Environmental Science Advances

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2023 Outstanding Papers published in the *Environmental Science* journals of the Royal Society of Chemistry

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We are delighted to introduce the winners of our 2023 Outstanding Paper Awards in this Editorial.

In order to choose the most outstanding papers of 2023, we put together a shortlist of articles published during the year based on a variety of metrics including article downloads, Altmetrics, and citations. We enlisted our Advisory Boards, Editorial Boards, and Associate Editors to select outstanding papers published in our journals from this shortlist.

We are now glad to introduce you to the overall selection of outstanding papers from *Environmental Science: Advances*, *Environmental Science: Atmospheres*, *Environmental Science: Nano*, *Environmental Science: Processes & Impacts* and *Environmental Science: Water Research & Technology*.

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Environmental Science: Advances

Outstanding Paper: Gobindlal, Shields, Whitehill, Weber and Sperry, **Mechanochemical destruction of per- and polyfluoroalkyl substances in aqueous film-forming foams and contaminated soil**, ***Environ. Sci.: Adv.***, 2023, **2**, 982–989, **https://doi.org/10.1039/D3VA00099K**.

Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals with persistent properties that resist degradation in the environment. Aqueous film-forming foams (AFFFs) containing PFAS have been widely used in firefighting training, which may lead to severe environmental contamination. In this paper, Gobindlal and co-workers demonstrate a highly efficient mechanochemical destruction (MCD) technique that could achieve high rates of destruction of PFAS in AFFF concentrates and AFFF-contaminated soils. The process involving the addition of quartz sand to liquid AFFFs as the sole additive, highlighted the potential of MCD for remediating PFAS in contaminated land.

Runner-up Outstanding Paper: Stavinski, Maheshkar, Thomas, Dantu and Velarde, **Mid-infrared spectroscopy and machine learning for postconsumer plastics recycling**, ***Environ. Sci.: Adv.***, 2023, **2**, 1099–1109, **https://doi.org/10.1039/D3VA00111C**.

Outstanding Review: Li, Chen, Li, Breivik, Abbasi and Li, **What do we know about the production and release of persistent organic pollutants in the global environment?**, ***Environ. Sci.: Adv.***, 2023, **2**, 55–68, **https://doi.org/10.1039/D2VA00145D**.

Environmental Science: Atmospheres

Outstanding Paper: Dada, Okuljar, Shen, Olin, Wu, Heimsch, Herlin, Kankaanrinta, Lampimäki, Kalliokoski, Baalbaki, Lohila, Petäjä, Maso, Duplissy, Kerminen and Kulmala, **The synergistic role of sulfuric acid, ammonia and organics in particle formation over an agricultural land**, *Environ. Sci.: Atmos.*, 2023, **3**, 1195–1211, **https://doi.org/10.1039/D3EA00065F**.

This paper describes the complex interactions of agricultural activity and new-particle formation. Specifically, it addresses the role of ammonia and amines emitted from a small farm in Finland that practices mixed husbandry of small-scale crop farming and pasture grazing. In a comprehensive experimental study, the authors show that particle formation is driven when those amines and ammonia combine with sulfuric acid, and subsequent rapid

growth is likely driven by highly oxygenated organics that are also emitted from the farmland. This particle formation is substantially greater than formation rates observed in boreal forest environments. The overall environmental effects of this activity are nuanced; they likely include indirect cooling associated with the nucleated particles rapid growth to form cloud condensation nuclei, but there may be associated negative health consequences as well. The paper thus serves as a benchmark for how thorough study can reveal subtleties in environmental consequences.

Runner-up Outstanding Paper: Lasne, Lostier, Romanias, Vassaux, Lesueur, Gaudion, Jamar, Derwent, Dusanter and Salameh, **VOC emissions by fresh and old asphalt pavements at service temperatures: impacts on urban air quality**, ***Environ. Sci.: Atmos.***, 2023, **3**, 1601–1619, https://doi.org/10.1039/D3EA00034F.

Outstanding Review: Weschler and Nazaroff, **Human skin oil: a major ozone reactant indoors**, ***Environ. Sci.: Atmos.***, 2023, **3**, 640–661, https://doi.org/10.1039/D3EA00008G.

Outstanding Emerging Investigator Series Paper: Bates, Jacob, Cope, Chen, Millet and Nguyen, **Aqueous oxidation of isoprene-derived organic aerosol species as a source of atmospheric formic and acetic acids**, ***Environ. Sci.: Atmos.***, 2023, **3**, 1651–1664, https://doi.org/10.1039/D3EA00076A.

Environmental Science: Nano

Outstanding Paper: Hendriks, Kissling, Buerki-Thurnherr and Mitrano, **Development of single-cell ICP-TOFMS to measure nanoplastics association with human cells**, ***Environ. Sci.: Nano***, 2023, **10**, 3439–3449, https://doi.org/10.1039/D3EN00681F.

The interactions between sub-micron particles and human cells have been of interest for decades. Much of this work has focused on natural and incidental airborne particulates, but in recent years such exposure studies have been expanded to incorporate anthropogenic (human-produced) nanoparticles. These studies have shown that nanoparticles readily associate with human cells and are subsequently taken up *via* a number of well-established pathways. A long-standing challenge, however, has been the difficulty in differentiating human cells from sub-micron carbon-based or plastic particles. Mitrano *et al.* were able to address this challenge through the development of a novel single-cell inductively coupled plasma time-of-flight mass spectrometry (sc-ICP-TOFMS) method. In this approach, mass spectrometry is used to differentiate elemental composition signals arising from individual human cells from those arising from palladium doped nanoplastics. Through the simultaneous monitoring of phosphorous and zinc (representative of cells) and two palladium isotopes (representative of nanoplastic) the authors were able to assess nanoplastic-cell association. This novel approach has potential wide-spread implications with respect to improved assessment of nanoparticle induced cell toxicity as well as nanocarrier-based drug delivery.

Runner-up Outstanding Paper: Gakis, Aviziotis and Charitidis, **Metal and metal oxide nanoparticle toxicity: moving towards a more holistic structure–activity approach**, ***Environ. Sci.: Nano***, 2023, **10**, 761–780, https://doi.org/10.1039/D2EN00897A.

Outstanding Review: Pan, Guo, Zhai, Zhang, Rao, Cao and Guan, **Nanobiopesticides in sustainable agriculture: developments, challenges, and perspectives**, ***Environ. Sci.: Nano***, 2023, **10**, 41–61, https://doi.org/10.1039/D2EN00605G.

Outstanding Emerging Investigator Series Paper: Aguila, Hardee, Schaef, Zare, Qomi, Crum, Holliman, Rodriguez, Anovitz, Rosso and Miller, **Kinetics of diopside reactivity for carbon mineralization in mafic–ultramafic rocks**, ***Environ. Sci.: Nano***, 2023, **10**, 2672–2684, https://doi.org/10.1039/D3EN00087G.

Environmental Science: Processes & Impacts

Outstanding Paper: Rensmo, Savvidou, Cousins, Hu, Schellenberger and Benskin, **Lithium-ion battery recycling: a source of per- and polyfluoroalkyl substances (PFAS) to the environment?**, ***Environ. Sci.: Processes Impacts***, 2023, **25**, 1015–1030, https://doi.org/10.1039/D2EM00511E.

In this work, Rensmo and colleagues review the use of PFAS in lithium-ion batteries. PFAS are a large family of highly fluorinated anthropogenic chemicals that have been associated with many adverse effects on health when released to the environment. Lithium-ion batteries are being increasingly used in electric vehicles and limited availability of critical elements means recycling is particularly important. However, a shift in recycling practices away from high temperature pyrometallurgy processes, which destroys PFAS, toward hydrometallurgy, which operates at lower temperatures, may result in additional PFAS release to the environment. A wide range of PFAS may be released during new recycling practices, highlighting the need to substitute PFAS in these batteries or improve recycling practices to prevent their release.

Runner-up Outstanding Paper: Olson, Boaggio, Rice, Foley and LeDuc, **Wildfires in the western United States are mobilizing $PM_{2.5}$-associated nutrients and may be contributing to downwind cyanobacteria blooms**, ***Environ. Sci.: Processes Impacts***, 2023, **25**, 1049–1066, https://doi.org/10.1039/D3EM00042G.

Outstanding Review: Flood-Garibay, Angulo-Molina and Méndez-Rojas, **Particulate matter and ultrafine particles in urban air pollution and their effect on the nervous system**, ***Environ. Sci.: Processes Impacts***, 2023, **25**, 704–726, https://doi.org/10.1039/D2EM00276K.

Outstanding Emerging Investigator Series Paper: Guo, Chan, Gautam and Zhao, **Autoxidation of glycols used in inhalable daily products: implications for**

the use of artificial fogs and e-cigarettes, ***Environ. Sci.: Processes Impacts***, 2023, **25**, 1657–1669, **https://doi.org/10.1039/D3EM00214D**.

Environmental Science: Water Research & Technology

Outstanding Paper: Mejías-Molina, Pico-Tomàs, Beltran-Rubinat, Martínez-Puchol, Corominas, Rusiñol, Bofill-Mas, **Effectiveness of passive sampling for the detection and genetic characterization of human viruses in wastewater**, ***Environ. Sci.: Water Res. Technol.***, 2023, **9**, 1195–1204, **https://doi.org/10.1039/D2EW00867J**.

This work by Mejías-Molina and colleagues investigates the efficacy of using torpedo-shaped passive samplers containing electronegative membranes to detect viral targets in wastewater. This approach offers a practical and cost-effective solution for monitoring viral pathogens, particularly in smaller-scale settings. This paper demonstrates the enormous public health potential for passive sampling in evaluating viruses in wastewater systems. The breakthrough ability to detect genetic information through passive sampling has unrealized potential to our community.

Runner-up Outstanding Paper: Xu and Li, **Enhancing solar absorbance using a 2D graphene oxide/CuO composite film for efficient solar desalination**, ***Environ. Sci.: Water Res. Technol.***, 2023, **9**, 523–532, **https://doi.org/10.1039/D2EW00656A**.

Outstanding Review: Mutzner, Zhang, Luthy, Arp and Spahr, **Urban stormwater capture for water supply: look out for persistent, mobile and toxic substances**, ***Environ. Sci.: Water Res. Technol.***, 2023, **9**, 3094–3102, **https://doi.org/10.1039/D3EW00160A**.

Outstanding Emerging Investigator Series Paper: Delgado Vela and Al-Faliti, **The role of phage lifestyle in wastewater microbial community structures and functions: insights into diverse microbial environments**, ***Environ. Sci.: Water Res. Technol.***, 2023, **9**, 1982–1991, **https://doi.org/10.1039/D2EW00755J**.

We congratulate the authors of each of these papers for their excellent work and take this opportunity to thank them for submitting their work to the *Environmental Science* portfolio. We extend our thanks to our Advisory and Editorial Board members, as well as our Associate Editors, for their efforts in identifying and evaluating the top papers. And we thank the environmental science community for their continued support of the journal, as authors, reviewers and readers.

Zongwei Cai, Kevin C. Jones and Celia Manaia
Editors-in-Chief
Environmental Science: Advances

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