Mechanical property and prediction model for FDM-3D Printed Polylactic Acid (PLA)

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ABSTRACT

Fused deposition modeling (FDM) has been the preferred technology in 3D printing due to its ability to build functional complex geometry parts. The lack of the printing parameter information and prediction model that directly reflects towards 3D printed part's mechanical properties has been a barrier for the FDM 3D printer users to appraise the product's strength as a whole. In the present work, 27 tensile specimens with different parameter combinations were printed using a low-cost FDM 3D printer according to the ASTM standard to evaluate their tensile properties. Statistical analysis was performed using MINITAB to validate the experimental data and model development. The investigational outcomes reveal that ultimate tensile strength was primarily affected by infill density, whereby it increases with increasing infill density. Elastic modulus, fracture strain, and toughness were mainly affected by infill density and layer thickness. The ideal printing parameter for optimal tensile behavior was identified to be 0.3 mm layer height, 40° raster angle, and 80% infill density from the 9th combination. The tensile values obtained for the optimal printing parameter were 28.45150 MPa for ultimate tensile strength, 0.08012 mm/mm for fracture strain, 828.06000 MPa for elastic modulus, 20.19923 MPa for yield strength, and 1.72182 J/m^3 for toughness. The statistical analysis further affirmed the optimum printing has a minimal deviation from the experimental response. Finally, a mathematical model is proposed for the tensile properties prediction.

KEYWORDS

3D printing; Fused deposition modeling; Mechanical test; PLA; RSM

ACKNOWLEDGEMENTS
The authors are grateful to Universiti Malaysia Pahang (www.ump.edu.my) for the financial support provided under the Grants RDU192216, RDU190352, and RDU192403.