Effects of printing parameters on the mechanical characteristics and mathematical modeling of FDM-printed PETG

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Abstract

3D printing technology has revolutionized free-form construction and customization demand through its ease of use, fast production, accurate, regulated deposition, and flexibility with soft functional materials. Fused deposition modeling (FDM) is an ideal technique for the 3D printing of plastics. The low cost, high prototyping precision, and ease of use make it a popular additive manufacturing process. The dimensional stability, quality, functionality, and properties of printed specimens are all affected by the process parameters used in the FDM technology. As such, the present work investigates the effect of the infill pattern and infill density on the PETG mechanical characteristics. The work also finds the optimum parameters to enhance the mechanical properties using the response surface methodology (RSM). Scanning electron microscopy (SEM) was used to study micro-surface defects under different processing conditions. Based on the tensile strength experiments, the concentric pattern was recorded to have the highest UTS, *E*, and yield values compared to the other designs, at 28.53 MPa, 0.81 GPa, and 20.00 MPa, respectively. In contrast, from compression analysis, the highest compression strength and compression modulus (24.03 MPa and 3.71 GPa, respectively) were obtained for the triangular infill pattern, which absorbs more compressive force compared with the other patterns. Meanwhile, it was also observed that increasing the density from 25 to 75% improves mechanical properties. The RSM analysis reveals the significant parameters for both testing methodologies with mathematical models to predict the properties with 95% certainty.

KEYWORDS

Fused deposition modelling; Polyethylene terephthalate glycol; Mechanical characteristics; Response surface methodology; ANOVA; Scanning electron microscopy

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