Acidolysis of polybenzoxazine vitrimers: from recyclates to recycled materials

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One of society's main challenges currently is waste management; more specifically, the recycling and valorization of plastic and composites wastes. In the latter case, the recovery of high-value reinforcing fibres is of particular interest and has motivated the use of vitrimers as matrix materials in carbon-fiber reinforced polymers (CFRPs) [1]. Conventional composite recycling often requires high temperatures and pressures and strong reagents [2]; consequently, while the reinforcement can be recovered, the matrix is often downcycled or disposed of. The dynamic covalent bonds present in vitrimers endow these crosslinked polymer networks with reshapeability, reprocessability and recyclability while preserving the high levels of performance typically associated with thermosets. Chemical recycling has been identified as a promising approach for component separation in vitrimer composites via dynamic bond cleavage. Polybenzoxazine (PBz) vitrimers are single-component, self-catalyzing, reprocessable and recyclable thermosets of high interest due to properties competitive with other resins used in CFRPs [3]. They have been chemically recycled in acetic acid by Adjaoud et al. [4] and more recently by Seychal and coworkers [5], these being among the few examples of recycling using weak acids. That said, the parameters governing the efficacy and mechanisms of the process are still in need of further investigation.

This poster focuses on the acidolysis of PBz vitrimers under mild conditions. The recyclates were characterised using nuclear magnetic resonance (NMR) spectroscopy to better understand degradation mechanisms. Vitrimer digestion was followed by various post-treatments of the resulting recyclate in order to favor dynamic bond recovery within the network. The post-treated recyclates were then hot pressed and the reconsolidation quality and post-recycling properties assessed by micro-computed x-ray tomography (µ-CT), thermal and rheological measurements. The findings of this effort have implications for the chemical recycling of vitrimers more broadly.

References:

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