International Organization
for
Chemical Sciences in Development

**Perspective**

# Towards material circularity: case studies of aluminium, plastics and textiles

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A new paper from the core group of **IOCD's *Chemists for Sustainability*** (Alain Krief, Henning Hopf, Goverdhan Mehta and Stephen Matlin) in collaboration with Klaus Kümmerer and Lisa Keßler at Leuphana University in Germany, discusses the role of the chemical sciences in sustainability.[1] The article makes three key points:

- **Waste is a core problem in the lack of sustainability of the current ways that people use and dispose of materials.** Waste refers not just to the commonly understood category of 'municipal solid waste' (comprising residential, commercial and institutional waste) which is largely disposed of through landfill, incineration or, where controls are lax, through casual discarding in the environment. It also includes the fluids that are exuded into water courses and the gases, volatile materials and microparticulate aerosols and dusts discarded by emission into the atmosphere. We throw away materials as if the Earth had an unlimited capacity to absorb them. But there is no such thing as 'away'.[2] When we throw anything away, it must go somewhere. Together, the materials that people discard pollute the planet's environment and, in the Anthropocene which we now inhabit, are causing massive changes to planetary conditions that are resulting in global warming, climate change, the mass extinction of species – damaging the very conditions necessary to sustain human life on Earth.[3,4,5]

- **It is now essential to adopt a 'post-trash' framework, aiming to approach as closely as is practical to a 'zero waste' society.** The post-trash approach[6] aims to combine three parallel channels of action to (1) ***clean up***: dealing with the historic waste that has been discarded into land, sea and air, contaminating the planet's atmospheric and aquatic systems; (2) ***catch up***: using the most effective currently available technologies to reduce waste outputs from materials currently in use and in production; and (3) ***smarten up***: using rigorous sustainability criteria to progressively improve design, planning and management of materials and processes with the overall objective of maximum practical material circularity.

- **The chemical sciences are central to the achievement of sustainability[7] in the post-trash age.** This means that chemists must work with a wide range of other actors, across other fields of science and technology, with industry and with civil society and policy-makers to improve material circularity. They must acquire new knowledge and skills, such as in systems thinking and interdisciplinary collaboration,[8] underpinned by a clear and rigorously applied understanding of sustainability.[9,10]

The paper illustrates these points with three case studies, explore the sustainability of production, use and disposal of aluminium, plastics and textiles. The case studies employ a systems perspective to examine the ways that different processes and materials interact with one another, the environment and human systems – including aspects related to culture, economics, fashion, policy and regulation. The intra- and inter-system relationships are illustrated by use of the Systems Thinking Concept Map Extension (SOCME) visualization tool which has been developed in earlier collaborative work by IUPAC and IOCD.[11,12,13,14]

The article concludes that tackling the challenges of the material sustainability of society requires a combination of scientific/technical capacities, to which the chemical sciences can contribute, as well as economic viability and political and social support.

The IOCD Action Group, *Chemists for Sustainability* (C4S)[15] works to promote sustainable development, highlight the indispensable roles that science must play, and defend the scientific approach against movements that undermine public trust in science.

**Acknowledgements**
Writing of the published article[1] on which this Perspective is based was initiated at a workshop of *Chemists for Sustainability* (C4S), organized and hosted in Namur, Belgium by the International Organization for Chemical Sciences in Development (IOCD). C4S received funding from the Gesellschaft Deutscher Chemiker and the Royal Society of Chemistry. Lisa Keßler, who contributed to the article, gratefully acknowledges financial support from the Robert Bosch Foundation (12.5.F082.0021.0).

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*Recommended citation:*
S. A. Matlin. *Towards material circularity: case studies of aluminium, plastics and textiles*. Perspective. International Organization for Chemical Sciences in Development, Namur, posted online September 2020. http://www.iocd.org/perspectives

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