

Thermo-mechanical study of PLA for FFF process

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Abstract. The objective of the present work is the study of Polylactic Acid (PLA) filament properties on final quality of Fused Filament Fabrication (FFF) parts. The main operating parameters (design and process) of the FFF process are taken into account, identifying important correlations between PLA properties and part performances. A commercial low-cost FFF machine was selected for realizing investigated parts. The quality of the products is evaluated in terms of mechanical strength and linear temperature expansion coefficient. The experimental activity and related testing of products are fully described.

Fused Filament Fabrication (FFF) is the most widespread Additive Manufacturing (AM) processes used for thermoplastic prototypes, tools and low-volume products. Also called Fused Deposition Modeling, it is an extrusion-based process in which products are realized by melting polymer-based filaments and depositing molten materials on a horizontal build platform. The calculation of layer contours from a digital model of the part (slicing) is the basis for the generation of extrusion trajectories by appropriate programming software. The objectives of this research are the analysis of a PLA filament and the evaluation of its processability with FFF process. The analysis starts with the examination of the polymeric material and measurements of its main thermal and rheological properties to identify the main processing parameter window. The choice of FFF is justified due to the several advantages offered over other additive manufacturing processes such as the reduction in part weight, better mechanical properties in relation to the part weight, and possibility of hybridizing process with traditional techniques. After the material characterization, parts are fabricated. Two cylinders with different lengths are produced, identified as type A ($\varnothing 20 \times 20 \text{ mm}^3$) and type B ($\varnothing 10 \times 30 \text{ mm}^3$). The two parts are simultaneously produced, to guarantee the same processing conditions. The processability of the PLA filament are assessed through the evaluation of the mechanical behavior of the 3D FFF parts in terms of stress-strain and thermal expansion comparing results in a selected range of process conditions. The process chain is shown in **Figure 1**.

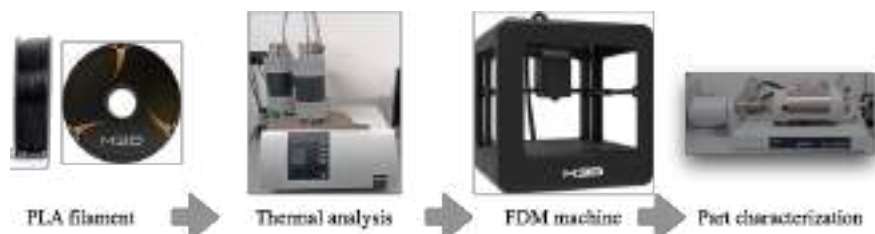


FIGURE 1: Thermo-mechanical characterization.

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