DEVELOPMENT OF A PP-BASED MATERIAL WITH FLAME RETARDANT PROPERTIES FOR 3D PRINTING

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Frache A[1,2], Lorenzi E[1,2], Arrigo R[1,2]

[1]*Department of Applied Science and Technology, Politecnico di Torino, Alessandria, Italy*
[2]*National Interuniversity Consortium of Materials Science and Technology (INSTM), Florence, Italy*

Fused filament fabrication (FFF) is one of the most used techniques for 3D printing of thermoplastic materials. Despite the rapid development of FFF techniques, their application is still limited by the modest availability of suitable materials. In particular the use of polypropylene (PP), one of the most studied and used polymer, is still very limited and challenging in FFF process. In addition, there is a lack of functionalized PP-based materials, including, for example, those with flame-retardant properties. In this context, a PP-based flame retardant filament suitable for FFF processing and its burning behavior were developed.
A polypropylene-polyethylene random copolymer (PP COPO), the organophilic phyllosilicate Cloisite 20A (C20A) and polypropylene-graft-maleic anhydride (PP-g-MA) were used. The nanocomposite PP COPO + 5% C20A + 3% PP-g-MA was produced through melt compounding in a twin-screw extruder. After that a filament suitable for 3D printing was successfully prepared and samples for cone calorimeter test were produced by FFF process. In order to make a comparison, the same specimens were also produced by compression molding. A complete thermal, rheological, and morphological characterization was performed on the materials obtained.
First, it was verified that the nanocomposite had the rheological characteristics suitable for the 3D FFF process with in particular the presence of the yeld stress behavior at low frequencies.
After that, the process conditions to obtain the filament were optimized with special attention to the cooling parameters of the wire exiting the extruder to avoid ovalization of the filament. After that, samples were produced and tested for flame-resistant properties.
At the cone calorimeter, an improvement in behavior was found with a lowering of the peak HRR by 30 percent. Also comparing the carbon residues obtained from the FFF process and compression molding, it was noted that the former gave better compactness of the protective layer of the polymer giving promising results. Finally in the UL-94 test, it could be found that again with the FFF process, comparable or better results were obtained than the compression molding process but also with the different effect of the methodology of deposition of the filament to go to form the specimen.