The OPCW Science & Technology Monitor

A sampling of Science & Technology relevant to the Chemical Weapons Convention

17 March 2015 Volume 2, Number 4

Featured Content:

(Bio)Materials for healing and recovery from injury.

Image from 3D Printing magazine.

Science and technology of food.

In this issue:

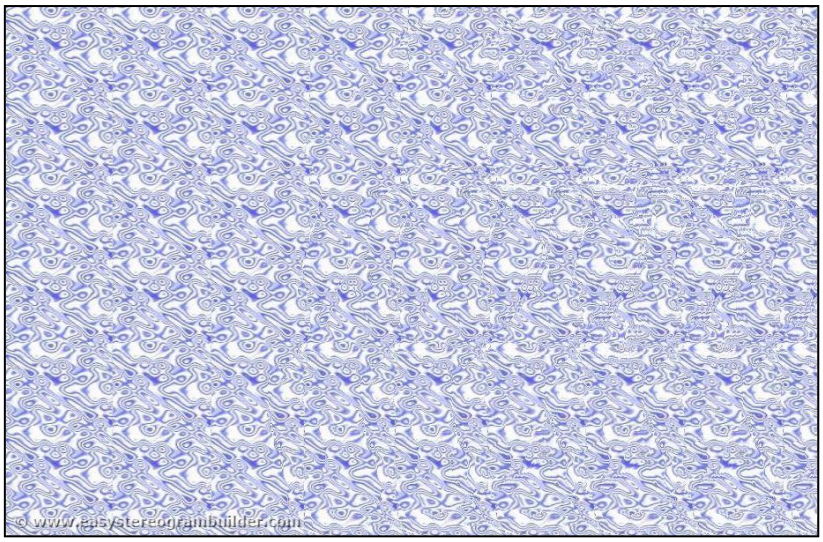
Welcome

Welcome to the *OPCW Science and Technology Monitor*, an occasional bulletin to provide updates on developments in science and technology across a broad spectrum of topics relevant to the CWC. Past issues are now available from the Science and Technology special section of the OPCW website.

Today marks the 65th anniversary of the discovery of the element Californium at the University of California at Berkeley. Californium-252 has been used as a neutron source in devices for non-destructive identification of chemical warfare agents. As residents of California, are more likely to recognize 17 March for being St. Patricks Day; we offer them a home science experiment with a "green" theme.

The S&T Puzzle

We have our first non-OPCW winner! Congratulations go to a subscriber from the CTBTO, who recognized the ultrasonic pulse echo analysis on a single container of a chemical agent (photo revealed on the left). Statistics now stand at: VER 4, OCS 1, OSP 2 and CTBTO 1.



For the next edition of the puzzle, we ask you to identify the familiar item that is depicted in the image to on the right. First person to correctly answer will receive their choice of choosing a featured topic, designing the next puzzle, or a beverage hand selected by the Science Policy Adviser. Send answers by email or tweet to #OPCWST. Good luck!

Science Fun:

As our colleague from the Lab (shown below) constantly reminds us, what could possibly be more fun than toys?

We also know that toys are valuable tools for science, they can be used to encourage career paths, teach math and physics (details here), build 3D printers, provide hours of intense study when combined with a washing machine or inspire real-world smart building materials; and all that is just with LEGO®!

There are certainly other science toys to be found including 3D printing pens! Like so many of the objects we surround ourselves, toys too can be controlled by apps on Smartdevices. You might even want to try controlling marionettes with drones (not for commercial purposes though because this has already been patented!).

Moving from toys to games, one can learn how to create devices with synthetic biology or simulate (and figure out the best way to survive) a zombie apocalypse (play for yourself here). Machines can also learn to play games, unfortunately this may result in an unbeatable poker player (details here).

News and Updates

Recently published reports and newsletters:

Industrialization of Biology: A Roadmap to Accelerate the Advanced Manufacturing of Chemicals from the National Academies Press (can be read online).

Final Report of the Expert Panel of Technology and Innovation in UN Peacekeeping.

Issue 20 of *inno4dev* (UNDP Innovation News Update).

January-February 2015 OECD news on innovation, science, technology and industry.

Hospital and Healthcare Security (Sixth Edition).

Report on Global Strategic Trends out to 2045 from the UK Ministry of Defence.

Science resources:

Visualisation tools for geographic data.

After school science resources from AAAS.

Science teacher resources from Science Friday.

Celebrate "Brain Awareness Week" with this collection of educational materials.

Some news from world of science:

From the weeks of 22 – 28 February; and 1 – 7 and 8 – 14 March 2015 in chemistry.

Enjoy the science images of the month from *Nature* and the 2015 Wellcome Trust best science images.

Biomaterials

It is not always easy to remain injury free (just ask our science adviser), but there is good news to be found from scientific developments in the field of biomaterials. Historically, many materials employed in injury recovery have seemed a bit barbaric (nuts and bolts really!); and now modern biomaterials are being engineered to interact with components of living systems to impart therapeutic benefits.

3D Printing has been an enabling technology in the field of biomaterials: commonly implantable materials, such as titanium can be printed into pelvic and shoulder bones; and in the engineering of tissues and artificial organs, water-based gels containing synthetic DNA and

Inevitably, the combining of Smartdevices with toys has created some legal questions. For those that prefer simpler ways to have fun, hovering Styrofoam or a collection of science toys from before the days of Smartphones may be of greater interest.

Crowdsourcing:

Want to develop mobile applications, software, hardware, data visual-ization and/or platform solutions to contribute to space exploration and improve life on Earth? Join the International Space Apps Challenge.

Seeking a wearable alcohol biosensor! As a reference point, here's how a breathalyzer works.

Develop a diagnostic test to combat antibiotic resistance (and win a one million Euro prize!).

Upcoming S&T Related Events:

21 - 26 March 2015
249th American Chemical Society (ACS) National Meeting & Exposition. Denver, Colorado, USA.

During the open session of the ACS Board of Directors meeting, the 2013 Nobel Peace Prize recipient, the OPCW will be honoured for its work in finding peaceful applications of chemical sciences worldwide.

6 - 7 May 2015
6th Meeting of the Scientific Advisory Board's Temporary Working Group on Verification. The Hague

peptides (details here) along with the use of DNA strands as a glue to hold biocompatible materials together (details here) offer great promise.

The use of hydrogels (such as those described in the 3D printing references) may also enable advances for implantable devices (such as heart valves and devices to treat hearing disorders).

Nanofibers derived from collagen (obtained from fish skin) have been demonstrated to aid in skin regeneration (details here) and there are "Smart" bandages that can deliver medicines (details here) and monitor vital signs. Simple methods to create nanoparticle based antibacterial and antifungal tapes have also been reported (details here).

Injectable materials with would healing properties are another area of interest, these include platelet mimicking nanoparticles and compounds that stop wounds from bleeding (details here). Similar principles have aided the healing of injured grape vines (details here).

Food and Science

Like so many of the day to day things we experience in the world, our food has highly complex science behind it. There is much we can learn from the science that has been applied to and developed for studying food, for example consider the field of "foodomics" – an area of study that employs omics methodologies across the food life cycle (e.g. from raising plants and animals, to processing and cooking, and all the way to the metabolism of your meal). This field seeks to improve understanding of food and nutrition and presents a variety of complex technical challenges.

Health concerns have required the development of a multitude of methods for analysing food samples and additives. Examples include the identification of arsenolipids in canned cod liver, determination of aflatoxin in milk, enzymatic tests for caffeine content of beverages and fluorescent probes for the fat content of milk. Playing with your food (or drink in this case) can help one to study bacterial transfer. Concerns of safety supply chains have prompted the development of tracers that can be added to food and used to ensure product authenticity.

Familiar chemical analytical tools such as ^{1}H NMR have been used to distinguish beef from horse meat, identify the country of origin of coffee beans, and to determine if tomatoes were grown organically or not. Gas Chromatography/Mass Spectrometry, another familiar technique, finds valuable use for the quality control of Japanese Sake.

Scientific advances are creating many new applications in food. Molecular biology is enabling new approaches to food production, such as lab grown meat (details here); 3D Printing is providing new means of food preparation; materials science underpins molecular gastronomy; sensors that detect food odours can be used in analysis; and even Big Data is used in food studies. We have seen informatics studies of Indian

22 - 26 June 2015
CTBT Science and Technology Conference (SnT2015)
Vienna, Austria

14 - 26 July 2015
19th Annual Green Chemistry and Engineering Conference.
Bethesda, ML, USA.

19 - 22 July 2015
12th World Congress on Industrial Biotechnology.
Montreal, Canada.

6 - 13 August 2015
IUPAC 2015
48th General Assembly
45th World Chemistry Congress. Busan, Republic of Korea

10 - 14 August 2015
Biological Weapons Convention Meeting of Experts.
Geneva, Switzerland.

27 September - 1 October 2015
ECCE10 (10th European Congress of Chemical Engineering);
ECAB3 (3rd European Congress of Applied Biotechnology); and
EPIC5 (5th European Process Intensification Conference)
Nice, France.

5 - 8 October 2015
SOLVE.
Cambridge, MA, USA.

31 October - 2 November 2015
The Port Hackathon.
CERN

16 - 19 November 2015
Malta Conference. Rabat, Morocco.

18 - 21 November 2015
16th Asian Chemical Congress. Dhaka, Bangladesh.

15 - 20 December 2015
Pacifichem 2015.
Honolulu, Hawaii, USA.

recipes looking for the spices that make it taste best (details here) and chemometrics techniques for identifying production methods, geographical origin and species authentication of shrimp.

Chemical components of common spices are known to have antimicrobial properties that can be used to better understand pathogenicity and even to develop antimicrobial surfaces (think about "cutting boards", details here).

We now give you two examples of modern technology and the kitchen: satellite technology for cooking steaks and a recipe for powdered alcohol (see video here); and end with a reminder that sometimes a simple look at complex science is valuable, as illustrated by chocolate and garlic.

Big Data

Have you ever considered how much data is generated every minute, how that data might be visualized, who could possibly analyze it all or what it might actually be used for? This topic seems to come up more and more as we look across the horizon at developments in science and technology. This has of course raised many questions regarding potential security implications (and how to think about them) as well as privacy implications (and how to address them, details here). Reports of how marketing data might be collected don't always ease these concerns!

Data science expertise has developed into is an extremely important asset to any organisation with applications across a broad range of fields: biology, chemistry, linguistics (including the influence of language of publication on fame), geo-information, transportation (details here), behavioural sciences, unemployment statistics, agriculture and more.

Big data has also shown itself to have potential value, particularly in regard to public health. Certain internet search terms might be indicators for spreading of the flu and possibly other diseases as well and there are indications of negative comments on social media correlating to heart disease (details here). However, there is still work to be done to ensure these methods are reliable. Still, the ability to share information and the use of text messages and/or social media can help improve public health (and this in turn generates more data to analyze). Data collected from the Ebola outbreak has informed studies on the risk assessment of the spread of disease, provided insights into the effectiveness of surveillance and intervention, and lead to predictions on the when the epidemic might end (details here). Data collection for public health has also generated is own ethical challenges.

A wealth of data comes from communication, as can be seen in this real-time tweet map. The Big Data of social (and professional) networks can tell us much about how effective (or problematic, details

Contact Us:

Questions, comments, suggestions, want to make a contribution, or be added to the mailing list? Please contact us through the OPCW Office of Strategy and Policy (OSP).

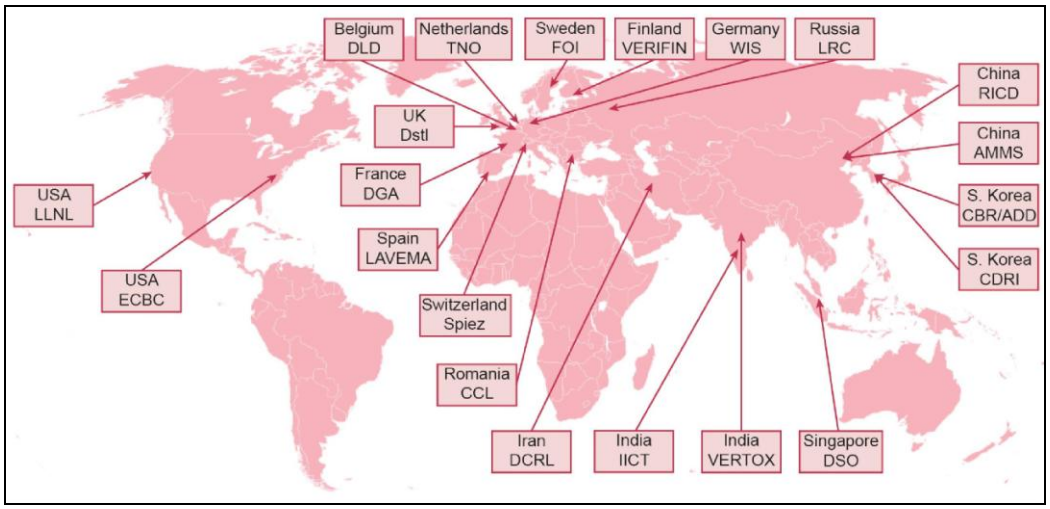
For more frequent updates, Visit us on the web or follow us on Twitter at @OPCW_ST.

here) and far reaching our networks are; take a look at the twitter networks of foreign ministries and international organisations. For those of you who like to use Twitter, here are some tips on the use of hashtags and assessing content.

Designated Laboratories

The Designated Laboratory network forms a key part of the verification regime of the Chemical Weapons Convention (CWC) by providing laboratories with proven expertise in off-site analysis of CWC-related samples. Theses laboratories provide a high degree of confidence that the chemical analyses needed to determine issues occurring during OPCW inspections or allegations of use of chemical weapons can be carried out unambiguously. As of August 2014, the network consists of twenty-one laboratories in seventeen States Parties; these are illustrated on the map below.

Many scientists from the designated laboratories are currently serving as or have previously been members of the OPCW Scientific Advisory Board (as well as its Temporary Working Groups). These individuals have played a vital role in providing specialised advice to the Director-General on a variety of technical issues.



The designated laboratories publish a variety of high quality scientific papers and reports. To learn more about the individual laboratories we present an appendix with links to public websites and recent publications from across the laboratory network. Please note that some of the materials are only available in the national language of the State Party.

Country	Laboratory	Links to Recent Publications
	Defence Laboratories Department	- Rapid and Efficient Filtration-Based Procedure for Separation and Safe Analysis of CBRN Mixed Samples
	The Laboratory of Analytical Chemistry, Research Institute of Chemical Defence	- Study on the N-terminal valine adducts in hemoglobin after exposing to mustard gas by mass spectrometry
	Laboratory of Toxicant Analysis, Institute of Pharmacology and Toxicology, Academy of Military Medical Sciences	- Determination of nerve agent metabolites in human urine by isotope-dilution gas chromatography-tandem mass spectrometry after solid phase supported derivatization - A novel approach for high sensitive determination of sulfur mustard by derivatization and isotope-dilution LC-MS /MS analysis
	VERIFIN, Finnish Institute for Verification of the Chemical Weapons Convention	- Verification and quantification of saxitoxin from algal samples using fast and validated hydrophilic interaction liquid chromatography-tandem mass spectrometry method - Development and validation of efficient stable isotope dilution LC-HESI-MS/MS method for the verification of ß-lyase metabolites in human urine after sulfur mustard exposure
	DGA Maîtrise NRBC, Département d'analyses chimiques	- Effects of Repeated Low-Dose Exposure of the Nerve Agent VX on Monoamine Levels in Different Brain Structures in Mic - 2014 Annual Report
	Bundeswehr Research Institute for Protective Technologies and NBC Protection	- Analysis of chemical warfare agents-searching for molecules - 2014 Annual Report
	Vertox Laboratory, Defence Research & Development Establishment	- A highly selective and sensitive "turn-on" fluorescence chemodosimeter for the detection of mustard gas

	Council of Scientific and Industrial Research, Centre for Analysis of Chemical Toxins, Indian Institute of Chemical Technology	- Rapid screening of N-oxides of chemical warfare agents degradation products by ESI-tandem mass spectrometry - Mass spectral characterization of the CWC-related isomeric dialkyl alkylphosphonothiolates /alkylphosphonothionates under gas chromatography/mass spectrometry conditions
	Defence Chemical Research Laboratory	- Determination of lewisite metabolite 2-chlorovinylarsonous acid in urine by use of dispersive derivatization liquid-liquid microextraction followed by gas chromatography–mass spectrometry - Photoassisted and photocatalytic degradation of sulfur mustard using TiO_2nanoparticles and polyoxometalates - News from DCRL
	TNO Defence, Security and Safety	- Verification of Exposure to Cholinesterase Inhibitors: Generic Detection of OPCW Schedule 1 Nerve Agent Adducts to Human Butyrylcholinesterase - December 2015 issue of *TNOTIME*
	Chemical Analysis Laboratory, CB Department, Agency for Defence Development	
	The Chemical Defence Research Institute	- Armed Forces Institute of Chemical Defense, has been accredited by the Organization for the Prohibition of Chemical Weapons Lab
	Chemical Analysis and Testing Laboratory, Scientific Research Center for CBRN Defense and Ecology	- Encapsulation of highly toxic organic compounds: Novelly functionalized nanoparticles for the safe storage of pollutants and their by-products
	Laboratory for Chemical and Analytical Control, Military Research Centre	- Dilute-and-shoot' RSLC-MS-MS method for fast detection of nerve and vesicant chemical warfare agent metabolites in urine

	Verification Laboratory, Defence Medical and Environmental Research Institute, DSO National Laboratories	- Chemical analysis of bleach and hydroxide-based solutions after decontamination of the chemical warfare agent O-ethyl S-2-diisopropylaminoethyl methylphosphonothiolate (VX) - *Creating Disruptive Capabilities* DSO brochure
	Laboratorio de Verificación de Armas Químicas (LAVEMA), Instituto Tecnológico "La Marañosa"	
	FOI, CBRN Defence and Security, Swedish Defence Research Agency	- Detection and monitoring of CWA and BWA using LIBS - 2014 Annual Report
	Spiez Laboratory, Swiss NBC Defence Establishment	- Identification of sulfur mustard hydrolysis products by LC-UV-SPE NMR - Spiez Convergence Workshop Report 2014
	Defence Science and Technology Laboratory, Chemical and Biological Systems, Porton Down	- Potency of irritation by benzylidenemalononitriles in humans correlates with TRPA1 ion channel activation - Detection of the organophosphorus nerve agent VX and its hydrolysis products in white mustard plants grown in contaminated soil - Issue 27 of Dstls *insight*
	Edgewood Chemical and Biological Forensic Analytical Center	- Quantitation of five organophosphorus nerve agent metabolites in serum using hydrophilic interaction liquid chromatography and tandem mass spectrometry - Purity analysis of hydrogen cyanide, cyanogen chloride and phosgene by quantitative (13)C NMR spectroscopy - 2014 Annual Report
	Lawrence Livermore National Laboratory	- Derivatization of pinacolyl alcohol with phenyldimethylchlorosilane for enhanced detection by gas chromatography-massspectrometry - 2014 Annual Report - January-February 2015 issue of LLNL's *Science and Technology Review*