

## Contents

**CHEMWATCH**

(click on page numbers for links)

### REGULATORY UPDATE

#### ASIA PACIFIC

Final report — Secondary notification assessment on Polymer FDP-S948B-09.....	4
Australian NGOs celebrate 'huge win' on animal testing ban .....	5
MOT to Release Safety Technical Conditions for Vehicles Transporting Dangerous Goods .....	6
Taiwan EPA to Revise Incentive Measures for Toxic Chemical Operators.....	8

#### AMERICA

Chemours faces first Notice of Violation issued under TSCA.....	9
Statement from FDA Commissioner Scott Gottlieb, M.D., and Susan Mayne, Ph.D., director of the Centre for Food Safety and Applied Nutrition, on tests confirming a 2017 finding of asbestos contamination in certain cosmetic products and new steps that FDA is pursuing to improve cosmetics safety .....	11
U.S. Senate Republicans hold rare climate hearing, and more might be coming .....	16

#### EUROPE

Rolls-Royce seeks UK REACH changes amid Brexit woes.....	18
BPR Union List updated with 1 expired active substance approval .....	20
Germany AwSV List of published WGK classifications updated .....	20

### REACH UPDATE

Biocidal Products Committee concludes on Union authorisations for disinfectants .....	22
How to notify PIC exports to the UK after UK's withdrawal from the EU ....	23
Authorisations granted for two uses of chromium trioxide .....	24
Testing proposals .....	24
Guidance on Annex VIII to CLP – poison centres notifications .....	24
Guidance on labelling and packaging according to CLP updated .....	25
Consultation on harmonised classification and labelling .....	25
New proposals and intentions to harmonise classification and labelling ..	26

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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.**

## Contents

CHEMWATCH

### JANET'S CORNER

Dessertium.....27

### HAZARD ALERT

Sodium Fluoroacetate .....28

### GOSSIP

Digesting hydrocarbons .....33

A better way to make acrylics.....36

Can couches and vinyl floors make kids really sick?.....37

Material made from citrus fruit peel could help clean up oil spills .....38

Self-growing material could make muscles that become stronger  
with use hydrogel muscle .....39

Smart skin sticker could detect asthma attacks before they happen .....40

Ultra-lightweight ceramic material withstands extreme temperatures.....40

Scientists develop first fabric to automatically cool or insulate  
depending on conditions.....42

Chemical data mining boosts search for new organic semiconductors ....44

Light-based production of drug-discovery molecules.....45

Lithium-air batteries can store energy for cars, houses and industry .....46

New device simplifies measurement of fluoride contamination in water .48

Better red than dread: Barrier keeps batteries safe.....49

3-D experiments shed new light on shape memory alloys .....51

Running an LED in reverse could cool future computers .....53

Platinum nanoparticles for selective treatment of liver cancer cells.....55

Upcycling plastic bags into battery parts.....56

Researchers develop fire-retardant coating featuring renewable  
materials.....57

Scientists discover that charcoal traps ammonia pollution.....58

### CURIOSITIES

Blood sugar tied to fracture risk in type 1 diabetes.....61

How the brain responds to texture.....62

New heated tobacco device causes same damage to lung cells as  
e-cigs and smoking, study finds .....64

## Contents

**CHEMWATCH**

Spelling bees? No, but they can do arithmetic, say researchers .....	66
To Stop Mosquitoes From Biting, Scientists Put Them on Diet Pills .....	67
Your home is a hidden source of air pollution .....	68
The battle against bugs: it's time to end chemical warfare .....	70
9 Ways to Cut Down on Plastic .....	72
Explainer: cadmium in chocolate .....	73
Will Eating Nuts Make You Gain Weight? .....	75
How Many Push-Ups You Can Do Could Predict Your Risk of Heart Disease .....	77
Here's What Happened When an Alaskan City Took Fluoride Out of Their Drinking Water .....	78
Why sparks fly when you microwave grapes .....	80
Reality check: Can cat poop cause mental illness? .....	81
Eating lots of meat tied to higher risk of liver disease .....	84
How humans evolved to be both shockingly violent and super-cooperative.....	85

### TECHNICAL NOTES

(Note: Open your Web Browser and click on Heading to link to section)...	90
ENVIRONMENTAL RESEARCH .....	90
MEDICAL RESEARCH.....	90
OCCUPATIONAL RESEARCH .....	90
PUBLIC HEALTH RESEARCH.....	91

## Regulatory Update

CHEMWATCH

### ASIA PACIFIC

#### Final report — Secondary notification assessment on Polymer FDP-S948B-09

2019-03-08

The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has published the final report on the Secondary Notification assessment on Polymer FDP-S948B-09 in the March edition of the Chemical Gazette. The secondary notification assessment of Polymer in FDP-S948B-09 has been completed under the Industrial Chemicals (Notification and Assessment) Act 1989 (the Act). NICNAS has given notice that Polymer in FDP-S948B-09 is no longer undergoing secondary notification assessment. However, secondary notification requirements for the chemical still apply. Manufacturers and importers of the chemical must advise NICNAS of the changes in circumstances.

#### Consultation and communication process

Secondary notification timeline:

- draft report released to the applicant for feedback from 6 September to 5 October 2018 (as required by section 60D of the Act)
- draft report released for public comment from 2 November to 4 December 2018 (as required by section 60E of the Act)
- requests for variation of the draft report submitted by the applicant on 3 December 2018
- Director's decisions on requests to vary the draft report released to the applicant on 21 December 2018 and published 1 January 2019 (as required by section 60E of the Act)
- final report incorporating the approved variations published 5 March 2019 (in accordance with section 60F of the Act)

A copy of the final report is available at: [Download the final secondary notification report on Polymer in FDP-S948B-09 \[PDF 1.2MB\]](#)

NICNAS Chemical Gazette, 5 March 2019

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

**The National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has published the final report on the Secondary Notification assessment on Polymer FDP-S948B-09 in the March edition of the Chemical Gazette.**

## Regulatory Update

CHEMWATCH

### Australian NGOs celebrate 'huge win' on animal testing ban

2019-03-08

Two NGOs have called the Australian parliament's recent passing of a ban on animal testing on cosmetics a "huge win" for their Be Cruelty-Free Australia campaign. And the Humane Society International (HSI) and Humane Research Australia (HRA) have also expressed support for the government's commitment to reducing the reliance on animal testing for all industrial chemicals, while encouraging the use of alternatives. On 14 February the country's parliament passed the part of the Industrial Chemicals Bill 2017 that included a ban on animal testing for chemical introductions with an end use solely in cosmetics. Just three days earlier, government minister Bridget McKenzie wrote to the HSI making 11 commitments. In her 11 February letter Ms McKenzie said the government would be incorporating measures into the ministerial rules to limit the use of animal test data in multi end-use cosmetics. These contain substances that can be used in cosmetics but also in other products, and may have been tested on animals for other purposes. The letter also commits the government to:

- implementing strategies to encourage the cosmetics industry not to use animal test data;
- requiring a declaration of compliance with the animal test data ban from industry, as part of pre-introduction reporting or post-market annual declarations "as appropriate to the category of industrial chemical introduction";
- requiring the executive director of the new chemicals scheme, Australian Industrial Chemicals Introduction Scheme (AICIS), to publish statistics every year on the use of animal test data; and
- an agreement in principle to explore the ability to use a portion of the funding under the current 2017-18 budget measure to support the development and uptake of new approach methods to replace animal testing.

Senator McKenzie says in her letter that the commitments come as part of the "general international trend away from reliance on the use of animals to determine the hazards and risks associated with the use of industrial chemicals." Three of the six parts of the Industrial Chemicals bill passed the Australian parliament on 18 February. The final three parts – which relate to costs and charges – are expected to be heard in April. Once cleared it is expected to take effect on 1 July 2020.

## Regulatory Update

CHEMWATCH

### NGO pressure

Under its joint Be Cruelty-Free Australia campaign, HSI and HRA have spent several years negotiating with the government for a change of language in the bill. They argued that the terms “solely for cosmetics” but not for “multi end-use substances” would lead to companies declaring any new cosmetic ingredient as multi-use and relying on new animal testing data as a cheaper option. HSI said this might have meant that 79% of cosmetic end-use chemical assessments would not fall within the scope of the ban. Campaign manager, Hannah Stuart, told Chemical Watch that “the government commitments to HSI not only address our concerns with the ban but actually provide more in terms of animal protection outcomes through further reduced reliance on animal testing.” She added that the ban and related additional commitments will apply to all relevant cosmetic chemical introduction categories, rather than only some – including cosmetic end uses of ‘multi-use’ introductions.

After the new rules are finalised, there will be a short period, normally 15 days, where either the House of Representatives or the Senate can vote to veto the rules under a dis-allowance procedure. Otherwise, the rules are enacted. Amendments can only be made if the rules are disallowed. Australia has been moving towards banning the use of animal test data in cosmetics for a number of years. The Department of Health announced in 2016 that it would do this the following year. However, implementation of the ban was delayed, because it is a part of the Industrial Chemicals Bill. Further information is available at:

- Government commitment letter
- Nicnas reforms update

Chemical Watch, 6 March 2019

<http://chemicalwatch.com>

### **MOT to Release Safety Technical Conditions for Vehicles Transporting Dangerous Goods**

2019-03-08

On 25 February, Mr. Yu Xingyuan, the chief of freight and logistics management in China’s Ministry of Transport (MOT), made a speech regarding the “regulations and supervisions in dangerous goods road transport in China” during the “Sino-German Dangerous Goods Transportation Workshop” held in Beijing. During the speech, Mr. Yu pointed out problems in dangerous goods transportation (hereinafter

**MOT emphasises reform of management on dangerous goods road transportation with a focus on tank and tanker inspections**

## Regulatory Update

### CHEMWATCH

referred as “TDG”), detailed management of China TDG and offered some insight on future reform of the sector. Mr. Yu highlighted the following issues in China TDG:

- Loopholes in safety management and inefficient implementation of regulations;
- No proper equipment standards, especially in tankers;
- Poor transport management in co-op vehicles;
- Issues relating to dangerous goods licensing and local policies; and
- Implementation of small quantity exemptions.

China is moving to address these problems in the following ways:

#### **Improve two weak points**

- The management of consignment and filing
- The inspection of tanks and atmospheric pressure tanker

#### **Upgrade two systems**

- Full implementation of the dangerous goods transport bill management system: *Encourage transport entities to fulfil obligations*
- Improve the exemption system for dangerous goods transport: *Under current regulation, 7 gases are exempted as general goods provided package and loading capacity are compliant with certain requirements. This exemption saves around 14 billion RMB in logistics costs and for this reason further refinement of exemption criteria is needed.*

#### **Build a system**

China will build a safety management system to administrate its 375k transport vehicles and 11.5k practitioners. The system will focus on:

- Sharing information on tank inspection as threshold for access licensing and vehicle registration;
- Developing a national intranet for waybills;
- Complete intranet connecting 20 provinces by year 2019;
- Achieve full-chain and whole-process supervision in TDG.

Several standards are scheduled to be issued/ updated:

- *Safety technical conditions for dangerous goods road transport operating vehicles*

## Regulatory Update

CHEMWATCH

- *GB13392 dangerous goods road transport vehicle mark*

Chemlinked, 5 March 2019

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

### Taiwan EPA to Revise Incentive Measures for Toxic Chemical Operators

2019-03-08

On 27 February 2019, Taiwan EPA issued a proposed revision to the Measures for Incentives for Operation of Toxic Chemicals. The Measures was formulated to spur R&D and innovation in green chemistry. It is now subject to a period of public consultation lasting 60 days. Compared to the current version, major changes are proposed as below:

1. Renaming *Measures for Incentives for Operation of Toxic Chemicals and Chemical Substances of Concern* to cover chemical substances of concern
2. Expanding eligibility to reward those committed to R&D and promotion of green chemistry
3. Adding provisions to disqualify those having significant chemical accidents in the last year before application for the incentives
4. Changing the awarding frequency from every year to every two years
5. Changing provisions regarding formulation and operation of the awarding panel
6. Amending the incentive measures and adding restrictions on the reelection of winners
7. Adding provisions for pursuing the awards and bonus if violations are found

The new *Toxic and Chemical Substances of Concern Control Act*, previously known as the *Toxic Chemical Substance Control Act* (TCSCA), was revised and promulgated in Nov 2018. The proposed changes of name and some articles in this Measures were to align with the updates in the Act. According to Article 72 of the Act, the competent authority may grant incentives to enterprises that comply with one of the following conditions:

- The handler has not violated the Act for ten years.
- The handler has achieved outstanding results in risk prevention and relevant equipment improvement of toxic chemicals and chemical substances of concern.

**Taiwan is to revise the Measures for Incentives for Operation of Toxic Chemicals.**

## Regulatory Update

CHEMWATCH

- Those that invent or improve methods for the reduction of dangers or pollution created through the manufacture, transport, storage or use of toxic chemicals and chemical substances of concern and are also suitable to be widely promoted.

Using this system, we envisage a new regulatory framework where conscious use of incentives to achieve environmental protection goals will not only be workable but also conducive to more efficient regulation of toxic chemicals and chemical substances of concern. Further information is available at:

[Measures for Incentives for Operation of Toxic Chemicals and Chemical Substances of Concern](#)

Chemlinked, 6 March 2019

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

### AMERICA

#### Chemours faces first Notice of Violation issued under TSCA

2019-03-08

The United States Environmental Protection Agency (EPA) has issued its first Notice of Violation under TSCA to chemical giant Chemours, based on a variety of alleged reporting and notification failures. Issued on 13 February, the Notice of Violation (NOV) claims that Chemours violated provisions under Section 5 and 8 of TSCA, including with regard to its use of the fluorinated compound GenX and its intermediate hexafluoropropylene oxide (HFPO). The EPA told Chemical Watch that the NOV – a non-judicial enforcement action taken by the agency to stop or correct a behaviour – is the first it has issued for TSCA noncompliance. The law requires companies to submit pre-manufacturing notices (PMNs) before manufacturing any new chemical substance, and significant new use notifications (Snuns) for use of a substance beyond what is permissible under a significant new use rule (Snur). But the NOV cites several failures by the company to follow these and other requirements at two company facilities, one located in North Carolina and the other in West Virginia in 2017. These include:

- failure to submit a Snun for emissions of HFPO, which is subject to a Snur requiring it to be used in an enclosed process, and failure to notify a customer that the substance is subject to a Snur;

**EPA alleges notification, reporting non-compliance related to GenX**

## Regulatory Update

CHEMWATCH

- failure to control effluent and emissions during the use of GenX as required by a 2009 TSCA Section 5(e) consent order;
- failure to submit a PMN for a substance that was manufactured for a commercial purpose and not listed on the TSCA inventory;
- failure to submit a Snun for a confidential substance that is subject to a Snur restricting its annual production to 10,000; and
- failure to include three substances, and to report “significant figures of accuracy” on four chemicals, under the 2016 Chemical Data Reporting (CDR) exercise.

When approached by Chemical Watch, the company said it “take[s] these matters very seriously.” “Based on an initial review we believe that we have already addressed many of the issues raised and have responses to address the others,” said spokeswoman Lisa Randall.

### ‘Aggressive’ action

Bob Sussman, a former lawyer to the EPA, expressed surprise at the issuance of the NOV. He said in an interview that there are other, more informal actions the agency could take if they just want to levy fines for TSCA violations. “Maybe this is a shift in approach for just this one company, though we don’t know that yet,” Mr Sussman said. “It’s certainly more aggressive than anything EPA has done for a while.” Following immediate action to correct the violations, the NOV has requested that Chemours submit to the EPA an outline of the actions it “has already undertaken and/or provide the time-frame for actions it will implement to come into compliance with TSCA.” The agency also reiterated an earlier request for documentation of when Chemours first learned of GenX-related contamination in and around its facilities. The NOV says the EPA has not yet received this information, and its submission is “significant to Chemours’ compliance with substantial risk information required under TSCA Section 8(e)” – a provision of the law that requires companies to inform the agency upon learning that a substance it handles presents a “substantial risk” to the environment or human health. No financial penalty is mentioned in the NOV, but according to Mr Sussman, NOVs are often, though not always, followed by civil or criminal action. Criminal provisions of TSCA indicate that ‘knowing or wilful’ notice or reporting violations can carry a penalty of one year in prison and/or a fee of up to \$25,000 per day of violation.

### GenX controversy

## Regulatory Update

### CHEMWATCH

The EPA says a published discovery of perfluoroalkyl substances (PFASs) in North Carolina's Cape Fear River – which the Fayetteville Works site abuts – prompted its investigation into Chemours. And its action comes alongside state-level enforcement stemming from the company's release of GenX into the watershed. This has resulted in a consent order requiring Chemours, among others, to pay North Carolina a penalty of \$12m and to reduce its GenX emissions by 99%, in comparison with 2017 levels, by the end of this year. Chemours told Chemical Watch that it has already invested \$100m in emission control technology to work toward this. GenX – a fluorinated chemical used for non-stick and other waterproof coatings – has been the subject of widespread controversy, amid concerns that the short-chain substance carries similar health concerns as the older, long-chain PFASs, like PFOA, that it replaced. The EPA classifies the substance as an "emerging contaminant" in need of more research. The agency has indicated that oral exposure to GenX – such as through drinking water – could impact the thyroid, reproductive organs and tissues, developing foetuses, and the kidney. A 2017 EPA fact sheet said the agency is using data from Chemours to update its risk assessment of the chemical. Further information is available at:

- [NOV](#)
- [Inspection report](#)
- [Chemours' GenX and PFAS plan](#)
- [NC DEQ consent order](#)
- [NC DEQ GenX investigation](#)
- [Criminal enforcement of TSCA](#)

Chemical Watch, 5 March 2019

<http://chemicalwatch.com>

### **Statement from FDA Commissioner Scott Gottlieb, M.D., and Susan Mayne, Ph.D., director of the Centre for Food Safety and Applied Nutrition, on tests confirming a 2017 finding of asbestos contamination in certain cosmetic products and new steps that FDA is pursuing to improve cosmetics safety**

2019-03-08

Each day, cosmetic products are sold to consumers across the U.S. – some to children under the age of 18, still in the formative years of development.

## Regulatory Update

### CHEMWATCH

These products are used as part of daily beauty and cleansing routines, often times on the skin's most sensitive areas, like the face, eyelids and lips. That's why it's so important that cosmetic products are safe, properly labelled and free of contamination. It's also why when we hear about reports of contamination, like the 2017 reports of asbestos contamination in certain cosmetic products sold by Claire's and Justice retailers, we're especially concerned. Today, we're providing an update on our assessment of the contaminated Claire's and Justice products. This includes the release of new independent testing results and an associated safety alert that warns consumers against the use of certain cosmetics sold by Claire's. We're also announcing new steps that the FDA is taking, given existing limitations on our cosmetic oversight authority, to better ensure the safety of the cosmetic products men, women and children use every day. Our goal is to help ensure the safety of the products that consumers use and pursue steps that modernise our pursuit of that mission. The cosmetics industry is undergoing rapid expansion and innovation. These changes help bring new opportunities and choices to consumers. There are now more varieties of cosmetic products available to consumers than ever before. But they can also bring new uncertainty, complexity and risks. And at the same time, the provisions in the Federal Food, Drug, and Cosmetic Act (FD&C Act) – the law governing the FDA's oversight of cosmetic products — have not been updated since it was first enacted in 1938. The current law does not require cosmetics to be reviewed and approved by the FDA prior to being sold to American consumers. There are reasons why the FD&C Act doesn't require prior approval of cosmetics before marketing. Our statute is based on risk, and many cosmetics do not pose the same risks as medical products that require prior approval before they can be lawfully marketed. Our regulatory approach across our broad portfolio is not a one-size-fits-all approach. But at the same time, when it comes to cosmetics, our authority hasn't changed in many years even as the industry has undergone rapid evolution. Right now, when it comes to cosmetics, companies and individuals who market these products in the U.S. hold the responsibility for the safety and labelling of their products. This means that ultimately a cosmetic manufacturer can decide if they'd like to test their product for safety and register it with the FDA. To be clear, there are currently no legal requirements for any cosmetic manufacturer marketing products to American consumers to test their products for safety. Although the FDA doesn't have pre-market review authority, there are other tools besides the requirement for approval that the FDA uses to ensure the safe marketing of products. In the case of cosmetic products, the FD&C Act imparts the responsibility on us to monitor the cosmetics market and take action to protect consumers, if needed, in the post-

## Regulatory Update

### CHEMWATCH

market setting. Cosmetics must not be “adulterated” or “misbranded,” meaning they must be safe for consumers when used according to directions on the label, or in the customary or expected way, and they must be properly labelled. The FDA’s current work focuses on reviewing scientific literature; reviewing reports of adverse events involving cosmetics that we receive from consumers and health professionals; research; surveillance; education and outreach; and pursuing enforcement action against products on the market that are not in compliance with the law, or against firms or individuals who violate the law.

#### Update on 2017 Finding

As part of our work to protect consumers from unsafe cosmetics on the market, the FDA routinely monitors the market for cosmetic products that may pose a public health risk. This is how the FDA, in 2017, first became aware of reports of asbestos contamination in certain cosmetic products sold by Claire’s and Justice retailers. On Sept. 5, 2017 Justice voluntarily recalled its Just Shine Shimmer Powder and seven additional cosmetic products including: Just Shine Bronzer Brush, Makeup Palette Pinks, Blues and Glitter Cream, and Eye Shadow Palette Cool, Pinks, Eye Shadow and Glitter Cream. For its part, on Dec. 22, 2017 Claire’s removed from its stores the following products: Ultimate Mega Make Up Set, Metallic Hot Pink Glitter 48-Piece Makeup Set, Bedazzled Rainbow Heart Makeup Set, Rainbow Bedazzled Star Make Up Set, Rainbow Glitter Heart Shaped Makeup Set, Mint Glitter Make Up Set, Rainbow Bedazzled Rectangle Make Up Set, and Pink Glitter Palette with Eyeshadow & Lip Gloss. Because the 2017 testing was done by third-party laboratories, the agency believed it was important to scientifically confirm that these reports were accurate. That’s why after Claire’s withdrew and Justice recalled suspect products from the market, the FDA began the process of conducting independent tests to determine if some of these products did in fact contain asbestos. In late February of this year, we received the results of this testing initiative. The FDA announced the results of these tests. Those tests confirmed the presence of asbestos in three of the product samples collected from Claire’s and one of the product samples collected from Justice. All suspect Justice products, including the one testing positive for asbestos, were previously recalled from the market in 2017. The FDA issued a Safety Alert warning consumers to not use three of Claire’s products:

- Claire’s Eye Shadows – Batch No/Lot No: 08/17;
- Claire’s Compact Powder – Batch No/Lot No: 07/15; and,

## Regulatory Update

### CHEMWATCH

- Claire's Contour Palette – Batch No/Lot No: 04/17 because they tested positive for asbestos.

The FDA requested that Claire's recall the products because they should not be used by consumers. Claire's has refused to comply with the FDA's request, and the agency does not have authority to mandate a recall. The FDA is therefore warning consumers not to use these products and will continue to communicate our safety concerns about them. We strongly encourage consumers and health care providers to report cosmetic-related adverse reactions to the FDA's MedWatch reporting system or a consumer complaint coordinator. We understand how concerning this finding is for any consumer and parents whose children may have used one of these products. We take these concerns, and our obligation to protect consumers, seriously. Because of the health risks posed by asbestos, which are well-documented by other government agencies, we want to reassure all parents and consumers that the FDA is dedicated to exploring new ways to better protect Americans from this and other public health risks and preventing consumers from being exposed to similar risks from cosmetics. These findings serve as an important reminder that under our current authority, the FDA has only limited tools to ensure the safety of cosmetics products. We are dependent on manufacturers to take steps to ensure the safety of their products and we are calling on manufacturers to improve their oversight for risks such as those we're identifying today. Under the current regulatory framework, cosmetics manufacturers and retailers bear critical responsibilities in assuring the safety of their products.

#### New Steps to Protect Consumers

That's why, we're calling upon the cosmetic industry to take important new steps. Ultimately, the FDA also seeks to engage with stakeholders to work on other new opportunities to improve our overall framework for assuring the safety of the cosmetic products that consumers use. Among the steps that we're taking to reinforce the obligations of manufacturers, first, we'll soon be working with cosmetics manufacturers and requesting information about what procedures they use to ensure their cosmetics are safe and, in particular, about how they ensure that talc used in any cosmetic product is free from asbestos. We will be investigating how manufacturers source talc with appropriate traceability, and whether they test raw talc and/or their finished products. We also want to know how many cosmetics products contain talc and whether manufacturers have received adverse event reports associated with talc-containing products. We believe this information will help us better identify specific

## Regulatory Update

### CHEMWATCH

cosmetic products and raw ingredient suppliers that may be more likely to be contaminated and inform steps that the FDA may be able to take to better protect consumers. Next, although the law doesn't require cosmetic products to be registered with the FDA, we're also calling upon cosmetic firms to take responsible steps to voluntarily register their products and list ingredients, including talc, used in their products via the FDA's Voluntary Cosmetic Registration Program (VCRP). This program provides a mechanism for cosmetic manufacturers, distributors and packers to voluntarily file information on their products that are currently being marketed to U.S. consumers and to register their manufacturing and/or packaging facility locations. We're also calling upon manufacturers to proactively report adverse events involving cosmetic products to our Centre for Food Safety and Applied Nutrition's Adverse Event Reporting System. Although this is not required by current law, we believe this reporting is an important component of responsible marketing and safe oversight of these products. At the same time, we're committed to taking other steps to ensure safety of consumers, in accordance with the authorities provided to us by the FD&C Act and available resources, and by leveraging our authorities to the greatest extent. We'll continue evaluating concerns about ingredients or products and will make determinations, based on currently available science, if certain cosmetic ingredients should be prohibited and restricted. Moving forward, we'll continue our work uncovering ingredients or products of concern and will take swift action to inform and advise consumers of any identified public health risks. Ensuring the safety of cosmetics is a high priority for us. We're also committed to continuing our efforts specifically around talc and asbestos. In 2010, we surveyed 34 cosmetic products including body powders, face powders, foundation, eye shadow, blush and samples from four major talc suppliers and found no traces of asbestos contamination using the most sensitive techniques available. As announced today with regard to Claire's Eye Shadows, Claire's Compact Powder, and Claire's Contour Palette, the FDA will continue to have products tested and take regulatory and enforcement action as needed. We'll also continue to monitor the scientific literature for safety concerns related to talc in cosmetic products and conduct our own research. Separately, the FDA has formed an interagency working group with representatives from other federal agencies to propose draft standards to improve analytical consistency for talc testing, which will be the subject of an upcoming public forum. Our overarching aim is to ensure the safety of cosmetic products and protect consumers. To significantly shift the safety paradigm of cosmetics in the U.S., we would need to work with stakeholders, including Congress, to modernize the outdated regulatory framework that the FDA has been operating

## Regulatory Update

### CHEMWATCH

under for more than 80 years when it comes to cosmetics. Our program for cosmetics also has remained small despite the industry's significant expansion and global supply chain. To modernise our overall approach, we need to expand the scope of what we're able to do commensurate with the scope of the cosmetics industry, and we're going to seek a broader dialogue on how we can make the overall system more robust. To improve consumer safety and secure our mission for years to come, a more modern approach could include tools that are tailored for cosmetics, including appropriate frameworks for registration and listing of products and their ingredients, good manufacturing practice regulations, company reporting of adverse events, access to records (including consumer complaints) during routine or for-cause inspections, mandatory recalls, disclosure of known cosmetic allergens on a product's label, and ingredient review. Our focus remains on protecting Americans from unsafe products. As we continue our critical work to protect consumers, we look forward to advancing the important dialogue with our colleagues in the cosmetics industry on ways to further enhance the FDA's efforts to ensure the safety of cosmetic products. We're confident that by working collaboratively with all stakeholders, we can enhance the agency's ability to conduct this vital work and provide consumers with greater assurance around the safety of the cosmetic products used throughout the U.S. each day.

U.S FDA, 5 March 2019

<http://www.fda.gov/>

### **U.S. Senate Republicans hold rare climate hearing, and more might be coming**

2019-03-08

It's been some time since the Senate Energy and Natural Resources Committee has held a hearing on climate change, so naturally its top two lawmakers felt compelled to get a couple of things out of the way during a recent two-hour meeting. Global warming is "directly impacting our way of life," said Senator Lisa Murkowski, the Alaska Republican who leads the panel. Sen. Joe Manchin of West Virginia, the top-ranking Democrat, added, "There's no doubt that humans have made a tremendous impact on what we're dealing with." It's a baseline of understanding that, by now, seems obvious to most climate scientists. But it was a milestone moment for the Senate panel. Manchin said the meeting was the first time since 2012 the committee had held a hearing on climate change. (In response, a Republican aide pushed back with the argument that climate change is a frequent topic of discussion on the panel.) Irrespective of the timeline,

**It's been some time since the Senate Energy and Natural Resources Committee has held a hearing on climate change, so naturally its top two lawmakers felt compelled to get a couple of things out of the way during a recent two-hour meeting.**

## Regulatory Update

### CHEMWATCH

Manchin and Murkowski both represent states that lean heavily on the energy industry, and their simple acknowledgement of the climate crisis yesterday was enough to draw small applause from some corners. “It is significant that we even had the hearing—particularly when you have two leaders on the committee, both of whom come from fossil fuel states,” Sen. Angus King (I-ME) said in an interview afterward. “There were some differences on the level of urgency, but I think the underlying premise is that this is something we have to deal with.” Melinda Pierce, legislative director for the Sierra Club in Washington, D.C., had a similar takeaway. The “hearing was notable because it actually occurred,” she said. “It is a good day when a Republican-led committee actually listens to experts about real climate impacts, clean energy and innovation.” But Pierce added this caveat: “This wasn’t revolutionary in terms of setting an agenda for bold action, but it was a start.” Indeed, the committee mostly skimmed over potential solutions—touching on ideas such as microgrids, carbon capture technology and better energy efficiency for buildings. As the main thrust of the hearing was about climate change and the electricity sector, Murkowski made sure to note also that a reduction in carbon emissions is only part of her committee’s responsibility. “As more renewables come online ... our committee will focus on maintaining grid reliability and resiliency,” she said. “We’ll prioritise keeping energy affordable, [and] we’ll be working to advance cleaner energy technologies that can help reduce greenhouse gas emissions.” Manchin wanted to make clear, too, that he was sceptical of efforts to dramatically shrink the United States’ carbon footprint in the near future. “Solutions must be grounded in reality, which requires the recognition that fossil fuels aren’t going anywhere anytime soon,” he said. At another point in the hearing, he noted the vast reserves of natural gas beneath his home state. “We have an ocean of gas under us in West Virginia—an ocean of gas,” he said. Neither of these comments is likely to assuage the concerns of climate hawks, but they do suggest there could be a window for Congress to make small changes to energy policy in the short term. “Responsible Republicans and Democrats are considering realistic, durable solutions to the issue,” said Alex Flint, executive director of the conservative Alliance for Market Solutions in Washington, D.C., which backs the idea of using a carbon tax to fight global warming. “They represent the evolving state of climate change politics.” It’s unlikely, however, that any recommendation from the Senate committee will approach the scale of something like the Green New Deal, which supporters argue is the only way to head off the worst effects of climate change. Murkowski said, “We do have a considerable role to play in developing reasonable policies that can draw bipartisan support that I think will be a pragmatic contribution to the overall discussion.” She

## Regulatory Update

CHEMWATCH

specifically cited topics such as new research and energy efficiency. "I think you'll likely see these as subjects of further discussion," she added.

Science, 5 March 2019

<http://sciencemag.org/>

### EUROPE

#### Rolls-Royce seeks UK REACH changes amid Brexit woes

2019-03-08

British engineering company Rolls-Royce has asked for improvements to UK REACH legislation, to ensure "appropriate" use of restricted chemicals continues in the event Britain leaves the EU without a deal on 29 March. The company, which makes engines for aircraft, ships, trains and for other industrial uses, has shared concerns with the government about the effects of a 'no-deal' Brexit on the supply of chemicals for the industry. "What is of particular interest is the continued downstream use in the UK of substances where an upstream applicant in the EU is awaiting an authorisation decision," a spokesperson told Chemical Watch. The specific concern relates to UK downstream users like Rolls-Royce that are reliant on applications for authorisations submitted by entities in the EU27 or the European Economic Area (EEA), for which a decision has not been made. Rolls-Royce is seeking re-authorisations from the European Commission for SVHCs that are already in use, as its existing permissions are set to expire. If, as expected, the authorisations are not granted by 29 March, the company could become non-compliant in Britain when UK REACH legislation kicks in. The issue was raised at a parliamentary debate on the draft UK REACH statutory instrument (SI) earlier this week, when MP Norman Lamb said Rolls-Royce had "approximately ten" applications for authorisations awaiting a Commission decision. These concern various uses of chromates, including chromium trioxide – a carcinogen – in automotive, aerospace and other industries. The consequences of a legal loophole with regard to authorisation are "potentially disastrous" for the company and many other small and medium-sized enterprises "that probably have no idea about all this complexity", Mr Lamb told Parliament. MP Mary Creagh warned that limiting use of chromates could lead to "market freeze" for entire supply chains. "In a heavily regulated industry such as aerospace people cannot just switch suppliers from one day to the next," she said.

**Engine maker concerned about EU authorisation decisions**

Future decisions

## Regulatory Update

### CHEMWATCH

The government has said it will “grandfather” all existing authorisations granted in the EU in the event of a no-deal Brexit. Companies wanting to continue to export to the trade bloc would need to transfer authorisations to EU27 entities. However, the draft UK REACH SI, published in January, does not make any provisions to grandfather ‘pending’ authorisation applications submitted in the EU that affect UK downstream users. Junior minister Thérèse Coffey from the Department for the Environment, Food and Rural Affairs (Defra) told Parliament that the UK “will not have a position” to allow for future EU authorisation decisions. The new legislation states that if ECHA’s committees have given their final opinions on an EU/EEA authorisation application, then the Secretary of State will make the decision once the applicant has submitted the necessary information. Any downstream users still awaiting final opinions will be required to submit a separate application for UK market authorisation. Ms Coffey conceded, however, that the Health and Safety Executive (HSE), the designated UK REACH authority, “will work with companies to help them to get into compliance as soon as possible”. It is understood that Defra has been in discussions with Rolls-Royce.

#### ECHA ‘not concerned’

Matti Vainio, ECHA’s head of risk management, said the agency was “not directly concerned” about UK downstream users like Rolls-Royce because they are not selling substances into the EU market that require authorisation. From an EU perspective, there is no market disruption of the use of the authorised substance, he said. Compliance of downstream companies in the UK with regard to EU authorisations that are pending is a “completely sovereign decision of the UK”, he told Chemical Watch. The agency says 12 downstream companies based in the UK have submitted authorisation applications in the EU so far. Eight have been granted while the others await a decision. ECHA has also identified six upstream companies in the UK – manufacturers and importers of substances or only representatives – now contemplating transferring their authorisation applications to EU27 entities. Two others have already done so. Further information is available at:

- Draft REACH SI
- Transcript of House of Commons

Chemical Watch, 28 February 2019

<http://chemicalwatch.com>

**On 7 March 2019, the Biocidal Products Regulation (BPR) Union List was updated.**

## Regulatory Update

CHEMWATCH

### **BPR Union List updated with 1 expired active substance approval**

2019-03-08

On 7 March 2019, the Biocidal Products Regulation (BPR) Union List was updated. The following expired active substance approval was added:

- Dichlofluanid: Product type 8 (wood preservatives)

This brought the number of expired active substance approvals to 3.

Yorda's Hive, 7 March 2019

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

### **Germany AwSV List of published WGK classifications updated**

2019-03-08

On 28 February 2019, the German Ordinance on Facilities Handling Substances That Are Hazardous to Water (AwSV) List of published water hazard class (WGK) classifications was updated. The following substances were newly assigned a WGK:

- Benzeneacetic acid, 4-(cyclopropylcarbonyl)-alpha,alpha-dimethyl-, ethyl ester: WGK 2 (obviously hazardous to water)
- Cyclohexanamine, 4-methyl-, acetate (1:1): WGK 1 (slightly hazardous to water)
- Cytidine, N-benzoyl-5'-O-[bis(4-methoxyphenyl)phenylmethyl]-2'-O-(2-methoxyethyl)-5-methyl-, 3'-[2-cyanoethyl N,N-bis(1-methylethyl)phosphoramidite]: WGK 2 (obviously hazardous to water)
- Dicopper hydroxide phosphate: WGK 3 (highly hazardous to water)
- 11,12-dideoxy-3-de((2,6-dideoxy-3-C-methyl-3-O-methyl-3-oxo-12,11-(oxycarbonyl(4-(4-(3-pyridinyl)-1H-imidazol-1-yl)butyl)imino))-erythromycin: WGK 3 (highly hazardous to water)
- Diphosphoric acid, ammonium salt: WGK 1 (slightly hazardous to water)
- Ethanone, 2-[bis(phenylmethyl)amino]-1-(3,4-dihydroxyphenyl)-: WGK 2 (obviously hazardous to water)
- 2-hydroxy-4-(methylthio)butyronitrile: WGK 3 (highly hazardous to water)
- 2S-isopropyl-5R-methyl-1R-cyclohexyl 2,2-dihydroxyacetate: WGK 2 (obviously hazardous to water)

**On 28 February 2019, the German Ordinance on Facilities Handling Substances That Are Hazardous to Water (AwSV) List of published water hazard class (WGK) classifications was updated.**

## Regulatory Update

### CHEMWATCH

- Pethidine hydrochloride: WGK 2 (obviously hazardous to water)
- Potassium {[(2Z)-4-ethoxy-4-oxobut-2-en-2-yl]amino}acetate and monohydrate: WGK 1 (slightly hazardous to water)
- Potassium pentahydrogen bis(phosphate)  
WGK 1 (slightly hazardous to water)
- Sulfamic acid, N-(2,3-dihydro-1,5-dimethyl-3-oxo-2-phenyl-1H-pyrazol-4-yl)-N-methyl-, sodium salt (1:1): WGK 1 (slightly hazardous to water)
- Tripotassium orthophosphate: WGK 1 (slightly hazardous to water)
- Trisodium hydrogen diphosphate: WGK 1 (slightly hazardous to water)
- Trisodium trimetaphosphate: WGK 1 (slightly hazardous to water)

Yorda's Hive, 7 March 2019

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

## REACH Update

CHEMWATCH

### Biocidal Products Committee concludes on Union authorisations for disinfectants

2019-03-08

The Biocidal Products Committee (BPC) discussed three applications for the approval of an active substance. The BPC concluded that the following active substance should not be approved:

- Carbendazim for product-type 9 (fibre, leather, rubber and polymerised materials preservatives).

The committee's opinion is that carbendazim, which meets the exclusion criteria, cannot be approved for product-type 9 because of unacceptable risks posed to the environment that cannot be mitigated. Regarding the approval of two other active substances, the BPC requested the respective evaluating Member States to assess whether the active substances meet the new criteria for endocrine-disrupting properties before the committee adopts its opinions. The active substances are:

- Azametiphos for product-type 18 (insecticides, acaricides and products to control other arthropods); and
- epsilon-metofluthrin for product-type 19 (repellents and attractants).

The BPC also adopted positive opinions supporting Union authorisation for:

- two applications concerning biocidal product families based on iodine/PVP iodine in product-type 3 (veterinary hygiene disinfectants); and
- three applications concerning biocidal product families based on propan-2-ol in product-type 2 (disinfectants and algaecides not intended for direct application to humans or animals) and product-type 4 (food and feed area disinfectants).

In addition, the committee adopted an opinion addressing a request from the European Commission on a dispute between Member States in a simplified authorisation procedure for a biocidal product. The Commission together with the EU Member States will take the final decision on the approval of the active substances and on the Union authorisation of biocidal products. The committee met from 26 February to 1 March 2019. The opinions will be available on ECHA's website in the near future. The next meeting will be held in June 2019. Further information is available at:

- [More information about the opinions](#)
- [More information about the BPC](#)

**The committee adopted seven opinions, including one on the approval of an active substance and five on Union authorisation.**

## REACH Update

CHEMWATCH

- [Approval of active substances](#)
- [Authorisation of biocidal products](#)

ECHA, 5 March 2019

<http://echa.europa.eu>

### How to notify PIC exports to the UK after UK's withdrawal from the EU

2019-03-08

To cover exports taking place in the first 35 days from the date of the United Kingdom's withdrawal from the EU if no withdrawal agreement is in place, a temporary procedure has been made available. The European Chemicals agency (ECHA) has published a manual export notification form that will allow exporters based in the EU-27 to notify their planned exports to the United Kingdom before the date of the UK's withdrawal from the EU. These export notifications will take effect if the UK is, as of the withdrawal date, a third country without a withdrawal agreement entering into force. This is a temporary procedure that will allow EU-27 companies that are exporting chemicals subject to the PIC Regulation to the UK right after the withdrawal to comply with their obligations to notify their exports 35 days before the expected date of import. Once the UK's withdrawal from the EU has been confirmed, a permanent process will be put in place. ECHA will then follow up with the companies and designated national authorities that have used the temporary procedure. Details are available on ECHA's web pages on the UK's withdrawal from the EU. Further information is available at:

- [How to notify PIC exports to the UK after the UK's withdrawal from the EU](#)
- [Manual export notification form](#)
- [UK's withdrawal from the EU](#)
- [Advice to companies](#)
- [Q&As on PIC and the UK's withdrawal from the EU](#)

ECHA, 4 March 2019

<http://echa.europa.eu>

**To cover exports taking place in the first 35 days from the date of the United Kingdom's withdrawal from the EU if no withdrawal agreement is in place, a temporary procedure has been made available.**

## REACH Update

CHEMWATCH

### Authorisations granted for two uses of chromium trioxide

2019-03-08

The European Commission has granted authorisations for two uses of chromium trioxide (EC 215-607-8, CAS 1333-82-0) to Hansgrohe SE. The expiry date of the review period is 14 February 2031. Further information is available at: [Summary in Official Journal](#)

ECHA News, 6 March 2019

<http://echa.europa.eu>

### Testing proposals

2019

The European Chemicals Agency (ECHA) has launched 18 new public consultations on testing proposals. The deadline for comments is 15 April 2019. There are currently 23 open public consultations on testing proposals. Further information is available at: [Give comments](#)

ECHA News, 6 March 2019

<http://echa.europa.eu>

### Guidance on Annex VIII to CLP – poison centres notifications

2019-03-08

The first version of *Guidance on harmonised information relating to emergency health response – Annex VIII to CLP* is now available on the European Chemicals Agency's (ECHA) website. The document explains the provisions of Article 45 and the new Annex VIII to the CLP Regulation and provides duty holders with practical advice on how to comply with their obligation to submit information on the hazardous mixtures they place on the market. A copy of the guidance document is available at: [Guidance document](#).

ECHA News, 6 March 2019

<http://echa.europa.eu>

**The European Chemicals Agency (ECHA) has launched 18 new public consultations on testing proposals.**

## REACH Update

CHEMWATCH

### Guidance on labelling and packaging according to CLP updated

2019-03-08

The European Chemicals Agency (ECHA) has released the updated version of the *Guidance on Labelling and Packaging in accordance with Regulation (EC) No 1272/2008*. The updated version takes into account the changes brought to the CLP Regulation by Annex VIII, including the introduction of the unique formula identifier (UFI), a new labelling element required for hazardous mixtures. It also contains new practical examples of the labelling of co-axial cartridges. A copy of the guidance document is available at: [Guidance document](#)

ECHA News, 6 March 2019

<http://echa.europa.eu>

### Consultation on harmonised classification and labelling

2019-03-08

The European Chemicals Agency (ECHA) is looking for comments on the harmonised classification and labelling proposals for the following substances:

- Silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-, hydrolysis products with silica; pyrogenic, synthetic amorphous, nano, surface treated silicon dioxide (EC 272-697-1, CAS 68909-20-6). The substance is mainly used as an active substance in biocidal products used as insecticide, acaricide and products to control other arthropods. It has no existing harmonised classification and labelling in Annex VI to CLP. Comments are invited on selected physical, human health and environmental hazards.
- 3-methylpyrazole (EC 215-925-7, CAS 1453-58-3). The substance is an industrial chemical mainly used as a fertiliser in agriculture, and with uses in forestry and fishing. It has no existing harmonised classification and labelling in Annex VI to CLP. Comments are invited on selected human health hazards, including developmental toxicity and specific target organ toxicity (lung) after repeated exposure.

The deadline for comments is 3 May 2019. Further information is available at: [Give comments](#)

ECHA News, 6 March 2019

<http://echa.europa.eu>

**ECHA is seeking comments on the harmonised classification and labelling proposals for silanamine and 3-methylpyrazole.**

## REACH Update

CHEMWATCH

### New proposals and intentions to harmonise classification and labelling

2019-03-08

The proposal to harmonise the classification and labelling of 2-ethyl-2-[[[1-oxoallyl)oxy)methyl]-1,3-propanediyl diacrylate; 2,2-bis(acryloyloxymethyl) butyl acrylate; trimethylolpropane triacrylate (EC 239-701-3, CAS 15625-89-5) has been submitted.

An intention to harmonise the classification and labelling of perfluoroheptanoic acid (EC 206-798-9, CAS 375-85-9) has also been received. Further information is available at: [Registry of CLH intentions](#)

ECHA News, 6 March 2019

<http://echa.europa.eu>

## Janet's Corner

CHEMWATCH

### Dessertium

2019-03-07

off the mark.com by Mark Parisi



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## Hazard Alert

### CHEMWATCH

#### Sodium Fluoroacetate

2019-02-18

Sodium fluoroacetate, known in pesticide form as 1080, is the organofluorine chemical compound with the formula  $\text{FCH}_2\text{CO}_2\text{Na}$ . [1] It is a naturally occurring poison found in plants in Australia, South Africa and Brazil. [2] Sodium fluoroacetate is a sodium salt of fluoroacetic acid which is a tan coloured alkaline powder with a pH of 10.3. It melts at 197-203 degrees C with decomposition. It is soluble in water, but practically insoluble in all nonpolar solvents. Sodium fluoroacetate is stable in sunlight, at a temperature of 54 degrees C, and in tin coated metal containers. [3]

#### USES [1]

##### Pesticide Use

Sodium fluoroacetate is used as a pesticide, especially for mammalian pest species. Farmers and graziers use the poison to protect pastures and crops from various herbivorous mammals. In New Zealand and Australia, it is also used to control invasive non-native mammals that prey on or compete with native wildlife and vegetation.

In Australia, sodium fluoroacetate is seen as a critical component of the integrated pest-control programs for rabbits, foxes, wild dogs, and feral pigs. Since 1994, broad-scale fox control using 1080 meat baits in Western Australia has significantly improved the population numbers of several native species and led, for the first time, to three species of mammals being taken off the state's endangered species list.

Worldwide, New Zealand is the largest user of sodium fluoroacetate. This high usage is attributable to the fact that, apart from two species of bat, New Zealand has no native land mammals, and those that have been introduced have had devastating effects on vegetation and native species. 1080 is used to control possums, rats, stoats, and rabbits.

Sodium fluoroacetate is used in the United States to kill coyotes. Prior to 1972 when the EPA cancelled all uses, sodium fluoroacetate was used much more widely as a cheap predacide and rodenticide; in 1985, the restricted-use "toxic collar" approval was finalised.

1080 is also used as a rodenticide in Mexico, Japan, Korea, and Israel.

**Sodium fluoroacetate, known in pesticide form as 1080, is the organofluorine chemical compound with the formula  $\text{FCH}_2\text{CO}_2\text{Na}$ .**

## Hazard Alert

CHEMWATCH

### SOURCE & ROUTES OF EXPOSURE

#### Sources of Exposure [4]

Occupational exposure to sodium fluoroacetate may occur through dermal contact with this compound at workplaces where sodium fluoroacetate is produced or used. Under the current permitted use pattern there will be no exposure of this compound to the general public.

#### Routes of Exposure [5]

Sodium fluoroacetate can affect the body if it is inhaled, if it comes into contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

### HEALTH EFFECTS [6]

#### Acute Effects

- Contact can irritate and burn the skin and eyes and may affect vision.
- Breathing sodium fluoroacetate can irritate the nose and throat.
- Breathing sodium fluoroacetate can irritate the lungs causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary oedema), a medical emergency, with severe shortness of breath.
- Sodium fluoroacetate can cause nausea, vomiting, diarrhoea and abdominal pain.
- Over exposure can cause hallucinations, twitching of the muscles, convulsions and serious heart rhythm changes which can cause death.

#### Cancer Hazard

- Sodium fluoroacetate has not been tested for its ability to cause cancer in animals.

#### Reproductive Hazard

- There is limited evidence that sodium fluoroacetate may damage the testes.

#### Other Long-Term Effects

- Sodium fluoroacetate may damage the kidneys.
- Repeated exposure may affect the liver and thyroid gland.

## Hazard Alert

CHEMWATCH

### SAFETY [7]

#### First Aid Measures

- If inhaled: If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.
- In case of skin contact: Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.
- In case of eye contact: Flush eyes with water as a precaution.
- If swallowed: Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

#### Exposure Controls & Personal Protection

##### Engineering Controls

- Avoid contact with skin, eyes and clothing.
- Wash hands before breaks and immediately after handling the product.

##### Personal Protective Equipment

The following personal protective equipment is recommended when handling sodium fluoroacetate:

- Eye/face protection: Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
- Skin protection: Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands. The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
- Body Protection: Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
- Respiratory protection: Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components

## Hazard Alert

CHEMWATCH

tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

### REGULATION

#### United States [8]

OSHA: The United States Occupational Safety & Health Administration has set the following Permissible Exposure Limits (PEL) for sodium fluoroacetate:

- General Industry: 0.05 mg/m<sup>3</sup> (Skin);
- Construction Industry: 0.05 mg/m<sup>3</sup> TWA (Skin)

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for sodium fluoroacetate of 0.05 mg/m<sup>3</sup> TWA (Skin)

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL) for sodium fluoroacetate of 0.05 mg/m<sup>3</sup> TWA (Skin), 0.15 mg/m<sup>3</sup> STEL (Skin)

#### Australia [9]

Safe Work Australia: Safe Work Australia has set the following Time Weighted Average (TWA) concentration for sodium fluoroacetate 0.05 mg/m<sup>3</sup> for a 40-hour work week and a 15-minute short-term exposure limit (STEL) of 0.15 mg/m<sup>3</sup>.

### REFERENCES

1. [https://en.wikipedia.org/wiki/Sodium\\_fluoroacetate](https://en.wikipedia.org/wiki/Sodium_fluoroacetate)
2. <http://www.toxipedia.org/pages/viewpage.action?pageId=6015922>
3. <http://archive.epa.gov/pesticides/reregistration/web/pdf/3073fact.pdf>
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8. [https://www.osha.gov/dts/chemicalsampling/data/CH\\_267600.html](https://www.osha.gov/dts/chemicalsampling/data/CH_267600.html)

## Hazard Alert

**CHEMWATCH**

9. <http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/772/Workplace-exposure-standards-airborne-contaminants.pdf>

## Gossip

## CHEMWATCH

### Digesting hydrocarbons

2019-02-19

Volatile organic compounds can be found in the air—everywhere. A wide range of sources, including from plants, cooking fuels and household cleaners, emit these compounds directly. They also can be formed in the atmosphere through a complex network of photochemical reactions. Researchers at Sandia National Laboratories and colleagues from other institutions investigated the reactions of hydroxyl and methylperoxy radicals to understand their impact on the atmosphere's ability to process pollutants. This work, which was published in *Nature Communications*, showed that the reactions can impact levels of a key chemical marker used to assess the understanding of the processing and abundances of pollutants. This ultimately helps our understanding of how both nature and human activity affect the chemical composition of the atmosphere. Recent studies in this area had indicated that the reaction of methylperoxy with the hydroxyl radical occurs more rapidly than previously thought, and so this reaction could change the current understanding of chemistry in both low-temperature combustion and the Earth's atmosphere. The hydroxyl radical, an important molecule in combustion and atmospheric chemistry, initiates the oxidation, or processing, of fuel and pollutant molecules. When this radical reacts with fuel molecules in the presence of oxygen, a new class of radicals—known as peroxy radicals—is formed. In the Earth's atmosphere, when the hydroxyl radical reacts with methane (which is both a greenhouse gas and the most abundant hydrocarbon), methylperoxy is created.

#### Impacts to combustion

Rebecca Caravan, a Sandia postdoctoral appointee and lead researcher of the collaborative new effort, said investigating the subsequent reactions of peroxy radicals is critical to understanding low-temperature combustion because the peroxy radical's fate determines to what extent fuel will undergo autoignition. The researchers wanted to understand how the reaction of hydroxyl and methylperoxy radicals could impact this—for example, whether autoignition could be inhibited due to the removal of reactive radicals and the production of relatively unreactive chemicals. "Determining the impact of any specific reaction within any given environment requires knowing both how fast the reaction occurs and the products of the reaction," she said. "Carefully quantifying the products is often the more difficult task. A relatively small change in in these reactions can significantly change the magnitude and even the direction of the impact a reaction has in a given environment." Recent

**Researchers at Sandia National Laboratories and colleagues from other institutions investigated the reactions of hydroxyl and methylperoxy radicals to understand their impact on the atmosphere's ability to process pollutants.**

## Gossip

## CHEMWATCH

theoretical work indicated that a possible product of the hydroxyl radical and methylperoxy reaction could be methanol and oxygen. These products would have significant effect on our understanding of the chemistry in Earth's troposphere—the part of the atmosphere between zero to 10 kilometres (6 miles), which contains around 75 percent of the atmosphere's mass. Caravan said that methanol has long been significantly underpredicted in the troposphere by atmospheric modelers. Because methanol can be formed from multiple sequences of oxidation reactions in the troposphere, understanding how chemical reactions contribute to the levels of methanol in the atmosphere sheds light on how the atmosphere processes hydrocarbons emitted by both nature and human activity, therefore helping us understand the influence of both on the chemical composition of the atmosphere. Sandia combustion chemist Craig Taatjes, the principal investigator of this research effort, said, "We recognised that our fundamental measurements of methanol yield from the hydroxyl radical and methylperoxy reaction could have an impact on modelled atmospheric methanol abundance, so we brought in modeller colleagues who could focus on those consequences of our investigations."

### International collaboration

The discrepancy between modelled and measured methanol is particularly significant in the remote troposphere—regions with relatively limited influence from human activity. Dwayne Heard, professor of atmospheric chemistry at the University of Leeds in the United Kingdom, said an understanding of these regions is needed before human changes can be understood. "We know that changes in man-made emissions are leading to a warming of the atmosphere and a deterioration in the quality of the air that we breathe," Heard said. "However, set against this are natural, dominant processes that occur everywhere—for example, over the oceans where there is relatively little influence from humans." Studies of radical-radical chemistry are complicated; the multiple side reactions need to be understood along with the reaction of interest. To tackle this, researchers from Sandia and NASA's Jet Propulsion Laboratory employed the world-renowned capabilities at Sandia's Combustion Research Facility and the Advanced Light Source at Lawrence Berkeley National Laboratory. The researchers relied on the Sandia Multiplexed Photoionisation Mass Spectrometer instruments developed by Sandia researchers David Osborn and Lenny Sheps. The team also used the tunable vacuum ultraviolet ionising radiation from the Chemical Dynamics beamline at the Advanced Light Source to observe and characterise the chemistry and reaction products. The researchers then worked to interpret their

## Gossip

## CHEMWATCH

experimental observations via models and calculations. They examined the role of longer timescale chemistry on the reaction products by collaborating with partners at the University of Lille in France, who used their atmospheric simulation chamber. Additional team members at the University of Bristol in the United Kingdom used a global chemical model to assess the experimental results on the troposphere. "It was a highly collaborative, international project with each party bringing their own world-class capabilities," said Caravan. The Sandia team was funded by the Department of Energy's Basic Energy Sciences Office. The co-authors of the paper were supported by NASA and British and French agencies.

### Impact on the atmosphere

Because of this collaborative effort, it is now understood that in the troposphere around 25 percent of methylperoxy radicals are removed by the fast reaction with the hydroxyl radical, meaning that fewer peroxy radicals undergo other reactions known to lead to methanol. To counterbalance that, the methanol yield from the reaction of hydroxyl radicals with methylperoxy would need to be about 15 percent, but the authors' measure yields in the range 6-9 percent. The implications of this result on the understanding of tropospheric methanol are significant. The hydroxyl radical and methylperoxy reaction fails to resolve the discrepancy between higher measured and lower modelled methanol abundances; in fact, this discrepancy is now exacerbated. Methanol in remote regions is now underpredicted by around a factor of 1.5 in global models of the atmosphere. "This work highlights our incomplete understanding of key tropospheric chemical reactivity. We are missing significant reactions, opening the door to further investigation," Caravan said. Alexander Archibald, a Cambridge University professor and an expert in the field, says the experiments led by Caravan demonstrate that methanol has additional secrets to reveal. "While the reaction between methylperoxy radicals and hydroxyl radicals may not be a major source of methanol, models still underestimate the amount of methanol," said Archibald. "The exciting work that Caravan and co-workers have performed closes one chapter in the story, but the book remains unfinished. Further work is required to help complete our understanding of this important compound in the atmosphere."

Phys.org, 11 February 2019

<http://phys.org>

## Gossip

### CHEMWATCH

#### A better way to make acrylics

2019-02-19

Acrylics are an incredibly diverse and useful family of chemicals used in all kinds of products, from diapers to nail polish. Now, a team of researchers from UConn and ExxonMobil describe a new process for making them. The new method would increase energy efficiency and reduce toxic by-products, they report in the Feb. 8 issue of Nature Communications. The global market for acrylic acid is enormous. The world used close to 5 million metric tonnes of it in 2013, according to industry group PetroChemicals Europe. And no wonder, for acrylics and the closely related acrylates are the building blocks for many kinds of plastics, glues, textiles, dyes, paints, and papers. Strung together in long chains, they can make all kinds of useful materials. Acrylate mixed with sodium hydroxide, for example, makes a super absorbent material used in diapers. Add extra methyl groups (carbon plus three hydrogens), and acrylate makes plexiglass. The current industrial processes for making acrylics require high temperatures close to 450 F, and produce unwanted and sometimes harmful by-products, such as ethylene, carbon dioxide, and hydrogen cyanide. UConn chemist Steve Suib, director of the University's Institute for Materials Science, and colleagues at UConn and ExxonMobil have designed a new way of making acrylics at mild temperatures. Their technique can be finely tuned to avoid producing unwanted chemicals. "Scientists at ExxonMobil Research & Engineering partnering with professor Suib's group in UConn have been probing new technologies that can lower energy intensity, skip steps, improve energy efficiency, and reduce CO2 footprint in the production process of acrylics," says Partha Nandi, a chemist at ExxonMobil. "The recent publication in Nature Communications describes discovery of a new route to produce a class of acrylate derivatives in potentially fewer steps and with less energy." The technique uses a porous catalyst made of manganese and oxygen. Catalysts are materials used to speed up reactions. Often, they provide a surface for the molecules to sit on while they react with each other, helping them to meet up in the right configurations to do the deed. In this case, the pores fill that role. The pores are 20 to 500 Angstroms wide, big enough for fairly large molecules to fit inside. The manganese atoms in the material can trade their electrons with nearby oxygens, which makes it easier for the right chemical reactions to happen. Depending on the starting ingredients, the catalyst can facilitate all different kinds of acrylics and acrylates, with very little waste, Suib says. "We hope this can be scaled up," he says. "We want to maximise yield, minimise temperature, and make an even more active catalyst," that will help the reaction go faster. The

**A team of researchers from UConn and ExxonMobil describe a new process for making acrylics.**

## Gossip

### CHEMWATCH

group also found adding a little bit of lithium helped speed things up, too. They are currently studying the exact role of lithium, and experimenting with ways of improving the manganese and oxygen catalyst.

Phys.org, 11 February 2019

<http://phys.org>

### Can couches and vinyl floors make kids really sick?

2019-02-19

Children who live in homes with all vinyl flooring or flame-retardant chemicals in the sofa have significantly higher concentrations of potentially harmful compounds in their blood or urine than children who live in homes that don't, according to a new study. The study shows that kids living in homes where the sofa in the main living area contains flame-retardant polybrominated diphenyl ethers (PBDEs) in its foam have a six-fold higher concentration of PBDEs in their blood serum. In laboratory tests, scientists have linked exposure to PBDEs to neurodevelopmental delays, obesity, endocrine and thyroid disruption, cancer, and other diseases. In the new study, researchers found that children from homes with vinyl flooring in all areas had concentrations of benzyl butyl phthalate metabolite in their urine 15 times higher than those in children living with no vinyl flooring. Experts have linked benzyl butyl phthalate to respiratory disorders, skin irritations, multiple myeloma, and reproductive disorders. "SVOCs are widely used in electronics, furniture, and building materials and can be detected in nearly all indoor environments," says Heather Stapleton, an associate professor of environmental health at Duke University's Nicholas School of the Environment. "Human exposure to them is widespread, particularly for young children who spend most of their time indoors and have greater exposure to chemicals found in household dust." "Nonetheless, there has been little research on the relative contribution of specific products and materials to children's overall exposure to SVOCs," she says. To address that gap, the researchers began a three-year study in 2014 of in-home exposures to SVOCs among 203 children from 190 families. "Our primary goal was to investigate links between specific products and children's exposures, and to determine how the exposure happened—was it through breathing, skin contact, or inadvertent dust inhalation," Stapleton says. The researchers analysed samples of indoor air, indoor dust, and foam collected from furniture in each of the children's homes, along with a hand wipe sample, urine, and blood from each child. "We quantified 44 biomarkers of exposure to phthalates, organophosphate esters, brominated flame

**Children who live in homes with all vinyl flooring or flame-retardant chemicals in the sofa have significantly higher concentrations of potentially harmful compounds in their blood or urine than children who live in homes that don't, according to a new study.**

## Gossip

### CHEMWATCH

retardants, parabens, phenols, antibacterial agents, and perfluoroalkyl and polyfluoroalkyl substances (PFAS)," Stapleton says. Stapleton and colleagues presented the findings at the annual meeting of the American Association for the Advancement of Science. Additional researchers are from Duke, Boston University's School of Public Health, and the Centres for Disease Control & Prevention.

Futurity, 18 February 2019

<http://www.futurity.org>

### Material made from citrus fruit peel could help clean up oil spills

2019-02-19

Unwanted citrus fruit peel could be re-purposed into ultra-light sponges that can clean up oil spills, while also reducing food waste. Fengzhi Tan at Dalian Polytechnic University in China gathered the discarded peel of pomelos, a large citrus fruit similar to a grapefruit. They chipped off the yellow skin, leaving only the spongy pith, which they ground and dried into a powder. Then they added a liquid silicon-based compound and heated it to 80°C for 12 hours and then 60°C for 24 hours to turn it into an aerogel – a type of material so light and porous that it can float on air. These ultralight materials are also very strong, so they have been suggested as possible heat shield materials for spacecraft. Cellulose-based aerogels, like this new one, are known to be good for soaking up oil and have been made from cotton, corn stalks and leaves, and banana peels. In this pomelo-peel-based aerogel, the internal pores are 10 to 1000 nanometres wide, and they make up most of the material. This is on the larger end of the scale as far as pore size goes for aerogels. Scanning electron microscope images reveal that the porosity – or the fraction of empty space to actual material – is up to 98.6 percent. Thin filaments of fibre from the citrus peel crisscross to make the layers between the pores. The team tested whether the aerogel could remove kerosene from water. They found that water formed droplets on the surface of the material, while kerosene was quickly and completely absorbed. They also put dyed kerosene into a beaker of water and dipped the aerogel inside. After 1 minute, the kerosene was entirely soaked up. The team tested the same sample of the aerogel in consecutive experiments and found that

**Unwanted citrus fruit peel could be re-purposed into ultra-light sponges that can clean up oil spills, while also reducing food waste.**

## Gossip

## CHEMWATCH

it retained nearly 94 per cent of its capacity to soak up oil after 10 cycles, suggesting the material could be used multiple times.

New Scientist, 6 February 2019

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

### Self-growing material could make muscles that become stronger with use hydrogel muscle

2019-02-19

A new material is the stuff of envy for muscleheads everywhere: it bulks up and self-strengthens without ever needing to hit the gym. Takahiro Matsuda and his colleagues at Hokkaido University in Japan have developed a “self-growing” hydrogel, which improves its size and strength after repeated mechanical force. They believe it could be used to make flexible exosuits, for people with skeletal injuries, which become stronger the more they are used. Hydrogels are soft, flexible materials that come in a wide variety of forms: they’re used in disposable nappies and adhesive wound dressings, comprise soft contact lenses, and can even be edible – jelly is one such example. They’re formed of networks of absorbent polymer chains, and are 90 per cent water. The team’s self-growing hydrogel was inspired by the process human muscles undergo in response to exercise. Strength training and other activities damage muscle fibres, triggering a regeneration process that involves the growth of new tissue. The self-growing material is composed of two intertwined networks of polymers – essentially chains of molecules: one strand is rigid, and the other soft and stretchable. When the rigid strands were broken by force – being stretched, for example – it triggered new chains and crosslinks to form, while the softer second network maintained the structure of the gel. Developing a substance that could grow or reconstruct itself like living tissues has previously proved elusive. The self-growing hydrogel is a step up from self-healing materials, which recover to their previous state after being damaged. It’s “one of the mechanically strongest and toughest hydrogels in the world”, says Matsuda. Just like human muscles require nutrients for growth, the hydrogel was suspended in a liquid “nutrient” solution of molecules, building blocks which it fed on to strengthen itself. By tweaking the amount and type of monomer available, as well as the applied force, the team could control the specific properties the material went on to acquire. Beyond use in exosuits, the team also think the hydrogel could be used to create robots that can adapt to their

**A new material is the stuff of envy for muscleheads everywhere: it bulks up and self-strengthens without ever needing to hit the gym.**

## Gossip

## CHEMWATCH

environment, by sensing forces applied to it and increasing in toughness in areas that are stressed.

New Scientist, 31 January 2019

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

### Smart skin sticker could detect asthma attacks before they happen

2019-02-19

A smart sticker that could alert people with asthma of an impending attack has been created using a children's toy. The device is made using Shrinky Dinks – plastic sheets that shrivel to a fraction of their original size when heated. They are popular among children because they can be coloured and cut into shapes before shrinking. The Shrinky Dinks are used to shrink ultra-thin metal sheets into stretch-detecting sensors that wirelessly transmit breathing data to a smartphone. The hope is that this data could be analysed to spot subtle changes in breathing rate that may be early signs of a worsening condition, or track improvements following medical treatment. It could be a useful tool for monitoring people with chronic lung conditions, such as asthma and cystic fibrosis, says Michelle Khine at the University of California, Irvine, who led the team. People will use the device by sticking it to their lower ribs. The device monitors changes in electrical resistance as it stretches and retracts on the skin. When the wearer is still, the sensor's measurements are as good as a medical-grade spirometer, a machine that measures lung volume from how much air a person expels from a forced breath, says Michael Chu, one of the team. Spirometry is still the most accurate approach, but the new method has the advantage of continuous monitoring over time. Currently, the sensor becomes less accurate when the wearer is very active, for example if they are running. Khine says the next step is to use the device to try to predict asthma attacks before they happen.

New Scientist, 13 February 2019

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

### Ultra-lightweight ceramic material withstands extreme temperatures

2019-02-19

UCLA researchers and collaborators at eight other research institutions have created an extremely light, very durable ceramic aerogel. The

**A smart sticker that could alert people with asthma of an impending attack has been created using a children's toy.**

## Gossip

### CHEMWATCH

material could be used for applications like insulating spacecraft because it can withstand the intense heat and severe temperature changes that space missions endure. Ceramic aerogels have been used to insulate industrial equipment since the 1990s, and they have been used to insulate scientific equipment on NASA's Mars rover missions. But the new version is much more durable after exposure to extreme heat and repeated temperature spikes, and much lighter. Its unique atomic composition and microscopic structure also make it unusually elastic. When it's heated, the material contracts rather than expanding like other ceramics do. It also contracts perpendicularly to the direction that it's compressed -- imagine pressing a tennis ball on a table and having the centre of the ball move inward rather than expanding out -- the opposite of how most materials react when compressed. As a result, the material is far more flexible and less brittle than current state-of-the-art ceramic aerogels: It can be compressed to 5 percent of its original volume and fully recover, while other existing aerogels can be compressed to only about 20 percent and then fully recover. The research, which was published today in *Science*, was led by Xiangfeng Duan, a UCLA professor of chemistry and biochemistry; Yu Huang, a UCLA professor of materials science and engineering; and Hui Li of Harbin Institute of Technology, China. The study's first authors are Xiang Xu, a visiting postdoctoral fellow in chemistry at UCLA from Harbin Institute of Technology; Qiangqiang Zhang of Lanzhou University; and Menglong Hao of UC Berkeley and Southeast University. Other members of the research team were from UC Berkeley; Purdue University; Lawrence Berkeley National Laboratory; Hunan University, China; Lanzhou University, China; and King Saud University, Saudi Arabia. Despite the fact that more than 99 percent of their volume is air, aerogels are solid and structurally very strong for their weight. They can be made from many types of materials, including ceramics, carbon or metal oxides. Compared with other insulators, ceramic-based aerogels are superior in blocking extreme temperatures, and they have ultralow density and are highly resistant to fire and corrosion -- all qualities that lend themselves well to reusable spacecraft. But current ceramic aerogels are highly brittle and tend to fracture after repeated exposure to extreme heat and dramatic temperature swings, both of which are common in space travel. The new material is made of thin layers of boron nitride, a ceramic, with atoms that are connected in hexagon patterns, like chicken wire. In the UCLA-led research, it withstood conditions that would typically fracture other aerogels. It stood up to hundreds of exposures to sudden and extreme temperature spikes when the engineers raised and lowered the temperature in a testing container between minus 198 degrees Celsius and 900 degrees above zero over just a few seconds. In another test,

## Gossip

### CHEMWATCH

it lost less than 1 percent of its mechanical strength after being stored for one week at 1,400 degrees Celsius. "The key to the durability of our new ceramic aerogel is its unique architecture," Duan said. "Its innate flexibility helps it take the pounding from extreme heat and temperature shocks that would cause other ceramic aerogels to fail." Ordinary ceramic materials usually expand when heated and contract when they are cooled. Over time, those repeated temperature changes can lead those materials to fracture and ultimately fail. The new aerogel was designed to be more durable by doing just the opposite -- it contracts rather than expanding when heated. In addition, the aerogel's ability to contract perpendicularly to the direction that it's being compressed -- like the tennis ball example -- help it survive repeated and rapid temperature changes. (That property is known as a negative Poisson's ratio.) It also has interior "walls" that are reinforced with a double-pane structure, which cuts down the material's weight while increasing its insulating abilities. Duan said the process researchers developed to make the new aerogel also could be adapted to make other ultra-lightweight materials. "Those materials could be useful for thermal insulation in spacecraft, automobiles or other specialized equipment," he said. "They could also be useful for thermal energy storage, catalysis or filtration." The research was partly supported by grants from the National Science Foundation.

Science Daily, 14 February 2019

<http://www.sciencedaily.com>

### Scientists develop first fabric to automatically cool or insulate depending on conditions

2019-02-19

Despite decades of innovation in fabrics with high-tech thermal properties that keep marathon runners cool or alpine hikers warm, there has never been a material that changes its insulating properties in response to the environment. Until now. University of Maryland researchers have created a fabric that can automatically regulate the amount of heat that passes through it. When conditions are warm and moist, such as those near a sweating body, the fabric allows infrared radiation (heat) to pass through. When conditions become cooler and drier, the fabric reduces the heat that escapes. The development was reported in the February 8, 2019 issue of the journal *Science*. The researchers created the fabric from specially engineered yarn coated with a conductive metal. Under hot, humid conditions, the strands of yarn compact and activate the coating, which changes the way the fabric interacts with infrared radiation.

**Researchers have engineered a new fabric from synthetic yarn with a carbon nanotube coating that is activated by temperature and humidity, releasing heat in warm humid conditions and trapping heat when conditions are cool and dry.**

## Gossip

### CHEMWATCH

They refer to the action as “gating” of infrared radiation, which acts as a tunable blind to transmit or block heat. “This is the first technology that allows us to dynamically gate infrared radiation,” said YuHuang Wang, a professor of chemistry and biochemistry at UMD and one of the paper’s corresponding authors who directed the studies. The base yarn for this new textile is created with fibres made of two different synthetic materials -- one absorbs water and the other repels it. The strands are coated with carbon nanotubes, a special class of lightweight, carbon-based, conductive metal. Because materials in the fibres both resist and absorb water, the fibres warp when exposed to humidity such as that surrounding a sweating body. That distortion brings the strands of yarn closer together, which does two things. First, it opens the pores in the fabric. This has a small cooling effect because it allows heat to escape. Second, and most importantly, it modifies the electromagnetic coupling between the carbon nanotubes in the coating. “You can think of this coupling effect like the bending of a radio antenna to change the wavelength or frequency it resonates with,” Wang said. “It’s a very simplified way to think of it, but imagine bringing two antennae close together to regulate the kind of electromagnetic wave they pick up. When the fibres are brought closer together, the radiation they interact with changes. In clothing, that means the fabric interacts with the heat radiating from the human body.” Depending on the tuning, the fabric either blocks infrared radiation or allows it to pass through. The reaction is almost instant, so before people realise they’re getting hot, the garment could already be cooling them down. On the flip side, as a body cools down, the dynamic gating mechanism works in reverse to trap in heat. “The human body is a perfect radiator. It gives off heat quickly,” said Min Ouyang, a professor of physics at UMD and the paper’s other corresponding author. “For all of history, the only way to regulate the radiator has been to take clothes off or put clothes on. But this fabric is a true bidirectional regulator.” According to the Science paper, this is first textile shown to be able to regulate heat exchange with the environment. “This pioneering work provides an exciting new switchable characteristic for comfort-adjusting clothing,” said Ray Baughman, a professor of chemistry at the University of Texas who was not involved in the study. “Textiles were known that increase porosity in response to sweat or increasing temperature, as well as textiles that transmit the infrared radiation associated with body temperatures. However, no one before had found a way to switch both the porosity and infrared transparency of a textile so as to provide increased comfort in response to environmental conditions.” More work is needed before the fabric can be commercialised, but according to the researchers, materials used for the base fibre are readily available and the carbon coating can be

## Gossip

## CHEMWATCH

easily added during standard dyeing process. "I think it's very exciting to be able to apply this gating phenomenon to the development of a textile that has the ability to improve the functionality of clothing and other fabrics," Ouyang said.

Science Daily, 7 February 2019

<http://www.sciencedaily.com>

### Chemical data mining boosts search for new organic semiconductors

2019-02-19

Organic semiconductors are lightweight, flexible and easy to manufacture. But they often fail to meet expectations regarding efficiency and stability. Researchers are now deploying data mining approaches to identify promising organic compounds for the electronics of the future. Producing traditional solar cells made of silicon is very energy intensive. On top of that, they are rigid and brittle. Organic semiconductor materials, on the other hand, are flexible and lightweight. They would be a promising alternative, if only their efficiency and stability were on par with traditional cells. Together with his team, Karsten Reuter, Professor of Theoretical Chemistry at the Technical University of Munich, is looking for novel substances for photovoltaics applications, as well as for displays and light-emitting diodes -- OLEDs. The researchers have set their sights on organic compounds that build on frameworks of carbon atoms.

#### Contenders for the electronics of tomorrow

Depending on their structure and composition, these molecules, and the materials formed from them, display a wide variety of physical properties, providing a host of promising candidates for the electronics of the future. "To date, a major problem has been tracking them down: It takes weeks to months to synthesise, test and optimise new materials in the laboratory," says Reuter. "Using computational screening, we can accelerate this process immensely."

#### Computers instead of test tubes

The researcher needs neither test tubes nor Bunsen burners to search for promising organic semiconductors. Using a powerful computer, he and his team analyse existing databases. This virtual search for relationships and patterns is known as data mining. "Knowing what you are looking for is crucial in data mining," says PD Dr. Harald Oberhofer, who heads the

**Researchers are now deploying data mining approaches to identify promising organic compounds for the electronics of the future.**

## Gossip

### CHEMWATCH

project. "In our case, it is electrical conductivity. High conductivity ensures, for example, that a lot of current flows in photovoltaic cells when sunlight excites the molecules."

#### Algorithms identify key parameters

Using his algorithms, he can search for very specific physical parameters: An important one is, for example, the "coupling parameter." The larger it is, the faster electrons move from one molecule to the next. A further parameter is the "reorganisation energy": It defines how costly it is for a molecule to adapt its structure to the new charge following a charge transfer -- the less energy required, the better the conductivity. The research team analysed the structural data of 64,000 organic compounds using the algorithms and grouped them into clusters. The result: Both the carbon-based molecular frameworks and the "functional groups," i.e. the compounds attached laterally to the central framework, decisively influence the conductivity.

#### Identifying molecules using artificial intelligence

The clusters highlight structural frameworks and functional groups that facilitate favourable charge transport, making them particularly suitable for the development of electronic components. "We can now use this to not only predict the properties of a molecule, but using artificial intelligence we can also design new compounds in which both the structural framework and the functional groups promise very good conductivity," explains Reuter.

Science Daily, 14 February 2019

<http://www.sciencedaily.com>

### Light-based production of drug-discovery molecules

2019-02-19

Photoelectrochemical (PEC) cells are widely studied for the conversion of solar energy into chemical fuels. They use photocathodes and photoanodes to "split" water into hydrogen and oxygen respectively. PEC cells can work under mild conditions with light, which makes them also suitable for other catalysing reactions that turn organic molecules into high added-value chemicals, like those used to develop drugs. However, PEC cells have rarely been used in organic synthesis so far, except in some recent conceptual attempts that have tested only a handful of simple substrates. Overall, PEC cells remain largely unexplored for broad-scope synthetic methodologies of functional organic molecules. They could

**Photoelectrochemical (PEC) cells are widely studied for the conversion of solar energy into chemical fuels.**

## Gossip

### CHEMWATCH

nevertheless prove most helpful in one of the most appealing synthetic methods for pharmaceuticals and agrochemicals, called “direct amination”. It involves adding an amine group to an organic molecule without pre-activating the molecule by an additional processing step. Direct amination normally requires high temperatures, and also needs what is known as a “directing group” - a chemical unit that fixes the reaction site but has no other functions, and which often has to be removed before using the new compound in applications. Now, the labs of Xile Hu and Michael Grätzel at EPFL’s Institute of chemical sciences and engineering (ISIC) have developed a new method for aminating arenes - hydrocarbons with a ring in their structure - without the need for a directing group. “Our method is operationally simple and can be used to synthesize a broad range of nitrogen-containing heterocycles relevant to drug discovery,” writes Lei Zhang, the lead author of the study. Proving the point, the researchers used their method to make several pharmaceutical molecules, including derivatives of the muscle relaxant metaxalone and the antimicrobial benzethonium chloride. Based on a PEC cell, the method catalyses the reaction with light and the low-cost, Earth-abundant semiconductor hematite. “Pioneering studies in Michael Grätzel’s lab have yielded robust hematite samples that are efficient for water splitting, but hematite has never been used to catalyse organic synthesis,” says Hu. In the current study, hematite was found to work well for direct amination under visible light, while its high stability promises a long lifetime as a working catalyst. And because it harvests light, the photoelectrocatalysis used here consumes less energy than direct electrocatalysis. “This is an important demonstration of principle for using PEC cells for the production of high added-value chemicals and pharmaceuticals,” says Hu. “The work merges two traditionally separated fields, namely photoelectrochemistry and organic synthesis. There are plenty of untapped opportunities for this approach, and we are excited to further explore these opportunities.”

EurekaAlert, 18 February 2019

<http://www.eurekaalert.org>

## Lithium-air batteries can store energy for cars, houses and industry

2019-02-19

Current lithium ion battery technology will probably not be able to handle the coming decades’ huge demand for energy. It is estimated that by 2050, electricity will make up 50% of the world’s energy mix. Today that rate is 18%. But installed capacity for renewable energy production is expected

**Growth in the offer of renewable energy sources will mean increased demand for devices optimal for energy storing; São Paulo and UK researchers presented advances in new battery development at FAPESP Week London**

## Gossip

## CHEMWATCH

to increase fourfold. This will require batteries that are more efficient, cheaper and environmentally friendly. One of the alternatives being studied today in many parts of the world is the lithium-air battery. Some of the Brazilian efforts in the search for such device were presented on Day Two of FAPESP Week London, held February 11-12, 2019. "There is a lot of talk today about electric cars. Some European countries are also thinking about banning combustion engines. In addition, renewable sources like solar energy need batteries to store what is generated during the day through solar radiation," said Rubens Maciel Filho, a professor at the School of Chemical Engineering of the University of Campinas (UNICAMP). The lithium-air battery, currently functioning only on a laboratory scale, uses ambient oxygen as a reagent. The battery stores additional energy through an electrochemical reaction that results in the formation of lithium oxide. "It is a sustainable way to store electrical energy. With advances, it can support numerous discharge/charge cycles. It has great potential for use in transportation, in light and heavy vehicles alike. It can also work in electric power distribution networks," said the researcher. But turning experiments into commercially viable products involves understanding the fundamentals of the electrochemical reactions that occur in the process. "It also requires the development of new materials that allow us to leverage desirable reactions and minimize or avoid undesirable ones," said Maciel, director of the New Energy Innovation Centre (CINE). With units at UNICAMP, the Nuclear Energy Research Institute (IPEN) and the São Carlos Chemistry Institute at the University of São Paulo (USP), the centre is supported by FAPESP and Shell under the scope of the Engineering Research Centres Program (ERC). He went on to explain that some of the phenomena need to be observed in operando, or in other words, in real time. "The idea is to keep track of the reactions that occur in dynamic experiments and the different chemical species that are formed, even if temporarily. Otherwise, some of the stages in the process get lost and the battery becomes inefficient in terms of charge time and duration of charge." To conduct these measurements, the researchers are using the National Synchrotron Light Laboratory (LNLS) at the Brazilian Centre for Light Research in Energy and Materials (CNPEM), located in Campinas. Another project presented during the session involved sulfur-air batteries. Despite not being as efficient, they are inexpensive and store energy for many hours. "They can store energy for up to 24 hours at a very low cost. Its main ingredients are sulfur and caustic soda and they are extremely inexpensive. That is why we are investing in them," said Nigel Brandon, a professor at Imperial College. Because of these characteristics, sulfur-air batteries can be used in homes or businesses. Brandon believes, however, that their greatest potential is in charging stations for electric

## Gossip

## CHEMWATCH

cars, which will become much more commonplace due to the European goal of cutting carbon emissions 80% by 2050. "It is important to underscore the fact that the different battery projects are not competing with each other but rather are complementing each other," said Geoff Rodgers of Brunel University London, session facilitator.

### Sun, hydrogen and biofuels

More efficient batteries are particularly important in a scenario in which the use of solar energy is expected to increase. Peak solar radiation during the day will require the need for efficient storage of energy so it can be drawn upon at night. Maciel also talked about a project at CINE to develop more efficient photovoltaic cells that could be used in the future to convert solar energy to electricity as well to obtain chemical products, or even hydrogen from water hydrolysis. Liquid hydrogen is a very efficient fuel, but its production entails high-energy costs. It is one of the options being considered in the United Kingdom since biofuels are not as viable as in Brazil. "We are looking for new bacterial enzymes for oxidation of lignin, an aromatic polymer that makes up more than 25% of plant cell walls and is part of the residue of biofuel production. The goal is to develop new products such as biofuels, new plastics and chemical products for industry," said Timothy Bugg of the University of Warwick.

EurekAlert, 15 February 2019

<http://www.eurekalert.org>

### **New device simplifies measurement of fluoride contamination in water**

2019-02-19

Adding fluoride to water is common practice in a number of countries, including the U.S., Australia, Brazil, Malaysia, India and Vietnam. In low concentrations (below 1.5 mg/L), it can prevent tooth decay and even strengthen bones, but levels above that can have the opposite effect, causing serious dental and bone disease, especially in children and developing fetuses. To keep things in check, the WHO has set 1.5 mg/L as the maximum limit for fluoride in drinking water. "To determine whether drinking water is safe, we need to detect fluoride in water at the level of parts-per-million (ppm)," says Kyriakos Stylianou at the Laboratory of molecular simulation at EPFL Valais Wallis. "Around one to 1.5 ppm is good for teeth, but in many countries, the water sources have concentrations above 2 ppm, which can cause serious health issues." But

## Gossip

### CHEMWATCH

measuring fluoride at such low concentrations with sufficient accuracy is expensive and requires a well-equipped chemical lab. Because of this, fluoride contamination in water affects a number of developing countries today, and even parts of developed countries. Led by Stylianou, a team of scientists has now built a device that can accurately measure fluoride concentrations using only a few drops of water—even with low-level contamination—resulting in a simple change in colour brightness. Published in the *Journal of the American Chemical Society (JACS)*, the device is named SION-105. It is portable, considerably cheaper than current methods, and can be used on-site by virtually anyone. The key to the device is the design of a novel material that the scientists synthesised (and after which the device is named). The material belongs to the family of “metal-organic frameworks” (MOFs), compounds made up of a metal ion (or a cluster of metal ions) connected to organic ligands, thus forming one-, two-, or three-dimensional structures. Because of their structural versatility, MOFs can be used in an ever-growing list of applications, including separating petrochemicals, detoxing water, and getting hydrogen or even gold out of it. SION-105 is luminescent by default, but darkens when it encounters fluoride ions. “Add a few droplets of water and by monitoring the colour change of the MOF, we can determine whether it is safe to drink the water or not,” explains Mish Ebrahim, the paper’s first author. “This can now be done on-site, without any chemical expertise.” The researchers used the device to determine the fluoride content in groundwater samples from Vietnam, the United Arab Emirates, and Saudi Arabia. The data corresponded very well when compared to measurements made using ion chromatography, a standard method for measuring fluoride concentration in water. “This comparison showcases the performance and reliability of SION-105, which, coupled with the portability and ease-of-use of the device, make it a very user-friendly solution for water sampling in remote areas where frequent fluoride concentration monitoring is paramount,” says Stylianou.

Phys.org, 15 February 2019

<http://phys.org>

### **Better red than dread: Barrier keeps batteries safe**

2019-02-19

Rice University scientists have taken the next step toward the deployment of powerful, rechargeable lithium metal batteries by making them safer and simpler to manufacture. The Rice lab of chemist James Tour made test cells with a coat of red phosphorus on the separator that keeps the

**Rice University scientists have taken the next step toward the deployment of powerful, rechargeable lithium metal batteries by making them safer and simpler to manufacture.**

## Gossip

### CHEMWATCH

anode and cathode electrodes apart. The phosphorus acts as a spy for management systems used to charge and monitor batteries by detecting the formation of dendrites, protrusions of lithium that can cause them to fail. Lithium metal anodes charge much faster and hold about 10 times more energy by volume than common lithium-ion anodes used in just about every electronic device on the market, including cellphones and electric cars. Anodes are one of two electrodes needed for battery operation. But charging lithium-infused anodes forms dendrites that, if they reach the cathode, cause a short circuit and possibly a fire or explosion. When a dendrite reaches a red phosphorus-coated separator, the battery's charging voltage changes. That tells the battery management system to stop charging. Unlike other proposed dendrite detectors, the Rice strategy doesn't require a third electrode. "Manufacturing batteries with a third electrode is very hard," Tour said. "We propose a static layer that gives a spike in the voltage while the battery is charging. That spike is a signal to shut it down." The research appears in *Advanced Materials*. The red phosphorus layer had no significant effect on normal performance in experiments on test batteries by the Tour lab. The researchers built a transparent test cell with an electrolyte (the liquid or gel-like material between the electrodes and around the separator that allows the battery to generate a current) known to accelerate aging of the cathode and encourage dendrite growth. That let them monitor the voltage while they watched dendrites grow. With an ordinary separator, they saw the dendrites contact and penetrate the separator with no change in voltage, a situation that would lead a normal battery to fail. But with the red phosphorus layer, they observed a sharp drop in voltage when the dendrites contacted the separator. "As soon as a growing dendrite touches the red phosphorus, it gives a signal in the charging voltage," Tour said. "When the battery management system senses that, it can say, 'Stop charging, don't use.'" Last year, the lab introduced carbon nanotube films that appear to completely halt dendrite growth from lithium metal anodes. "By combining the two recent advances, the growth of lithium dendrites can be mitigated, and there is an internal insurance policy that the battery will shut down in the unlikely event that even a single dendrite will start to grow toward the cathode," Tour said. "Literally, when you make a new battery, you're making over a billion of them," he said. "Might a couple of those fail? It only takes a few fires for people to get really antsy."

## Gossip

## CHEMWATCH

Our work provides a further guarantee for battery safety. We're proposing another layer of protection that should be simple to implement."

Phys.org, 15 February 2019

<http://phys.org>

### 3-D experiments shed new light on shape memory alloys

2019-02-19

Shape memory alloys are well known for their remarkable properties—superelasticity, shape memory and actuation allow them to be crumpled up and then spring back to a “remembered” original shape. But the advanced material remains drastically underutilised in commercial applications, uses that could include morphing the shape of airplane structures to make flight more efficient or deploying communication dishes and solar arrays in space. Researchers from Colorado School of Mines are working to better understand how their complex internal microstructures change during shape memory behaviours and the results of their first-of-their-kind experiments were recently published by three major materials science and mechanics journals, *Acta Crystallographica*, *Journal of the Mechanics and Physics of Solids* and *Scripta Materialia*. “Discovered over 70 years ago, the promise of shape memory alloys (SMAs) has led to over 10,000 patents in the U.S. and 20,000 worldwide. However, that promise has not been matched by its technological impact—only a limited number of these 20,000 SMA patents have been realised as commercially viable products,” said Ashley Bucsek Ph.D. '18, lead author of the three papers and now a President's Postdoctoral Fellow at the University of Minnesota. “The story is similar for many other advanced materials, taking decades to move from development to implementation. One reason for this gap between development and implementation is that researchers are literally just scratching the surface with conventional microscopy techniques, when most of the micromechanisms in SMAs are 3-D, out-of-plane and sensitive to internal constraints.” To bridge that gap, Bucsek and her fellow researchers put nickel titanium—the most widely used and available SMA—under some of the most powerful 3-D microscopes available today, located at the Cornell High Energy Synchrotron Source (CHESS) at Cornell University in upstate New York. Specifically, she used near-field and far-field high-energy diffraction microscopy (HEDM), which fall under the umbrella of 3-D X-Ray Diffraction techniques, allowing her to visualise the material's interior microstructure in three dimensions while it's responding in

**Researchers from Colorado School of Mines are working to better understand how their complex internal microstructures change during shape memory behaviours**

## Gossip

### CHEMWATCH

real time. "Even though HEDM has been developed at CHESS and other synchrotrons around the world for over a decade now, the procedures for applying HEDM to studying advanced materials with features like low-symmetry phase mixtures and large crystal size disparities were essentially non-existent," Bucsek said. "As a result, each of these three experiments required the development of novel experimental, data analysis and data visualisation techniques to extract the desired information. Many of the results were surprising, shedding light on decades-old areas of contention in SMA micromechanics." In SMAs, it is often the high-symmetry phase called "austenite" that is stable at a higher temperature, but if enough stress is applied or the temperature is decreased, it will phase transform to a low-symmetry phase called "martensite." The first paper, "Measuring stress-induced martensite microstructures using far-field high-energy diffraction microscopy," published in September in *Acta Crystallographica Section A: Foundations and Advances*, looked to predict the specific variety of martensite that would form. "Using this approach, we found that martensite microstructures within SMAs strongly violated the predictions of the maximum transformation work criterion, showing that the application of the widely accepted maximum transformation work criterion needs to be modified for cases where SMAs may have engineering-grade microstructure features and defects," Bucsek said. The second experiment tackled load-induced twin rearrangement, or martensite reorientation, a reversible deformation mechanism by which materials can accommodate large loads and deformations without damage through rearrangements of crystallographic twins. The paper, "Ferroelastic twin reorientation mechanisms in shape memory alloys elucidated with 3-D X-ray microscopy," is set to be published in March in *Journal of the Mechanics and Physics of Solids*. "A specific sequence of twin rearrangement micromechanisms occurs inside macroscopic deformation bands as they propagate through the microstructure, and we showed that the strain localisation inside these bands causes the lattice to curve up to 15 degrees, which has important implications on elastic strain, resolved shear stress, and maximising the twin rearrangement," Bucsek said. "These findings will guide future researchers in employing twin rearrangement in novel multiferroic technologies." Solid-state actuation is one of the most important applications of SMAs, used in a number of nanoelectromechanical and microelectromechanical systems, biomedical, active damping and aerospace actuation systems. The target of the final experiment was a phenomenon in which special high-angle grain boundaries emerge inside austenite grains when SMAs are actuated. During actuation, phase transformation from austenite to martensite then back to austenite is induced by heating, cooling and

## Gossip

### CHEMWATCH

then reheating the SMA while under a constant load. The paper, "3-D in situ characterisation of phase transformation induced austenite grain refinement in nickel-titanium," will appear in March in Scripta Materialia. "Using electron microscopy, it has been observed that the austenite can exhibit large rotations when the sample is reheated, which is detrimental to both work output and fatigue. However, because of the small sample sizes required for electron microscopy, these rotations were observed very inconsistently, appearing but then not appearing under the same loading conditions, or appearing after a few cycles but then not appearing after a few thousand cycles," Bucsek said. "Our results showed that these grain rotations can occur after just one cycle in moderate condition. But because of the low volume and heterogenous dispersion of the rotations, a bulk volume is required to observe them." "Dr. Bucsek's thesis work documented in these articles shows the importance of using 3-D techniques to study the 3-D structure of materials. She was able to observe and understand mechanisms that have been postulated and debated for over 50 years for the first time," Stebner said. "The biggest hindrance to adopting new materials, like most technologies, is fear of the unknown. Such understanding will undoubtedly lead to wider acceptance and application of these miraculous materials, as it improves our confidence in developing means to certify and qualify them." "The operation of the Cornell High Energy Synchrotron Source, which was used to perform the X-ray microscopy measurements, was also provided by NSF. "Throughout her thesis work, Dr. Bucsek developed new, creative ways to apply HEDM methods to the study of shape memory alloy systems," said Darren Pagan, staff scientist at CHESS. "Her ability to overcome challenges associated with data processing and interpretation enabled new insights to be gained into the micromechanics of shape memory alloy deformation."

Phys.org, 14 February 2019

<http://phys.org>

### Running an LED in reverse could cool future computers

2019-02-20

In a finding that runs counter to a common assumption in physics, researchers ran a light emitting diode (LED) with electrodes reversed in order to cool another device mere nanometres away. The approach could lead to new solid-state cooling technology for future microprocessors, which will have so many transistors packed into a small space that current methods can't remove heat quickly enough. "We have demonstrated a second method for using photons to cool devices," said Pramod Reddy,

**In a finding that runs counter to a common assumption in physics, researchers ran a light emitting diode (LED) with electrodes reversed in order to cool another device mere nanometres away.**

## Gossip

### CHEMWATCH

who co-led the work with Edgar Meyhofer, both professors of mechanical engineering. The first -- known in the field as laser cooling -- is based on the foundational work of Arthur Ashkin, who shared the Nobel prize in Physics in 2018. The researchers instead harnessed the chemical potential of thermal radiation -- a concept more commonly used to explain, for example, how a battery works. "Even today, many assume that the chemical potential of radiation is zero," Meyhofer said. "But theoretical work going back to the 1980s suggests that under some conditions, this is not the case." The chemical potential in a battery, for instance, drives an electric current when put into a device. Inside the battery, metal ions want to flow to the other side because they can get rid of some energy -- chemical potential energy -- and we use that energy as electricity. Electromagnetic radiation, including visible light and infrared thermal radiation, typically does not have this type of potential. "Usually for thermal radiation, the intensity only depends on temperature, but we actually have an additional knob to control this radiation, which makes the cooling we investigate possible," said Linxiao Zhu, a research fellow in mechanical engineering and the lead author on the work. That knob is electrical. In theory, reversing the positive and negative electrical connections on an infrared LED won't just stop it from emitting light, but will actually suppress the thermal radiation that it should be producing just because it's at room temperature. "The LED, with this reverse bias trick, behaves as if it were at a lower temperature," Reddy said. However, measuring this cooling -- and proving that anything interesting happened -- is hideously complicated. To get enough infrared light to flow from an object into the LED, the two would have to be extremely close together -- less than a single wavelength of infrared light. This is necessary to take advantage of "near field" or "evanescent coupling" effects, which enable more infrared photons, or particles of light, to cross from the object to be cooled into the LED. Reddy and Meyhofer's team had a leg up because they had already been heating and cooling nanoscale devices, arranging them so that they were only a few tens of nanometres apart -- or less than a thousandth of a hair's breadth. At this close proximity, a photon that would not have escaped the object to be cooled can pass into the LED, almost as if the gap between them did not exist. And the team had access to an ultra-low vibration laboratory where measurements of objects separated by nanometres become feasible because vibrations, such as those from footsteps by others in the building, are dramatically reduced. The group proved the principle by building a minuscule calorimeter, which is a device that measures changes in energy, and putting it next to a tiny LED about the size of a grain of rice. These two were constantly emitting and receiving thermal photons from each other and elsewhere in their

## Gossip

### CHEMWATCH

environments. "Any object that is at room temperature is emitting light. A night vision camera is basically capturing the infrared light that is coming from a warm body," Meyhofer said. But once the LED is reverse biased, it began acting as a very low temperature object, absorbing photons from the calorimeter. At the same time, the gap prevents heat from traveling back into the calorimeter via conduction, resulting in a cooling effect. The team demonstrated cooling of 6 watts per meter squared. Theoretically, this effect could produce cooling equivalent to 1,000 watts per meter squared, or about the power of sunshine on Earth's surface. This could turn out to be important for future smartphones and other computers. With more computing power in smaller and smaller devices, removing the heat from the microprocessor is beginning to limit how much power can be squeezed into a given space. With improvements of the efficiency and cooling rates of this new approach, the team envisions this phenomenon as a way to quickly draw heat away from microprocessors in devices. It could even stand up to the abuses endured by smartphones, as nanoscale spacers could provide the separation between microprocessor and LED. The research is to be published in the journal *Nature* on Feb. 14, 2019, titled, "Near-field photonic cooling through control of the chemical potential of photons." This research was supported by the Department of Energy and the Army Research Office. The devices were made in the U-M Lurie Nanofabrication Facility. Meyhofer is also a professor of biomedical engineering. Reddy is also a professor of materials science and engineering.

Science Daily, 13 February 2019

<http://www.sciencedaily.com>

### Platinum nanoparticles for selective treatment of liver cancer cells

2019-02-20

In recent years, the number of targeted cancer drugs has continued to rise. However, conventional chemotherapeutic agents still play an important role in cancer treatment. These include platinum-based cytotoxic agents that attack and kill cancer cells. But these agents also damage healthy tissue and cause severe side effects. Researchers at ETH Zurich have now identified an approach that allows for a more selective cancer treatment with drugs of this kind. Platinum can be cytotoxic when oxidised to platinum(II) and occurs in this form in conventional platinum-based chemotherapeutics. Non-oxidised platinum(0), however, is far less toxic to cells. Based on this knowledge, a team led by Helma Wennemers, Professor

**Researchers recently demonstrated that platinum nanoparticles can be used to kill liver cancer cells with greater selectivity than existing cancer drugs.**

## Gossip

### CHEMWATCH

at the Laboratory of Organic Chemistry, and Michal Shoshan, a postdoc in her group, looked for a way to introduce platinum(0) into the target cells, and only then for it to be oxidised to platinum(II). To this end, they used non-oxidised platinum nanoparticles, which first had to be stabilized with a peptide. They screened a library containing thousands of peptides to identify a peptide suitable for producing platinum nanoparticles (2.5 nanometres in diameter) that are stable for years.

#### Oxidised inside the cell

Tests with cancer cell cultures revealed that the platinum(0) nanoparticles penetrate into cells. Once inside the specific environment of liver cancer cells, they become oxidised, triggering the cytotoxic effect of platinum(II). Studies with ten different types of human cells also showed that the toxicity of the peptide-coated nanoparticles was highly selective to liver cancer cells. They have the same toxic effect as Sorafenib, the most common drug used to treat primary liver tumours today. However, the nanoparticles are more selective than Sorafenib and significantly more so than the well-known chemotherapeutic Cisplatin. It is therefore conceivable that the nanoparticles will have fewer side effects than conventional medication. Joining forces with ETH Professor Detlef Günther and his research group, Wennemers and her team were able to determine the platinum content inside the cells and their nuclei using special mass spectrometry. They concluded that the platinum content in the nuclei of liver cancer cells was significantly higher than, for instance, in colorectal cancer cells. The authors believe that the platinum(II) ions -- produced by oxidation of the platinum nanoparticles in the liver cancer cells -- enter the nucleus, and there release their toxicity. "We are still a very long and uncertain way away from a new drug, but the research introduced a new approach to improve the selectivity of drugs for certain types of cancer -- by using a selective activation process specific to a given cell type," Wennemers says. Future research will expand the chemical properties of the nanoparticles to allow for greater control over their biological effects.

Science Daily, 14 February 2019

<http://www.sciencedaily.com>

#### **Upcycling plastic bags into battery parts**

2019-02-20

Plastic bag pollution has become a huge environmental problem, prompting some cities and countries to heavily tax or ban the sacks. But what if used plastic bags could be made into higher-value products?

**Researchers have reported a new method to convert plastic bags into carbon chips that could be used as anodes for lithium-ion batteries.**

## Gossip

## CHEMWATCH

Now, researchers have reported a new method to convert plastic bags into carbon chips that could be used as anodes for lithium-ion batteries. They report their results in ACS Omega. Many plastic bags are used only once and then disposed, ending up in landfills, oceans and elsewhere in the environment, where they can take hundreds of years to decompose. Scientists have long recognised that the polyethylene in plastic bags could be an inexpensive source of energy-storing carbon. However, previous methods to upcycle polyethylene into pure carbon have been inefficient or required expensive, complex processes. Vilas Pol and colleagues wanted to develop a simpler yet efficient approach to convert plastic waste into useful carbon-containing materials. The researchers immersed polyethylene plastic bags in sulfuric acid and sealed them inside a solvothermal reactor, which heated the sample to just below polyethylene's melting temperature. This treatment caused sulfonic acid groups to be added to the polyethylene carbon-carbon backbone so that the plastic could be heated to a much higher temperature without vaporising into hazardous gases. Then, they removed the sulfonated polyethylene from the reactor and heated it in a furnace in an inert atmosphere to produce pure carbon. The team ground the carbon into a black powder and used it to make anodes for lithium-ion batteries. The resulting batteries performed comparably to commercial batteries.

Phys.org, 13 February 2019

<http://phys.org>

### Researchers develop fire-retardant coating featuring renewable materials

2019-02-20

Texas A&M University researchers are developing a new kind of flame-retardant coating using renewable, nontoxic materials readily found in nature, which could provide even more effective fire protection for several widely used materials. Dr. Jaime Grunlan, the Linda & Ralph Schmidt '68 Professor in the J. Mike Walker '66 Department of Mechanical Engineering at Texas A&M, led the recently published research that is featured on the cover of a recent issue of the journal *Advanced Materials Interfaces*. Successful development and implementation of the coating could provide better fire protection to materials including upholstered furniture, textiles and insulation. "These coatings offer the opportunity to reduce the flammability of the polyurethane foam used in a variety of furniture throughout most people's homes," Grunlan noted. The project is a result of an ongoing collaboration between Grunlan and a group of researchers

**Texas A&M University researchers are developing a new kind of flame-retardant coating using renewable, nontoxic materials readily found in nature, which could provide even more effective fire protection for several widely used materials.**

## Gossip

### CHEMWATCH

at KTH Royal Institute of Technology in Stockholm, Sweden, led by Lars Wagberg. The group, which specialises in utilising nanocellulose, provided Grunlan with the ingredients he needed to complement his water-based coating procedure. In nature, both the cellulose—a component of wood and various sea creatures—and clay—a component in soil and rock formations—act as mechanical reinforcements for the structures in which they are found. “The uniqueness in this current study lies in the use of two naturally occurring nanomaterials, clay nanoplatelets and cellulose nanofibrils,” Grunlan said. “To the best of our knowledge, these ingredients have never been used to make a heat shielding or flame-retardant coating as a multilayer thin film deposited from water.” Among the benefits gained from using this method include the coating’s ability to create an excellent oxygen barrier to plastic films—commonly used for food packaging—and better fire protection at a lower cost than other, more toxic ingredients traditionally used flame-retardant treatments. To test the coatings, Grunlan and his colleagues applied the flexible polyurethane foam—often used in furniture cushions—and exposed it to fire using a butane torch to determine the level of protection the compounds provided. While uncoated polyurethane foam immediately melts when exposed to flame, the foam treated with the researchers’ coating prevented the fire from damaging any further than surface level, leaving the foam underneath undamaged. “The nanobrick wall structure of the coating reduces the temperature experienced by the underlying foam, which delays combustion,” Grunlan said. “This coating also serves to promote insulating char formation and reduces the release of fumes that feed a fire.” With the research completed, Grunlan said the next step for the overall flame-retardant project is to transition the methods into industry for implementation and further development.

Phys.org, 13 February 2019

<http://phys.org>

### Scientists discover that charcoal traps ammonia pollution

2019-02-20

Cornell University scientists Rachel Hestrin and Johannes Lehmann, along with collaborators from Canada and Australia, have shown that charcoal can mop up large quantities of nitrogen from the air pollutant ammonia, resulting in a potential slow-release fertilizer with more nitrogen than most animal manures or other natural soil amendments. The results were published in Nature Communications. Ammonia is a common component

**Researchers have shown that charcoal can mop up large quantities of nitrogen from the air pollutant ammonia.**

## Gossip

## CHEMWATCH

of agricultural fertilisers and provides a bioavailable form of the essential nutrient nitrogen to plants. However, ammonia is also a highly reactive gas that can combine with other air pollutants to create particles that travel deep into the lungs, leading to a host of respiratory issues. It also indirectly contributes to climate change when excess fertiliser inputs to soil are converted into nitrous oxide, a potent greenhouse gas. In Canada, ammonia emissions have increased by 22 per cent since 1990, and 90 per cent are produced by agriculture, particularly from manures, slurries and fertiliser applications. Mitigating this pollutant—without limiting fertilisers and food growth for our growing world population—is key to a sustainable future. Charcoal, also known as fire-derived organic matter or biochar, is both a natural material found in the environment and an agricultural amendment. Recent investigation into the potential agricultural benefits of charcoal have sparked interest in its chemical properties and capacity to retain and supply essential nutrients to plants. The researchers used the Canadian Light Source at the University of Saskatchewan to examine how ammonia gas interacts with charcoal under natural conditions. According to Lehmann, “The unique end stations at CLS are great for this kind of nitrogen X-ray spectroscopy.” Hestrin and Lehmann’s study identifies charcoal’s ability to capture nitrogen from airborne ammonia through the formation of covalent bonds, which could provide a long-term slow release fertiliser for field and greenhouse crop production. Previous studies showed that these reactions occurred between ammonia and engineered carbon materials under high temperatures, but there was no evidence for ambient temperature and pressure conditions. Hestrin says that using the beamline capabilities at the Canadian Light Source was essential to this game-changing discovery and turned it into a much bigger project than originally planned. “The CLS beamline provided the best method to investigate how charcoal can retain nitrogen from ammonia. Discovering that nitrogen was retained through a variety of covalent bonds was a real game-changer in our research. It implies that nitrogen captured from compost or manure might be less susceptible to loss through leaching or volatilisation than we previously thought.” Nitrogen plays an important role in climate change, and it is present in numerous forms, some essential for living organisms, and others that are toxic or noxious gases. Providing sufficient nitrogen to crops while reducing nitrogen leaching into groundwater or gaseous emissions into the atmosphere has important environmental consequences. Currently, up to 50 per cent of the nitrogen that goes into a composting facility can be lost as ammonia gas—capturing it directly at the source could significantly cut pollution and loss of a valuable plant nutrient. Further research into this ground-breaking discovery indicates that the environmental

## Gossip

### CHEMWATCH

impact of charcoal's nitrogen capture from ammonia gas could play an important role in the global carbon and nitrogen cycles. In addition to its potential for improving agricultural nutrient management, the influences of charcoal in soils, air and water on nitrogen storage and availability in natural ecosystems should also be considered.

Phys.org, 12 February 2019

<http://phys.org>

## Curiosities

### CHEMWATCH

#### Blood sugar tied to fracture risk in type 1 diabetes

2019-02-20

People with type 1 diabetes are more likely to break a bone when their average blood sugar levels are dangerously high, a large study suggests. Researchers examined data on more than 47,000 people with diabetes, including 3,329 with type 1, the less common form, which typically develops in childhood or young adulthood when the pancreas can't produce insulin. The rest had type 2 diabetes, which is linked to obesity and aging and happens when the body can't properly use or make enough insulin to convert blood sugar into energy. All of these patients were diagnosed with diabetes in the UK between 1995 and 2015. During the study period, 672 people with type 1 diabetes and 8,859 with type 2 diabetes experienced bone fractures. For type 1 diabetics, the risk of fracture was 39 percent higher when their average blood sugar levels over time were dangerously high than it was with lower blood sugar levels, the study found. Moderately high average blood sugar didn't appear to impact the risk of fracture for these patients, however. "In patients with type 1 diabetes, it is important to have good glycaemic control, for almost everything and also to prevent fractures," said Dr. Francesc Formiga of Barcelona University. Blood sugar levels didn't appear to influence the risk of fractures for patients with type 2 diabetes. Despite this, patients with both types of diabetes should make every effort to keep their blood sugar in a healthy range, Formiga, who wasn't involved in the study, said by email. "People with high levels of sugar should be aware that it is not good for their global health or for their bones and may increase the risk of fractures, therefore they should modify their treatment, according to the recommendations of their doctors," Formiga said. Diabetes has long been linked to an increased risk of fractures, but research to date has been mixed regarding exactly what role blood sugar levels play in this risk, Dr. Christian Meier of University Hospital Basel in Switzerland and colleagues write in the *Journal of Clinical Endocrinology and Metabolism*. Several complications of diabetes may contribute to an increased risk of falls and fractures including cognitive impairment; nerve damage (neuropathy) that diminishes sensation in the feet and other extremities; and retinopathy, or eye damage that makes it harder to detect obstacles that might cause a fall. Among type 1 diabetes patients in the study, people with vascular complications like retinopathy were 29 percent more likely to experience fractures than people who didn't have these complications. Vascular complications didn't appear to influence fracture risk for people with type 2 diabetes. With type 1 diabetes, kidney failure was also associated with more than doubled odds of a fracture, the study found. The study wasn't

**People with type 1 diabetes are more likely to break a bone when their average blood sugar levels are dangerously high, a large study suggests.**

## Curiosities

### CHEMWATCH

designed to prove whether or how elevated blood sugar might impact the risk of falls or fractures in people with diabetes. One limitation of the study is that researchers didn't account for whether patients had diabetic neuropathy, said Dr. James Richardson, a professor in physical medicine in rehabilitation at Michigan Medicine in Ann Arbor who wasn't involved in the research. That factor might explain a lot of the accidents leading to bone fractures, he said. "Fall risk is markedly increased in people who cannot successfully respond to a postural perturbation (such as a trip or slip, ankle turn) in the roughly 400 milliseconds available to do so," Richardson said by email. "This requires rapid and precise information that 'reports' the perturbation," Richardson said. "This comes, primarily, from precise sensation in the feet and ankles and excellent visual acuity."

Reuters Health, 9 February 2019

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

### How the brain responds to texture

2019-02-20

Our hands and fingertips are amazingly sensitive to texture. We can easily distinguish coarse sandpaper from smooth glass, but we also pick up more subtle differences across a wide range of textures, like the slick sheen of silk or the soft give of cotton. Information about texture is transmitted from sensors in the skin and through the nerves to the somatosensory cortex, the part of the brain responsible for interpreting the sense of touch. New research by neuroscientists at the University of Chicago shows that as neurons in this part of the brain process this information, they each respond differently to various features of a surface, creating a high-dimensional representation of texture in the brain. "Objects can have textures that we can describe in simple terms like rough or soft or hard. But they can also be velvety or cottony or furry," said Sliman Bensmaia, PhD, associate professor of organismal biology and anatomy at UChicago and senior author of the study. "The variety of different adjectives you can use to describe texture just highlights that it's a rich sensory space. So, it makes sense that you need to have a rich neural space in the brain to interpret that too." The study was published in the Proceedings of the National Academy of Sciences (PNAS). Bensmaia is a leading expert on how the brain and nervous system interpret the sense of touch, including texture. In a 2013 study from PNAS, his lab showed how different kinds of nerve fibres respond to different aspects of texture. Some nerves respond mainly to spatial elements of coarse textures, like the raised bumps of a Braille letter that create a pattern when pressed against the skin. Others

**New research by neuroscientists shows that as neurons process information about texture from the skin, they each respond differently to various features of a surface, creating a high-dimensional representation of texture in the brain.**

## Curiosities

### CHEMWATCH

respond to vibrations created when the skin rubs across fine textures, like fabrics, which account for the vast majority of textures we encounter in the real world. In that study, Bensmaia and his colleagues used a rotating drum covered with strips of various coarse and fine textures, such as sandpaper, fabrics and plastics. The drum then ran the textures across the fingertips of Rhesus macaque monkeys, whose somatosensory system is similar to humans, while the researchers recorded the responses in the nerve. For the new study, led by postdoctoral scholar Justin Lieber, PhD, the researchers recorded the corresponding responses to the same textures directly from the brain, using electrodes implanted into the somatosensory cortex of the monkeys. The new data shows that the neurons respond in a highly idiosyncratic way to different aspects of texture. Some neurons respond to coarse features of a texture. Others respond to fine features, certain patterns of indentation in the skin, or any number of combinations in between. Bensmaia and Lieber identified at least 20 different patterns of response. "Some of them map onto things we understand, like roughness or the spatial pattern of a texture," Bensmaia said. "But then it becomes combinations of skin vibration coupled with patterns of skin deformation, things that are abstract and a little harder to describe." But these more abstract features of texture are what can make the difference in being able to distinguish between bedsheets with different thread counts. The researchers recorded responses to 55 different textures, and Bensmaia says he can tell which one was used just by looking at the pattern of activity it generated in the brain. "Velvet is going to excite one subpopulation of neurons more than another, and sandpaper is going to excite another overlapping population," he said. "So, it's this variety in the response that allows for the richness of the sensation." Bensmaia and Nicho Hatsopoulos, PhD, professor of organismal biology and anatomy, who studies how the brain directs movement in the limbs, have also pioneered research to build brain-controlled robotic prosthetic limbs. These devices work by implanting arrays of electrodes in the somatosensory cortex and areas of the brain that control movement. The electrodes pick up activity in neurons as the patient thinks about moving their own arm to direct the robotic arm to move accordingly. The prosthetic hand is fitted with sensors to detect sensations of touch, such as pressing on individual fingertips, which in turn generates electrical signals that stimulate the appropriate areas of the brain. Theoretically, the same techniques could recreate sensations of texture through a neuroprosthetic, but Bensmaia points out that the new study shows why this could be a challenging task. The neurons that correspond to each fingertip are located in clearly defined areas of the somatosensory cortex, so it's easier to stimulate the appropriate spot for a given touch. But

## Curiosities

### CHEMWATCH

neurons throughout the somatosensory cortex respond to texture inputs, and they're mixed together. There's no defined region of neurons that respond to sandpaper or the plastic keyboard of a laptop, for example. "It's going to be pretty challenging to be able to create textural sensations through electrical stimulation, because you don't have these monolithic groups of neurons working together," he said. "It's very heterogenous, which could make it difficult to implement in prosthetics. But that's also how we get this rich sensation of texture in the first place." The study "High-dimensional representation of texture in the somatosensory cortex of primates," was supported by the National Institute of Neurological Disorders and Stroke.

Science Daily, 7 February 2019

<http://www.sciencedaily.com>

### **New heated tobacco device causes same damage to lung cells as e-cigs and smoking, study finds**

2019-02-20

A new study that directly compares new heated tobacco devices with vaping and traditional cigarettes shows that all three are toxic to human lung cells. The study published in ERJ Open Research suggests that the new device, which heats solid tobacco instead of an e-liquid, is no less toxic to the cells than ordinary cigarette smoke. Researchers say the study adds to evidence that these newer electronic nicotine delivery devices may not be a safer substitute for cigarette smoking. The study was led by Dr Pawan Sharma, a researcher at the University of Technology Sydney and the Woolcock Institute of Medical Research, Sydney, Australia. He said: "Smoking is the leading cause of preventable death, and with the introduction of e-cigarettes in the last decade, the trend of nicotine uptake is not going to slow down in the near future. If the current trend continues, tobacco use will cause more than eight million deaths annually by 2030 around the world." "The latest addition in this emerging trend is the planned and vigorous introduction of heated tobacco devices. They are commonly called next generation or heat-not-burn products. We know very little about the health effects of these new devices, so we designed this research to compare them with cigarette smoking and vaping." Researchers tested the effects of all three nicotine sources on two types of cells taken from the human airways: epithelial cells and smooth muscle cells. In healthy lungs, epithelial cells act as the first line of defence to any foreign particles entering the airway while smooth muscle cells maintain the structure of the airway. However, smoking can lead

**A new study that directly compares new heated tobacco devices with vaping and traditional cigarettes shows that all three are toxic to human lung cells.**

## Curiosities

### CHEMWATCH

to difficulty in breathing primarily by hampering the normal functions of these cells. Dr Sharma and his team exposed the cells to different concentrations of cigarette smoke, e-cigarette vapour and vapour from a heated tobacco device, and measured whether this was damaging to cells and whether it affected the cells' normal functions. The researchers found that cigarette smoke and heated tobacco vapour were highly toxic to the cells both at lower and higher concentrations while e-cigarette vapour demonstrated toxicity mainly at higher concentrations. Researchers say that these concentrations represent the levels of nicotine found in chronic smokers. Dr Sukhwinder Sohal, a researcher at the University of Tasmania, Launceston, Australia, and leading author on the study, said: "We observed different levels of cellular toxicity with all forms of exposures in human lung cells. What came out clearly was that the newer products were in no way less toxic to cells than conventional cigarettes or e-cigarette vaping." Dr Sharma added: "Our results suggest that all three are toxic to the cells of our lungs and that these new heated tobacco devices are as harmful as smoking traditional cigarettes. "It took us nearly five decades to understand the damaging effects of cigarette smoke and we don't yet know the long-term impact of using e-cigarettes. These devices that heat solid tobacco are relatively new and it will be decades before we will fully understand their effects on human health. "What we do know is that damage to these two types of lung cells can destroy lung tissue leading to fatal diseases such as chronic obstructive pulmonary disease, lung cancer and pneumonia, and can increase the risk of developing asthma, so we should not assume that these devices are a safer option." Dr Sharma hopes his results will stimulate more research on heated tobacco devices and he plans to continue this work by studying the effects of nicotine devices on more sophisticated models of lung tissue and in mice. Professor Charlotta Pisinger is Chair of the European Respiratory Society's Tobacco Control Committee and was not involved in the research. She said: "These new heated tobacco devices are marketed as producing 95% lower levels of toxic compounds because the tobacco is heated, not burned. However, the first independent studies have shown that combustion is taking place and toxic and carcinogenic compounds are released, some in lower levels than in conventional cigarette smoke, others in higher levels. A review of the tobacco industry's own data on these devices has shown that, in rats, there is evidence of lung inflammation, and there is no evidence of improvement in lung inflammation and function in smokers who switch to heated tobacco. "The introduction and vigorous marketing of new devices is very tempting to smokers who want to stop smoking and mistakenly believe they can switch to another harmless tobacco product. It is also opening another avenue for attracting young people to use and become

## Curiosities

### CHEMWATCH

addicted to nicotine. This study adds to evidence that these new devices are not the safe substitute to cigarette smoking they are promoted to be.”

Science Daily, 11 February 2019

<http://www.sciencedaily.com>

### Spelling bees? No, but they can do arithmetic, say researchers

2019-02-20

Honeybees can learn to add and subtract, according to research showing that while the insects have tiny brains, they are still surprisingly clever. Researchers behind the study have previously found that honeybees can apparently understand the concept of zero, and learn to correctly indicate which of two groups of objects is the smaller. But now they say insects can learn to carry out exact numerical calculations such as adding and subtracting a given number. “Their brain can manage a long-term rule and applying that to a mathematical problem to come up with a correct answer,” said Dr Adrian Dyer, co-author of the research from RMIT University in Australia. “That is a different type of number processing to spontaneous quantity judgments.” If the team are right, the insects are in good company. While it was once thought that only humans could manage such calculations, the authors note recent research has revealed a veritable menagerie of creatures can keep track of numbers or even add or subtract. “[There was] evidence that other primates could do it and then an African grey parrot, Alex, famously could do it, but also some spiders could do it,” said Dyer. The team say the latest research adds to a growing body of evidence, including human studies, that language is not necessary for learning how to manipulate numbers. And there’s more. “It is teaching us a lot about what brains can do and what necessary structures you might need in brains to achieve certain outcomes,” said Dyer. However, Paul Graham, professor of neuroethology at the University of Sussex, was cautious, and said it was not clear that the bees really did have a concept of mathematical operations, or even numbers. “In reality, you don’t really know what the animal has done, because you are not investigating how it is doing it,” he said, adding it was hard to design an experiment to rule out other, simpler explanations for the bees’ behaviour. Writing in the journal *Science Advances*, Dyer and colleagues describe how their research involved releasing bees into a simple maze in which they were shown a picture of a small number of coloured shapes. After flying through a hole, the bees were presented with two further images showing a different number of shapes. When the shapes in the set up were blue, insects that

**Study says honeybees can learn to carry out exact numerical calculations**

## Curiosities

### CHEMWATCH

made a beeline for the image with one more shape than in the initial picture were offered a sugary drink. When the shapes were yellow, they were rewarded for flying to the image with one fewer shape. If the bee flew to the “incorrect” image, they were given a quinine solution – which is unpleasant to bees. “It is very hard to train a bee to understand a plus or minus sign because that is an abstract symbol, so we use colour because they learn colour very quickly,” said Dyer. Fourteen bees were involved in the experiment and each completed 100 of the training exercises, with the shapes and numbers – up to a maximum of five – chosen at random from a pool of possibilities. Each bee was then tested 10 times on two different scenarios for each colour. Crucially, the first image the bees saw in the test setups contained three shapes. Neither the number nor the particular shape used had been presented to the bees as the initial picture during training, meaning they could not choose the “correct” answer from memory. The results showed that the bees did better on the tests than chance, getting the correct answers between 64% and 72% of the time, depending on the test. “It is not that every bee could do this [spontaneously], but we could teach them to do it,” said Dyer. Dyer said the prevalence of numerical competence across the animal kingdom was “suspicious”, leading him to believe it might be a widespread phenomenon in animals that aids survival. However, he added it was difficult to test this, and said there was an alternative explanation – the real phenomenon is the ability to make associations and solve conundrums, rather than have or acquire numerical skills per se. “It might be they don’t actually use this in any natural context. They just have a brain which is plastic enough to learn our problem,” he said. “Not everything we do [as humans] is essential to our survival in [terms of] evolution: playing a guitar, surfing and travelling into space are all things we can do because we have a lot of neural flexibility, we are really bright ... honeybees have been around a long time and they are very good at surviving in different environments and coming up with novel solutions, and maybe that has just led to a brain that can learn this task if they need to.”

The Guardian, 6 February 2019

<http://www.guardian.com>

## To Stop Mosquitoes From Biting, Scientists Put Them on Diet Pills

2019-02-20

Keeping mosquitoes at bay is a task that scientists have been buzzing about for quite some time now. Not only because the pests can be a

## Curiosities

### CHEMWATCH

nuisance, but also because they can transmit terrible diseases like West Nile Virus and Malaria. The quest to fend off the hungry swarms has led scientists to some innovative solutions — including the recent discovery that human diet pills can curb the appetites of some mosquitoes. The research, detailed in a new study published in the prestigious journal *Cell* by a team of researchers from Rockefeller University, examined the *Aedes aegypti* mosquitoes, which are the principle spreader of dengue fever throughout South America, Africa, and the Eastern United States. Female *Aedes aegypti* mosquitoes are driven to feed on human blood in order to acquire a protein they need to lay their eggs. But the researchers found that giving the mosquitoes a saline solution containing human diet drugs left the mosquitoes feeling full and without an appetite — similarly to how the drugs would work in humans. Although the study didn't specify which drug or drugs were used specifically, it did say that the diet pills work by suppressing the Neuropeptide Y (NPY) receptors responsible for diet regulation in humans, and mosquitoes apparently. By analysing the mosquitoes' NPY receptors, the researchers were able to determine which ones were affecting their diet, meaning they could reproduce similar effects by interfering with those NPY receptors without the use of human diet drugs. The study has huge implications for new ways to control pest populations. Understanding ways to curb the insects' appetites would reduce the need for insecticides, which many insects are developing immunity to and which have been tied to the deaths of both birds and bees. New population control methods would also offer alternatives to controversial gene drives, which destroy populations entirely. "We're starting to run out of ideas for ways to deal with insects that spread diseases," the study's senior author, Leslie Vosshall, told the BBC, "and this is a completely new way to think about insect control."

Futurism, 8 February 2019

<https://futurism.com>

## Your home is a hidden source of air pollution

2019-02-20

Indoor Air Quality (IAQ) refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. A new study by the University of Colorado Boulder suggests that cooking, cleaning and other regular home activities create the level of critical and unstable chemical particles in the average home, thereby increasing the level of indoor air quality equivalent to the polluted major city. Airborne chemicals that are produced inside a home are not

**The relative importance of chemicals in pesticides, coatings, printing inks, adhesives, cleaning agents, and personal care products has increased.**

## Curiosities

### CHEMWATCH

there: Volatile organic compounds (VOC) from products such as shampoo, perfume, and cleaning solutions eventually get out and contribute to the production of ozone and fine particles, which is a big source at the global level air pollution than cars and trucks. Marina Vance, an assistant professor of mechanical engineering at CU Boulder said, "Homes have never been considered an important source of outdoor air pollution and the moment is right to start exploring that. We wanted to know: How do basic activities like cooking and cleaning change the chemistry of a house?" In 2018, Marina Vance co-drove the community HOMEChem field campaign, which utilised propelled sensors and cameras to screen the indoor air quality of a 1,200-square-foot manufactured home on the University of Texas Austin grounds. Through the span of a month, Vance and her partners directed an assortment of everyday family exercises, including cooking a full Thanksgiving supper amidst the Texas summer. While the HOMEChem investigation's outcomes are as yet pending, Vance said that it's obvious that homes should be very much ventilated while cooking and cleaning, in light of the fact that even fundamental assignments like boiling water over a stovetop fire can add to abnormal amounts of vaporous air toxins and suspended particulates, with negative health impacts. To her group's astonishment, the measures indoor concentrations were sufficiently high that their touchy instruments should have been recalibrated very quickly. Vance said, "Even the simple act of making toast raised particle levels far higher than expected. We had to go adjust many of the instruments." Joost de Gouw, a CIRES Visiting Professor said, "Indoor and outdoor experts are collaborating to paint a more complete picture of air quality." "Many traditional sources like fossil fuel-burning vehicles have become much cleaner than they used to be. Ozone and fine particulates are monitored by the EPA, but data for airborne toxins like formaldehyde and benzene and compounds like alcohols and ketones that originate from the home are very sparse." While de Gouw says that it is too early on in the research to make recommendations on policy or consumer behaviour, that it's encouraging that the scientific community is now thinking about the "esosphere," derived from the Greek word 'eso,' which translates to 'inner.' "There was originally scepticism about whether or not these products actually contributed to air pollution in a meaningful way, but no longer. Moving forward, we need to re-focus research efforts on these sources and give them the same attention we have given to fossil fuels. The picture that we have in our heads about the

## Curiosities

### CHEMWATCH

atmosphere should now include a house."The study results are published in the journal Science.

Tech Explorist, 18 February 2019

<https://www.techexplorist.com>

### The battle against bugs: it's time to end chemical warfare

2019-02-20

Insects are important wildlife often overlooked in urban habitats. What we do notice are the cockroaches, ants and mosquitoes in and around our homes. All too often we reach for the insect spray. But not all insects are pests – a wide variety of them help keep our cities healthy. They pollinate plants, feed other wildlife, recycle our rubbish, and eat other insect pests. Insects are vital to our well-being. Unfortunately, like many other wild animals, insects are under threat. A recent study warned that 40% of the world's insect species face the prospect of extinction, amid threats such as climate change, habitat loss, and humanity's overenthusiastic use of synthetic chemicals. Australians use large amounts of pesticides to tackle creepy crawlies in their homes and gardens. But our fondness for fly spray has potentially serious impacts on urban ecosystems and public health. We need a more sustainable way to deal with urban insect pests. Our recently published article in the Journal of Pest Science outlines some of the ways to do it.

#### What's wrong with pesticides anyway?

Since becoming publicly available in the 1950s, insect sprays have been a popular way to deal with cockroaches, flies, moths, and ants around the home and backyard, and are also widely used by local councils to keep pests at bay. But what may have been effective in the past won't necessarily work in the future, or may have unintended consequences. Many pests, such as mosquitoes, are now becoming resistant to commonly used products. In parts of the world affected by diseases such as dengue, this jeopardises our ability to control outbreaks. Another, perhaps wider, problem is that indiscriminate use of insecticides can kill more than just pests. Many species on which we rely for keeping our backyard gardens, bushland, wetlands and parks healthy can become collateral damage. This includes predatory species that can themselves help keep pests under control. As pest species often reproduce faster than their predators

**A recent study warned that 40% of the world's insect species face the prospect of extinction, amid threats such as climate change, habitat loss, and humanity's over-enthusiastic use of synthetic chemicals.**

## Curiosities

### CHEMWATCH

(a pattern that's likely to be reinforced by climate change), we can get trapped in a cycle in which pest numbers bounce back higher than ever.

#### How do we do things differently?

Fortunately, there are alternatives to chemical pest control that don't harm your household or the environment. For centuries, sustainable agriculture systems have used environmentally friendly approaches, and city-dwellers can take a leaf from their books. Integrated pest management is one such sustainable approach. It focuses on prevention rather than treatment, and uses environmentally friendly options such as biological control (using predators to eat pests) to safeguard crops. Chemical insecticides are used only as a last resort. There are many other farming practices that support sustainable pest control; these focus on behavioural change such as keeping areas clean, or simple physical controls such as fly mesh or netting around fruit trees. Adopting these methods for urban pest control isn't necessarily straightforward. There might be local regulations on particular pest control activities, or simply a lack of knowledge about urban pest ecology. For urgent pest situations, it may be more expensive and time-consuming to set up a biological control program than to arrange the spraying of an insecticide. Insecticides take effect immediately, whereas biological control takes longer to have an effect. Prevention, the cornerstone of integrated pest management, requires careful planning before pests become a nuisance. The goal of integrated pest management is not to eliminate insect pests entirely, but rather to reduce their numbers to the point at which they no longer cause a problem. By this logic, chemical insecticides should only be used if the economic damage caused by the pests outweighs the cost of the chemicals. If you hate the idea of a single cockroach living anywhere nearby, this might require you to adjust your mindset.

#### What can I do at home?

Don't give pests opportunities. Be mindful of how we produce and dispose of waste. Flies and cockroaches thrive in our rubbish, but they can be effectively managed by ensuring that food waste is stored in insect-proof containers, recycled, or properly disposed of. Don't leave buckets of water around the backyard, as this invites mosquitoes to breed. Don't open your door to pests. Seal cracks and crevices in the outside of your house, and ensure there are screens on your doors and windows. Support the animals that control insect pests – they'll do the hard work for you! In particular, don't be so quick to kill spiders and wasps, because they prey on pests in your home and garden.

## Curiosities

### CHEMWATCH

#### What can we do as a community?

Urban communities can learn a lot from sustainable farming. First, there needs to be better education and support provided to the public and policy makers. Workshops run by local councils and information sessions with local gardening groups are a great way to start. We can also work together to help debunk the popular myth that most insects are damaging or unwanted pests. Reaching for the fly spray might be easy, but remember you may end up killing friends as well as foes.

The Conversation, 18 February 2019

<http://www.theconversation.com>

#### **9 Ways to Cut Down on Plastic**

2019-02-20

Drowning in plastic, but not sure how to set yourself free? Plastic purgers say you can drastically reduce, if not eliminate, your plastic consumption by changing a few daily habits. Here are nine steps to get you started.

##### 1. Carry a reusable bag.

This is Plastic-Free-Living 101. Take a cloth bag to the grocery store, farmers' market, drugstore and anywhere else you may be given a plastic bag.

##### 2. Use plastic-free containers.

Glass or metal jars can be used to store grains, nuts, flour and other foods, as well as laundry detergent, dish soap and body creams. But don't automatically purge all of your plastic containers; that creates unnecessary waste.

##### 3. Pack a travel kit.

Bamboo cutlery and a nonplastic food tray, straw and water bottle will eliminate the need for most single-use plastics while on-the-go. "Restaurants and vendors all over the world are getting much more used to people bringing their own containers," said Jay Sinha, a founder of Life Without Plastic, an online store.

##### 4. Buy in bulk.

To avoid food packaging, shop the bulk aisle at the market and bring your own glass containers. Weigh the jar beforehand to avoid being overcharged.

**Drowning in plastic, but not sure how to set yourself free? Plastic purgers say you can drastically reduce, if not eliminate, your plastic consumption by changing a few daily habits.**

## Curiosities

### CHEMWATCH

#### 5. Buy used items.

Some household plastic is unavoidable, especially in modern appliances. So, until they make an all-metal vacuum cleaner, Beth Terry, who writes the blog *My Plastic-free Life*, suggests buying secondhand, through Craigslist or at a thrift shop. "I'm not buying new plastic," she said. "I'm also avoiding the packaging."

#### 6. Recycle "good" plastics.

Clear plastic bottles, bottles for shampoos, yogurt containers, toys and reusable food containers have a higher probability of being recycled. Disposable cutlery, cling wrap and coffee cups and lids have very low probability.

#### 7. Wear natural clothes.

Synthetic fibres from clothing "are an enormous plastic pollution problem," said Mr. Sinha, because they are a key contributor to microplastic pollution. Choose clothing made of fabrics like cotton, wool, hemp and silk.

#### 8. Make your own.

With so many toiletries packaged in plastic, Chantal Plamondon, a founder of *Life Without Plastic*, became a home chemist. "We make our own toothpaste out of baking soda, coconut oil and essential oils," she said. "We make body creams out of coconut or macadamia oil."

#### 9. Do without.

If it's plastic or nothing, you can always choose nothing.

New York Times, 16 February 2019

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

### Explainer: cadmium in chocolate

2019-02-20

Cadmium is toxic to humans. Currently, the average exposure to cadmium in Europe is close to or slightly above what is deemed safe for health. In January, the European Union introduced limits on cadmium in chocolate. So, what are the rules, and why are things changing?

Why is the EU concerned about cadmium?

**The EU has set new limits on the heavy metal in your food**

## Curiosities

### CHEMWATCH

Cadmium is toxic to kidneys. It can also cause mineral loss in bones and is linked to cancer in the kidneys, lung, bladder and breast. The metal tends to stay in the liver and kidneys, with a very long biological half-life (the time it takes for half of the amount to leave the body) of 10–30 years. In Europe around 90% of cadmium exposure in non-smokers comes from diet, mostly from potatoes, breads, bakery goods, chocolate products and leafy vegetables. Countries in the EU sample and analyse products to verify that cadmium concentrations do not exceed the maximum levels set down in EU legislation. The European Food Safety Association (EFSA) recommends a tolerable weekly intake of 2.5µg/kg. Currently, the average weekly exposure is around 2µg/kg in adults, but around 3.9µg/kg in children and 4.9µg/kg in toddlers. The limits are thus being lowered to cut down exposure.

So, what are the limits?

These vary depending on the foodstuff. Maximum levels are in place for foods such as cereals, vegetables, meat, fish and nutritional supplements. More stringent levels for baby food came into force in 2015. Previously chocolate products didn't have a cadmium limit; from 1 January this changed. Four upper limits for cadmium in chocolate are to be enforced. The strictest applies to chocolate usually consumed by children (0.1mg/kg), while darker chocolate has higher maximum levels (0.8mg/kg). Regulation was delayed for five years to allow producing countries and the chocolate industry to prepare.

How does cadmium get into chocolate?

Cadmium is in soil, and so gets absorbed by roots of cacao trees, from which it travels to the plant's leaves and beans. The more acidic a soil, the more cadmium available for roots. Most cadmium originates from weathered bedrock, so geology helps decide how much may end up in a chocolate bar. For example, some South American countries have volcanic soil and their cacao beans tend to have higher concentrations than cacao grown in say West Africa. Cacao trees accumulate cadmium quite efficiently, so levels in beans and powder can be relatively high. How well supplied the plant is with micronutrients, especially zinc, also matters. Research suggests cacao genetics plays a role – different cultivars of cacao are more or less prone to suck up cadmium. Not all cadmium levels are down to nature. There are anthropogenic sources of cadmium in soil, including urban pollution, mining and the use of phosphate fertiliser.

Is there a way for producers or chocolate makers to minimise cadmium getting into chocolate?

## Curiosities

### CHEMWATCH

Larger chocolate manufacturers can blend beans from different areas and dilute them with other ingredients. However, this is more challenging for single origin chocolate makers, however. Growers can increase soil pH by adding lime, which will reduce cadmium uptake by trees. Adding zinc to soil also helps. Plant varieties less prone to taking up cadmium can also be grown, and some advocate breeding cultivars disinclined to take up cadmium. Microbial cocktails that might immobilise the heavy metal are also in development.

Chemistry World, 14 February 2019

<https://www.chemistryworld.com/>

### Will Eating Nuts Make You Gain Weight?

2019-02-20

The Australian Dietary Guidelines recommend we eat 30 grams (1 ounce) of nuts – a small handful – each day. But many of us know nuts are high in calories and fat. So, should we be eating nuts or will they make us gain weight? In short, the answer is yes, we should eat them, and no, they won't make us gain weight if eaten in moderate amounts. The fats in nuts are mostly the "good" fats. And aside from that, our bodies don't actually absorb all the fat found in nuts. But we do absorb the nutrients they provide.

#### Dietary fat: friend or foe?

Nuts do contain fat, and the amount of fat varies between nut types. For example, a 30g serving of raw cashews or pistachios contains around 15g of fat (0.5 ounces), whereas the same amount of raw macadamias contains around 22g of fat (0.7 ounces). There are different kinds of fats in our diet and some are better for us than others. Nuts contain mainly monounsaturated and polyunsaturated fats. These types of fats are known as "good fats". They can help lower cholesterol when we eat them in place of saturated fats. The type of fats present varies between nuts. For example, walnuts are rich in polyunsaturated fats, whereas other types of nuts such as hazelnuts and macadamias have more monounsaturated fat.

#### What the evidence says

Even if the type of fat in nuts is good for us, they are still high in fat and calories. But this doesn't mean we should be avoiding them to manage our weight. Studies that looked at people's eating habits and body weight over a long period have found people who regularly eat nuts tend to gain less weight over time than people who don't. We see a similar pattern in

## Curiosities

### CHEMWATCH

clinical studies that asked people to include nuts in their diets and then looked at the effects on body weight. A review of more than 30 studies examined the effects of eating nuts on body weight. It did not find people who ate nuts had increased their body weight, body mass index (BMI), or waist circumference, compared to a control group of people who did not eat nuts. In fact, one study found that when people ate a pattern of food aimed at weight loss, the group of people who ate nuts lost more body fat than those who didn't eat nuts.

#### Let's nut this out

There are several possible explanations for why eating nuts doesn't seem to lead to weight gain.

- We don't absorb all of the fat in nuts: The fat in nuts is stored in the nut's cell walls, which don't easily break down during digestion. As a result, when we eat nuts, we don't absorb all of the fat. Some of the fat instead is passed out in our faeces. The amount of calories we absorb from eating nuts might be between 5 percent and 30 percent less than what we had previously thought.
- Nuts increase the amount of calories we burn: Not only do we not absorb all the calories in nuts, but eating nuts may also increase the amount of energy and fat we burn. It's thought this may partially be explained by the protein and unsaturated fats in nuts, although we don't yet know exactly how this occurs. Increases in the number of calories burnt can help us maintain or lose weight.
- Nuts help us feel full for longer: As well as fat, nuts are rich in protein and fibre. So, nuts help to keep us feeling full after we eat them, meaning we're likely to eat less at later meals. Recent studies have also suggested providing people with nuts helps improve the overall quality of the types of foods they eat. This may be because nuts replace "junk foods" as snacks.
- People who eat nuts have healthier lifestyles in general: We can't rule out the idea that eating nuts is just a sign of a healthier lifestyle. However, randomised controlled trials, which can control for lifestyle factors like eating habits, still find no negative effect on body weight when people eat nuts. This means the favourable effects of nuts are not just the result of nut eaters having healthier lifestyles – the nuts themselves play a role.

Overall, the evidence suggests nuts are a healthy snack that can provide us with many of the nutrients our bodies need. We can confidently include

## Curiosities

### CHEMWATCH

the recommended 30g of nuts a day in a healthy diet, without worrying about the effect they will have on our waistlines.

Science Alert, 18 February 2019

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

### How Many Push-Ups You Can Do Could Predict Your Risk of Heart Disease

2019-02-20

Scientists have identified what they think could be a simple, practical test to predict people's heart health, and it's about as quick as saying, "Drop and give me 40". In a new study led by Harvard University, researchers found that men's ability to do more than 40 push-ups was linked with significantly reduced risk of serious heart problems over the next 10 years – in some cases slashing risk by as much as 96 percent. "Our findings provide evidence that push-up capacity could be an easy, no-cost method to help assess cardiovascular disease risk in almost any setting," says occupational medicine resident Justin Yang from the Harvard T.H. Chan School of Public Health. "Surprisingly, push-up capacity was more strongly associated with cardiovascular disease risk than the results of submaximal treadmill tests." Of course, the ability to do 40 push-ups in the first place is generally indicative of a high level of physical fitness – especially among middle-aged men, which is what the group the researchers were studying. So, it's not exactly news that being physically fit reduces your risk of cardiovascular disease (CVD) events – such as heart attacks and developing coronary artery disease. But what's new and useful here is the ability to predict these kinds of health problems with such a simple, universal test – and with what looks to be greater accuracy than expensive equipment like treadmills. Not that the results we have now necessarily apply to everyone. In the study, Yang and his team studied a relatively niche cohort: 1,104 active male firefighters, with an average age of 39.6 at the beginning of the study. These participants were observed over the space of a decade. During the 10-year study, 37 of these men experienced CVD-related outcomes, such as heart failure, sudden cardiac death, or receiving a diagnosis of coronary artery disease. What's interesting, though, is that of all those 37 men, all but one were participants who weren't able to complete over 40 push-ups in their baseline physical exam at the outset of the study. Broadly speaking, the team observed lower CVD risks in all groups with higher push-up capacity, but if you could do above 40 push-ups (out of a maximum 80 in the baseline test), the results put you in a much healthier place compared to those whose capacity is low.

**In a new study led by Harvard University, researchers found that men's ability to do more than 40 push-ups was linked with significantly reduced risk of serious heart problems over the next 10 years**

## Curiosities

### CHEMWATCH

“Participants able to complete more than 40 push-ups had a 96 percent reduction in incident CVD events compared with those completing fewer than 10 push-ups,” the authors write in their paper. It’s worth noting that male firefighters aren’t representative of other segments of society as a whole, so the results seen here wouldn’t necessarily be reproduced in other people, which the researchers acknowledge. But it’s still a finding that bears further consideration in follow-up studies, especially since gauging push-up capacity is such a relatively easy clinical test for health professionals to conduct with patients who are physically able to undergo it. “The push-up examination requires no special equipment, is low cost or no cost, can easily be performed in almost any setting within 2 minutes, and provides an objective estimate of functional status,” the authors explain. “It is a quantitative measurement that is easily understood by both the clinician and the patient.” If clinicians adopt the findings, it could be a simple adjustment to physical examinations of patients that are already testing fitness levels. The adjustment may be simple – and the science may be obvious – but that doesn’t mean the takeaways wouldn’t potentially be life-saving. “Push-up capacity is positively correlated with aerobic capacity and physical fitness,” senior author of the study and CVD specialist, Stefanos Kales, told Inverse. “These types of objective functional markers are generally good predictors of mortality.” The findings are reported in JAMA Network Open.

Science Alert, 18 February 2019

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

## Here’s What Happened When an Alaskan City Took Fluoride Out of Their Drinking Water

2019-02-20

Despite what dentists keep telling us about the protective effects of fluoride on people’s teeth, virulent myths insisting otherwise somehow manage to persist. These kinds of mistaken beliefs might be false, but their consequences are very real. Like when, in 2007, the people of Juneau, the capital of Alaska, voted to stop putting fluoride in their drinking water, over concerns about what harms it might be doing to them. The decision, coming after years of debate in Juneau between dentists and other groups, resulted in a massive, immediate change in public health policy for the city and borough’s residents. But while research into the benefits of water fluoridation has existed for decades – and suggests fluoride reduces cavities (aka caries) and associated dental disease – less is known about the effects of fluoride cessation. In other words, what happens

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## Curiosities

### CHEMWATCH

when a population suddenly stops taking fluoride in their drinking water, like Juneau's citizenry did? Now, thanks to a recent study led by first author and public health researcher Jennifer Meyer from the University of Alaska Anchorage, we've got new insights into the subsequent effects. In the study, Meyer assessed Medicaid dental claim billing records for two groups of children and adolescents aged 18 or under. One of these groups represented what the researchers call "optimal" community water fluoridation (CWF) exposure: 853 non-adult patients on behalf of whom Medicaid dental claims were filed in 2003, years before the fluoride cessation began in 2007. The other group was made up of 1,052 non-adult patients from families who similarly met Medicaid income requirements, and who made the same kind of dental claims almost a decade later, in 2012. Of course, that's five years after the fluoride was taken out of Juneau's tap water, so that group represents what the researchers describe as "suboptimal CWF conditions". That time gap resulted in a statistically significant difference in children's cavity levels, the researchers say. "By taking the fluoride out of the water supply... the trade-off for that is children are going to experience one additional caries procedure per year, at a ballpark (cost) of US\$300 more per child," Meyer explained to KTOO News. Those figures are based on the youngest children assessed in the study, aged under six years of age. Among those patients, kids who were exposed to fluoride in their tap water had on average 1.55 caries procedures annually – but this jumped to 2.52 procedures annually for the children in the suboptimal group. The effect was more subtle for age groups older than the 0 to <6 age group, but nonetheless, every age group analysed in the study (0 to <6, 0 to <7, 7 to <13, 13 to 18, and 0 to 18) experienced higher levels of cavity procedures if they didn't have fluoride in their drinking water. It's not known for sure why the cessation demonstrated less of an effect on older children, but the researchers suggest the older kids in the suboptimal cohort may have received a partial protective effect from any fluoride exposure when they were younger (ie. before 2007, when the fluoride ban kicked in). "Previous research indicates that without the presence of optimal levels of fluoride in drinking water, and thus in the mouth and saliva, teeth may form with weaker enamel and lack the ability to remineralise early signs of decay," the authors explain in their paper. "We expected to observe more significant impacts among patients with the lowest exposure to optimal CWF." Of course, more cavities necessitating dental procedures means more money is needed to fix the damaged teeth. After adjusting for inflation, those increased costs represented anywhere between a 28 percent to a 111 percent jump for the various age groups, with the maximum increase being just over \$300 annually for children in the 0 to <6 age group

## Curiosities

### CHEMWATCH

who grew up with suboptimal CWF exposure. Basically, according to the researchers, the cessation was a very expensive move. "The cost to have a fluoride management program, to actually fluoridate the water, is pennies by comparison to what it costs to treat a cavity," Meyer told KTOO, pointing out that voluntary alternatives like pharmacy fluoride tablets can also prevent decay, but come with their own problems. "I think that's a great option for people, but it's also a headache. You gotta get the prescriptions filled, you gotta remember to give it, you've gotta make sure kids don't take more than one – you know, there's risks to that... It sets up a precedent for inequity." It's unknown whether the latest findings will be enough to sway the minds of other local city assemblies considering enacting their own fluoride bans – but for those who do the actual science, the science on fluoride remains perfectly clear. "These results support current evidence that even in modern conditions with widely available fluoride toothpaste, rinses, and professionally applied prophylaxis, CWF is associated with population benefits," the authors write, "including cost effectiveness and caries prevention." The findings are reported in BMC Oral Health.

Science Alert, 15 February 2019

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

### Why sparks fly when you microwave grapes

2019-02-20

YouTubers have gone grape crazy. In a plethora of internet videos, kitchen scientists have cut a grape almost in half—leaving just a strip of skin connecting the two sides—and stuck it in the microwave. In seconds, sparks erupt. Now, physicists think they know why this happens. Here's the common explanation: water-heavy grapes trap the wavelengths of energy microwave ovens emit because the waves are roughly the same size as the diameter of grapes. That energy starts charging up electrolytes inside the fruit, which then flow from one half of the grape to the other—using the strip of skin like an electrical wire and gaining energy as they go. The current quickly burns through the skin, causing the charged electrolytes to try to jump from one half of the grape to the other, supercharging the surrounding air into a bright flare of plasma—the same light-emitting state of matter responsible for the sun's rays and fluorescent lighting. To test this hypothesis, the researchers put grapes into microwaves and watched what unfolded with thermal cameras. Early on, the scientists found that a pair of grapes could also produce plasma, as long as they were kept within 3 millimetres of each other. If grapes can produce plasma

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## Curiosities

### CHEMWATCH

without the skin strip, the researchers say, then the energy that produces the plasma must build up another way. The thermal cameras revealed a hotspot between the grapes from a build-up of electromagnetic energy—not inside the grapes where the internet’s explanation would predict. This led the physicists to a new explanation: When two grapes are close to each other in a microwave, the waves they absorb bounce back and forth in the tiny space between them, creating an increasingly powerful electromagnetic field. This continues until the electromagnetic field becomes so powerful that it supercharges nearby electrolytes that then shoot out in a brief explosion of fiery plasma, the researchers report today in *Proceedings of the National Academy of Sciences*. Aside from damaging microwave ovens, the authors say their findings could, with the right materials, one day be extended to trap and concentrate visible wavelengths of light for use in nano-scale microscopy.

Science, 18 February 2019

<http://sciencemag.org/>

### Reality check: Can cat poop cause mental illness?

2019-02-20

Alert! “Cats Can Literally Make You Crazy.” Wait! “Cats Don’t Cause Mental Illness.” The news headlines are as alarming as they are contradictory. All refer to *Toxoplasma gondii*, a brain parasite carried by our feline companions that infects roughly one in three people. Scientists have long hypothesized that *T. gondii* plays a role in mental illness, including schizophrenia. But though more than 100 studies have found a correlation, none has shown that the parasite actually causes mental illness. So, what’s really going on? Here’s what you need to know:

How do humans get infected?

*T. gondii* is not a bacterium or a virus, but a single-celled microscopic organism distantly related to the parasite that causes malaria. Cats get *T. gondii* and the disease it causes, toxoplasmosis, by eating infected rodents, birds, and other animals. Estimates suggest about 40% of cats in the United States are infected; most don’t show any symptoms, but they can develop jaundice or blindness and experience personality changes if the parasite spreads to the liver or nervous system. In the first few weeks after infection, a cat can shed millions of hardy egg pods called oocysts into its litterbox each day. Although some people get toxoplasmosis from direct contact with domestic cats and cat faeces, many more are infected when oocysts shed by cats make it into the soil and water, where they can

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## Curiosities

### CHEMWATCH

survive for a year or longer. Only about 11% of people are infected with *T. gondii* in the United States, though rates are much higher in regions where people eat more raw meat or sanitation is poor; for example, infection rates exceed 90% in some parts of Europe and South America. In healthy people, toxoplasmosis often causes a flulike illness or no symptoms at all. But it can occasionally be dangerous—or even fatal—in those with weakened immune systems. Antibiotics can treat the infection, though drugs may not completely banish the parasite.

Why do scientists think toxoplasmosis could cause mental illness?

Most of the evidence comes from rodents, which develop bizarre behaviours when infected with *T. gondii*. They lose their fear of the smell of cat urine, in some cases walking right into the jaws of waiting felines. Scientists think *T. gondii* alters brain function by forming cysts in regions that process fear and decision-making. The cysts may also affect behaviour by ramping up levels of dopamine, a neurotransmitter involved in reward and risk-taking. There's some evidence that *T. gondii* can rewire the brain permanently, making mice unafraid of cats even long after the parasite has been cleared. *T. gondii* also forms cysts inside human neurons. In people with HIV or other immune-weakening conditions, the cysts can grow and replicate, causing deadly brain inflammation, dementia, and psychosis. Although scientists have long assumed the cysts are benign in healthy people, a growing body of data suggests *T. gondii* infection can alter personality and increase the chance of developing schizophrenia and other mental illness. Even without directly infecting the brain, a chronic *T. gondii* infection can ramp up inflammation, and inflammation has been linked to mental disorders such as schizophrenia, autism, and Alzheimer's disease.

How strong is the evidence that this happens in people?

Here's where things get tricky. Although the mechanistic hypothesis for how toxoplasmosis could cause mental illness is "very compelling," it's extremely difficult to test in a human population, says Karen Sugden, a geneticist at Duke University in Durham, North Carolina. In a 2016 study, Sugden found that 200 New Zealanders infected with *T. gondii* didn't have significantly higher odds of schizophrenia or any other mental disorder. But she says the study doesn't prove that the parasite has no link to mental illness. Schizophrenia usually doesn't emerge until the late teens or 20s. To find out if toxoplasmosis causes schizophrenia, Sugden says one would have to know if participants were exposed to *T. gondii* as children or teens—before they developed a mental illness. But her study

## Curiosities

### CHEMWATCH

only tested for the parasite at age 38, too late to tell whether the infection or schizophrenia came first. Many correlational studies—including Sugden's—don't have access to that kind of information, she notes. Sugden's study, like others, also relied on small sample sizes. Schizophrenia is a rare disease, typically occurring in about 1% of the population. To achieve robust statistical results, researchers need to follow tens or even hundreds of thousands of people over long periods, testing for *T. gondii* and mental illness periodically to determine which came first, she says.

Have any studies addressed the timing of *T. gondii* and the onset of mental illness?

Last month, scientists published the first study to address timing in more than 80,000 Danish blood donors. Yet even in this large group, the number of schizophrenia diagnoses was fairly small: 151 people. The study found that people who were exposed to *T. gondii* had 47% increased odds of being diagnosed with schizophrenia. When the researchers looked at the timing issue—narrowing their analysis to 28 people who were first diagnosed with schizophrenia after testing positive for *T. gondii* exposure—they found that these individuals were 2.5 times more likely to develop the disease post-exposure. That number lines up with other large, correlational studies, which have also found a roughly 2.5-fold increase in the odds of schizophrenia diagnosis in infected people, says Robert Yolken, a virologist at the Johns Hopkins University School of Medicine in Baltimore, Maryland, and one of the authors of the Danish study. Because the overall rate of schizophrenia diagnosis is rare, however, infection only slightly increases the odds—from say, a one in 100 chance to a two to three in 100 chance of a schizophrenia diagnosis. Yolken and other researchers suspect that *T. gondii* may not cause mental illness by itself, but interacts with genetic variants that make some people more susceptible. This adds *T. gondii* to the list of environmental factors that increase schizophrenia risk by a small but measurable amount, such as prenatal infection and socioeconomic status, he says.

So, should you worry?

Even if you do become one of the roughly one in three people who carry a latent *T. gondii* infection, current research suggests the odds of developing schizophrenia as a direct result of toxoplasmosis infection are low.

How low? It would be premature to put a number on it, but it appears to be on par with other schizophrenia risk factors you probably don't worry about, such as living in a city. "The advice for avoiding toxoplasmosis infection has already been around for a really long time,"

## Curiosities

### CHEMWATCH

Sugden says. It includes keeping cats indoors where they can't hunt infected animals, disposing of cat litter daily, properly cooking food, and other recommendations from the U.S. Centres for Disease Control and Prevention. Yolken, who has two cats, doesn't want people to be overly worried about their pets—just worried enough to support research for a toxoplasmosis vaccine for cats and better treatments for both cats and people. He thinks it will only be possible to truly pin down *T. gondii*'s effects on mental health once it's possible to prevent and treat the parasite. The need is most urgent in countries where infection rates are high, he notes. "The question is, how much better could people be doing if we could get rid of toxoplasmosis?" he says. "The risk may be low, but we could lower it more."

Science, 15 February 2019

<http://sciencemag.org/>

### Eating lots of meat tied to higher risk of liver disease

2019-02-20

People who eat a lot of animal protein may be more likely to have excessive fat in their livers and a higher risk of liver disease than individuals whose main source of protein is vegetables, a Dutch study suggests. Researchers focused on what's known as non-alcoholic fatty liver disease (NAFLD), which is usually associated with obesity and certain eating habits. While dietary changes are recommended to treat this type of liver disease, research to date hasn't clearly demonstrated whether these changes can work for prevention. For the current study, researchers examined data from dietary questionnaires and liver fat scans for 3,882 adults who were 70 years old on average. Scans showed 1,337 participants, or 34 percent had NAFLD, including 132 individuals who were a healthy weight and 1,205 who were overweight. Overweight people who ate the most animal protein were 54 percent more likely to have fatty liver than individuals who consumed less meat, the analysis found. "This was independent of common risk factors for NAFLD such as sociodemographic factors, lifestyle, and metabolic factors, said senior study author Dr. Sarwa Darwish Murad, a hepatologist at Erasmus MC University Medical Centre in Rotterdam, the Netherlands. "Perhaps most importantly, the association was independent of total caloric intake," Murad said by email. "We also showed that a diverse diet is important." Study participants without fatty liver consumed an average of 2,052 calories a day, compared with 1,996 calories per day on average for people with fatty liver, researchers report in *Gut*. People with fatty liver also got more of their total calories

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## Curiosities

### CHEMWATCH

from protein: 16 percent compared with 15.4 percent without the liver condition. Vegetable consumption was similar for both groups; meats accounted for the difference in protein consumption. Most people have a little bit of fat in their liver. Fatty liver disease can occur when more than 5 percent of the liver by weight is made up of fat. Excessive drinking can damage the liver and cause fat to accumulate, a condition known as alcoholic fatty liver, but even when people don't drink much, they can still develop non-alcoholic fatty liver disease. The study wasn't a controlled experiment designed to prove whether or how diet changes might impact the risk of developing fatty liver. Researchers also relied on questionnaires to assess participants' diets and calorie intake, which can be unreliable, and they lacked data on non-dietary causes of liver fat accumulation including certain medications and viral infections. Even so, the findings add to the evidence suggesting that healthy eating habits can minimise the risk of fatty liver disease, even when people have a genetic risk for this condition, said Shira Zelber-Sagi, a researcher at the University of Haifa in Israel who wasn't involved in the study. "Meat contains saturated fat, especially red meat, which induces fatty liver," Zelber-Sagi said by email. Processed meat is particularly unhealthy because it can contribute to inflammation and so-called insulin resistance, or an inability to respond normally to the hormone insulin that can lead to elevated blood sugar levels and diabetes, Zelber-Sagi added. Both inflammation and insulin resistance can lead to fat accumulation in the liver. The current study results add to the evidence suggesting that people should limit red and processed meat and try to eat more fish and follow a Mediterranean diet, Zelber-Sagi added. A Mediterranean diet is rich in whole grains, fish, lean protein, veggies and olive oil. At most, people should eat red meat no more than once or twice a week, Zelber-Sagi advised. Processed meat should be avoided or consumed only rarely.

Reuters Health, 13 February 2019

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

## How humans evolved to be both shockingly violent and super-cooperative

2019-02-20

Are humans, by nature, good or evil? The question has split opinions since people began philosophising. Some, like the followers of Jean-Jacques Rousseau, say we are a naturally peaceful species corrupted by society. Others side with Thomas Hobbes and see us as a naturally violent species civilised by society. Both perspectives make sense. To say that we are

**The origins of our paradoxical nature lie in murder and self-domestication. It's a weird story that may even explain why our species came into existence**

## Curiosities

### CHEMWATCH

both “naturally peaceful” and “naturally violent” seems contradictory, however. This is the paradox at the heart of my new book. The paradox is resolved if we recognise that human nature is a chimera. The chimera, in classical mythology, was a creature with the body of a goat and the head of a lion. It was neither one thing nor the other: it was both. I argue that, with respect to aggression, a human is both a goat and a lion. We have a low propensity for impulsive aggression, and a high propensity for premeditated aggression. This solution makes both Rousseauians and Hobbesians partially right, but it raises a deeper question: why did such an unusual combination of virtue and violence evolve? The story of how our species came to possess this unique mixture hasn't been told before, and offers a rich and fresh perspective on the evolution of our behavioural and moral tendencies. It also addresses the fascinating but surprisingly neglected question of how and why our species, *Homo sapiens*, came into existence at all. Since the 1960s, efforts to understand the biology of aggression have converged on an important idea. Aggression – meaning behaviour intended to cause physical or mental harm – falls into two major types, so distinct in their function and biology that from an evolutionary viewpoint they need to be considered separately. I use the terms “proactive” and “reactive” aggression, but many other word pairs describe the same dichotomy, including cold and hot, offensive and defensive, premeditated and impulsive. To judge from other relevant animals, a high level of proactive aggression is normally associated with high reactive aggression. The common chimpanzee is the primate species that most often uses proactive aggression to kill its own kind, and it also has a high rate of reactive aggression within communities. The wolf's proactive aggression against members of its own species is often lethal. As with chimpanzees, although relationships within wolf groups are generally benign and cooperative, they are far more emotionally reactive than dogs are. Lions and hyenas are also wolf-like in these respects. Something different happened in the human lineage. While proactive aggression stayed high, reactive aggression became suppressed. The evidence, I argue, points to self-domestication being the “something different” that made humans special. An animal is domesticated if it becomes tame as a result of genetic adaptation, as opposed to being tamed within its lifetime. The idea of self-domestication as a way to understand human docility goes back at least 2000 years to the ancient Greeks and has been repeatedly reinvented. Until recently, the term was used only as a description to emphasise special behavioural qualities that we share with domesticated animals, such as social tolerance and low emotional reactivity to provocation. But now we can add the fact that anatomical changes found in *H. sapiens* compared with earlier hominins show a

## Curiosities

### CHEMWATCH

strong similarity to the anatomical changes that occur in domestication. "Domesticates" mostly have smaller bodies than their wild ancestors. Their faces tend to be shorter, projecting relatively less forward. Differences between males and females are less developed. And domesticates usually have smaller brains. The differences between modern humans and our earlier ancestors look like the differences between a dog and a wolf. So, how did humans become self-domesticated? Evidence from fossils reveals the process started certainly by 200,000 years ago, and possibly with the first glimmerings of *H. sapiens* a little more than 300,000 years ago. Language-based conspiracy was the key, because it gave whispering subordinates the power to join forces to kill bullies – presumably, alpha males, since men tend to be more violent than women. As happens in small-scale, traditional societies today, language allowed underdogs to agree on a plan and thereby to make predictably safe murders out of confrontations with intended victims that would otherwise have been dangerous. Genetic selection against the alpha males' propensity for reactive aggression was an unforeseen result of eliminating the would-be despots. The selection against alpha-male behaviour led to an increasingly calm tenor of life within social communities of *H. sapiens*. Our species is now more Rousseauian than it has ever been.

#### Conform or die

The same ability to perform capital punishment that led to self-domestication also created the moral senses, as Christopher Boehm at the University of South California has argued. In the past, to be a nonconformist, to offend community standards or to gain a reputation for being mean were dangerous adventures; to some extent this is still true today. Rule breakers threatened the interests of the elders – the coalition of males holding power – so they risked being ostracised as outsiders or sorcerers. Nonconformists who refused to change their behaviour were executed. Selection accordingly favoured the evolution of emotional responses that led individuals to feel and display unity with the group. Conformity was vital. The moral senses of individuals thus evolved to be self-protective to a degree not shown by other primates. The strongly conformist behaviours produced by the new tendencies provided a safe passage through life, and they had a second effect as well. By reducing competition and selfishness, they promoted behaviour that benefited the group as a whole. The idea that the moral senses evolved to protect individuals from the socially powerful suggests that group selection may be unnecessary for explaining why we are such a group-oriented species. So, what about proactive aggression? A predisposition for premeditated

## Curiosities

### CHEMWATCH

violence was in place in our Homo ancestors by at least 300,000 years ago, and perhaps as much as 2 million years ago. How much earlier it was present isn't marked by anything so concrete as domestication, which comes with a syndrome of behavioural and physical characteristics. Based on inferring the behaviour of our ancestors, however, a high propensity for coalitionary proactive aggression probably operated at least through the 2 million or more years of the Pleistocene. The reason for this claim is the antiquity of hunting. Homo erectus, the first ancestor of H. sapiens that was committed, like us, to living on the ground, evolved around 2 million years ago. Cut marks that H. erectus left on meat-bearing bones show that they butchered animals the size of large antelope. By 1 million years ago, ambush hunting is suggested (humans repeatedly reused a site of that age at Olorgesailie, Kenya, a place where animal prey were limited to narrow travel routes and could therefore be killed easily); this implies cooperation and planning too. However, only with H. sapiens and Neanderthals, in the past few hundred thousand years, have we found sufficient evidence that hunting had clearly become premeditated: using spears, catching small animals apparently by setting snares, and hunting from elevated positions. So, a conservative interpretation might limit proactive hunting to the Mid-Pleistocene. After our ancestors became good hunters, they could have killed strangers; hunting is a transferable skill. Hunting and simple war both require searching and safe dispatching, and both benefit from long-distance travel and well-honed coordination. Wolves, lions and spotted hyenas use coalitionary proactive aggression not only to get food but also to kill rivals in other groups. Chimpanzees are also social hunters and killers of their own species. Bonobos, by contrast, aren't known to be social hunters (despite their liking of meat) and, to date, haven't shown clear evidence of planned aggression. Among humans still living in small-scale societies, there is a similar association: societies relying more on hunting tend to have more frequent war.

#### "The moral senses of individuals evolved to be self-protective"

For all these reasons, human hunting of prey seems likely to have been associated with the ability to kill rivals in neighbouring groups 2 million years ago. The origins of proactive violence may be far deeper, however. In our 1996 book, *Demonic Males*, Dale Peterson and I argued that the killing of strangers probably went back 7 million years or more to our common lineage with chimpanzees and bonobos, when our Central African ape ancestor was probably a chimpanzee-like hunter and killer. Much as chimpanzees and wolves attack strangers, once our ancestors had achieved the ability to kill safely, a motivation to kill strangers would

## Curiosities

### CHEMWATCH

probably have been present too. There seems no reason to excuse our ancestors from the links between hunting and violence found in other animals. Regardless of when coalitionary proactive aggression began against strangers, killing within groups was limited until humans developed a superior language ability. Much changed after individuals became able to share complex ideas with one another. People could then form alliances based on shared interests that they could articulate. With the arrival of planned and communally approved executions, the bullying by an alpha male was exchanged for the subtler tyranny of the previous underdogs. The newly powerful coalitions of males became the set of elders who would rule society – a system that largely continues today, albeit more with laws, threats and imprisonment than with execution. Both our “angelic” and “demonic” tendencies, therefore, depended for their evolution on the sophisticated forms of shared intentionality made possible by high-level language – an ability that undoubtedly also contributed to much pro-social behaviour. A chimpanzee-style form of shared intentionality launched the process at least 7 million years ago. It took the mysterious dawning of an improved language facility, sometime between 500,000 and 300,000 years ago, to shake us into a new world. Language created the chimeric aspects of our personality, high killing power lying alongside reduced emotional reactivity. A unique cognitive ability gave us a uniquely contradictory psychology – a predisposition for both virtue and violence.

New Scientist, 13 February 2019

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

## Technical Notes

CHEMWATCH

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## Technical Notes

### CHEMWATCH

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Separating spatial patterns in pollution attributable to woodsmoke and other sources, during daytime and night-time hours, in Christchurch, New Zealand

Passive exposure to pollutants from conventional cigarettes and new electronic smoking devices (IQOS, e-cigarette) in passenger cars