not currently a one size fits all solution. Member states have implemented the appointed bodies in different ways and have different requirements for submission. In many cases, submission is free, whereas some countries charge a fee for submission. Several countries accept notification via the ECHA Submission Portal only, whereas others have a national system for submission. Additionally, most countries require notification to be in the local language.

### Benefits of notifying now

The deadline for compliance with Annex VIII is 1 January 2020 for consumer mixtures, 1 January 2021 for professional mixtures, and 1 January 2024 for industrial mixtures. It's a good idea to notify soon rather than waiting until the deadline for several reasons. Companies have moral obligation to submit the relevant information so that in the case of an accident, the required information is available to emergency responders. Notification is currently free in most member states and it is unclear if the fees will change in the future. Additionally, companies that notify before the deadline may take advantage of the transitional period. Before the deadlines, mixtures continue to be subject to existing national requirements. If the relevant information relating to a hazardous mixture, according to the national requirements, is submitted to the appointed body for the deadline, there is no obligation to comply with Annex VIII until 1 January 2025. This means that less information is required for notification and the UFI does not need to appear on the label until the year 2025. However, if there is a change in the mixture composition, product identifier, or toxicological properties during the transitional period, then a submission in accordance with Annex VIII is required before the product may be placed on the market. A list of national appointed bodies is available at the ECHA Poison Centre website: <https://poisoncentres.echa.europa.eu/>

Nex Reg, 29 May 2019

<http://www.nexreg.com>

## REACH Update

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### Chemicals in a circular economy

2019-06-06

The European Chemicals Agency (ECHA) has published information 2019-06-06 about how the EU is taking action to promote clean material cycles and reduce the use of hazardous chemicals throughout a product's life cycle. You can also watch a short animation that explains how chemicals make up an essential part of a circular economy and how we need to make sure they are dealt with properly. Further information is available at:

- [Chemicals in our life](#)
- [Watch the video](#)

ECHA News, 5 June 2019

<http://echa.europa.eu>

### New communications strategy supports the strategic priorities

2019-06-06

The European Chemicals Agency's (ECHA) new Communications Strategy 2019-2023 drives the agency to be ambitious, strategic and consistent. The aim is to tailor communications to the needs of target audiences in a language which is relevant and easy to understand, and communicate through the right channels and networks. ECHA have also identified five priority focus areas to respond to the challenges of the changing communications landscape. Further information on the new strategy is available in the strategy document at: [Strategy \[PDF\]](#)

ECHA News, 5 June 2019

<http://echa.europa.eu>

### High-level conference "EU Chemicals Policy 2030"

2019-06-06

On 27 and 28 June 2019, the European Commission and the Danish Ministry for Environment and Food are organising a high-level conference to discuss recent developments in the EU chemicals policy and future steps. Further information on the conference and how to register is available at: [More](#)

ECHA News, 5 June 2019

<http://echa.europa.eu>

**The European Chemicals Agency (ECHA) has published information 2019-06-06 about how the EU is taking action to promote clean material cycles and reduce the use of hazardous chemicals throughout a product's life cycle.**

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### CLH targeted consultation launched on Clomazone

2019-06-06

On 27 May 2019, the European Chemicals Agency (ECHA) started a public commenting period on the Harmonised Classification and Labelling (CLH) targeted consultation for the following substance:

- Clomazone

Yorda's Hive, 30 May 2019

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

### Diisohexyl phthalate notified to the RoI for SVHCs

2019-06-06

On 28 May 2019, the following substance was notified to the Registry of Intentions for Substances of Very High Concern (SVHCs):

- Diisohexyl phthalate

This brought the number of Annex XV dossiers expected on 5 August 2019 for new SVHCs to 2.

Yorda's Hive, 30 May 2019

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

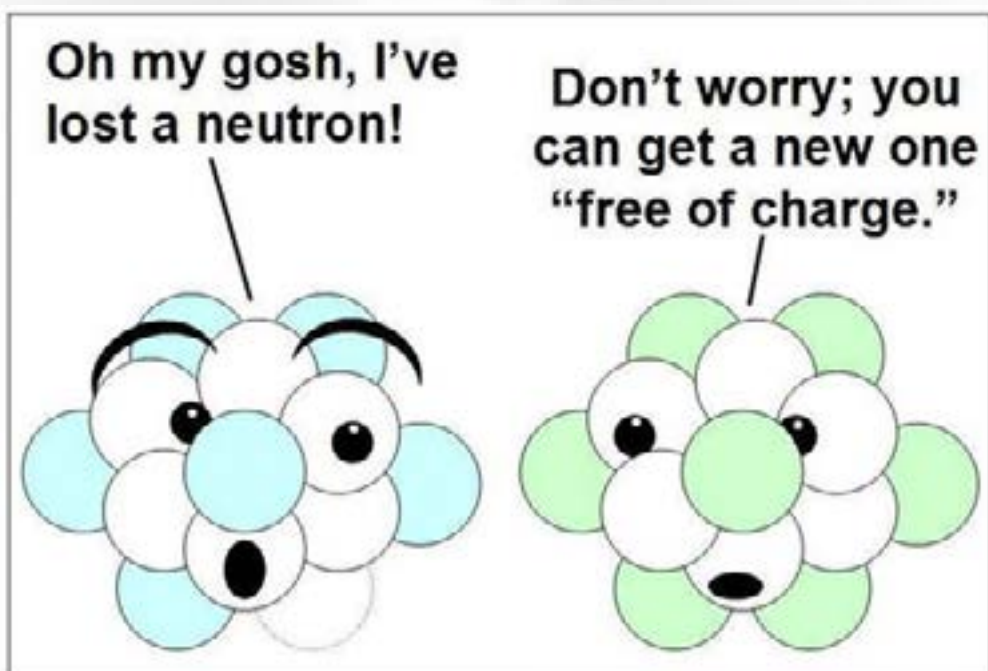
**On 28 May 2019,  
one new substance  
was notified to the  
Registry of Intentions  
for Substances of  
Very High Concern.**

## Janet's Corner

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Free of Charge

2019-06-05



Chemistry Jokes

<http://www.chemistryjokes.com>



## Hazard Alert

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### Lindane ( $\gamma$ -Hexachlorocyclohexane)

2019-05-20

Lindane, also known as gamma-hexachlorocyclohexane, ( $\gamma$ -HCH), is an organochlorine chemical variant of hexachlorocyclohexane that has been used both as an agricultural insecticide and as a pharmaceutical treatment for lice and scabies.[1] It is a white solid that may evaporate into the air as a colourless vapour with a slightly musty odour. It is also available as a prescription (lotion, cream, or shampoo) to treat head and body lice, and scabies. Lindane has not been produced in the United States since 1976, but is imported for insecticide use. [2]

#### USES [3]

Lindane is used as an insecticide on fruit and vegetable crops, for seed treatment, in forestry, and for livestock and pet treatment. Whilst it is no longer manufactured in the United States, it is still formulated there. Aerial application of the chemical is prohibited. Lindane is also used topically for the treatment of head and body lice and scabies; it is available in 1 percent preparations as a lotion, cream, or shampoo.

#### SOURCES AND ROUTES OF EXPOSURE [2,3,4]

The most probable route of lindane exposure in humans is oral ingestion of food containing the insecticide. Lindane may also be inhaled, when released to the air during its formulation or use as an insecticide, from wind erosion of contaminated soil, or from release from hazardous waste sites. Lindane has been detected in groundwater and surface water samples collected near hazardous waste sites; however, the chemical has only very rarely been detected in drinking water supplies. Furthermore, lindane exposure can occur dermally, when applied as a lotion or shampoo to treat lice or scabies. Workers involved in the formulation or application of products containing  $\gamma$ -HCH may be exposed to higher concentrations. Once in the body, lindane is stored for a short time in body fat. It tends to leave the body very quickly through urine. Small amounts leave the body in faeces and when you exhale.

#### HEALTH EFFECTS [3]

##### Acute Effects

Acute inhalation exposure to lindane in humans has resulted in irritation of the nose and throat, effects on the blood (anaemia), and skin effects

## Hazard Alert

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(elevated itchy patches of skin). The major effects noted from oral exposure to lindane in humans are effects on the nervous system, such as seizures and convulsions. Vomiting and nausea and effects on the cardiovascular and musculoskeletal systems have also been reported. Oral studies in animals have reported effects on the liver, kidney, immune, and nervous systems from acute lindane exposure.

### Chronic Effects

Chronic exposure to lindane by inhalation in humans has been associated with effects on the liver, blood, and nervous, cardiovascular, and immune systems. Effects noted in animal studies from chronic oral exposure to lindane include effects on the blood (decrease in numbers of red and white blood cells), immune, and nervous systems, and the liver and kidney.

### Reproductive/Developmental Effects

Limited information is available regarding the reproductive or developmental effects of lindane in humans. The one available study reported increased levels (not statistically significant) of follicle stimulating hormone and decreased levels of testosterone in men occupationally exposed to lindane. It is not known whether these hormonal changes could result in diminished reproductive capability. Animal studies have reported reproductive effects, such as decreased sperm count, increased testicular weight, and disruption of spermatogenesis from oral exposure to lindane. Disrupted ovarian cycling and reduced ovulation rate were reported in female animals exposed to lindane by gavage (experimentally placing the chemical in the stomach). Lindane has not been reported to cause developmental effects, such as birth defects, in animals via oral exposure.

### Cancer Risk

No studies are available concerning carcinogenic effects in humans or animals following inhalation exposure to lindane. Lindane has been demonstrated to be a liver carcinogen in mice via oral exposure. EPA considers lindane to be a possible human carcinogen and has ranked it in EPA's Group B2/C.

### **SAFETY [5]**

#### First Aid Measures

- Eye Contact: Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least

## Hazard Alert

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15 minutes. WARM water MUST be used. Get medical attention immediately.

- Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
- Serious Skin Contact: Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.
- Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
- Serious Inhalation: Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.
- Ingestion: If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

### Exposure Controls and Personal Protection

#### Engineering Controls

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

#### Personal Protection

The following personal protective equipment should be used when handling lindane:

- Splash goggles
- Lab coat
- Dust respirator (be sure to use an approved/certified respirator or equivalent)
- Gloves

For large spills, the following should be used:

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- Splash goggles
- Full suit
- Dust respirator
- Boots
- Gloves.
- A self-contained breathing apparatus should be used to avoid inhalation of the product.

Note: Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

### REGULATION [5,6,7]

#### Exposure Limits

##### United States

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold limit value – time-weighted average (TLV-TWA) = 0.5 mg/m<sup>3</sup> for lindane.

National Institute for Occupational Safety and Health (NIOSH) Recommended exposure limit (REL) = 0.5 mg/m<sup>3</sup> for lindane. Immediately dangerous to life and health (IDLH) limit = 50 mg/m<sup>3</sup> for lindane.

Occupational Safety and Health Administration (OSHA) Permissible exposure limit (PEL) = 0.5 mg/m<sup>3</sup> for lindane.

Environmental Protection Agency (EPA) Safe Drinking Water Act Maximum contaminant level (MCL) = 0.0002 mg/L for lindane.

Food and Drug Administration (FDA) Maximum permissible level in bottled water = 0.0002 mg/L for lindane. Action levels for lindane in food and in animal feed range from 0.1 to 0.5 ppm. Lindane is a prescription drug subject to labelling and other requirements.

##### Australia

Safe Work Australia TWA: 0.008 ppm and 0.1 mg/m<sup>3</sup>

##### United Kingdom

NIOSH SKIN TWA: 0.5 (mg/m<sup>3</sup>)

Inhalation TWA: 0.1 (mg/m<sup>3</sup>)

## Hazard Alert

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### REFERENCES

1. <http://en.wikipedia.org/wiki/Lindane>
2. <http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=138>
3. <http://www.epa.gov/ttn/atw/hlthef/lindane.html>
4. <http://www.epa.gov/osw/hazard/wastemin/minimize/factshts/hexagama.pdf>
5. <http://www.sciencelab.com/msds.php?msdsId=9924243>
6. <http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/Lindane.pdf>
7. [http://www.safeworkaustralia.gov.au/sites/SWA/AboutSafeWorkAustralia/WhatWeDo/Publications/Documents/639/Workplace Exposure Standards for Airborne Contaminants.pdf](http://www.safeworkaustralia.gov.au/sites/SWA/AboutSafeWorkAustralia/WhatWeDo/Publications/Documents/639/Workplace%20Exposure%20Standards%20for%20Airborne%20Contaminants.pdf)

## Gossip

## CHEMWATCH

### When sand behaves like oil

2019-05-21

Sand, rice and coffee are all examples of granular materials. The behaviour of granular substances plays a key role in many natural processes, such as avalanches and the motion of sand dunes, but they are also important in industry. In the manufacture of pharmaceuticals or foods, it is important to process granular materials as efficiently as possible. Despite the variety of practical applications, the physical laws that govern how granular materials behave are only partly understood. The opposite is true in the case of liquids: a number of well-established physical laws and mathematical instruments are used to describe their behaviour. This is particularly true for unstable, complex mixtures, such as emulsions, which have structures that quickly rearrange themselves.

#### A new order

Researchers from the group led by Christoph Müller, Professor of Energy Science and Engineering at ETH Zurich, in collaboration with scientists at Columbia University in New York, have discovered that under certain circumstances, mixtures made of granular materials exhibit striking similarities to mixtures of immiscible liquids and can even be described by similar physical laws. To carry out their experiments, the researchers placed heavy and light grains in different configurations in a narrow container, which they vibrated while simultaneously passing air through it from below. These two processes “fluidised” the grains, so that they began to behave similarly to liquids. From the outside, the researchers then observed how the materials in the container rearranged over time.

#### Contrasting structures

If, for example, a layer of heavy sand is placed on top of lighter sand, fluidisation will cause the lighter grains to migrate upwards due to their lower density and form globule-like structures much like viscous liquids. “The grains actually behave similar as oil in water would,” explains Christopher McLaren, a doctoral student in Müller’s group. “A complex interaction occurs between the two materials.” If a small quantity of light sand is embedded in heavy sand, the light sand will more or less move upwards in compact globules. However, in heavy sand, a more complex pattern emerges: a ball of heavy grains, surrounded by light grains, will not simply sink to the bottom intact. Rather, it will gradually disintegrate into several smaller globules, and the material will continue to branch out as time passes.

**Researchers have discovered that under certain circumstances, mixtures made of granular materials exhibit striking similarities to mixtures of immiscible liquids and can even be described by similar physical laws.**

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#### Diverse applications

"Our findings are significant for several applications," says Alexander Penn, a postdoc involved in the experiments. "If, for example, a pharmaceuticals manufacturer wants to produce a very homogeneous powder mixture, it has to understand the physics of these materials in detail, so that it can control the process." The findings are also likely to be of interest to geologists, helping them to better understand the processes involved in landslides or how sandy soils behave during earthquakes. Moreover, the work will also be relevant to the current energy debate. "If you analyse industrial processes, you can see that a significant share of the needed energy is used to process granular materials," explains Penn. "If we know how to better control granular materials, we can develop more energy-efficient manufacturing processes."

EurekAlert, 8 May 2019

<http://www.eurekalert.org>

#### **Move over, silicon switches: There's a new way to compute**

2019-05-21

Logic and memory devices, such as the hard drives in computers, now use nanomagnetic mechanisms to store and manipulate information. Unlike silicon transistors, which have fundamental efficiency limitations, they require no energy to maintain their magnetic state: Energy is needed only for reading and writing information. One method of controlling magnetism uses electrical current that transports spin to write information, but this usually involves flowing charge. Because this generates heat and energy loss, the costs can be enormous, particularly in the case of large server farms or in applications like artificial intelligence, which require massive amounts of memory. Spin, however, can be transported without a charge with the use of a topological insulator - a material whose interior is insulating but that can support the flow of electrons on its surface. In a newly published Physical Review Applied paper, researchers from New York University introduce a voltage-controlled topological spin switch (vTOPSS) that requires only electric fields, rather than currents, to switch between two Boolean logic states, greatly reducing the heat generated and energy used. The team is comprised of Shaloo Rakheja, an assistant professor of electrical and computer engineering at the NYU Tandon School of Engineering, and Andrew D. Kent, an NYU professor of physics and director of the

**NYU Researchers discover new method of controlling magnetic circuits using energy efficient switch that does not require electric currents**

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University's Centre for Quantum Phenomena, along Michael E. Flatté, a professor at the University of Iowa. Rakheja employs a simple analogy to explain the impact of switching between two states more effectively. "Imagine if you were preparing a recipe and had to go into a different room anytime you needed an ingredient before returning to the kitchen to add it," she says. "It's just as inefficient when the portions of computing hardware needed to do a calculation and the portions needed to store it are not well integrated." While heterostructure devices like theirs, composed of a magnetic insulator and topological insulator, are still slightly slower than silicon transistors, vTOPSS increases functionality and circuit design possibilities, as it has integrated logic and non-volatile memory. "This is ultimately a matter of user experience and added features," Rakheja says. Because vTOPSS will reduce reliance on cloud memory, it also holds the potential for making computing safer, as hackers will have greater difficulty gaining access to a system's hardware. Next steps will include further optimisation at the materials and design level to improve the switching speed, as well as developing prototypes.

EurekaAlert, 8 May 2019

<http://www.eurekaalert.org>

### Clean fuel cells could be cheap enough to replace gas engines in vehicles

2019-05-21

Advancements in zero-emission fuel cells could make the technology cheap enough to replace traditional gasoline engines in vehicles, according to researchers at the University of Waterloo. The researchers have developed a new fuel cell that lasts at least 10 times longer than current technology, an improvement that would make them economically practical, if mass-produced, to power vehicles with electricity. "With our design approach, the cost could be comparable or even cheaper than gasoline engines," said Xianguo Li, director of the Fuel Cell and Green Energy Lab at Waterloo. "The future is very bright. This is clean energy that could boom." Researchers initially concentrated on hybrid vehicles, which now have gas engines as well as batteries due to issues involving limited driving range and long charging times. Existing fuel cells could theoretically replace those gas engines, which power generators to recharge batteries while hybrid vehicles are in operation, but are impractical because they are too expensive. The researchers solved that problem with a design that makes fuel cells far more durable by delivering a constant, rather than fluctuating, amount of electricity. That means

**Advancements in zero-emission fuel cells could make the technology cheap enough to replace traditional gasoline engines in vehicles, according to researchers at the University of Waterloo.**



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the cells, which produce electricity from the chemical reaction when hydrogen and oxygen are combined to make water, can be far simpler and therefore far cheaper. "We have found a way to lower costs and still satisfy durability and performance expectations," said Li, a professor of mechanical and mechatronics engineering. "We're meeting economic targets while providing zero emissions for a transportation application." Researchers hope the introduction of fuel cells in hybrid vehicles will lead to mass production and lower unit costs. That could pave the way for the replacement of both batteries and gas engines entirely by providing an affordable, safe, dependable, clean source of electrical power. "This is a good first step, a transition to what could be the answer to the internal combustion engine and the enormous environmental harm it does," said Li. Li collaborated with lead researcher Hongtao Zhang, a former post-doctoral fellow, Waterloo mathematics professor Xinzhi Liu and Jinyue Yan, an energy expert and professor in Sweden.

EurekAlert, 8 May 2019

<http://www.eurekalert.org>

### Scientists Just Built a Laser From Sound Waves That Can Help Us Detect Weak Forces

2019-05-21

What makes optical laser light different from a light bulb or the sun is that all the light waves emerging from it are moving in the same direction and are pretty much in perfect step with each other. This is why the beam coming out of the laser pointer does not spread out in all directions. In contrast, rays from the sun and light from a light bulb go in every direction. This is a good thing because otherwise it would be difficult to illuminate a room; or worse still, the Earth might not receive any sunlight. But keeping the light waves in step – physicists call it coherence – is what makes a laser special. Sound is also made of waves. Recently there has been considerable scientific interest in creating phonon lasers in which the oscillations of light waves are replaced by the vibrations of a tiny solid particle. By generating sound waves that are perfectly synchronized, we figured out how to make a phonon laser – or a "laser for sound." In work we recently published in the journal Nature Photonics, we have constructed our phonon laser using the oscillations of a particle – about a hundred nanometres in diameter – levitated using an optical tweezer.

[Waves in sync](#)

**Most people are familiar with optical lasers through their experience with laser pointers. But what about a laser made from sound waves?**

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An optical tweezer is simply a laser beam which goes through a lens and traps a nanoparticle in midair, like the tractor beam in Star Wars. The nanoparticle does not stay still. It swings back and forth like a pendulum, along the direction of the trapping beam. Since the nanoparticle is not clamped to a mechanical support or tethered to a substrate, it is very well isolated from its surrounding environment. This enables physicists like us to use it for sensing weak electric, magnetic and gravitational forces whose effects would be otherwise obscured. To improve the sensing capability, we slow or “cool” the nanoparticle motion. This is done by measuring the position of the particle as it changes with time. We then feed that information back into a computer that controls the power in the trapping beam. Varying the trapping power allows us to constrain the particle so that it slows down. This setup has been used by several groups around the world in applications that have nothing to do with sound lasers. We then took a crucial step that makes our device unique and is essential for building a phonon laser. This involved modulating the trapping beam to make the nanoparticle oscillate faster, yielding laser-like behaviour: The mechanical vibrations of the nanoparticle produced synchronised sound waves, or a phonon laser. The phonon laser is a series of synchronised sound waves. A detector can monitor the phonon laser and identify changes in the pattern of these sound waves that reveal the presence of a gravitational or magnetic force. It might appear that the particle becomes less sensitive because it is oscillating faster, but the effect of having all the oscillations in sync actually overcomes that effect and makes it a more sensitive instrument.

### Possible applications

It is clear that optical lasers are very useful. They carry information over optical fibre cables, read bar codes in supermarkets and run the atomic clocks which are essential for GPS. We originally developed the phonon laser as a tool for detecting weak electric, magnetic and gravitational fields, which affect the sound waves in a way we can detect. But we hope that others will find new uses for this technology in communication and sensing, such as the mass of very small molecules. On the fundamental side, our work leverages current interest in testing quantum physics theories about the behaviour of collections of billion atoms – roughly the number contained in our nanoparticle. Lasers are also the starting point for creating exotic quantum states like the famous Schrodinger cat state, which allows an object to be in two places at the same time. Of course, the

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most exciting uses of the optical tweezer phonon laser may well be ones we cannot currently foresee.

Science Alert, 20 May 2019

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

### Artificial sponges could pull uranium from seawater for nuclear power

2019-05-21

A specialised sponge could harvest uranium from seawater for use as fuel in nuclear power plants, and could also be used to help clean waste from those plants. The easiest way to get uranium is to mine it from ores in Earth's crust. There are about 7.6 million tonnes of uranium that should be relatively simple to mine, which is projected to be enough to cover global needs for about a century. Seawater holds more than 4.5 billion tonnes of uranium, making it potentially an excellent backup source. Natural sponges are often used to monitor heavy metals in the ocean because they accumulate the substances as huge amounts of water flow through them. Dong Wang at Hainan University in China and his colleagues have created a special sponge that sucks up uranium through the same process. The sponge is made of melamine foam, which is also used in certain household cleaning sponges. The foam is dipped in a solution of chemicals that easily bond to uranium and then dried, leaving a chemical film over the sponge's internal structure. After eight weeks submerged in a five-tonne tank of seawater, the sponge had absorbed about 1.9 milligrams of uranium per gram of sponge. This is a similar yield to other methods of harvesting uranium from the ocean, says Sheng Dai at Oak Ridge National Laboratory in Tennessee. But the melamine sponge is more biodegradable than the plastics used in many of those other methods, making it more environmentally friendly, he says. When the sponge has absorbed uranium, it takes on the element's yellowish hue. It can then be rinsed out, the uranium extracted for use in a nuclear power plant, and the sponge placed back in the ocean. It loses some efficacy with every recycling because it also picks up other elements that can be harder to rinse off. This method is more expensive than mining uranium from the ground for now, but when ores eventually run low, relatively little sponge material could be used to harvest lots of nuclear fuel from the seas. "You don't need to put

**A specialised sponge could harvest uranium from seawater for use as fuel in nuclear power plants, and could also be used to help clean waste from those plants.**

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acres of sponges in the ocean," says Dai. "That's the beauty of the nuclear industry – you don't need much."

New Scientist, 11 May 2019

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

### US EPA struggles to replace animal tests for pesticide toxicity

2019-05-21

The United States Environmental Protection Agency is working to reduce the number of animals used in testing the acute toxicity of pesticides. The agency uses such information to determine what personal protective equipment is needed for workers. In early 2016, the US Environmental Protection Agency set an immediate goal to reduce the number of animals used to test the toxicity of pesticides. The agency claims that it is making significant progress toward meeting that goal, but manufacturers are still using tens of thousands of laboratory animals each year to demonstrate that new pesticides entering the US marketplace meet safety standards. The primary way the EPA's pesticide office has reduced the use of animals is by granting waivers for certain tests. The agency has been much slower to identify and validate nonanimal methods to replace in vivo animal studies. One of the biggest hurdles to replace in vivo animal studies with in vitro human-relevant tests is a lack of correlation between the results of human and animal studies. Toxicologists know that animal studies are not always reproducible and useful for predicting adverse human health effects. Even so, animal studies are still the gold standard that scientists try to model and replicate with in vitro systems. A growing group of scientists is calling for that to change. The EPA evaluates about 500 new pesticide formulations plus a small number of new active ingredients each year. The agency typically requires manufacturers to provide data on acute dermal, oral, and inhalation toxicity, as well as skin and eye irritation and skin sensitisation. Completing all six acute mammalian toxicity tests, referred to as the six-pack, requires more than 50 laboratory animals for each formulation or active ingredient. If the six-pack tests can be modernised, "applicants and registrants will be able to use in vitro and computational approaches that have the potential to reduce the number of animals needed for testing by over 20,000 per year," an EPA spokesperson says. The EPA did not grant C&EN's request to interview someone from its pesticide office. The agency instead provided written answers to questions submitted by C&EN, saying the information should be attributed to an unnamed spokesperson. The EPA uses the six-pack

**Non-animal approaches have been available for years, but regulators are slow to adopt them**

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studies to classify pesticides into four categories according to their toxicity. The most dangerous pesticides are category I. Products in this category have the most stringent personal protective equipment (PPE) labelling requirements to protect workers who apply the pesticides. The six tests measure only acute effects, which occur within a short time after exposure to a chemical, as opposed to medium- or long-term effects—called subchronic and chronic, respectively—which happen after repeated exposures over several days or weeks. Evaluating subchronic and chronic effects requires additional animal tests. To satisfy the six-pack testing requirements, manufacturers can, in some cases, use data from already-registered products that are similar in composition. Manufacturers can also request waivers for some of the tests if the pesticide meets certain criteria. The EPA grants waivers when a test is not relevant to a particular chemical, according to guidelines released by the agency in 2012. For example, the agency would consider waiving acute oral toxicity tests when a chemical exists as a vapour or gas.

In 2016, the EPA released additional guidelines, announcing that it would waive the acute dermal test for new pesticide formulations. The EPA justified its decision with an analysis comparing oral and dermal acute toxicity data previously submitted to the agency for a range of different pesticides. If the EPA used just the oral studies, "PPE requirements on the labelling would have been equally protective or more protective" for 95% of the formulations analysed, the EPA reported in 2016. The agency is still working on guidance for waiving the acute dermal test for active ingredients in pesticides. Of the remaining five tests, the EPA has made the most progress toward nonanimal testing for skin sensitisation—an inflammatory skin reaction caused by an allergic response after repeated skin contact with a chemical. In April 2018, the agency began accepting nonanimal approaches to test active ingredients for skin sensitisation. The policy builds on methods already established by the Organisation for Economic Co-operation and Development (OECD). Those methods use a combination of in vitro cellular assays, computational approaches, and biochemical tests, such as peptide-binding assays. None of the methods can be used alone as a replacement for the animal test. Each test targets a specific event along the pathway that leads to skin sensitisation. Such tests, however, have been validated only for active ingredients. "The assays need to be validated for formulations and mixtures, and that work is being done now," the EPA spokesperson says. The situation is similar for the skin and eye irritation tests. "There are OECD in vitro test methods that have been around for many years now, and they have been validated," says Kristie Sullivan, vice president for research policy at the

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Physicians Committee for Responsible Medicine, an advocacy group that promotes scientific research without the use of animals. “But all of the validation was done with either cosmetics or personal care products or industrial chemicals. Maybe some active ingredient pesticides. The real gap is, again, the pesticide formulations and mixtures.” During the past few years, companies have voluntarily provided pesticide formulations to toxicology-testing laboratories, such as Integrated Laboratory Systems and the Institute for In Vitro Sciences (IIVS). The labs are working closely with industry, the EPA, and other stakeholders to determine how well the OECD in vitro tests work on the formulations. So far, for both eye and skin irritation, “we aren’t quite finding what we are looking for,” Sullivan says. One of the challenges is the classification system that the EPA uses for pesticides. That system is different from the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) used in the European Union and by the US Occupational Safety and Health Administration. Non-animal test methods for skin and eye irritation have been validated for GHS categorisation. They are not easily transferable to the EPA’s categories because the GHS has three categories, whereas the EPA has four, says Hans Raabe, vice president and chief operating officer at IIVS. It is quite straightforward to predict skin irritation using the currently available in vitro test methods, Raabe says. “This is due in large part to our mechanistic understanding of cellular responses in the skin after chemical exposure and the fact that these responses can be modelled with available in vitro test methods.” Tests using “reconstructed human epidermal tissue constructs were successfully validated for identifying chemicals that fall within the GHS classification of corrosive and skin irritant categories,” Raabe says. The catch is that in vitro tests are better at predicting the extremes—corrosive and non-irritant. It is the EPA’s middle categories—severe and moderate irritant—that are difficult to predict with the in vitro tests.

“The EPA and GHS skin irritation category systems are not particularly well aligned,” Raabe notes. “It certainly would be easier if all regulatory systems followed one approach—for example, the GHS categorisation scheme—so that the test methods validated for GHS schemes would be directly applicable to the EPA.” Regulators in the EU and many countries that follow the GHS categorisation already accept nonanimal methods for skin irritation for many purposes. One problem that all regulators around the world face is the reproducibility of the in vivo test itself, Sullivan says. Chemicals tested multiple times for eye and skin irritation using animal tests have discordant results, according to analyses of the literature. “How do you decide what the correct answer is?” Sullivan asks. “I think the time

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has come for us to break our reliance on the animal test as the reference standard and begin to rely on the categorisation of the in vitro test methods to move forward for classification and labelling purposes," Raabe says. The newer in vitro methods include tissues, organ culture systems, and chemical exposures that are more relevant for humans than the animal studies. "We spend a lot of time pondering why we can't get 100% correlations to the animal test results when we should be asking ourselves why we assume that the animal test is always correct," Raabe says. For the remaining two six-pack tests—acute oral and inhalation toxicity—the EPA is considering accepting calculations used under the GHS that add up the hazards of each chemical in a mixture as an alternative to animal tests. A pilot program is underway to collect data from in vivo oral and inhalation toxicity studies on pesticide formulations to evaluate the ability of the GHS mixtures equation to predict the acute toxicity categories derived from traditional animal studies. The EPA acknowledges that non-animal approaches can yield more information than animal studies and improve the agency's ability to predict the hazards of chemicals. The agency is working closely with stakeholders to find and validate nonanimal methods, but "it is a highly time-consuming process," the EPA spokesperson says. The EPA cannot predict how long it will take to replace the six pesticide tests, but the agency says that it will continue to waive tests and accept alternative approaches "as the science is ready for use."

Chemical & Engineering News, 18 May 2019

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

## Boosting the performance of aqueous potassium-ion batteries

2019-05-21

Rechargeable batteries that feature an aqueous, potassium-based electrolyte have been sitting on battery designers' drawing boards for years. Compared with popular lithium-ion batteries, which depend on an electrolyte solution of expensive lithium salts in flammable organic solvents, aqueous potassium-ion batteries (AKIBs) could offer advantages in cost and safety. But the AKIBs reported until now have not worked very well. They don't store enough energy to be practical, because of the difficulty in finding cathodes, anodes, and electrolytes that work well together. And they don't last long, because the electrodes degrade as potassium ions move in and out during charging cycles. To overcome these problems, Yong-Sheng Hu and Yaxiang Lu of the Chinese Academy of Sciences and co-workers made an AKIB with a perylene diimide-

**Water-based electrolyte offers safety and cost advantages compared with electrolytes in conventional lithium-ion batteries**

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based anode, an iron-manganese Prussian blue-type cathode, and a highly concentrated KCF<sub>3</sub>SO<sub>3</sub> aqueous electrolyte. The battery's overall performance tops all previous efforts. It operates reliably over an 80°C temperature range, exhibits an energy density of 80 W h/kg, and retains nearly 75% of its charge capacity for more than 2,000 charging cycles (Nat. Energy 2019, DOI: 10.1038/s41560-019-0388-0). Battery specialist Lauren E. Marbella of Columbia University describes the work as "an important step forward," noting that the new battery is "a promising model" from which to build future designs.

Chemical & Engineering News, 18 May 2019

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

### **New research shows how clustered particles determine elasticity of some gels**

2019-05-21

From the toothpaste you squeeze on your brush first thing in the morning to the yogurt you slurp down to the fabric softener that keeps your pyjamas cosy and soft, gels are ubiquitous in consumer products, foods, and in industrial applications, too. However, until now, scientists have been unable to explain the microscopic structures within gels that impart their elasticity, or springiness, nor how those structures form. A team of scientists from the University of Delaware, Massachusetts Institute of Technology, North Carolina State University and University of Michigan discovered that the elasticity of gels arises from the packing of clusters of particles in the gels, which the group dubbed locally glassy clusters. This research, described in a paper published in the journal Nature Communications, could help people engineer better materials and products at the microscale. This insight could help companies in the consumer products, biotechnology, and agriculture sectors and beyond. Many companies formulate and sell gel products, and sometimes, the stiffness of gels changes as a result of instability. Eric Furst, professor and chair of UD's Department of Chemical and Biomolecular Engineering and one of the paper's corresponding authors, keeps an old bottle of fabric softener on a shelf in his office and uses it to demonstrate what happens when gels separate or "collapse". The product is supposed to be easy to pour, but when it goes bad, it becomes gloppy and unappealing. "Our results provide insight into how to engineer cluster size distribution to control stiffness, flow, and stability of gel materials," said Furst. The first author of the new paper is Kathryn A. Whitaker, who received a doctoral

**A team of scientists, including UD's Eric Furst, discovered that the elasticity of gels arises from the packing of clusters of particles in the gels, which the group dubbed locally glassy clusters.**



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degree in chemical engineering from UD in 2015 and is now a senior research engineer at Dow in Midland, Michigan.

#### Investigating gels

Gels are semi-solid materials that flow like liquids but contain solid particles, too. When scientists examine these substances under a microscope, they see that the solid particles within gels form a network, like the structure of a building. To make the substance flow so that you can squeeze it or spread it thin, you need to break that structure. When this requires a lot of force, the substance is stiff and has a high elastic modulus. When less force is required, the substance flows easily and has a lower elastic modulus. The research group led by Furst studied a gel made of particles of poly(methylmethacrylate) latex (PMMA), commonly known as acrylic, dispersed in a mixture of two colourless liquids, cyclohexane and cyclohexyl bromide. They found that this gel was composed of glassy clusters of particles connected to each other with weak areas in between. To understand how these clusters contributed to the gel's properties, the team wanted to determine the boundaries where each cluster began and ended. "This is like Facebook," said Furst. "We were trying to figure out—who is connected locally to whom?" Collaborator James W. Swan, assistant professor of chemical engineering at MIT, conducted simulations to explore the physics behind the clusters. He then applied graph theory, the mathematical study of graphs, to the simulation data to figure out which clusters connected to each other, identify the edges of each group and colour-code the clusters. It was like defining the boundaries of intermingling friend groups. Next, the researchers compared the simulation results to physical studies of the gels and confirmed that the connections and distributions matched their predictions. They determined that the way these locally glassy clusters pack together determines the material's elastic modulus. The interconnected clusters act as rigid, load-bearing units within the gel. "Until now, no one had seen and described how these clusters packed and how they affected elasticity," said Furst. "We brought the puzzle together." The paper's authors also include Zsigmond Varga, a process development engineer at ExxonMobil; Lilian C. Hsiao, an assistant professor of chemical and biomolecular engineering at North Carolina State University and Michael J. Solomon, a professor of chemical engineering and Dean and Vice Provost for Academic Affairs, Graduate Studies, Rackham Graduate School at the University of Michigan. This paper was years in the making as the investigators followed up on lingering questions that bothered them and prompted them to keep working. "This discovery was the result of the teamwork of the principal

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investigators, the experimental skills of our students, and the passion and tenacity we all brought as we worked through this problem,” said Furst.

Phys.org, 20 May 2019

<http://phys.org>

### A way to determine the absolute stereochemistry of small, organic molecules

2019-05-21

A team of researchers from several institutions in Czech Republic has developed a way to determine the absolute stereochemistry (3-D spatial configuration) of small, organic molecules. In their paper published in the journal *Science*, the group describes their new technique and how well it worked. Hongyi Xu and Xiaodong Zou with Stockholm University, have published a Perspective piece on the work done by the team in the same journal issue. As the researchers note, the current method for determining the absolute configuration of molecules that have chiral centres is done via X-ray crystallography. The measurement is based on observing how X-rays fired at molecules bounce around. Unfortunately, this method only works on relatively large crystal structures. Efforts to use a similar technique on smaller crystals based on electron diffraction have fallen short of expectations due to the fragile nature of the target—nanocrystals are destroyed by the energy in the electron beams. In this new effort, the researchers have found a way to overcome this problem, which allowed them to determine the stereochemistry of very small crystals for the first time. This is a pretty big deal, Xu and Zou note, because the U.S. FDA and the European Medicines Agency require absolute configuration information for a prospective new drug before it can be approved. This requirement has held back the creation and sale of drugs based on nanocrystals, as pharmaceutical companies had no way to fulfil the requirement. To overcome the problem of electron beams destroying nanocrystals before their stereochemistry could be recorded, the researchers simply used more beams—four of them. They fired them all at once at different parts of the nanocrystal and recorded information regarding the diffracting that occurred before the nanocrystal was destroyed. Xu and Zou note that X-rays scatter only once when used to determine the configuration of a molecule—with electron diffraction, electrons scatter multiple times, and as they do so, the intensities of their diffractions change—sensors that read such changes are able to measure such dynamical diffraction effects. The result was a description of the absolute stereochemistry of a given molecule. Xu and Zou suggest

**A team of researchers from several institutions in Czech Republic has developed a way to determine the absolute stereochemistry (3-D spatial configuration) of small, organic molecules.**

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that the new technique is likely to open the door to development of new materials used in drug design.

Phys.org, 20 May 2019

<http://phys.org>

### **Cement as a climate killer: Using industrial waste to produce carbon neutral alternatives**

2019-05-21

Producing cement takes a big toll on our climate: Around eight per cent of annual global carbon dioxide emissions can be attributed to this process. However, the demand for cement continues to rise. A team of geoscientists from Martin Luther University Halle-Wittenberg (MLU) has found a way to produce more environmentally friendly and sustainable alternatives. In the journal *Construction and Building Materials* they describe how industrial residues can be used to produce high-quality, climate-friendly materials. The basic raw material for cement is limestone, which is converted to cement clinker in large furnaces. The environmental impact of this process is disastrous: "Around one tonne of carbon dioxide is released during cement production for every tonne of limestone. The majority of this is emitted by the limestone itself," says Professor Herbert Pöllmann, a geoscientist at MLU. Replacing the limestone in cement production would result in an enormous savings potential, adds the researcher. However, the material produced would need to have the same beneficial properties as traditional cement. In their search for alternative raw materials, the researchers from Halle came across two types of industrial waste: Residual materials from the production of kaolin and aluminium. "I don't really like the term industrial waste. It is actually industrial residues that can still be used very effectively, for example to produce alternative forms of cement," says Pöllmann. For the new study, his team tested different mixing ratios and analysed the physical properties of the newly produced cements. The study showed that the two industrial residuals can be used to produce cements that have the same properties as conventional mixtures. The advantage of the two residual materials that the mineralogists at MLU investigated is that they contain no carbon dioxide which could be released during further processing. "And you can use them to produce large quantities of cement that has great properties," explains Pöllmann. In the new study, he and his team also describe in detail the mixing ratios and production steps of the more environmentally friendly cements. According to the researcher, producers could either switch completely to the more climate-friendly materials

**A team of geoscientists from Martin Luther University Halle-Wittenberg (MLU) has found a way to produce more environmentally friendly and sustainable alternatives to cement.**

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or produce cement mixtures that use a lower ratio of limestone and are therefore also more climate-friendly. However, the process does have its limits: "There aren't enough industrial residues to cover the global demand for cement," says Pöllmann. Therefore, his team is also looking for suitable natural products such as volcanic ash or various mineral resources that have not yet been used industrially and that do not release carbon dioxide as well, for example various types of clay.

EurekAlert, 20 May 2019

<http://www.eurekalert.org>

### Metals influence C-peptide hormone related to insulin

2019-05-21

Metals such as zinc, copper and chromium bind to and influence a peptide involved in insulin production, according to new work from chemists at the University of California, Davis. The research is part of a new field of "metalloendocrinology" that takes a detailed look at the role of metals in biological processes in the body. "We're asking questions people didn't realise we don't have the answers to," said Marie Heffern, assistant professor of chemistry at UC Davis and senior author on the paper, to be published in the journal ChemBioChem. Metals play a role in many biochemical processes. Haemoglobin contains iron and carries oxygen in the blood; zinc and copper are involved in a third to a half of all body functions. But while scientists know the overall amount of an element in a given component of the body, such as blood, they generally don't know the exact location of these metals, the state they are in or their biological role in the body. "A metal is an ingredient - what you do with it is what makes the difference," Heffern said. Her laboratory at UC Davis is using new techniques to understand how metals are distributed inside and outside cells, how they bind to proteins and other molecules and the subtle influences they have on those molecules. The new study looked at C-peptide, or connecting peptide, a short chain of amino acids. C-peptide is being investigated for potential in treating kidney disease and nerve damage in diabetes, so any better understanding of how it behaves in different conditions could be useful in drug development.

#### Influencing shape and uptake by cells

When the pancreas makes insulin, C-peptide connects two chains of insulin in a preliminary step. C-peptide is then cut out, stored along with insulin and released at the same time. C-peptide used to be considered a by-product of insulin production but now scientists know that it acts as

**New field of metalloendocrinology explores subtle effects of metals in body**

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a hormone in its own right. The researchers measured how readily zinc, copper and chromium bound to C-peptide in test tubes, and how the metals affected the ability of cells to take up C-peptide. The metals had subtle effects on the structure of C-peptide, notably on its ability to curl into a helix in some conditions. Copper and chromium prevented cells from taking up the hormone, but other metals such as zinc, cobalt and manganese did not have such an effect. The results show that metals can potentially “tune” the activity of hormones such as C-peptide by altering their structure or affecting uptake into cells, Heffern said. Additional authors on the paper are postdoctoral researcher Michael Stevenson, research specialist Kylie Uyeda, graduate student Jessica San Juan and Ian Farran, undergraduate majoring in biochemistry and molecular biology.

EurekAlert, 17 May 2019

<http://www.eurekalert.org>

### Ultra-clean fabrication platform produces nearly ideal 2D transistors

2019-05-21

Semiconductors, which are the basic building blocks of transistors, microprocessors, lasers, and LEDs, have driven advances in computing, memory, communications, and lighting technologies since the mid-20th century. Recently discovered two-dimensional materials, which feature many superlative properties, have the potential to advance these technologies, but creating 2D devices with both good electrical contacts and stable performance has proved challenging. Researchers at Columbia Engineering report that they have demonstrated a nearly ideal transistor made from a two-dimensional (2D) material stack -- with only a two-atom-thick semiconducting layer -- by developing a completely clean and damage-free fabrication process. Their method shows vastly improved performance compared to 2D semiconductors fabricated with a conventional process, and could provide a scalable platform for creating ultra-clean devices in the future. The study was published today in Nature Electronics. “Making devices out of 2D materials is a messy business,” says James Teherani, assistant professor of electrical engineering. “Devices vary wildly from run to run and often degrade so fast that you see performance diminish while you’re still measuring them.” Having grown tired of the inconsistent results, Teherani’s team set out to develop a better way to make stable devices. “So,” he explains, “we decided to separate the pristine device from the dirty fabrication processes that lead to variability.” As shown in this new study, Teherani and his colleagues developed a two-

**Columbia Engineering researchers report that they have demonstrated a nearly ideal transistor made from a 2D material stack**

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step, ultra-clean nanofabrication process that separates the “messy” steps of fabrication -- those that involve “dirty” metallisation, chemicals, and polymers used to form electrical connections to the device -- from the active semiconductor layer. Once they complete the messy fabrication, they could pick up the contacts and transfer them onto the clean active device layer, preserving the integrity of both layers. “The thinness of these semiconductors is a blessing and a curse,” says Teherani. “While the thinness allows them to be transparent and to be picked up and placed wherever you want them, the thinness also means there’s nearly zero volume -- the device is almost entirely surface. Because of this, any surface dirt or contamination will really degrade a device.” Currently, most devices are not encapsulated with a layer that protects the surface and contacts from contamination during fabrication. Teherani’s team showed that their method can now not only protect the semiconductor layer so that they don’t see performance degradation over time, but it can also yield high performance devices. Teherani collaborated with Jim Hone, Wang Fong-Jen Professor of Mechanical Engineering, making use of the fabrication and analysis facilities of the Columbia Nano Initiative and the National Science Foundation-funded Materials Research Science and Engineering Centre at Columbia. The team made the transferred contacts from metal embedded in insulating hexagonal boron nitride (h-BN) outside a glovebox and then dry-transferred the contact layer onto the 2D semiconductor, which was kept pristine inside a nitrogen glovebox. This process prevents direct-metallisation-induced damage while simultaneously providing encapsulation to protect the device. Now that the researchers have developed a stable, repeatable process, they are using the platform to make devices that can move out of the lab into real-world engineering problems. “The development of high performance 2D devices requires advances in the semiconductor materials from which they are made,” Teherani adds. “More precise tools like ours will enable us to build more complex structures with potentially greater functionality and better performance.” The study was supported by the National Science Foundation through CAREER Award (ECCS-1752401) and the Centre for Precision Assembly of Superstratic and Superatomic Solids (DMR-1420634). This work is also supported by the National Research Foundation of Korea through the Global Research Laboratory (GRL) program (2016K1A1A2912707) and Research Fellow program (2018R1A6A3A11045864).

Science Daily, 17 May 2019

<http://www.sciencedaily.com>

### **Hyperspectral camera captures wealth of data in an instant**

2019-05-21

Scientists and engineers develop a portable spectrometer able to capture far more data much quicker than other fibre-based systems. The TuLIPSS camera will be useful for quick analysis of environmental and biological data.

Standard snapshots from space don't quite show Earth in all its glory. There's so much more to see. To reveal details impossible to observe with the naked eye, Rice University engineers are building a portable spectrometer that can be mounted on a small satellite, flown on an airplane or a drone or someday even held in the hand. Bioengineer Tomasz Tkaczyk and his colleagues at Rice's Brown School of Engineering and Wiess School of Natural Sciences have published the first results from a NASA-funded project to develop a small, sophisticated spectrometer with unusual versatility. Their paper appears in *Optics Express*. A spectrometer is an instrument that gathers light from an object or a scene, separates the colours and quantifies them to determine the chemical contents or other characteristics of what it sees. The Rice device, called the Tunable Light-Guide Image Processing Snapshot Spectrometer (TuLIPSS), will let researchers instantly capture data across the visible and near-infrared spectrum, unlike current systems that scan a scene line-by-line and for later reassembly. Each pixel in the hyperspectral images produced by TuLIPSS contains either spectral or spatial information. The "pixels" in this case are thousands of optical fibres, flexible light guides that deliver the image components to a detector. Because they can reposition the fibres, researchers can customise the balance of image and spectral data sent to the detector. The device, for example, can be tuned to measure the chemistry of a tree to see if it's healthy or diseased. It can do the same for a cell, a single leaf, a neighbourhood or farm, or a planet. In continuous-capture mode, akin to a camera's motor drive, it can show how the spectral "fingerprints" in a stationary scene change over time, or grab the spectral signature of a lightning bolt in real time. Tkaczyk said TuLIPSS is unique because it works like any camera, capturing all the hyperspectral data -- what researchers refer to as a data cube -- in an instant. That means an airplane or orbiting satellite can snap an image of the ground quickly enough to avoid motion blur that would distort the data. Onboard processing will filter the data and send only what's required back to Earth, saving time and energy. "This would be an interesting tool in the case of an event like Hurricane Harvey," Tkaczyk said. "When there's a flood and

**Scientists and engineers develop a portable spectrometer able to capture far more data much quicker than other fibre-based systems.**

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potential contamination, a device able to fly over a reservoir could tell if that water is safe for people to drink. It would be more effective than sending someone to a site that may be hard to reach." In a normal camera, a lens focuses incoming light onto a sensor chip and converts the data into an image. In TuLIPSS, the lens focuses that light onto a middleman: the bundle of optical fibres. In the current prototype, these fibres collect more than 30,000 spatial samples and 61 spectral channels in the 450-to-750 nanometre range -- essentially, hundreds of thousands of data points -- split by prisms into their component bands and passed on to a detector. The detector then feeds these data points to software that recombines them into the desired images or spectra. The fibre array is tightly packed at the input and rearranged into individually addressable rows at the output, with gaps between them to avoid overlap. Spacing the rows allows researchers to tune spatial and spectral sampling for specific applications, Tkaczyk said. First author Ye Wang, who earned her doctorate this year at Rice, and her colleagues painstakingly built the prototype, assembling and positioning the fibre bundles by hand. They used scenes in and around Rice to test it, reconstructing images of buildings to fine-tune TuLIPSS and taking spectral images of campus trees to "detect" their species. They also successfully analysed the health of various plants with spectral data alone. Continuous capture images of moving traffic in Houston showed the system's ability to see which spectra are shifting over time (such as moving vehicles and changing traffic lights) and which are stable (everything else). The experiment was a useful proof-of-concept to show how well the spectrometer could filter motion blur in dynamic situations. Co-author David Alexander, a professor of physics and astronomy and director of the Rice Space Institute, said the researchers have begun discussions with the city of Houston and Rice's Kinder Institute for Urban Research about testing TuLIPSS in aerial studies of the city. "Since we need to test TuLIPSS anyway, we want to do something useful," he said, suggesting a hyperspectral map of the city could reveal how the urban landscape is changing, distinguish buildings from parks or map sources of pollen. "In principle, regular flights over the city will allow us to map out the changing conditions and identify areas that need attention." Tkaczyk suggested future versions of TuLIPSS will be useful for agricultural and atmospheric analysis, algae blooms and other environmental conditions where quick data acquisition will be valuable. "The real challenge has been to decide what to focus on first," Alexander said. "Ultimately, we want to be



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successful enough that the next phase of development pushes us closer to flying TuLIPSS in space.”

Science Daily, 20 May 2019

<http://www.sciencedaily.com>

### **New surface treatment could improve refrigeration efficiency**

2019-05-21

Unlike water, liquid refrigerants and other fluids that have a low surface tension tend to spread quickly into a sheet when they come into contact with a surface. But for many industrial processes, it would be better if the fluids formed droplets, which could roll or fall off the surface and carry heat away with them. Now, researchers at MIT have made significant progress in promoting droplet formation and shedding in such fluids. This approach could lead to efficiency improvements in many large-scale industrial processes including refrigeration, thus saving energy and reducing greenhouse gas emissions. The new findings are described in the journal *Joule*, in a paper by graduate student Karim Khalil, professor of mechanical engineering Kripa Varanasi, professor of chemical engineering and Associate Provost Karen Gleason, and four others. Over the years, Varanasi and his collaborators have made great progress in improving the efficiency of condensation systems that use water, such as the cooling systems used for fossil-fuel or nuclear power generation. But other kinds of fluids -- such as those used in refrigeration systems, liquification, waste heat recovery, and distillation plants, or materials such as methane in oil and gas liquifaction plants -- often have very low surface tension compared to water, meaning that it is very hard to get them to form droplets on a surface. Instead, they tend to spread out in a sheet, a property known as wetting. But when these sheets of liquid coat a surface, they provide an insulating layer that inhibits heat transfer, and easy heat transfer is crucial to making these processes work efficiently. “If it forms a film, it becomes a barrier to heat transfer,” Varanasi says. But that heat transfer is enhanced when the liquid quickly forms droplets, which then coalesce and grow and fall away under the force of gravity. Getting low-surface-tension liquids to form droplets and shed them easily has been a serious challenge. In condensing systems that use water, the overall efficiency of the process can be around 40 percent, but with low-surface-tension fluids, the efficiency can be limited to about 20 percent. Because these processes are so widespread in industry, even a tiny improvement in that efficiency could lead to dramatic savings in fuel, and therefore in

**A slippery surface for liquids with very low surface tension promotes droplet formation, facilitating heat transfer**

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greenhouse gas emissions, Varanasi says. By promoting droplet formation, he says, it's possible to achieve a four- to eightfold improvement in heat transfer. Because the condensation is just one part of a complex cycle, that translates into an overall efficiency improvement of about 2 percent. That may not sound like much, but in these huge industrial processes even a fraction of a percent improvement is considered a major achievement with great potential impact. "In this field, you're fighting for tenths of a percent," Khalil says. Unlike the surface treatments Varanasi and his team have developed for other kinds of fluids, which rely on a liquid material held in place by a surface texture, in this case they were able to accomplish the fluid-repelling effect using a very thin solid coating -- less than a micron thick (one millionth of a meter). That thinness is important, to ensure that the coating itself doesn't contribute to blocking heat transfer, Khalil explains. The coating, made of a specially formulated polymer, is deposited on the surface using a process called initiated chemical vapor deposition (iCVD), in which the coating material is vaporised and grafts onto the surface to be treated, such as a metal pipe, to form a thin coating. This process was developed at MIT by Gleason and is now widely used. The authors optimised the iCVD process by tuning the grafting of coating molecules onto the surface, in order to minimise the pinning of condensing droplets and facilitate their easy shedding. The process could be carried out on location in industrial-scale equipment, and could be retrofitted into existing installations to provide a boost in efficiency. The process is "materials agnostic," Khalil says, and can be applied on either flat surfaces or tubing made of stainless steel, copper, titanium, or other metals commonly used in evaporative heat-transfer processes that involve these low-surface-tension fluids. "Whatever material you come up with, it tends to be scalable with this process," he adds. The net result is that on these surfaces, condensing fluids such as liquid methane will readily form small droplets that quickly fall off the surface, making room for more to form, and in the process shedding heat from the metal to the droplets that fall away. Without the coating, the fluid would spread out over the whole surface and resist falling away, forming a kind of heat-retaining blanket. But with it, "the heat transfer improves by almost eight times," Khalil says. One area where such coatings could play a useful role, Varanasi says, is in organic Rankine cycle systems, which are widely used for generating power from waste heat in a variety of industrial processes. "These are inherently inefficient systems," he says, "but this could make them more

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efficient." The research was supported by the Shell-MIT Energy Initiative partnership.

Science Daily, 15 May 2019

<http://www.sciencedaily.com>

### This Physicist Is Using Mayonnaise to Study Nuclear Fusion

2019-05-21

One promising aspect of US nuclear fusion research may depend on a common kitchen condiment. To recreate the conditions necessary for fusion reactions, physicists sometimes use something called inertial confinement studies. In this case, that means using gas, frozen inside pea-sized metal pellets, which are placed in a centrifugal chamber and bombarded with high-powered lasers that compress the gas and heat it up to a few million Kelvin. This all happens in a matter of nanoseconds and, according to Phys.org, tends to have an unwanted side effect — the pellets often explode before reaching fusion conditions. In order to take the concept further, scientists need to better understand the physics at play. And that's where mayo comes in. Arindam Banerjee, an associate professor of mechanical engineering and mechanics at Lehigh University, studies the dynamics of materials in extreme environments. He and his team have built several devices to measure forces in inertial confinement studies. One subject of their investigations is the phenomenon of instability between materials of two different densities under extreme conditions, like the pellets and gas, known as Rayleigh-Taylor instability. Banerjee likens it to the air inside a balloon. "As the balloon compresses, the air inside pushes against the material confining it, trying to move out," Banerjee said in a press release. "At some point, the balloon will burst under pressure. The same thing happens in a fusion capsule. The mixing of the gas and molten metal causes an explosion." To understand how molten metal and gasses interact, Banerjee and collaborators looked to mimic the metal. They determined that the material properties and dynamics of the metal at a high temperature are much like those of — drum roll, please — mayonnaise at a low temperature. In the experiments, the team poured Hellman's Real Mayonnaise into a Plexiglass container and subjected it to some of the same conditions as the molten metal. Using a high-speed camera and an image processing algorithm, the team computed the parameters associated with the instability. The results of the study were published today in the journal *Physical Review E* — a rare example of mayonnaise in scientific literature. Understanding the

**Scientists' secret weapon in the race to develop fusion: mayonnaise.**

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fundamental hydrodynamics and physics of fusion reactions may indeed require out of the box thinking. By applying a creative mindset, and maybe substituting an ingredient or two, physicists can better model the forces at work in various reactions. Better understanding such forces, according to Banerjee — who's been experimenting with mayonnaise since at least 2015 — could be of value in helping to solve challenges in geophysics, astrophysics, industrial processes such as explosive welding, and high-energy density physics problems related to inertial confinement fusion.

Futurism, 8 May 2019

<https://futurism.com>

### Polymers jump through hoops on pathway to sustainable materials

2019-05-21

Recyclable plastics that contain ring-shaped polymers may be a key to developing sustainable synthetic materials. Despite some promising advances, researchers said, a full understanding of how to process ring polymers into practical materials remains elusive. In a new study, researchers identified a mechanism called "threading" that takes place when a polymer is stretched—a behaviour not witnessed before. This new insight may lead to new processing methods for sustainable polymer materials. Most consumer plastics are blends of linear polymers. The concept of plastics made purely from ring polymers—molecules that form a closed ring—presents an enticing opportunity for sustainability, as shown by the Autonomous Materials Systems group at the Beckman Institute for Advanced Science and Technology. Once a single bond holding ring polymers together breaks, the entire molecule falls apart, leading to disintegration on demand. However, processing such polymers into practical materials remains a challenge, the researchers said. A 2013 University of Illinois-led study showed that ring polymers could be broken with heat, but this comes at a price—the resulting plastics would likely become unstable and begin to break down prematurely. In the new study, U. of I. researchers Charles Schroeder and Yuecheng (Peter) Zhou examine the flow dynamics of DNA-based ring and linear polymer solutions to tease out clues about how synthetic polymers interact during processing. Their findings are published in the journal *Nature Communications*. "We lack a fundamental understanding of how ring polymers stretch and move in flow while navigating around other neighbour polymer chains. This work allowed us to probe these questions at a molecular level," said Schroeder, a chemical and biomolecular engineering professor,

**Recyclable plastics that contain ring-shaped polymers may be a key to developing sustainable synthetic materials.**

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Beckman Institute researcher and study co-author. In Schroeder's lab, the researchers stretch and squeeze polymers, causing them to flow and allowing direct observation of the behaviour of individual molecules using single-molecule fluorescence microscopy. "There is a fluctuation in the shape of the ring polymers and this depends on the concentration of linear polymers in the solution," said Zhou, a graduate student, Beckman Institute researcher and lead author of the study. "We do not see this behaviour in pure solutions of ring or linear polymers, so this tells us that something unique is happening in mixed solutions." Using a combination of direct single-molecule observations and physical measurements, the team concluded that the changes in shape of the ring polymers occur because linear molecules thread themselves through the ring molecules when stressed, causing the ring shape to fluctuate under fluid flow. "We observed this behaviour even when there is a very low concentration of linear polymers in the mix," Zhou said. "This suggests that it only takes a very minute level of contamination to cause this phenomenon." This threading of linear polymers through ring polymers during stress is something that had been theorized before, using bulk-scale studies of the physical properties, but now it has been observed at the molecular scale, the researchers said. "Bulk studies typically mask the importance of what is going on at the smaller scale," Schroeder said. How these observations will translate into further development of sustainable consumer plastics remains unclear, the researchers said. However, any insight into the fundamental molecular properties of mixed-polymer solutions is a step in the right direction. "To make pure ring polymer plastics a reality, we need to understand both mixed and pure solutions at a fundamental level," Schroeder said. "Once we can figure out how they work, then we can move on to synthesizing them and ultimately how to use them in sustainable consumer plastics."

Phys.org, 17 May 2019

<http://phys.org>

### **A more efficient way to cleave pendant olefins from terpenes and similar compounds**

2019-05-21

A team of chemists at the University of California has found a more efficient way to separate olefins from terpenes and similar compounds. In their paper published in the journal *Science*, the group describes the new approach and possible applications for its use. Seb Caille with Amgen has published a Perspective piece outlining the work by the team at UC in the

**A team of chemists at the University of California has found a more efficient way to separate olefins from terpenes and similar compounds.**

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same journal issue and explains why it is important. As medical science reveals more about the ways our bodies work, pharmaceutical companies continuously work to develop therapies that make use of new findings. But as Caille explains, such work is often beleaguered by problems associated with the study of ever more complex molecular structures. Many times, when a particular molecule or structure is found to be useful, it must first be extracted from its more complex state. In practical terms, this can mean putting a material through several steps as part of a manufacturing process. Caille also notes that generally, the more steps that are required to process a material, the more it costs to produce an end result, such as a drug. For this reason, chemists work to find ways to achieve the same ends using fewer steps. In this new effort, the researchers have developed a new way to separate pendant olefins from terpenes. Pendant olefins are a type of open-chain hydrocarbon with at least one bond. And terpenes, another kind of hydrocarbon, are volatile unsaturated hydrocarbons that are often found in the natural oils produced by plants, particularly trees. Pharmaceutical companies have found that such olefins can be useful in a wide range of applications, but it takes many steps to separate them from the hydrocarbons in which they are found—this is because of their unique carbon framework. The new process by the team at UC involves successively treating cooled terpenes with ozone and providing a hydrogen atom donor in a non-anhydrous solvent. They note that the treatment works because ozone is an iron oxidant. They suggest their single-process treatment could replace multiple steps used in other processing systems.

Phys.org, 17 May 2019

<http://phys.org>

### Chemists ID possible addiction-free pain reliever

2019-05-21

An estimated 1.7 million Americans suffer from substance abuse disorders related to opioid use for pain relief, according to the National Institute on Drug Abuse. This causes an economic burden of more than \$78 billion per year in health care and addiction treatment costs, as well as loss of worker productivity and increased criminal activity. In 2017, more than 47,000 people died as a result of drug abuse involving opioids and related drugs. As the problem amplifies, researchers are seeking non-addictive chronic pain treatment options that produce few or no negative side effects. Ken Hsu, a chemistry professor at the University of Virginia, and his graduate student, Myungsun Shin, has identified an enzyme that “chews up fat”

**Researchers have identified an enzyme that “chews up fat” molecules to produce chemical signals that control inflammation**

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molecules to produce chemical signals that control inflammation. The naturally occurring enzyme, called diacylglycerol lipase-beta, or DAGL-beta, is a possible new drug target for reducing pain. Hsu developed, during his postdoctoral training, selective molecules that inhibit DAGL-beta and reduce inflammation, similarly to aspirin and other non-steroidal anti-inflammatory drugs, or NSAIDs. However, unlike NSAIDs, DAGL-beta inhibitors can provide pain relief without gastrointestinal toxicity in preclinical models when used over a long term. And unlike opioids, DAGL-beta inhibitors do not exhibit addictive properties. "This could be a new route to treating long-term inflammation and pain without the side effects of toxicity and risk of addiction observed with current treatment options," Hsu said. "Generally, if we block inflammation, we also affect the immune response. But we're suggesting a different approach, one where we can stop inflammation without impacting the normal immune response." Hsu's findings were published today in the online edition of the journal *Cell Chemical Biology*. According to Hsu, studies at UVA in collaboration with Virginia Commonwealth University demonstrate that DAGL-beta inhibitors are highly effective at reducing different pain states, including neuropathic pain and chemotherapy-induced peripheral neuropathy. In the new study, the Hsu lab uncovered a new role for DAGL-beta in dendritic cells, a specialized type of innate immune cell that not only controls inflammation, but can also activate our body's ability to fight infections by stimulating T cells, which produce an immune response. "We found that by blocking DAGL-beta, we can stop inflammation without affecting immunity," Hsu said. "This supports the idea that DAGL-beta is a viable target for long-term blockade of inflammation and pain without potentially compromising our immune system." Hsu's research program is focused on using chemistry to find new ways to modulate the immune system, whether for fighting cancer, or, in this case, a better understanding of molecular pathways that can be targeted to reduce chronic inflammation and pain.

Phys.org, 16 May 2019

<http://phys.org>

## Manipulating atoms one at a time with an electron beam

2019-05-21

The ultimate degree of control for engineering would be the ability to create and manipulate materials at the most basic level, fabricating devices atom by atom with precise control. Now, scientists at MIT, the

**New method could be useful for building quantum sensors and computers**

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University of Vienna, and several other institutions have taken a step in that direction, developing a method that can reposition atoms with a highly focused electron beam and control their exact location and bonding orientation. The finding could ultimately lead to new ways of making quantum computing devices or sensors, and usher in a new age of “atomic engineering,” they say. The advance is described today in the journal *Science Advances*, in a paper by MIT professor of nuclear science and engineering Ju Li, graduate student Cong Su, Professor Toma Susi of the University of Vienna, and 13 others at MIT, the University of Vienna, Oak Ridge National Laboratory, and in China, Ecuador, and Denmark. “We’re using a lot of the tools of nanotechnology,” explains Li, who holds a joint appointment in materials science and engineering. But in the new research, those tools are being used to control processes that are yet an order of magnitude smaller. “The goal is to control one to a few hundred atoms, to control their positions, control their charge state, and control their electronic and nuclear spin states,” he says. While others have previously manipulated the positions of individual atoms, even creating a neat circle of atoms on a surface, that process involved picking up individual atoms on the needle-like tip of a scanning tunnelling microscope and then dropping them in position, a relatively slow mechanical process. The new process manipulates atoms using a relativistic electron beam in a scanning transmission electron microscope (STEM), so it can be fully electronically controlled by magnetic lenses and requires no mechanical moving parts. That makes the process potentially much faster, and thus could lead to practical applications. Using electronic controls and artificial intelligence, “we think we can eventually manipulate atoms at microsecond timescales,” Li says. “That’s many orders of magnitude faster than we can manipulate them now with mechanical probes. Also, it should be possible to have many electron beams working simultaneously on the same piece of material.” “This is an exciting new paradigm for atom manipulation,” Susi says. Computer chips are typically made by “doping” a silicon crystal with other atoms needed to confer specific electrical properties, thus creating “defects” in the material -- regions that do not preserve the perfectly orderly crystalline structure of the silicon. But that process is scattershot, Li explains, so there’s no way of controlling with atomic precision where those dopant atoms go. The new system allows for exact positioning, he says. The same electron beam can be used for knocking an atom both out of one position and into another, and then “reading” the new position to verify that the atom ended up where it was meant to, Li says. While the positioning is essentially determined by probabilities and is not 100 percent accurate, the ability to



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determine the actual position makes it possible to select out only those that ended up in the right configuration.

#### Atomic soccer

The power of the very narrowly focused electron beam, about as wide as an atom, knocks an atom out of its position, and by selecting the exact angle of the beam, the researchers can determine where it is most likely to end up. "We want to use the beam to knock out atoms and essentially to play atomic soccer," dribbling the atoms across the graphene field to their intended "goal" position, he says. "Like soccer, it's not deterministic, but you can control the probabilities," he says. "Like soccer, you're always trying to move toward the goal." In the team's experiments, they primarily used phosphorus atoms, a commonly used dopant, in a sheet of graphene, a two-dimensional sheet of carbon atoms arranged in a honeycomb pattern. The phosphorus atoms end up substituting for carbon atoms in parts of that pattern, thus altering the material's electronic, optical, and other properties in ways that can be predicted if the positions of those atoms are known. Ultimately, the goal is to move multiple atoms in complex ways. "We hope to use the electron beam to basically move these dopants, so we could make a pyramid, or some defect complex, where we can state precisely where each atom sits," Li says. This is the first time electronically distinct dopant atoms have been manipulated in graphene. "Although we've worked with silicon impurities before, phosphorus is both potentially more interesting for its electrical and magnetic properties, but as we've now discovered, also behaves in surprisingly different ways. Each element may hold new surprises and possibilities," Susi adds. The system requires precise control of the beam angle and energy. "Sometimes we have unwanted outcomes if we're not careful," he says. For example, sometimes a carbon atom that was intended to stay in position "just leaves," and sometimes the phosphorus atom gets locked into position in the lattice, and "then no matter how we change the beam angle, we cannot affect its position. We have to find another ball."

#### Theoretical framework

In addition to detailed experimental testing and observation of the effects of different angles and positions of the beams and graphene, the team also devised a theoretical basis to predict the effects, called primary knock-on space formalism, that tracks the momentum of the "soccer ball." "We did these experiments and also gave a theoretical framework on how to control this process," Li says. The cascade of effects that results from the initial beam takes place over multiple time scales, Li says, which made the

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observations and analysis tricky to carry out. The actual initial collision of the relativistic electron (moving at about 45 percent of the speed of light) with an atom takes place on a scale of zeptoseconds -- trillionths of a billionth of a second -- but the resulting movement and collisions of atoms in the lattice unfolds over time scales of picoseconds or longer -- billions of times longer. Dopant atoms such as phosphorus have a nonzero nuclear spin, which is a key property needed for quantum-based devices because that spin state is easily affected by elements of its environment such as magnetic fields. So, the ability to place these atoms precisely, in terms of both position and bonding, could be a key step toward developing quantum information processing or sensing devices, Li says.

EurekAlert, 17 May 2019

<http://www.eurekalert.org>

## Curiosities

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### Another Study Found a Link Between Parkinson's Disease and the Appendix.

2019-05-22

Clumps of proteins found in the brains of people who have Parkinson's disease are also found somewhere else in the body — inside the appendixes of healthy people. This finding has led researchers to study the link between the appendix and the risk of developing Parkinson's. For example, an October 2018 study found that removing the appendix was associated with a decreased risk of developing the disorder, Live Science reported. But new findings suggest the opposite — removing the appendix is associated with an increased risk of developing Parkinson's. The study, which has yet to be published in a peer-reviewed journal, will be presented later this month at Digestive Disease Week, a scientific meeting focused on digestive diseases. The new study looked at data on more than 62 million patients, using a database of records from 26 major healthcare systems across the U.S. The researchers identified patients who had appendectomies — surgery to remove the appendix — and flagged those who went on to develop Parkinson's disease at least six months later. The scientists found that, out of the more than 488,000 patients who had their appendixes removed, 4,470 (0.9%) of them went on to develop Parkinson's disease. Of the remaining 61.7 million patients who didn't have appendectomies, only around 177,000 (0.3%) later developed Parkinson's. The findings suggest that the risk of developing Parkinson's disease is around three-fold higher for people who had appendectomies than those who did not, regardless of age, gender or race. However, senior author Dr. Gregory Cooper, a professor of medicine at Case Western Reserve University in Cleveland, said, "at this point it's still an association," and not a cause-and-effect finding. In other words, the study does not prove that having the appendix removed causes Parkinson's. One possible explanation for the increased risk found in the study is that, during an appendectomy a specific agent — called alpha-synuclein proteins — are released into the body and travel up to the brain, Cooper said. These proteins are known to form clumps called Lewy bodies — a tell-tale sign of Parkinson's disease. Still, this explanation is "speculative," Cooper told Live Science.

#### Reverse causality?

Viviane Labrie, an assistant professor of neuroscience at Van Andel Research Institute in Michigan who was not a part of the new research, noted that the study "doesn't have a long follow-up window." That means that the researchers could only link appendectomies to the onset

**Clumps of proteins found in the brains of people who have Parkinson's disease are also found somewhere else in the body — inside the appendixes of healthy people.**

## Curiosities

### CHEMWATCH

of Parkinson's movement problems, she said. But these movement problems, or motor symptoms, don't truly represent the onset of the disease, Labrie told Live Science. Rather, Parkinson's disease has a roughly 20 year "prodromal period," before these tell-tale symptoms appear. During this time, other less-obvious symptoms may occur. For example, during the prodromal period, people with Parkinson's may experience symptoms such as constipation or other digestive issues, Labrie said. But, complicating matters further, those symptoms can increase the risk of appendicitis — the inflammatory condition that leads to an appendectomy. So, it's possible that the prodromal symptoms of Parkinson's disease may be causing the appendicitis and the subsequent surgery, and not the appendix removal causing Parkinson's disease, she said. Labrie was the senior author of a study published in October 2018 in *Science Translational Medicine*, which used data from a Swedish database of more than 1.6 million people that tracked patients for up to 52 years. That report found that people who had their appendix removed when they were young were 19% to 25% less likely to develop Parkinson's later in life. The "key difference between [the Swedish] study and the [new] US study is [the] length of time the patients were followed," Labrie said. Cooper agreed that a limitation of his study involved the limited data available during the follow-up period. This is because the patient information was de-identified, so the researchers couldn't see how long it took for specific patients to develop Parkinson's after an appendectomy. But because the database has been gathering data since 1997, at least some of the patients were followed for nearly 30 years, he said. In addition, the researchers didn't have access to patient medical records, so they couldn't look at other factors that may have influenced the results, such as specific symptoms or medications, Cooper added.

### The risk is still really low

Ultimately, there still isn't a consensus on if appendectomies are associated with a higher risk of Parkinson's disease. A 2016 study published in the journal *Movement Disorders* found similar results to this new study — that an appendectomy was associated with an increased risk of Parkinson's disease risk 10 or more years after the surgery; but that risk was much smaller than that noted in the recent study. Other research, such as a 2018 paper published in *Movement Disorders*, found little to no association between appendectomies and Parkinson's disease. In any case, Cooper stressed that while the study did find an association between an appendectomy and the risk of developing Parkinson's disease, the risk is very low: Less than 1% of people who developed Parkinson's disease had

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undergone an appendectomy, he said. "I don't want people to come out of here and say, 'Well, I have appendicitis I'm not going to get my appendix taken out because I don't want to get Parkinson's disease,'" he said. "If you have appendicitis ... you should get your appendix out." This was reminiscent of what Labrie told Live Science last fall, when her paper was published: "One of the things that we don't want to get across to people is that [they] should be having preventative appendectomies or that just because you have an appendix, you're going to get Parkinson's disease."

Live Science, 10 May 2019

<http://www.livescience.com>

### **Concern mounting over common food additive linked to cancer, bowel disease**

2019-05-22

Concern is mounting over the safety of popular food additive 171, otherwise known as titanium dioxide. The substance, which is used for food colouring, can be found in almost 1000 products on supermarket shelves, including mayonnaise, chocolate, toothpaste and even some lollies. Now, research published yesterday by the University of Sydney suggests the additive could lead to bowel disease or cancer, Nine News reports. Unlike other food colourings, which are chemical-based, titanium dioxide contains nanoparticles, which can also be found in anything from scratch-resistant sunglasses, car paint and medicines. Associate Professor Wojciech Chrzanowski, a co-lead author of the study, said its consumption has been linked to "auto-immune disease, asthma, allergies and reproductive issues." "We've been exposed to nanoparticles all our lives. Mr Chrzanowski said. "However, we are sort of entering the stage where we are over-exposed. "They should be aware of the potential risk associated with these (products) and maybe when possible limit the consumption of these products." France has announced it will ban its use as an additive from 2020. However, here are no current plans to ban the colouring in Australia.

News Now, 14 May 2019

<https://www.tvnz.co.nz>

**Concern is mounting over the safety of popular food additive 171, otherwise known as titanium dioxide.**

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### Inside the long war to protect plastic

2019-05-22

New York's Suffolk County had a trash problem. Facing brimming landfills and public pressure, legislators took a first-in-the-nation step: They banned plastic bags. But what the county saw as part of the solution, the plastics industry took as a threat. "We had never seen lobbyists like this before," said Steven Englebright, the chief sponsor of the bill. "The B.S. came in by the shovel-load." That was in 1988. Soon, Suffolk County — on Long Island — inspired similar initiatives in municipalities across the country.

As one lawyer for the industry wrote in an internal memo from the time: "Several years from now we may look back on 1988 as the opening round in a solid waste/packaging war." The plastics industry — from the chemical giants making the building blocks of plastic to companies using the packaging to sell their products — has been waging that war for more than 30 years. It has pumped millions of dollars into pro-plastic marketing, high-profile lawsuits and lobbyists who travel the country promising that recycling, not bans, presents the best way forward. All this despite decades of repeated warnings about weak recycling markets and plastic pollution problems. Today, about a dozen states restrict local governments from regulating plastic items, while only two (with a third pending) have passed state-wide plastic-bag bans. And manufacturers are profiting from a plastics boom. According to the research firm the Freedonia Group, by 2025, the plastic packaging market will be worth roughly \$365 billion.

"The industry has kept us from confronting plastics for decades through corporate lobbying and threats of litigation," said Jennie Romer, a lawyer, long-time anti-plastics activist and founder of the website PlasticBagLaws.org. "Billions of single-use plastic items have made it into our environment because of this." Of the roughly 300 million tons of plastic waste the world creates every year, an estimated 8 million tons makes its way into oceans. In March, scientists examining a dead whale found more than 88 pounds of plastic in its stomach. Because the material often breaks down into tiny particles, the oceans contain an estimated 5.25 trillion microplastics, which can easily absorb toxic chemicals and emit climate-changing gases. "We believe uncollected plastics do not belong in the environment," the Plastics Industry Association, a key trade group, wrote in a statement after declining an interview. "The problem is that waste management practices and infrastructure did not keep pace with the changing economy."

The group argued that plastics are more environmentally friendly than alternatives — using fewer resources to create, while also making end products lighter — and are crucial for global commerce. "In many ways, plastics have made the modern economy possible," the statement reads.

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“Other materials and processes transformed the world over the course of centuries or millennia. Plastics did so in decades.”

### Practically indestructible

Synthetic plastic first appeared in the early 1900s as an alternative to materials such as cork or paper. But World War II catalysed plastic's ascent. The material worked its way into every facet of the military — including in the cockpits and gunner noses of fighter planes. When soldiers returned home, plastics came with them and quickly became a fixture of American life. This wasn't an accident. In 1937 — after a series of golf getaways — leading manufacturers formed the Society of the Plastics Industry, now known as the Plastics Industry Association. Its mission was to promote and protect plastics. By the 1960s, the society was encountering early signs of what would become its greatest challenge. America's trash had accumulated into a crisis, and disposable plastics, even in much smaller amounts than the country now use, seemed to be making the problem worse. The first national conference on packaging waste convened in 1969, with an attendance list that included key manufacturers. “This material is practically indestructible,” griped Leonard Stefanelli, president of a California salvage company. “Packaging is a particularly large contributor to the problems of household refuse collection and street litter,” noted a New York City sanitation official. As concerns about plastic grew louder, the industry knew it had to offer municipal leaders something. It turned to recycling. “No doubt about it, legislation [restricting plastics] is the single most important reason why we are looking at recycling,” said Wayne Pearson, the then-executive director of the Plastics Recycling Foundation, an initiative that 45 companies such as Coca-Cola and Pepsi formed in the mid-1980s. The industry similarly established the Council for Solid Waste Solutions to promote recycling programs and infrastructure. Around the same time, the society also pushed incineration, which releases air pollution, as “really a form of recycling.” In 1987, a top official with the trade group, Roger Bernstein, brought the narrative to Suffolk County. Later, in an interview with Susan Freinkel for her 2011 book “Plastic: A Toxic Love Story,” Bernstein referred to recycling as a “guilt eraser.” The recycling argument was often persuasive. A 1989 Council for Solid Waste Solutions account of its efforts in Iowa — which, like other internal documents in this story, were unearthed through lawsuits and collected by Toxic Docs, a project based at Columbia University and the City University of New York — noted that “outright bans on polystyrene packaging were dropped with a promise of recycling by industry.” Just this February, the trash-handling firm Waste Management said in a government filing that

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manufacturers are pressuring its recycling-collection programs to accept more types of plastic “to alleviate public pressures to ban the sale of those materials.” Industry recycling pledges have kept coming despite decades of warnings — some of them internal — that this solution was limited. “Currently, there is no market for recycled plastics,” read one Society of the Plastics Industry document from 1972. “Recycling currently is not feasible for most multi-material packages,” acknowledged another from 1987. And as the recent Waste Management filing made clear, even now certain plastics have “no viable end markets.” Today, many US cities don’t accept plastic bags in their recycling stream because the thin sacks gum up sorting machinery. Just 9 percent of all plastic waste in the US was recycled in 2015, according to the latest federal estimate. That rate is almost certainly lower now: Cities were relying heavily on China to take the plastic they’d collected and finish the job, but last year the country all but stopped accepting those imports. Martin Bourque, executive director of a non-profit providing curbside recycling pickup in Berkeley, California, said that instead of selling his customers’ plastic food containers he must pay a US facility \$75 a ton to take them. Only half that material gets turned into recycled content. The rest, he said, ends up in a landfill. “The brands and the manufacturers and the petrochemical industry all want us to believe it’s recyclable,” said Bourque, with the Ecology Centre. “But it’s not a problem that we’re going to be able to recycle our way out of.”

#### Plastic bags become a flashpoint

When the recycling argument didn’t work, the industry would often sue — as was the case in Suffolk County. Although the ban passed in 1988, it spent years in the courts before its opponents ultimately prevailed and the legislation was repealed. The industry’s tactics in the 1980s paid off in the 1990s, which — with a few exceptions, such as McDonald’s move away from polystyrene foam (aka Styrofoam) — were a heyday for plastics. “There were no bans, essentially, in all that time,” Bernstein told author Freinkel. “There were no products that were put out of the marketplace.” But concerns eventually resurfaced. Plastic bags so badly clogged the drains of Mumbai, India, during flooding that, in 2000, the city banned them. Facing similar issues two years later, Bangladesh became the first country to do the same. In 2007, San Francisco implemented America’s first bag ban, prompting a new round of similar ordinances in US cities. “Legislation and regulation threaten to fundamentally change our business model,” William Carteaux, the Society of the Plastics Industry’s then-president, told a crowd of industry insiders in 2009. “We can’t continue to fight back just at the reactive stage when things



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are emotionally charged. We have to take the offensive." The industry spent millions of dollars opposing bans in California alone. One of their primary lawyers in the state, Stephen Joseph, was dubbed "Patron Saint of Plastic Bags" by Time magazine. He called unwashed reusable bags a "health hazard" and suggested that bans would mean more dog poop on streets. Ban advocates, he wrote in a 2010 court filing, "have disseminated environmental myths, misinformation and exaggerations to promote their goal." This time, though, lawsuits didn't work. California courts repeatedly rebuffed Joseph and the industry. In 2014, lawmakers there passed the country's first state-wide ban on plastic bags. "This bill is a step in the right direction," said former Gov. Jerry Brown. "We're the first to ban these bags, and we won't be the last." The industry, though, was about to add a new weapon to its arsenal.

### Banning bans

Bisbee is a small town of about 5,000, tucked into the Arizona hills just shy of the Mexican border. Like many places, it had a plastic bag problem. Empty grocery sacks would float down the street and into the surrounding landscape. In response, the city council banned them in 2012. "There was a dramatic change," said Mayor David Smith. Soon after, he could drive miles without seeing any littered bags. The industry didn't sue. It had a new plan. In early 2013, the society joined the American Legislative Exchange Council, ALEC, which routinely works with companies and conservative lawmakers to write and then promote legislation. One strategy ALEC pursues is "pre-emption" bills, which, when passed at the state level, prevent cities and other municipalities from regulating certain activities — ranging from wages to pesticides. In September 2015, ALEC approved a template for pre-empting local regulation of disposable containers and bags, complete with an easy-to-fill "[Insert Jurisdiction]" blank. Now, about a dozen states have passed some version of plastic pre-emption — including Arizona in 2016. The Plastics Industry Association said it left ALEC in 2017 and was never involved in the model policy process, which ALEC says is legislator-driven. Regardless, both organisations, along with other supporters of plastic pre-emption legislation, argue that it heads off a patchwork of local laws that could confuse and burden consumers and businesses alike. Environmentalists say the effect has been chilling, stopping new initiatives and reversing earlier wins. In the fall of 2017, the Arizona attorney general ruled that plastics bans like Bisbee's violated Arizona's new pre-emption regime. Smith said his city faced a choice: Repeal its ban or lose all state funding. "I called it extortion," Smith said, but he saw no way around it and the city rescinded its ban. The windswept

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bags came back. "We call them desert flags," he said, "because they hang on all the cactus."

### Plastic 'everywhere'

In 1971, biological oceanographer Edward J. Carpenter was out in a remote region of the North Atlantic known as the Sargasso Sea, sampling seaweed that was drifting on the ocean surface. To his surprise, he kept pulling up tiny pieces of plastic. The same thing happened on a separate trip along the New England coast. "The plastic was just everywhere," he said. "So, I tried to quantify it." Carpenter published his findings in two 1972 articles in the prestigious journal *Science*. They were among the first studies of plastic pollution and came with an unmistakable warning. "Increasing production of plastics, combined with present waste-disposal practices," he wrote, "will undoubtedly lead to increases in the concentration of these particles." This was just a few years after the Society of the Plastics Industry commissioned a report that estimated the amount of plastic waste would soon reach almost 11 billion pounds annually but argued the problem was "minor" and that plastics "do not appear to have any potential as land or water pollutants." Carpenter's research was an implicit challenge to that notion. Shortly after each of his articles was published, he said, the society flew an industry scientist out to Woods Hole Oceanographic Institution in Massachusetts to meet with his bosses and question him. "It was obvious that they were pretty upset about it," Carpenter said. He found the visits "kind of intimidating." The Plastics Industry Association, as the society rebranded itself in 2016, did not address questions about the incident directly. "We can't speak for anyone who's no longer a part of our organization, or no longer a part of the industry," it said in a statement. "But today we know that the plastics industry has nothing to hide." For decades, though, the industry cast doubt on marine plastic problems or dodged responsibility. At the 1989 International Conference on Marine Debris (which the industry-funded Council for Solid Waste Solutions co-sponsored), for instance, the society issued an official statement claiming that most plastic pollution was "beyond the 'control' of the plastics industry." In 2008, Joseph, the industry attorney, wrote in a court filing that "there is no evidence that plastic bags are a continuing significant problem for marine animals or seabirds." Meanwhile, plastics kept flowing into the oceans. In 1997, oceanographer Charles Moore spotted a tract of marine debris off the West Coast that became known as the "Great Pacific Garbage Patch." His 1999 study reported, "the mass of plastic was approximately six times that of plankton." A 2014 survey found plastic bags deep on the seafloor, hundreds of miles from land. Scientists estimated in 2015 —

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more than four decades after the first study about plastic in the stomachs of seabirds — that 90% of these animals have eaten the substance at some point in their lives. Last year, record levels of microplastics were found in the Arctic, with traces of 17 different plastics frozen in seawater. Even the industry seems unable to deny these plastics issues any longer. In January, a group that includes petrochemical companies, plastics manufacturers and distributors formed the Alliance to End Plastic Waste and pledged \$1.5 billion over five years to help “make the dream of a world without plastic waste a reality.” That funding represents a tiny fraction of the more than \$1 trillion that plastic packaging is expected to bring in during that same period. Many of the alliance members are also building new plastic plants — including one that would be the world’s largest in Texas. In a statement, the alliance said it hopes its pledge will trigger more investments in waste management. “We recognise this amount is not sufficient to achieve the goal of eliminating plastic waste in the environment,” wrote a representative of the Alliance to End Plastic Waste. “There is no single solution, and we don’t have all the answers.” On its website, the alliance adds, “Plastics have helped improve living standards, hygiene and nutrition around the world. ... We must maintain the critical benefits that plastics bring to people and communities around the world.”

#### Foot soldiers and fashion shows

As the executive director of the industry-backed American Progressive Bag Alliance (APBA), Matt Seaholm is like a first responder. When there’s new plastics legislation proposed, he’s there: New Jersey in September, South Carolina in November, Tennessee in January. “Imagine our surprise when he flew down from Washington,” said Monique Michel, an attorney with the Memphis City Council. The APBA, which declined an interview request for Seaholm, wrote in a statement, “Bans don’t work; they punish people into using alternatives that are worse for the environment.” The industry’s current foot soldiering echoes its Suffolk County-era strategy. These days it includes representatives from Novolex — one of the world’s largest plastic-bag manufacturers — as well as local lobbyists that the industry hires for tens of thousands of dollars per month. When Charleston, South Carolina, was considering a plastic bag ban in 2015 and 2016, the industry countered with materials that ranged from a “myth vs. fact” sheet about recycling to academic research. A slideshow from Clemson University, stating that plastic bags “are not a significant litter problem,” drew from a 2014 study that concluded that bans “may result in negative impact on the environment rather than positive.” Buried deep in the report: Hilex Poly Co., Novolex’s previous name, paid for the research. The lead author, Robert

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Kimmel, is the director of Clemson's Centre for Flexible Packaging, which receives industry funding. He has appeared as an expert witness for the industry. One of the main surveys in the study was conducted by Edelman Berland, the research arm of a firm that also lobbies for the APBA. "[Hilex Poly] did not try to influence us or our conclusions in any way, shape, or form," said Kimmel. "Paper bags are not a good alternative to [plastic] grocery bags." A study by the British government, for instance, found that a paper bag would have to be reused four times to have the same "global warming potential" as a conventional plastic bag. A cotton bag would have to be reused 131 times. And recent research found that when plastic grocery bags were banned in California, people used more plastic sacks of other types, reducing the plastics waste savings from 40 million pounds to 28 million. That study's author, Rebecca Taylor, recommends fees over bans — and that any fees extend to paper as well. (Many cities are already passing "second generation" bag bills that also include a fee on paper.) As this fight over plastics has expanded to more places, the industry is also targeting new demographics with its message. The APBA, for instance, has funded the Black Leadership Action Coalition, whose founder, Bertha Lewis, argues that bag fees and bans will disproportionately burden poor and minority communities. "New Yorkers, YOU BEEN HOODWINKED!" she wrote in response to a proposed bag fee in New York City. She declined multiple requests for interviews. The industry has also invested hundreds of millions of dollars into its "Plastics Makes it Possible" campaign, which started on TV in the 1990s and is now splashed across social media. The campaign has built a tiny house featuring plastics, gathered endorsements from celebrities such as The Big Bang Theory actress Kaley Cuoco — she hosted a plastic fashion show, saying, "Plastics make you cuter" — and paid for posts on sites like BuzzFeed. "Environmentally friendly board shorts," reads No. 12 on an industry-sponsored listicle of items made from recycled or reused plastics. Or there's No. 2: "Awesome plastic chairs."

#### Like mink coats and cigarettes

To a large extent, the industry's lobbying, promotion and outreach is working — demand for plastics keeps rising. But the perception of plastics is changing. "The water bottle has, in some way, become the mink coat or the pack of cigarettes," said John Caturano, senior sustainability manager for Nestlé Waters North America, at a conference this March. (Nestlé has pledged to make all its packaging "recyclable or reusable" by 2025.) "It's socially not very acceptable to the young folks, and that scares me." And, while state pre-emption laws still far outnumber state-wide bans, attempts to impose fees or other limitations are mounting. Legislators in Hawaii

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and New Jersey, among other places, are trying to expand their targets to include not only bags but also straws and foam containers. Lawmakers in several states are also trying “producer responsibility” bills, which are more broadly aimed at getting companies, instead of consumers, to bear the costs of recycling. Suffolk County, which never got to impose its 1988 ban, implemented a 5-cent fee on plastic and paper bags in January 2018. According to the county, businesses distributed 1.1 billion fewer bags during the first year of the policy. In March, New York became the second state in the country to enact a bag ban. “It’s gratifying, but we still have so much more plastic going into the waste stream,” said Steven Englebright, the original sponsor of the Suffolk County bill and now a New York state assemblyman. Action, he said, could have been taken much earlier. “We really should not have had a 30-year delay.”

PRI, 16 May 2019

<https://www.pri.org>

### **EPA Plans to Get Thousands of Deaths Off the Books by Changing Its Math**

2019-05-22

The United States Environmental Protection Agency plans to change the way it calculates the health risks of air pollution, a shift that would make it easier to roll back a key climate change rule because it would result in far fewer predicted deaths from pollution, according to five people with knowledge of the agency’s plans. The EPA had originally forecast that eliminating the Obama-era rule, the Clean Power Plan, and replacing it with a new measure would have resulted in an additional 1,400 premature deaths per year. The new analytical model would significantly reduce that number and would most likely be used by the Trump administration to defend further rollbacks of air pollution rules if it is formally adopted. The proposed shift is the latest example of the Trump administration downgrading the estimates of environmental harm from pollution in regulations. In this case, the proposed methodology would assume there is little or no health benefit to making the air any cleaner than what the law requires. Many experts said that approach was not scientifically sound and that, in the real world, there are no safe levels of the fine particulate pollution associated with the burning of fossil fuels. Fine particulate matter — the tiny, deadly particles that can penetrate deep into the lungs and enter the bloodstream — is linked to heart attacks, strokes and respiratory disease. The five people familiar with the plan, all current or former EPA officials, said the new modelling

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method would appear in the agency's analysis of the final version of the replacement regulation, known as the Affordable Clean Energy rule, which is expected to be made public in June. Asked on Monday whether the new method would be included in the agency's final analysis of the rule, William L. Wehrum, the EPA air quality chief, said only that the final version would include multiple analytical approaches in an effort to be transparent. He said the agency had made no formal change to its methodology. "It's a very important issue, and it's an issue where there has been a lot of debate over what the right approach is," Mr. Wehrum said. The EPA, when making major regulatory changes, is normally expected to demonstrate that society will see more benefits than costs from the change. Experts said that, while benefits would appear on paper in this case, the change actually disregards potential dangers to public health. "Particulate matter is extremely harmful and it leads to a large number of premature deaths," said Richard L. Revesz, an expert in environmental law at New York University. He called the expected change a "monumental departure" from the approach both Republican and Democratic EPA leaders have used over the past several decades and predicted that it would lay the groundwork for weakening more environmental regulations. "It could be an enormously significant impact," Mr. Revesz said. The Obama administration had sought to reduce planet-warming greenhouse gas emissions under the Clean Power Plan by pushing utilities to switch away from coal and instead use natural gas or renewable energy to generate electricity. The Obama plan would also have what is known as a co-benefit: levels of fine particulate matter would fall. The Trump administration has moved to repeal the Obama-era plan and replace it with the Affordable Clean Energy rule, which would slightly improve the efficiency of coal plants. It would also allow older coal plants to remain in operation longer and result in an increase of particulate matter. Particulate matter comes in various sizes. The greatest health risk comes from what is known as PM 2.5, the range of fine particles that are less than 2.5 microns in diameter. That is about one-thirtieth the width of a human hair. The EPA has set the safety threshold for PM 2.5 at a yearly average of 12 micrograms per cubic metre. While individual days vary, with some higher, an annual average at or below that level, known as the particulate matter standard, is considered safe. However, the agency still weighs health hazards that occur in the safe range when it analyses new regulations. Industry has long questioned that system. After all, fossil fuel advocates ask, why should the E.P.A. search for health dangers, and, ultimately, impose costs on industry, in situations where air is officially considered safe? Mr. Wehrum, who worked as a lawyer and lobbyist for chemical manufacturers and fossil fuel businesses before moving to the EPA, echoed that position in two interviews. He

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noted that, in some regulations, the benefits of reduced particulate matter have been estimated to total in the range of \$40 billion. Mr. Wehrum acknowledged that the administration was considering a handful of analyses that would reduce the prediction of 1,400 premature deaths as a result of the measure. He called the attention given to that initial forecast “unfortunate” and said the agency had included the figure in its analysis to show the varied results that can be achieved based on different assumptions. Mr. Wehrum said the analyses the agency is conducting “illuminate the issue” of particulate matter and the question of what level is acceptable for the purposes of policymaking. He said new approaches would allow for public debate to move ahead and that any new methods would be subject to peer review if they became the agency’s primary tool for measuring health risks. “This isn’t just something I’m cooking up here in my fifth-floor office in Washington,” Mr. Wehrum said. Roger O. McClellan, who has served on EPA advisory boards and as president of the Chemical Industry Institute of Toxicology, an industry-financed research centre, said that the data for health risks below the particulate matter standard was weak and that he did not accept the argument that agencies must calculate risk “down to the first molecule of exposure.” “These kinds of approaches — that every molecule, every ionisation, carries with it an associated calculable health risk — are just misleading,” Mr. McClellan said. To put the matter in perspective, most scientists say particulate matter standards are like speed limits. On many highways, a limit of 65 miles per hour is considered reasonable to protect public safety. But that doesn’t mean the risk of an accident disappears at 55 m.p.h., or even 25. Jonathan M. Samet, a pulmonary disease specialist who is dean of the Colorado School of Public Health, said the most recent studies showed negative health effects well below the 12-microgram standard. “It’s not a hard stop where we can say ‘below that, air is safe.’ That would not be supported by the scientific evidence,” Dr. Samet said. “It would be very nice for public health if things worked that way, but they don’t seem to.” Daniel S. Greenbaum, president of the Health Effects Institute, a non-profit research organisation that is funded by the EPA and industry groups, acknowledged there was uncertainty around the effects of fine particulate matter exposure below the standard. He said it was reasonable of the Trump administration to study the issue, but he questioned moving ahead with a new system before those studies are in. “To move away from

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the way this has been done without the benefit of this full scientific peer review is unfortunate," he said.

New York Times, 20 May 2019

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

### Smokers have higher risk for multiple strokes

2019-05-22

Smokers who have a stroke are much more likely to have another one if they don't quit or at least cut back, a Chinese study suggests. Smoking has long been linked to an increased risk of cardiovascular disease and serious cardiac events like heart attacks and strokes. But the new study sheds light on how smoking influences the risk of a second stroke in patients who already had one. Among the 3,069 stroke survivors in the study, 1,475, or 48 percent, were current smokers and another nine percent were former smokers. Among the current smokers, 908, or 62 percent, managed to quit within a few months after their stroke. As expected, smokers had a higher risk of a second stroke than people who never smoked at all, even if they managed to quit after their first stroke. However, smokers who did quit after that first stroke were 29 percent less likely to have a second one than people who kept smoking. "Smoking after a stroke has the same effects on the body as before the first stroke," said Allan Hackshaw, a researcher at University College London in the U.K. who wasn't involved in the study. "It can lead to problems with blood flow in the brain, and contribute to clots being formed in the blood vessels - and either of these increase the chance of having a stroke," Hackshaw said by email. "Cutting back would reduce the risk a bit, but the study shows that quitting completely has a large reduction in the risk of a second stroke." All of the patients in the study survived for at least three months after a stroke. Smokers' risk of a repeat stroke rose with the number of daily cigarettes they smoked. Compared to non-smokers, current smokers who had up to 20 cigarettes a day were 68 percent more likely to have a repeat stroke, while the risk was almost triple for smokers who had more than 40 cigarettes a day. Current smokers tended to be younger and less likely to have conditions like high blood pressure, heart rhythm disorders or coronary heart disease than non-smokers. They were also more likely to be heavy drinkers than non-smokers. The study wasn't a controlled experiment designed to prove whether or how smoking causes repeat strokes. One limitation of the study is the potential for smokers to go through other lifestyle changes when they quit - like improving eating and exercise habits - that contributed to a reduced stroke risk, Dr. Gelin Xu of

**Smokers who have a stroke are much more likely to have another one if they don't quit or at least cut back, a Chinese study suggests.**



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Nanjing Medical University in Jiangsu, China, and colleagues note in the *Journal of the American Heart Association*. Xu didn't respond to requests for comment. Even so, the results add to a large body of evidence linking smoking cessation to a reduced risk of stroke, and continued smoking to an elevated stroke risk, said Dr. Michael Hill of the Cumming School of Medicine at the University of Calgary in Canada. "Smoking is just about the worst possible thing you can do for your health," Hill, who wasn't involved in the study, said by email. "Yes, quitting helps a lot, but it is hard because it is addictive."

Reuters Health, 17 May 2019

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

### **Bayer bets on 'silver bullet' defence in Roundup litigation; experts see hurdles**

2019-05-22

Bayer AG plans to argue that a \$2 billion jury award and thousands of U.S. lawsuits claiming its glyphosate-based weed killer Roundup causes cancer should be tossed because a U.S. regulatory agency said the herbicide is not a public health risk. Some legal experts believe Bayer will have a tough time convincing appellate courts to throw out verdicts and lawsuits on those grounds. Bayer has a better shot if a business-friendly U.S. Supreme Court takes up the case, experts said. But that could take years. Bayer has come under intensifying pressure after a third consecutive U.S. jury found Roundup to be carcinogenic, awarding more than \$2 billion to a couple who used the chemical on their property - the largest verdict in the glyphosate litigation to date. Bayer, which inherited the Roundup litigation with its \$63 billion acquisition of Monsanto last year, faces lawsuits by more than 13,400 plaintiffs nationwide, alleging the product causes cancer. The Germany-based company's shares have been hammered since the first Roundup cancer verdict against it last August, wiping out some 40 billion euros (\$44.76 billion) in market value and leaving Bayer worth less than the price it paid for Monsanto. Bayer denies that Roundup causes cancer, saying decades of studies have shown glyphosate and the weed killer to be safe. Recently, the company said it will argue that the lawsuits, which are brought under state law, conflict with guidance from a federal agency, the U.S. Environmental Protection Agency. On 30 April, the EPA reaffirmed prior guidance saying that glyphosate is not a carcinogen and not a risk to public health when used in accordance with its current label. Citing the EPA decision, Bayer has repeatedly rebuked plaintiffs' calls to add a cancer warning to Roundup, saying the agency would reject that

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change. Under the legal doctrine of pre-emption, state law claims are barred if they conflict with federal law. "We have very strong arguments that the claims here are pre-empted ... and the recent EPA registration decision is an important aspect of that defence," William Hoffman, one of Bayer's lawyers, said during a call with reporters on Wednesday. Hoffman said the argument applied to all U.S. Roundup lawsuits. Pre-emption is generally regarded as a "silver bullet defence" because it stops claims across the board, said Adam Zimmerman, a law professor at Loyola Law School in Los Angeles. But Zimmerman and three other legal experts agreed that Bayer faces a big hurdle convincing appeals courts that the EPA determination on glyphosate shields it from state law claims. They cited a 2005 U.S. Supreme Court ruling that the EPA's approval of a product does not necessarily bar state law claims. The ruling, *Bates v Dow Agrosciences*, gives broad leeway to juries to decide if such claims should proceed, they said. Judges in the three Roundup cases that have gone to trial against Monsanto all rejected the company's pre-emption argument, citing this ruling. "In light of the *Bates* decision, it's going to be an uphill battle for the company to win on pre-emption on appeal," Zimmerman said. Bayer also said it will argue on appeal that trial courts improperly admitted evidence that was not backed up by science. But legal experts said appellate courts generally defer to lower court evidentiary rulings. Lars Noah, a law professor at the University of Florida, said Bayer's chances of success would increase significantly if the Supreme Court takes up the Roundup appeals. The high court only accepts around 70 cases each year, but a business-friendly majority on the court could be inclined to hear the dispute, said Alexandra Lahav, a law professor at the University of Connecticut. Since 2005, the high court has decided at least three pre-emption cases in favour of companies, none of which involved the EPA. The Supreme Court will soon rule in another case that rests on whether a U.S. Food and Drug Administration approval pre-empts tort claims. In that case, plaintiffs sued Merck & Co over the company's alleged failure to warn of the risk of serious bone fractures associated with its osteoporosis drug Fosamax. Merck, which denies the allegations, argued the lawsuits should be pre-empted because the FDA did not require an additional fracture warning in the drug's prescribing information. During a January hearing, the Justices appeared to side with the company. Bayer in a statement said it does not believe the 2005 *Bates* ruling posed a barrier for the appellate courts due to other Supreme Court rulings since then. Noah agreed that the Court has more recently signalled its appetite to limit lawsuits that contradict opinions by experts at regulatory agencies. "The *Bates* decision by now sticks out like a sore thumb," Noah said. "Bayer has more than

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enough ammunition in recent Supreme Court cases to show the trial court judges got it wrong.”

Reuters Health, 16 May 2019

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

### Weird physical illusion makes you think objects are impossibly light

2019-05-22

Do try this at home. It's an "impossible" physical experience a bit like an optical illusion. Take three empty matchboxes and fill one with something heavy. Now lift the weighted box on its own. Then put it down and next lift all three together. You won't believe your brain. In tests by Isabel Won and colleagues at Johns Hopkins University in the US, 90 per cent of students who tried it said that the individual weighted box felt heavier than the trio held together. That's not possible — and the students knew it. They told the psychologists what they were feeling was wrong, and begged to try the experiment again to work out what was going on. The team say their brains were being fooled in the same way as we are baffled by optical illusions, such as the impossible endless staircases drawn by Maurits Escher: "Impossibility can not only be seen but felt," they write. The set-up is borrowed from magicians who have known about the illusion for years. In the team's version, 30 students lifted, in turn, a box weighing 250 grams on its own and then together with two that each weighed 30 grams. The order of the lifting made no difference and the illusion persisted when the volunteers held the boxes suspended with string. Most weird of all, when they held all three on their palm and then snatched away the lighter pair, they felt the change as adding weight, not taking it away. Daniel Huber, at the University of Geneva says it's not clear what's going on in the brain. But he says it's probably related to a separate illusion where we perceive the smaller of two identically weighted objects as heavier. "The most common theories are based on sensory prediction errors," he says. In that case, expecting the smaller object to be lighter, the brain might overcompensate and so misleadingly register it as heavier than it really is.

New Scientist, 20 May 2019

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

**Rubber is essential to modern life, but the trees that provide it could be wiped out by a deadly disease. Some scrubby weeds may provide the unlikely solution**

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### The world's supply of rubber is in jeopardy. Can we find new sources?

2019-05-22

In a classic episode of *The Simpsons*, Bart and his schoolmates watch an educational film called *A World Without Zinc*. For reasons unexplained, a man called Jimmy wants to live without zinc. His wish is granted, but he soon regrets it: he can't go on a date because his car won't start, and he can't call his girlfriend because his telephone won't work. Horrified at what he has done, he tries to shoot himself. But his gun won't fire, because the firing pin is made of zinc. A real-life world without zinc would probably be survivable. But there are some commodities we would struggle without. Many are obvious: steel, oil, aluminium. But others are less so. In *A World Without Zinc*, Jimmy wakes up to find it was all a bad dream. In *A World Without Rubber*, however, the nightmare threatens to become all too real. Rubber is one of industrial civilisation's great unsung heroes. Apart from its obvious uses in tyres, wellies, condoms and underwear elastic, it is a crucial ingredient in some 40,000 products, including shock absorbers, transmission belts, gaskets, hoses, medical devices, sports equipment, cement, paints, plastics and pharmaceuticals. According to agricultural scientist K. P. Prabhakaran Nair, rubber is "essential to the enjoyment of the conveniences and amenities of modern life". Unfortunately, the prospect of a rubber crisis isn't the stuff of fiction. Demand keeps growing, but supply isn't keeping pace. With a deadly fungus threatening to wipe out rubber trees, and the rubber industry, the hunt is on for new sources of the stuff. Right now, the world has two of those sources: oil and trees. For many applications, the tree version – called natural rubber – is considered superior to the synthetic version made from petrochemicals. It is stronger, more elastic, better at absorbing impacts and more resistant to heat and friction. In other words, rubberier. To connoisseurs, the difference is like that between Madagascar vanilla and its synthetic substitute. "The supply of natural rubber is a security issue. A shortage could destabilise global trade". The key to good rubber is very long polymer molecules and a property called "spontaneous self-reinforcement" – reversible stiffening under mechanical stress. Think of a car cornering: the tyre deforms a bit, which causes it to stiffen in response. What enables natural rubber to be either elastic or hard is a process mediated by proteins and fats at the end of its long, polymer molecules. These have proved hard to create in the synthetic form. For some applications – everything from engine parts to silicone cooking utensils – synthetic rubber, or a blend of synthetic and natural, is superior. But for many, natural rubber is indispensable. For instance, aircraft tyres must be 100 per cent natural rubber or the heat

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and friction would make them explode on landing, says Katrina Cornish, a rubber expert at Ohio State University. For the past 70 years or so, the world's major source of natural rubber has been the Pará rubber tree (*Hevea brasiliensis*), a native of Brazil that is now grown all over the tropics. It is tapped for its latex, a white gunk that oozes out after the tree's bark has been carefully sliced. This is processed to make rubber as we know it. The total area under cultivation is about 100,000 square kilometres, mostly in South-East Asia. The Pará produces excellent rubber, but grows slowly and is extremely fussy about temperature, rainfall, altitude and soil, which restricts its range to just a few degrees north and south of the equator. Extracting the latex is labour-intensive and scaling up production almost impossible, meaning that supply is extremely – and ironically – inelastic. Recycling is notoriously difficult too. In 2017, global demand for rubber was close to 30 million tonnes. The natural rubber industry could only satisfy about 45 per cent of that. And that proportion will only diminish. "Up until the recession of 2008, the price of natural rubber went up about tenfold over a decade because of the expanding economies in Asia," says David Wolyn, a plant breeder and geneticist at the University of Guelph in Canada. "The recession tempered that increase, but people are still very concerned about future supply," he says.

#### Black death

But as countries in South-East Asia develop economically, landowners are shifting away from rubber. "They cut down their rubber trees and put oil palm in instead, which is less labour-intensive and you get your harvest sooner," says Cornish. The shift to palm oil is a threat to supply, but it isn't the worst. A much bigger one is the lack of genetic diversity of the Pará tree crop, which makes it frighteningly susceptible to disease – especially a fungus called South American leaf blight, the "black death" of rubber. It can't be treated: it killed off the rubber industry in South America in the 1930s. As yet, it hasn't spread to Asia thanks to strict quarantine measures, but if it does, the world economy is in big trouble. "If the blight ever got to South-East Asia, it would wreak havoc on our rubber supply," says Wolyn. The industry could be wiped out in a year, says Cornish. Because of this, leading agronomists have warned that the supply of natural rubber is an international security issue. A sudden shortage of aircraft tyres, for example, could destabilise global trade. The threat is so great that the United Nations lists the leaf blight as a potential biological weapon. All of which has spurred a decades-long, global search for alternative sources of natural rubber. Dozens of plants have been tried, yet most have failed. The Panama rubber tree, *Castilla elastica*, for example, produces good

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rubber, but usually dies after being tapped, while the India rubber plant, *Ficus elastica*, is hardy, but produces poor-quality rubber. Now, however, two unlikely candidates – a feeble northern weed and a scrubby desert shrub – may put the spring back into the rubber industry's step. It is rarely possible to pinpoint the exact time and place of a crop's domestication, but the Pará rubber tree is an exception: 1876, where the Amazon and Tapajós rivers meet in Pará state. That was where British explorer Henry Wickham collected some 70,000 *H. brasiliensis* seeds, which he took back to Kew Gardens in London on a falsified export licence. Kew germinated the seeds and dispatched seedlings to parts of what are now Sri Lanka, Malaysia, Singapore and Indonesia, where they were used to establish plantations. These quickly outcompeted the South American industry, which relied on smallholders tapping latex from wild trees. Today, about 90 per cent of all natural rubber comes from the descendants of Wickham's contraband trees, mostly in Indonesia, Thailand and Malaysia. According to Nair, every tree in these nations is a clone of one of just 1919 seedlings. "Some of the largest rubber-producing countries have miles of virtually genetically identical trees with their roots and canopies intermingled," says Cornish. That is a blight epidemic waiting to happen. The industry has tried to increase genetic diversity by cross-breeding with other strains, but none appears to be resistant to the black death. It is only a matter of time before the fungus makes landfall in Asia and rips through the plantations. Two small outbreaks are rumoured to have happened already. On both occasions, it took a scorched earth policy to stop the spread.

### Beating the blockade

Although the world as a whole has yet to endure a rubber famine, it has happened in some regions. One was the Soviet Union during the second world war, when South-East Asian exports were blockaded by the Japanese. Luckily, the USSR had already sown the seeds of a domestic rubber industry. In the early 1930s, Soviet agronomists tested more than 1000 species of indigenous plant as sources of rubber. The rubberiest was the Siberian dandelion, a native of the Tian Shan mountains of Kazakhstan. This close relative of the common-or-garden patio weed produces large amounts of high-quality rubber in its roots. Local people had long used it as a kind of chewing gum and the second half of its scientific name, *Taraxacum kok-saghyz*, means "root rubber" in Kazakh. Throughout the decade, the Soviets developed ways to cultivate and process the dandelion. By the time of the Nazi invasion in 1941, the USSR had 67,000 hectares of it, and domestic rubber was meeting 30 per cent of its needs. Production continued after the war, but was halted in 1951

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as cheaper South-East Asian rubber bounced back onto the market. The Japanese blockade also hit the US. In 1942, it set up the Emergency Rubber Project, employing more than 1000 scientists to find alternatives. They too experimented with Siberian dandelions, and also a desert shrub, *Parthenium argentatum*, better known as guayule (pronounced why-oolie). This had already been commercialised as a rubber crop in the early 20th century, although that industry died out in the Great Depression. The project cultivated wild guayule plants from Mexico and Texas, but the war ended before it could make much headway. Now, however, both plants are back in the frame. "They would go a long way to solving our problems," says Cornish. On the dandelion side, German tyre giant Continental has set up a research centre with the Fraunhofer Institute for Molecular Biology and Applied Ecology in Münster. Its US competitor Bridgestone runs a pilot plant in Arizona that makes guayule rubber. Both firms recently unveiled demonstration tyres proving that the alternative rubber is high-enough quality, although neither is yet commercially available. Dandelion rubber is also being developed in China, India and the US and there are guayule projects in Spain, Australia and South Africa. Team dandelion recently stole a march on the competition when a team at the Chinese Academy of Sciences published the *T. kok-saghyz* genome, a critical step towards rapid crop improvement. "It helps tremendously to understand the genetic traits the breeders are after," says plant geneticist Kenneth Olsen of Washington University in St Louis, Missouri. "That allows you to have a more informed breeding strategy." There are still hurdles to overcome, says Cornish, who has commercial interests in both plants. The dandelion isn't a strong plant, she says. "It grows slowly to start with and we don't have chemical weed control. It's not going to be a commercially viable crop until that is achieved." There is also the challenge of scaling up to the millions of hectares needed to meet demand – a problem for both contenders. Ultimately, the world needs all three crops, says Cornish. Demand for natural rubber is so high that nobody is going to put anyone else out of business. "We could have the rubber tree in the tropics, dandelion in northern temperate regions and guayule in semi-arid areas. They complement each other," she says. For now, maybe we should show more appreciation for this essential stuff – and hope we don't live to see a world without rubber.

New Scientist, 18 May 2019

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

**Sound isn't just something we hear.**

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### Scientists Have Created The Loudest Possible Sound Underwater

2019-05-22

Sound isn't just something we hear. It's a formidable physical phenomenon – a wave of pressure that reverberates through the air around us. But the medium sound moves through doesn't have to be air. Incredibly loud sounds can also travel through water, sometimes even being the result of particularly noisy fish. But if you really want to make a racket under the waves, experts recommend lasers. In a new experiment, researchers at the Department of Energy's SLAC National Accelerator Laboratory used an X-ray laser to produce an extremely loud noise. It was so extremely loud, in fact, the team says it was right at the limit of being the loudest possible sound that could ever be produced in water, theoretically speaking. "It is just below the threshold where [the sound] would boil the water in a single wave oscillation," physicist Claudiu Stan, now with Rutgers University Newark, told Physics Buzz. The device the researchers used to do this was the Linac Coherent Light Source (LCLS): an insanely powerful X-ray laser that can do things like create 'molecular black holes' and heat water to 100,000 degrees Celsius (about 180,000 degrees Fahrenheit) in less than a millionth of a millionth of a second. Here, the researchers wanted to use the LCLS to learn more about how high-intensity sound waves that produce very loud sounds might affect materials and biological samples. As part of the research, the team blasted incredibly tiny liquid microjets of water thinner than a strand of hair in a vacuum chamber with focused X-ray pulses of photons. When the laser intercepted the water stream, ultrafast ionisation took place in the microjet as the water was heated, vaporising the liquid and creating a cylindrical shock wave that propagated along the jet. According to the researchers, these shock waves had initial peak pressures that correspond to extreme sound intensities and sound pressure levels above 270 decibels (dB) – louder than an eardrum-rupturing jet plane taking off, or even a rocket launch. That's pretty crazy, and the results suggest it's also not possible to go louder than this in water, due to the way the water breaks down if the pressure exerted by the shockwaves becomes any greater. "The amplitudes and intensities were limited by the wave destroying its own propagation medium through cavitation, and therefore these ultrasonic waves in jets are one of the most intense propagating sounds that can be generated in liquid water," the researchers explain in their paper. "We estimate that the amplitudes of these pressure waves exceed the largest peak-to-peak pressures obtained with focused ultrasonic



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waves, and may thus be the highest intensity sounds generated to date in liquid water." The findings are reported in *Physical Review Fluids*.

Science Alert, 20 May 2019

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

### **New Study Shows What Eating 'Ultra-Processed' Food For 2 Weeks Does to Your Body**

2019-05-22

We know we should eat less junk food, such as crisps, industrially made pizzas and sugar-sweetened drinks, because of their high calorie content. These "ultra-processed" foods, as they are now called by nutritionists, are high in sugar and fat, but is that the only reason they cause weight gain? An important new trial from the US National Institute of Health (NIH) shows there's a lot more at work here than calories alone. Studies have already found an association between junk foods and weight gain, but this link has never been investigated with a randomised controlled trial (RCT), the gold standard of clinical studies. In the NIH's RCT, 20 adults aged about 30 were randomly assigned to either a diet of ultra-processed foods or a "control" diet of unprocessed foods, both eaten as three meals plus snacks across the day. Participants were allowed to eat as much as they wished. After two weeks on one of the diets, they were switched to the other for a further two weeks. This type of crossover study improves the reliability of the results since each person takes part in both arms of the study. The study found that, on average, participants ate 500 calories more per day when consuming the ultra-processed diet, compared to when eating the diet of unprocessed foods. And on the ultra-processed diet, they gained weight – almost a kilogram. Although we know that ultra-processed foods can be quite addictive, the participants reported finding the two diets equally palatable, with no awareness of having a greater appetite for the ultra-processed foods than for the unprocessed foods, despite consuming 500 calories more of them per day. Unconscious over-consumption of ultra-processed foods is often attributed to snacking. But in this study, most of the excess calories were consumed during breakfast and lunch, not as snacks.

#### Slow eating, not fast food

A crucial clue as to why the ultra-processed foods caused greater calorie consumption may be that participants ate the ultra-processed meals faster and so consumed more calories per minute. This can cause excess

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calorie intake before the body's signals for satiety or fullness have time to kick in. An important satiety factor in unprocessed foods is dietary fibre. Most ultra-processed foods contain little fibre (most or all of it is lost during their manufacture) and so are easier to eat fast. Anticipating this, the NIH researchers equalised the fibre content of their two diets by adding a fibre supplement to the ultra-processed diet in drinks. But fibre supplements are not the same thing as fibre in unprocessed foods. Fibre in unprocessed food is an integral part of the food's structure – or the food matrix, as it's called. And an intact food matrix slows down how quickly we consume calories. For instance, it takes us far longer to chew through a whole orange with its intact food matrix than it does to gulp down the equivalent calories as orange juice. An interesting message emerging from this and other studies seems to be that to regulate calorie intake, we must retain food structure, like the natural food matrix of unprocessed foods. This obliges us to eat more slowly, allowing time for the body's satiety mechanisms to activate before we have eaten too much. This mechanism does not operate with ultra-processed foods since the food matrix is lost during manufacture. Finding time for a meal of unprocessed foods eaten slowly can be a real challenge for many. But the importance of seated mealtimes is an approach vigorously defended in some countries, such as France, where a succession of small courses ensures a more leisurely – and pleasurable – way of eating. And it may also be an important antidote to the weight gain caused by grabbing a quick meal of ultra-processed foods.

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

### The Healthiest Weight Could Actually Be 'Overweight', Huge Study Finds

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A study spanning almost four decades and involving more than 100,000 adults in Denmark found that those with an 'overweight' body mass index (or BMI) were more likely to live longer than those in the 'healthy', 'underweight', and 'obese' categories. The results, which were published in May 2016, bring into question one of the fundamental assumptions we have about our health right now - that a 'healthy' BMI equals a longer life. And it's not the first time - a number of studies in the past have found that packing on a few extra pounds might not be so bad after all. Before we go into any of the details, these results are definitely not an excuse to cancel your gym membership and have ice cream for breakfast. No one's arguing that forgoing exercise and eating crap is your best shot at

**A study spanning almost four decades and involving more than 100,000 adults in Denmark found that those with an 'overweight' body mass index (or BMI) were more likely to live longer than those in the 'healthy', 'underweight', and 'obese' categories.**

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living a long, happy life. (Damn.) What these results are suggesting is that we might need to rethink our definition of what the term “overweight” actually means. The study, led by clinical biochemist Børge Nordestgaard from Copenhagen University Hospital, analysed the medical data of more than 100,000 adults in Denmark, recruited in three groups about 15 years apart. They found that during the four decades of analysis - from 1976 to 2013 - the BMI associated with lowest risk of death increased from 23.7 to 27. If your BMI is between 18.5 and 24.9, you’re considered normal or ‘healthy’, and if your BMI is between 25 and 29.9, you’re considered ‘overweight’. A BMI of 30 or more is classified as ‘obese’. The study also found that those in the ‘obese’ category ended up having the same risk of death as those in the ‘normal’ range, even when factors such as age, sex, family history of disease, socio-economic status, and smoking were taken into account. This means that in the past 40 years, the weight category associated with the longest lifespan has gone from ‘normal’ to squarely in the ‘overweight’ camp, which suggests that either our classification for ‘normal’ weight is wrong, or the link between our weight and our overall health is far more complicated than we thought. “BMI as a number alone may not be sufficient to predict health and risk of death,” physician Rexford Ahima from the University of Pennsylvania School of Medicine, who wasn’t involved in the study, told Science News back in 2016. “It has to be taken within context.” The case against BMI as being the go-to metric for a healthy weight has been brewing for some time, with NFL star Tom Brady and NBA veteran Paul Pierce famously nudging the ‘obese’ category, and a study from earlier in 2016 finding that 34.4 million ‘overweight’ and 19.8 million ‘obese’ Americans were actually healthy, based on a range of cardio-metabolic health markers. Quite simply, it looks like the body mass index is flawed. “In the overweight BMI category, 47 percent are perfectly healthy,” said Jeffrey Hunger from the University of California, Santa Barbara, who was part of the earlier study showing American ‘overweight and ‘obese’ people were healthy. “So, to be using BMI as a health proxy - particularly for everyone within that category - is simply incorrect. Our study should be the final nail in the coffin for BMI.” On top of that, the shift that Nordestgaard and his team found in their Danish study could signify how many of the health risks associated with a higher weight, such as high cholesterol and high blood pressure, are more effectively diagnosed and treated now than they were 40 years ago. “So maybe you can be overweight if you have [these conditions] treated,” he told Esther Landhuis at Science News at the time. The study does have its limitations - while the 100,000 people analysed are considered to be a good representation of the population of Copenhagen, it consisted of mostly white people, so we can’t say what these results could mean for people with other

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backgrounds. "A substantial fraction of Asians, for instance, develop type 2 diabetes and heart disease despite having BMIs lower than the existing cut-off point for being overweight," Landhuis pointed out. But it does agree with what a number of studies have been suggesting - how long a person lives is far more complicated than the ratio of kilos to cm on their frame. As Landhuis explained: "In one study of type 2 diabetes patients, those with normal weight when diagnosed were more likely to die than those who were overweight or obese. And a 2013 meta-analysis of 97 studies found that being overweight was associated with lower risk of death than having a normal BMI - a surprising finding that echoed a 2005 study by the same researchers." Hopefully, as more studies like these are published, we'll take a more personalised approach to health in the coming decades, so we don't end up focusing on the wrong things when it comes to what's best for an individual. The results were published in JAMA.

Science Alert, 18 May 2019

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### **Charcoal toothpaste may do harm and not much good**

2019-05-22

Charcoal toothpaste may be having a moment as a go-to brightening and whitening tool, but some dentists say these products might actually damage tooth enamel and make cavities more likely. At a minimum, any claims charcoal toothpaste marketers make have no scientific evidence behind them, the authors of a paper in the British Dental Journal warn. "The evidence highlighting any potential benefits of charcoal toothpaste over regular toothpaste is severely lacking," said Dr. Joseph Greenwall-Cohen of the University of Manchester Dental School in the UK, one of the co-authors. "In general, I would encourage all people to stick to regular toothpaste over charcoal toothpaste," Greenwall-Cohen said. A wide variety of charcoal toothpastes and tooth powders are available on store shelves, and packaging often claims that these products are "natural" or "eco-friendly" or have "antibacterial" or "antifungal" properties, the paper notes. This may persuade consumers they're buying something good for the environment that can also help prevent or treat gum disease or other oral health problems. "There is simply no scientific proof that these products are capable of detoxifying your mouth, offer any increased antimicrobial activities (antibacterial, antifungal, antiviral), or can fortify/remineralise/strengthen tooth structure," said Dr. John Brooks, a researcher at the University of Maryland School of Dentistry in Baltimore who wasn't involved in the paper. There's an outside chance that charcoal toothpaste

**Charcoal toothpaste may be having a moment as a go-to brightening and whitening tool, but some dentists say these products might actually damage tooth enamel and make cavities more likely.**

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might lure some people with poor oral health habits to suddenly start flossing and brushing after every meal, and if this happens it could be considered one benefit of these products, Greenwall-Cohen and colleagues write. But the problem is that people with poor oral hygiene who try charcoal toothpaste may actually find it damages their tooth enamel or increases their risk of cavities, they warn. Not much research to date has tested the safety and effectiveness of charcoal toothpaste against alternatives in head-to-head clinical trials. Some small studies looking at the effects of charcoal toothpaste have, however, found that it may be too abrasive to tooth enamel. Charcoal may erode the outer layer of enamel on teeth, exposing interior tissue and increasing the risk of tooth decay, some of these studies suggest. Charcoal may also cause cancer, Brooks, who has done research on charcoal toothpaste, said by email. "I have concerns about the chronic exposure of the oral mucosa (tissue) to charcoal as the federal government has classified charcoal as a carcinogen," Brooks said. "Another potential health concern we uncovered was that one-third of the 50 brands of charcoal toothpaste we investigated included bentonite clay, a mineral that may contain crystalline silica, another recognized carcinogen by the federal government," Brooks said. When consumers do seek out specific toothpaste ingredients, fluoride is what matters most, dentists say. Plenty of research has found brushing with a toothpaste that contains fluoride can help prevent tooth decay and cavities. "None of the charcoal toothpastes would likely offer any cavity-fighting potential any more than brushing with non-fluoride toothpaste," Brooks said.

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

## Technical Notes

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