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# An experimental and computational methodology for improving performance of 3D printed recycled thermoplastics

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## Abstract

Recycled thermoplastics, such as polylactic acid (PLA), are increasingly employed in extrusion-based additive manufacturing (EB-AM) due to its sustainability and low environmental footprint. However, repeated extrusion and re-printing cycles introduce thermo-mechanical degradation that alters viscosity, melt mobility and interlayer adhesion. These changes significantly influence the final mesostructure and the final mechanical performance of printed parts. With the aim of understanding the recycling capabilities of thermoplastics in EB-AM processes, we propose a hybrid experimental–computational methodology. Thus, an experimental characterization is carried out on different recycling cycles, combining mechanical and rheological characterization. In addition, we develop a computational model to simulate the coalescence process between perpendicular filaments. This model allows us to study how the change in viscosity due to the thermal degradation over the recycling cycles can affect the interlayer during the printing process. The combined methodology provides quantitative insight into how recycling alters the virgin material and enables the identification of optimal processing parameters for reliable printing of recycled materials. The framework also establishes a general pathway for linking material degradation, printing process and mechanical performance in EB-AM polymers. Acknowledgment: The authors acknowledge support

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