Keynote (S16-143, Time: Wednesday 10:15, Room: Bruker AXS)

Optimization of polypropylene-based materials for 3D printing processes: a detailed rheological study

Frache Alberto[1], Bernagozzi Giulia[2], Battegazzore Daniele[2], Arrigo Rossella[1]

[1]Politecnico di Torino, Alessandria, Italy
[2]Politecnico di Torino, Torino, Italy

Among all the 3D printing techniques for polymers processing, Fused Filament Fabrication (FFF) is the most used and the most developed in the global production system, being simple and economic in terms of both materials and tools. However, the limiting factor for additive manufacturing processes for polymer-based systems is the poor variety of available material. The aim of this work is the development of a deep knowledge about polypropylene (PP) focusing on its fundamental characteristics in order to be suitable for FFF process. PP-based compounds containing different amounts of talc, calcium carbonate or an organomodified montmorillonite have been formulated using a twin-screw extruder and characterized, aiming at optimizing the thermal and rheological properties of the materials. In particular, the introduction of the different types of fillers allowed reducing the melting entalphy of the PP-based systems, hence minimizing the typical high volumetric shrinkage of PP and, consequently, the severe warpage usually observed in 3D-printed manufacts based on semi-crystalline polymers. As far as the rheological behavior of the investigated materials is concerned, the results of small amplitude oscillatory shear measurements pointed out that the presence of all used fillers caused the disappearance of the Newtonian behavior exhibited by unfilled PP at low frequencies, with the occurrence of a yield-stress behavior which is progressively more pronounced as the amount of fillers increases. Furthermore, all investigated composites shown a marked shear thinning behavior at high frequencies. Therefore, the introduction of the different fillers allowed properly modifying the rheological behavior of PP, helping in ensuring an effective printability of the materials. Finally, a step-by-step optimisation of the process parameters has been conducted to fulfil the FFF filament requirements and to improve the details resolution of a 3D printed little model.