3D PRINTED PLA-BASED BLENDS WITH IMPROVED INTERLAYER BONDING

A. Frengkou[1], E. Gkartzou[1], S. Anagnou[1], D. Brasinika[2], C. A. Charitidis[1]*

[1]Laboratory of Advanced, Composite, Nano-Materials and Nanotechnology, School of Chemical Engineering, National Technical University of Athens, Greece,

[2]BioG3D- New 3D Printing Technologies, Technological Cultural Park Lavrion, Greece

(*****charitidis@chemeng.ntua.gr)

ABSTRACT

In order to optimise interlayer bonding and structural integrity of structures produced by Fused Filament Fabrication (FFF), commercial grades of high-molecular weight poly (lactic acid) (PLA) and PLA-based blends were comparatively assessed in terms of their mechanical properties. In FFF process, a continuous thermoplastic filament is melted in the extruder of the 3D printer and deposited on the build platform to form the object layer by layer. In order to study the mechanical properties of the different compositions and FFF processing profiles, tensile specimens were fabricated. An experimental protocol for FFF tensile specimens fabrication was defined, in order to eliminate common structural defects introduced during FFF process. 3D printed specimens were fabricated in the same position and orientation, after precise levelling and calibration of the FFF system, in order to avoid variations of print-head positional accuracy in XYZ working space. Fractographic analysis of tensile specimens with different process parameters was conducted, in order to provide feedback on the selection of process parameters such as layer height and path width, that result in improved structural integrity of FFF specimens. Subsequently, tensile specimens with different PLA formulations were fabricated with the same experimental protocol and selected process parameters for the comparative assessment of their mechanical properties and inter-fiber and inter-layer bonding. Tensile testing was based on an adjustment of ASTM D638 standard and was carried out under the same environmental conditions (temperature, humidity). Results from SEM fractographic analysis indicate an improvement on interlayer bonding and reduction of inter-fiber voids with the optimisation of the process parameters (Figure 1). This is in accordance with stress-strain curves exhibiting an increase in Young modulus and Ultimate Tensile Strength UTS). Additionally, further reduction of voids and improvement of UTS and elongation at break was achieved in PLA blends employing constituents with complementary rheological/ mechanical properties.

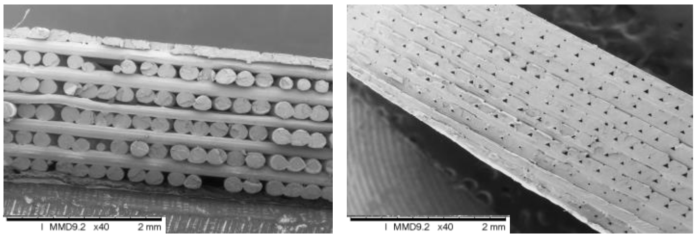

Figure 1: SEM micrographs of tensile fractured surfaces indicate improvement on interlayer bonding by the optimized parameter settings and reduction of gaps among individual layers. (from left to right).

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