Theoretical and experimental study of the persistent brominated compounds of the pyrolysis of e-waste plastics

The recycling of waste plastics used in electric and electronic equipment, or e-waste plastics, has been limited due to undesirable compounds that remain in the products after recycling, even using the most sophisticated methods. In our research, we will combine specialised software to simulate the reactions that would occur and the actual experimental studies performed in the laboratory to test the efficacy of a promising non-toxic compound in removing the compounds that limit the recycling of e-waste. The efficiency of the process will be assessed and further improved by applying parallel theoretical and experimental studies.

Abstract

As electronic waste (e-waste) has increased at an alarming rate, several efforts have been made to improve its circularity, with success in its collection but with limitations on its recycling. Although chemical recycling promises to be a game changer, its efficiency and efficacy in removing undesired chemical compounds have yet to reach the levels needed to recover valuable components easily. We will assess the ability of a non-toxic Zn-based inorganic adsorber to remove the main persistent compounds found after the recycling process, compounds that are present even by using some other catalysts/adsorbers reported in the literature. We performed computational simulations of the possible pathways of the expected reactions between the persistent compounds and the adsorber. To confirm this experimentally, we built a laboratory set-up in which a syringe pump feeds the compound, which is evaporated and carried by nitrogen gas into a heated quartz crucible containing a solid adsorber bed. The efficacy of the process will be assessed by measuring the amount of the original compound in the condensable and gaseous products and by analysing the bromine content in the solid residue and in the liquid fraction. The theoretical studies indicate that the compounds will interact with the adsorber in different ways, such as efficiently removing the bromine, generating char on the surface of the adsorber, or even generating more complex products. The combination of the experimental setup and the simulation tool will allow us to understand and tune the parameters needed to reach the circularity of these materials.

Keywords:

Brominated flame retardants (BFR), Recycling, Bromine removal, ZnO, plastics, electronic and electric equipment wastes (WEEE), Density functional theory (DFT), Pyrolysis.