

Investigation on extruded PS based Vitrimer-Homopolymer symmetric blends

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Vitrimers are a class of polymeric materials with great potential in becoming an alternative to conventional crosslinked systems, mostly due to their ability to act as crosslinked systems at low temperatures and as thermoplastic polymers at temperatures higher than a characteristic value known as T_v . This behavior arises due to their crosslinked network consisting of dynamic covalent bonds. The appeal of these materials originates from the recycling and sustainable design of plastics, as they prove to be a valuable alternative to classic thermoset polymers.

The goal of this work is to study the effects of vitrimeric materials as additives to their homopolymeric counterparts. To this end, Poly-Styrene based vitrimers by grafting dioxaborolane functionalities along the polymeric backbone of commercial grade PS, followed by a crosslinking of said functionalities. Successively, vitrimer and homopolymer were mixed through an extruder at different compositions, obtaining blends. Both pure components and blends were then reprocessed through the extruder multiple times, in order to ascertain the effect of the vitrimeric filler on the thermomechanical degradation behavior of PS.

The obtained products were then characterized to gain insight into the effect of vitrimeric networks on the mechanical properties of recycled plastics. Both pure components and blends' rheological properties were characterized through experiments in the linear viscoelastic regime, such as small amplitude oscillatory shear (SAOS), Creep and Stress Relaxation. The materials characterization was supported by electron microscopy (SEM), small angle x ray scattering (SAXS), calorimetry and further mechanical testing.

Through these test we found that the addition of a vitrimeric fraction to its homopolymer does not affect processability, as the materials were easily extrudable. On the other hand, from the rheological data we were able to determine an increase in both resistance to degradation and mechanical properties of the systems, such as an increase in zero shear viscosity by 27% when 5% weight content of the vitrimer is added to the homopolymer.

With these results we were able to identify vitrimeric systems as promising fillers when blended with their homopolymers, causing a general increase in the thermoplastic material's performance, while keeping the system's processability intact.