RECYCLED POLYPROPYLENE WITH ENHANCED PROCESSABILITY: EFFECT OF A REPAIRING ADDITIVE

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Plastic recycling is a key aspect to achieve effective polymer circularity, especially for polyolefins for which usually the mechanical recycling is considered a downcycling process. The last, due to the progressive deterioration of the polymer microstructure during the reprocessing, leading to a gradual loss of processability and properties, hence compromising the added value of r-polyolefins. In this context, in this work the effects of the thermomechanical degradation and of the introduction of a commercially available repairing additive on the evolution of the polypropylene (PP) microstructure were evaluated, aiming at proposing an effective upcycling strategy for achieving recycled PP with enhanced processability.
The mechanical recycling of PP was simulated by subjecting the material up to 9 re-processing cycles using a twin-screw extruder. The repairing additive (Nexamite R201 (NEX), Nexam Chemical) was introduced at 5 wt.% within PP during the first reprocessing cycle of PP (to simulate pre-consumer recycling) and in PP already subjected to 8 reprocessing cycles, mimicking the typical conditions of a post-consumer recycling. The NEX-induced microstructural modifications of PP during the reprocessing cycles were monitored through rheological, thermal, and spectroscopic analyses.
Firstly, the microstructural changes induced by the thermomechanical degradation that PP undergoes during a typical mechanical recycling process were evaluated through rheological and thermal analyses. The obtained results confirmed that the main mechanism of degradation of PP involves the occurrence of chain scission reactions, resulting in a severe progressive decrease of the polymer molecular weight. FTIR analyses suggested that the structural degradation affecting the polymer molecular weight is predominant as compared to the functional degradation, since the oxidative degradation undergoes from PP is quite negligible. A detailed rheological study allowed demonstrating that the introduction of NEX can effectively prevent the decrease of the molecular weight of PP, especially when the additive is added in a low degraded PP (i.e. in the case of pre-consumer recycling). Furthermore, it was also showed that NEX can induce some melt structuring phenomena, involving the obtainment of branched structures or crosslink points, especially if the melt processing is carried out for long residence times. Finally, the results coming from DSC analyses confirmed the inferred modification of the PP macromolecular architecture.