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## Environmental Chemistry and Sustainability

by Diane Purchase, Annemieke Farenhorst, Hemda Garelick, Nadia G. Kandile, Christine Luscombe, Laura McConnell, Bulent Mertoglu, Bradley Miller, Fani Sakellariadou, Roberto Terzano, and Weiping Wu

The 48<sup>th</sup> IUPAC World Chemistry Congress and the Canadian Chemistry Conference took place virtually on 15-20 August 2021. Oral presentations were uploaded in advance to be viewed on-demand; they were complemented by live discussion sessions with the speakers during the conference. The IUPAC Chemistry and the Environment Division (Division VI), also supported by the Polymer Division (Division IV), organized four symposia on *Environmental Chemistry and Sustainability* in the 'Chemistry and Sustainability' thematic programme. The symposia provided forums to share advanced knowledge on environmental chemistry, the connectivity between environmental chemistry and the UN Sustainable Development Goals, and improved technologies for safeguarding different environmental compartments and human health. For example, the next generations of sustainable polymers, the identification and impact of pollutants in the atmospheric, aquatic and terrestrial ecosystems caused by fires, and the innovation of sustainable applications in crop and livestock agricultural production.

The symposia took place over three days (16, 19-20 August), during which a number of high-profile international speakers presented on four special sessions:

- Sustainable polymers
- The environmental impact of fires
- Emerging technologies and conservation practices for sustainable agriculture and public health
- A Healthy Intake: environmental pollutants in air, water, food and their removal

All four symposia were well-attended and well-received, raising awareness of the important topics associated with the symposia.

### An overview from the President of Division VI—Hemda Garelick

Division VI has established a long tradition of examining and addressing the role of chemical science in and its impact on the environment and human health as well as the importance of cross-disciplinary collaboration.

The development of environmentally focussed symposia in the IUPAC World Chemistry Congress was established in 2009 for the IUPAC Congress held in

## Conference Call

Glasgow, sharing an opportunity with the chemistry community to examine and address these principles. These have since reoccurred in nearly every IUPAC World Chemistry Congress. Through the presentation by multidisciplinary experts and the use of case studies from different countries, the symposia contributed to the advancement of knowledge of chemistry in environmental and health impact and the promotion of sustainable solutions to global challenges.

In last year's Congress, the Division task groups and collaborating members from other Divisions were able to focus on a range of technologies and chemicals affecting the environment, and on the impact of environmental events driven by natural and human activities. An important principle driving the Division is the engagement with the community of observers such as young scientists, and promoting the Division's activities. In addition, and also since 2009, the Division has developed a tradition of awarding 'Chemistry and the Environment Division Award' for the best poster presented at each Congress.

The Montreal Congress has again given us the opportunity to further develop the above principles and plan for the future.

### Highlights from the symposia

**Sustainable polymers—organized by Weiping Wu, Nadia G. Kandile, Bulent Mertoglu and Christine Luscombe**

This symposium exchanged new ideas on sustainable polymers through an interdisciplinary approach by bringing chemists, polymer scientists, analytical chemists, environmental experts and biological engineers together. The first invited talk titled '*Transforming Thermosets into Thermoplastic-like Materials*' was delivered by John Torkelson, (Walter P. Murphy endowed Professorship) from Northwestern University. He presented an innovative approach to recycle polymer networks and network composites substantially. The research showed that by replacing a fraction of the dynamic crosslinks in the covalent polymer networks (DCPNs) with permanent crosslinks, it could substantially suppress elevated-temperature creep. This research is important for the recycle and reuse of crosslinked polymers

and their composites (such as rubber tires and polyurethane foam) in high-value products. Megan Robertson from the University of Houston gave a talk about research on the accelerated hydrolytic degradation behavior of the ester-containing epoxy resins, aiming to recycle the thermoset polymers to minimize their environmental impact. The presentation of Anne McNeil from the University of Michigan demonstrated an efficient approach to repurpose superabsorbent (crosslinked) sodium polyacrylates to pressure-sensitive adhesive, utilizing a combined decrosslinking and esterification reaction with a subsequent chain-shortening via sonication. The invited talks were followed by 13 talks covering the topics of synthesis of new degradable polymers, sustainable materials from natural/bio sources, the applications and recycling of sustainable polymeric materials. The speakers, audiences, and organizers discussed the challenges and possible solutions in the area of sustainable polymers as well as emerging microplastic pollutions.



### **The environmental impact of fires—organized by Roberto Terzano and Fani Sakellariadou**

This symposium addressed various topics related to accidental or intentional fires that degrade natural ecosystems and affect the anthropogenic environment.

The keynote presentation was delivered by Mike Flannigan, Director of the Canadian Partnership on Wildland Fire Science and Professor of Wildland Fire at the University of Alberta. He presented the prevailing issue of wildfire and climate change. Prof. Flannigan mentioned that global warming will lead to more wildfires and smoke in the years to come and he concluded that *in a warmer world, we will have to learn to live with wildfire*.

This was followed by several very interesting discussions on the presentations from scientists across the globe. They focused on issues such as the effects of fire on different environmental ecosystems, the ways to control and suppress fires, the effective monitoring of volatile organic compounds (VOCs), and the fire management. For example, the carbon monoxide (CO) monitoring during extreme fire events to develop mitigation methods was discussed. The chemical species emitted from wood and dung biomass burning were also considered, the former due to its use for heating and the rising incidence of wildfires, and the latter used primarily as a fuel source in many developing countries. Particularly in Sub-Saharan Africa, fires are often intentional and satisfy various aims. Therefore, it was concluded that the dissemination of knowledge and information will offer an extreme help towards sustainable practices in these Countries. Another topic of discussion was the increasing human and environmental health risks caused by fire events that may favour the oxidation and mobilization of chromium (Cr) in polluted soils. Also, issues such as the traditional ecological knowledge, the reintroduction of old-fashioned agricultural practices, and the knowledge of recent fire disasters were commented.

### **Emerging technologies and conservation practices for sustainable agriculture and public health—organized by Annemieke Farenhorst, Diane Purchase, and Laura McConnell**

Agriculture as a global industry is undergoing rapid transformations with many new and disruptive technologies, spanning multiple scientific disciplines from chemistry, to plant biotechnology, to remote sensing, and data science. This symposium focused on emerging technologies to improve the sustainability of crop production and to improve public health as well as

advancing the quality of air, soil, water, and biodiversity through conservation practices.

Rai Kookana of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia, provided the keynote presentation on emerging technologies and improved practices for sustainable agriculture. The online session deliberated the use of established technologies such as biobeds and biochar, and the emerging role of nanopesticides and RNAi (post transcriptional gene silencing). The discussion then moved to Annemieke Farenhorst's (University of Manitoba, Canada) presentation on the application of biobed technology to turn pesticide rinsate into cleaner water and its safety for reuse. Zijiang Yang (University of Maryland, USA) advocated the use of vegetative environmental buffer (VEB) as a promising technology to mitigate ammonia and particulate matters from poultry house; the group discussed the challenges the technology might face in arid regions and the potential spread of microbial pathogens. Garrett Whitworth (Thompson Rivers University, Canada) engaged in an interesting dialogue on the use of ash residual amendment to increase the sustainability of both forestry and agricultural operations through waste reuse, carbon sequestration and reduction in use of chemical fertilizers. This was followed by a conversation on crop protection using transgenic *Bacillus thuringiensis* (Bt) corn to reduce aflatoxin risk (presented by Felicia Wu from Michigan State University, USA) and the use of gene editing technologies to reduce fungal infection and mycotoxin contamination of crops. The use of plant growth promoting bacteria to mitigate fungicides (Paraskevas Parlakidis, Democritus University of Thrace, Greece) and the application of aldehyde-containing clays and zeolites to control olive fruit fly (Stefano Econdi, University of Milan, Italy) were discussed as promising technologies to support bioremediation of agricultural chemicals and biocontrol of pests, respectively. The session's invited speaker, Leah Riter (Bayer CropSciences, USA), rounded up the session exchanging views on her research on emerging technologies in chiral separations to improve environmental safety of pesticides.

### **A Healthy Intake: Environmental Pollutants in Air, Water, Food and their Removal. Organized by Kevin Wilkinson, Patrick Hayes, Hind Al-Abadleh, and Bradley Miller**

The keynote presentation for the symposia was given by Jon Abbatt of the University of Toronto entitled "Multiphase Aerosol Oxidation Processes

in the Atmosphere: Impacts on East Asian Haze and Wildfire Smoke.” The detailed and interesting work by his laboratory has elucidated the roles of a variety of gas-phase oxidants for aerosol sulfate formation and may inform better global climate change predictions. The kinetics and oxidation mechanisms of these aerosol particles from haze and wildfires affects ecologically sensitive areas around the world. The symposia had five sessions and eleven graduate students took home best oral presentation awards from each session. The award winners included Kardelen Kaya-Ozkipfer of Bogazici University, Istanbul, Turkey; Wisam Mohammed of Wilfrid Laurier University, Canada; Sarah Begin from Trent University, Canada; Zi Wang from McGill University, Canada; and Megan Himmelman of Saint Mary’s University, Canada.

### **Chemistry and the Environment Division Award—organized by Award Committee Chair Bradley Miller**

We are pleased to present the Chemistry and the Environment Division Award to three excellent posters at the conference. The winners were chosen from over 40 entries to the *Chemistry for the Environment* theme, based on the overall aesthetics, scientific merit and country of origin.

- 1<sup>st</sup> Place: \$300 Award to Nansi Fakhri, Université Saint-Joseph, Beirut, Lebanon, *et al.*: *PM2.5 sources in the Eastern Mediterranean capital Beirut: chemical characterization and contribution to ambient concentrations*
- 2<sup>nd</sup> Place: \$200 Award to Mahshid Keramatnejad, Concordia University, Montreal, Canada, *et al.*: *The Impact of Air Pollutants on the Biophysical Properties of A Model of Tear Film Lipid Layer*
- 3<sup>rd</sup> Place: \$100 Award to Andrés Villamil Hernández (Universidad Distrital Francisco José de Caldas, Bogotá, Colombia) *et al.*: *An experience for soil recovery and fortification from vermicompost*

Many congratulations to the winners and thank you to our judges!

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See <https://iupac.org/project/2021-008-1-600>

## **CHEMRAWN XXII E-waste in Africa— a boost to take strong actions for a better future**

by **Leiv K. Sydnes**

CHEMRAWN XXII finally became a reality 9-11 November 2021 after a long period of planning. The corona pandemic could have killed the conference when it was ready to be launched, but after some discussion and thorough equipment testing, the organizers decided to run the meeting as a hybrid event with the physical venue in Lagos, Nigeria. In order to reduce costs and facilitate a higher participation, the conference was partly integrated with the 44<sup>th</sup> International Conference of the Chemical Society of Nigeria, which celebrated its 50<sup>th</sup> anniversary on this occasion. This move paid off; CHEMRAWN XXII was attended by more than 600 participants from nine countries, which is among the highest attendances any CHEMRAWN meeting has ever had.

By drawing on examples from the serious situation in Africa, the conference gave an overview of the important parameters that are entangled and make the e-waste problem enormously complex, particularly in Africa. The seriousness became crystal clear in the keynote presentations that started right after the formal opening of the conference. In the very first lecture, the problems caused by e-waste were clearly presented by Aliju Jauro, the Director General of the National Environmental Standards & Regulations Enforcement Agency in Nigeria. The diversity of the problems is enormous, and the documentation of pollution of air, land, and water; and resulting health hazards was just overwhelming. His overview gave an excellent background for later lectures delivered by professors Seun Popoola (Nigeria) and Diana Purchase (UK), who focused on chemical consequences of inadequate e-waste recycling and showed how the complex chemical composition of e-waste leads to a range of health problems and enormous challenges in pollution clean-up and land decontamination. A clear take-home message was that although there is a significant knowledge base already available to carry out such work, more research is needed to improve the level of restoration so that heavily contaminated land again can be used for pasture and other agricultural purposes. And research is indeed carried out, also in the countries affected by the misery as evidenced by the 30 posters about e-waste related problems presented during the conference.