The OPCW Science & Technology Monitor

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

6 February 2015 **Volume 2, Number 2**

Featured Content:

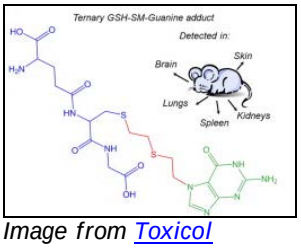


Image from Toxicol Lett.2015, 223 (1), pp 1-7.

A guanine ethylthio-ethylglutathione adduct as a major DNA lesion in skin exposed to sulfur mustard.

Image from Anal. Chem., 2015, 87 (1), pp 394–398.

Temporary paper based tattoo measures blood glucose levels.

Science Fun:

While the OPCW works toward its goal of eliminating the declared chemical weapon stock-piles on Earth, much has been happening away from Earth too!

In 2014 a Schedule 3 chemical was found on a comet. Now in 2015 on Mars, we found the long lost Beagle 2 at its crash site and organic molecules! Methane to be precise. A sign of life? Maybe the new NASA drone will confirm if something lives there.

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 available from the Office of Strategy and Policy (on our portal or by request).

Today's issue of the *S&T Monitor* arrives on the 129th anniversary of the discovery of the element germanium by Clement Winkler. Today germanium can be used as a detector in neutron beam devices for the underwater identification of toxic chemicals.

The S&T Puzzle

Congratulations to Stephane Hohn (again from VER) for his estimate of 2750 patent grants in our puzzle plot - closest estimate to the actual value of 2769! Many thanks to the others who plotted their own graphs, weighed paper or used other clever means to come to similar (but not quite close enough) estimates. We also congratulate Alexander Kelle (OSP, yes that's right) for his winning submission of the "OPCW S&T" logo. Puzzle statistics now stand at: VER 4, OCS 1, OSP 1.

For this weeks puzzle, we go beyond our newsletter and ask you to think about OPCW S&T information from across our communication channels. Have you ever wondered how many chemical substances are known? Closest estimate of the total number of chemical substances with CAS numbers (at the start of 2015) wins the prize: a choice of either choosing our next featured topic, designing the next puzzle, or a gift of a special beverage hand selected by the Science Policy Adviser. Good luck!

In this issue:

We hope so, because as observed on Earth, sometimes drones need friends who are fast on their feet!

That's not all! A space probe launched in 2006, New Horizons, has travelled over 3 billion miles to wake up at Pluto's doorstep. Meanwhile an exoplanet, with rings 200 times larger than those of Saturn, was just reported!

With such a fantastic universe, perhaps you might be interested in a vacation? Take a look at these travel posters for a few suggestions. Even if there is no life at these destinations, we may have already found alien life here on Earth! Take a closer look at these bacteria that eat and breathe electricity. To be on the safe side, one should be clean and hygienic, even on a spacecraft. To that end, take this advice for using a wash cloth.

Another handy tool to have in space is a 3D printer. Here are the tools that have been produced in zero gravity and even more 3D printable tools that have been designed to make space station life better! That 3D printer may also provide shelter upon arrival at the exoplanet! As you are more likely to gain access to 3D printers here on Earth, we offer this simple chart to help find the right one for your needs!

While you read this, you may want to prepare and enjoy an espresso – also available in space!

We now leave you with the science images of January. Over and out!

News and Updates

Recently published reports:

European Chemical Agency's (ECHA's) REACH 2018 Roadmap (full document)

CEFIC 2014 Facts and Figures for the European Chemical Industry

Results of a survey on scientists and the public from the Pew Research Center in collaboration with the American Association for the Advancement of Science (complete report here).

Presentations from the Centre for Defence Enterprise (CDE) networking event for science and technology (London, January 2015).

A blessing in the skies? A report on UAVs from The Hague Security Delta.

The Global Risks report 2015 from the World Economic Forum.

A summary report from the meeting on "Creating an Environment to Support Investment and Innovation in Synthetic Biology" (hosted by the UK Synthetic Biology Leadership Council and US National Academies' Forum on Synthetic Biology, October 2014).

From our Laboratory: A look at the novel sample-preparation methods and strategies of the Mobile Laboratory of OPCW.

e-learning:

Courseware from Project 10 of the EU CBRN Centre of Excellence Initiative.

News from other S&T relevant organisations:

Issue 26 of Dstl's *Insight*.

January 2015 Issue of PNNL's *Currents*.

Making news in chemistry:

From the weeks of 18 – 24 and 25 – 31 January 2015.

Biomarkers for Sulphur Mustard Exposure

Sulphur mustard (HD, commonly called mustard gas due to its weaponisation in aerosolized form), is a powerful vesicant and

Crowdsourcing:

A recent discovery of a new antibiotic using an "iChip" that allowed cultivation of bacteria not previously grown in lab conditions has sparked great interest in looking across a wide range of soil samples for possibly even more new antibiotics. Want to contribute some dirt? Sign up here.

How about a $1,000,000 digitization competition? Beware it might be a little buggy!

With all the science fun of the universe, perhaps you are interested in helping scientists to learn about Mars? NASA invites you to take part in a citizen science project by becoming a Martian! Or play the Cerebus game and actually map real planets!

Finally, how about some feedback for us – we are looking for suggestions for newsletter format and layout as well as any pictures that can be shared of subject matter relevant to S&T and OPCW, please send it all! (Please include credits and captions with photos).

Upcoming S&T Related Events:

12 – 16 February 2015
AAAS Annual Meeting 2015: Innovations, Information, and Imaging. San Jose, California, USA.

16 – 18 March 2015
CBRN – Research and innovation. Antibes - Juan-les-Pins, France.

biologically cytotoxic agent with a well characterised toxicological profile. "Mustard poisoning" is brought about by inhalation or exposure to the eyes and skin. First used as a chemical warfare agent in 1917, sulphur mustard was also an important chemical in the early development of cancer chemotherapy drugs.

Sulphur mustard containing munitions, the legacy of wars from the 20th century, continue to pose a hazard in several parts of the world. Injuries from sulphur mustard have also been reported at chemical weapon storage facilities. On the positive side, clean up of abandoned chemical weapon sites has produced technology to help keep workers safe from exposure (details here).

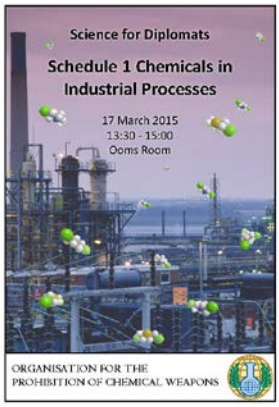
For medical purposes, recognizing exposure to sulphur mustard is important to ensure victims are properly treated. Evidence of exposure can be determined through analysis of hydrolysis/oxidation products, ß-lyase metabolites, DNA adducts and hemoglobin adducts from biomedical samples. Biomarkers (i.e. substances that can act as indicators of some biological state or condition) indicative of sulphur mustard exposure include guanine-ethylthioethyl-glutathione adducts and other DNA adducts in exposed skin, and plasma proteins obtained from blood samples. It is also possible to detect exposure using hair. To ensure the safety of those that study toxicity of sulphur mustard in animal models, customised vapour inhalers are needed for controlling dosage and thorough training in decontamination too!

Exposure to sulphur mustard can induce long-term health problems. Clinical studies on injured veterans have demonstrated changes in serum cytokine, albumin and metalloproteinase levels compared to control groups; along with other haematological complications. Other studies have looked at gene expression and substance P levels in veterans with sulphur mustard induced lung injury.

Paper

Paper, something very familiar to us, was invented about 2000 years ago

17 March 2015
Science for Diplomats side event at EC-78. "Schedule 1 Chemicals in Industrial Processes". Ooms Room, 13:30-15:00.



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

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.

in China and today around 400 million tonnes of it are produced worldwide each year! In the twenty-first century we talk about a "paperless" world, yet many people won't give up their paper! Even a Smartphone diagnostic system requires the use of paper!

Paper also has uses relevant to our work, for example: detecting chemical warfare agents and as a platform for biosensors. In fact, paper can be used for a variety of microfluidic applications and as a platform in drug discovery. To see the potential, consider these reports on biosensors containing synthetic gene networks that can detect small molecules and viruses, paper strips for disease detection (details here) and temporary tattoos that can measure blood-glucose levels (details here).

With some redox dyes and UV light, rewritable paper can be prepared (details here). Paper integrated with "nanowire" ink may eventually lead to the development of inexpensive medical tools. One can convert paper into a memory device with a sequence of ink-jet and screen-printing techniques. Bendable batteries based on paper platforms are even possible (details here).

Despite all the possibilities for electronic devices, there are times where only the absorptive properties of a material are required such as in expansion microscopy (details here). Likewise, paper will always have a place in hands-on science teaching and in art (especially origami)!

Bioactive Peptides

Peptides (short chains of amino acids linked by amide bonds) are one of the many types of molecules that can be defined as bioregulators (see the report of the TWG on the convergence of chemistry and biology for a more detailed definition).

Due to the bioactivity (bioregulation) of these substances, they have potential for use as therapeutics, including those aimed at preventing

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)

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.

diseases associated with mental health as well as for the treatment of central nervous system disorders. For example, Substance P has been proposed for use in the treatment of Alzheimer's Disease and brain tumours. Peptides with antihypertensive, antioxidative, anticoagulant, anticancer, anti-HIV and other useful properties have been identified. Bioactive peptides have also been considered for use in nutritional and food packing/preservation applications (an area of much current interest).

Sources of bioactive peptides include muscle sources, fish, milk, eggs, plants, seaweed, bacteria and fungi. Identification of therapeutic targets employ "omics" (especially "peptidomics" of endogenous bioactive peptides and their proteolysis products) and high-throughput screening technologies. Peptides, as well as some proteins, can also be chemically synthesized.

Peptides can also be used in the design of drugs for targeted delivery as binding sites on specific types of cells may recognize unique peptide sequences, enabling the possibility of non-invasive delivery routes. Yet, there are still challenges to overcome with oral delivery and ensuring adequate bioavailability of the administered drug.

Research on bioactive compounds continues to identify numerous candidates with potential medical uses, however, developing new pharmaceuticals is a lengthy, complex and (often) highly regulated process and many candidate drugs are eliminated from consideration before ever reaching a clinical trial.

Gas Masks

A chemical weapons inspector carries quite a variety of things while travelling on mission, protective equipment being the most vital for those involved in the hands on work of Chemical Weapons Convention Implementation. Perhaps the most critical piece of equipment is the gas mask. Respiratory protective equipment (e.g. gas masks) have actually been around for thousands of years, although World War I is

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where we often look to the origins of their development. School children were regularly given instructions on how to use gas masks in times of war (and some designers gave consideration to soothing fear). Gas masks can be fabricated at home with the right materials and these DIY instructions were originally published in 1942! Here is some further information on how gas masks work.

Gas mask technology has continued to advance throughout the 20th century and beyond, thanks to developments in materials chemistry. Methods for designing improved filters and for testing have continued to evolve. A more recent patent shows how designers are working towards filter canisters with convex shapes to better conform to the face of the wearer and the integration with other safety equipment (such as a helmet). There are also systems for the indication of remaining life of cartridges and canisters as well as demonstrations of masks that incorporate sensors for chemical detection. Some new gas mask designs look like they belong in a science fiction movie, and we certainly expect to see gas mask wireless devices in our future! Cleaning your mask, however, may still be quite effective with low tech methodology.