Greening-up Polymers Production: from Bio-Renewable Building Blocks to Sustainable Solvents

Vincenzo Taresco

School of Chemistry, University of Nottingham, Nottingham, UK

As environmental impact becomes a more pressing concern, there is an increasing interest in alternative solvents that have the potential to alleviate water contamination issues, reduce energy costs and reduce the impact on the environment. Supercritical carbon dioxide ($scCO_2$) is a promising alternative solvent, combining considerable environmental advantages with the desired solvation and diffusivity properties of super critical fluids. It is a cheap, non-flammable and environmentally friendly solvent, with an easily attainable critical point at relatively mild conditions (Tc = 31.1 °C and Pc =73.8 bar). A further advantage of using $scCO_2$ as a polymerisation medium, is found after the polymer is formed. When returning to atmospheric conditions, CO_2 reverts to the gas phase providing a solvent free polymer product, without the need for energy and cost intensive drying processes.

At the same time, there is significant potential for industrial use of renewables for a wide range of materials demanded by society. Plants and trees, food- and biodiesel- waste streams, among other sources, are increasingly attracting attention as sustainable sources for functionalised and polymerisable building blocks. Our research aims at expanding the opportunities to exploit the largely untapped renewable feedstocks coming from nature and waste streams and exploit benign enzymatic catalysis and/or controlled radical polymerisations using supercritical carbon dioxide (scCO2) and bio-derived solvents avoiding use of any petrochemically derived solvents.

This work highlights promising and clean approaches to produce bio-renewable polymers capable of either outperforming fossil-based alternatives or possessing new properties and functionalities of relevant interest in the framework of the circular economy.

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