Optimization of Impact Properties of Copper-Polylactic Acid (Cu-PLA) Composite Using Response Surface Methodology for FDM 3D Printing

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Abstract:
This study attempts to provide a statistical evaluation of the effect of Cu wt.% and infill pattern on the FDM-based 3D printed parts' impact properties. The developed model is based on the acquired experimental data accompanied by response surface methodology (RSM) analysis. The confidence level for RSM is set to 95% ($\alpha = 0.05$), where P-value lower than 0.05 shows a significant effect by the parameter. Besides determining significant parameters, this analysis also provides modeling of impact properties and optimizes the desired mechanical performance parameter. ANOVA analysis includes data of standard deviation (S), coefficient of determination (R2), adjusted and predicted (R2). Infill pattern and Cu wt.% show a significant effect on both factors, including energy absorbed and impact strength. The model created for the energy absorbed and impact strength has an error of 7.23 % and 6.60 %. The maximum energy absorbed and impact strength obtained through optimization is 2.5180 J and 35.3657 kJ/m2, respectively, through the combination of two main factors, including Concentric infill pattern with 25 wt.% Cu. The mathematical models of the impact properties were also developed using RSM, focusing on varying copper composition and infill patterns, which can be used to predict desired impact properties.

Keywords: Impact properties; Response surface methodology; Cu-PLA; ANOVA; Energy absorbed

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