THERMALLY DE-CROSSLINKING POLYMERS: THE PATHWAY TO REVERSIBLE THERMOSETS?

Ton Broekhuis[1] and Francesco Picchioni[1]

[1]University Groningen, The Netherlands
Email: a.a.broekhuis@rug.nl

ABSTRACT

Inspired by the phenomenon of self-healing in biological systems, the synthesis of man-made self-healing polymeric materials has become a newly emerging paradigm and a fascinating area of research. Self-healing materials have the capability to repair or recover themselves when suffering mechanically and/or thermally induced damage, which can occur autonomously or be activated by external stimuli (e.g. heat) for once or multiple times. However, costly and complex synthetic pathways, and the loss of mechanical properties after self-healing or remending so far limited further development. Here we report a self-healing polymeric material developed on the basis of furan-functionalized alternating olefin-carbon monoxide co- and terpolymers (aliphatic polyketones) and bis-maleimides. The highly cross-linked polymers can be thermally remended to complete recovery in fracture loading, while the remending process can be repeated multiple times without any loss in mechanical properties. The system and new information regarding the tailoring of reversibility temperatures and a surprising polymer-memory effect will be discussed. It is found that the achieved self-healing ability of this easily accessible system provides recyclability and reworkability, which often is perceived as difficult or impossible for thermosetting polymers. We believe that the simplicity of the synthesis, the broad range of available aliphatic polyketone precursors, and the striking healing ability of this system could expand the scientific understanding of self-healing materials and introduce the cradle-to-cradle concept for thermoset-based plastics and composites.