A COMPARATIVE STUDY IN FUSED FILAMENT FABRICATION USING RECYCLED POLYSTYRENE AND COMMERCIAL HIGH-IMPACT POLYSTYRENE.

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Abstract

Discarded expanded polystyrene (EPS) poses significant environmental challenges due to its accumulation in landfills and resistance to degradation. Upcycling EPS into 3D-printable recycled polystyrene (rPS) filament for use in fused filament fabrication (FFF) shows a promising sustainable solution. This study explores the mechanical recycling of EPS into rPS resin, which is then extruded into 3D-printable filament using a 3DEVO filament maker. A key focus is on studying the filament's properties and properties of its printed specimen. Filament diameter was monitored in real-time during extrusion using DevoVision software. The results showed that rPS filament achieved an average diameter of 1.75 mm with a standard deviation of ±0.03 mm when extruded at 200 °C. Extrusion at temperatures above 200 °C resulted in filament diameters exceeding 1.75 mm. Specimens printed with rPS filament exhibited higher tensile strength, tensile modulus, and elongation at break, but lower impact strength compared to those printed with commercial high-impact polystyrene (HIPS) filament. Micrographs show that HIPS is a more ductile material, which contributes to its better impact strength. However, due to poor layer adhesion during printing, it exhibited lower tensile properties. The onset thermal degradation temperature of rPS decreased by about 3% during the recycling process from EPS to filament. However, this reduction does not limit the use of rPS for FFF printing applications, as the printing temperature remains lower than its thermal degradation onset. Despite HIPS displaying greater thermal stability, rPS demonstrates strong potential as a sustainable printing material.

Keywords: Recycled polystyrene, High-impact polystyrene, Fused filament fabrication, 3D printing, Additive Manufacturing.