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ABSTRACT

Performance Analysis of High-Speed MEX Additive Manufacturing using High-Performance Polymer

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Fused filament fabrication (FFF) is the most common material extrusion (MEX) additive manufacturing (AM) technology. However, its printing speed, typically between 20 and 100 mm/s, is limited by factors such as the material's properties, the geometric complexity of the part, and the melting and extrusion capabilities of the hot end/extruder system. Previous attempts to increase FFF printing speeds to around 150 mm/s often resulted in compromised layer adhesion and diminished overall print quality. This study investigates the correlation between printing speed and the melting and extrusion performance of an FFF system utilizing a high-performance polymer. Printing speeds were systematically varied from 50 mm/s to 450 mm/s, with increments of 50 mm/s. The resulting printed parts were comprehensively analysed, with a focus on evaluating printing time, weight and dimensional accuracy, surface finish quality, tensile strength, degree of crystallinity, and elastic or complex modulus. Notably, compared to the control speed of 50 mm/s, a printing speed of 300 mm/s achieved an 80% reduction in printing time while maintaining comparable part properties across all measured parameters. This suggests the potential for significant throughput improvements in FFF by optimizing printing speed in conjunction with high-performance polymers.