ABSTRACT

This Master thesis investigated the enhancement of thermomechanical properties in DLP 3D-printed nanocomposites by synergistically incorporating low-content alumina and boron nitride fillers with polyurethane acrylate resin. The research explored the impact of nanofillers addition on thermal conductivity, thermal stability, mechanical properties, surface roughness, and chemical structure integrity. Various testing methods were executed, including thermal conductivity measurements by means of the FOX 50 Heat Flow Meter, thermal stability analysis via thermogravimetric analysis (TGA), mechanical performance evaluation using ASTM D638-IV tensile tests, hardness testing with the GS-709G Shore D Hardness Tester, surface roughness analysis with stylus profiler KLA Tencor D-600, and chemical structural analysis with Fourier-transform infrared spectroscopy (FTIR).

Findings highlighted that the addition of nanofillers improved thermal conductivity, with synergistic approach of filler loading exhibiting the most significant enhancements. Thermal stability was also enhanced, as evidenced by higher decomposition temperatures and lower degradation rates compared to pure resin. However, the study noted a trade-off with mechanical properties, where increased filler content reduced ductility and hardness. Surface roughness was found to influence thermal conductivity, highlighting the importance of optimizing surface characteristics for thermal performance.

Sample code RAB 6 exhibited notable enhancements, including a 9% increase in thermal conductivity at 30°C, a high decomposition temperature of 490°C, a substantial residue weight of 14.6%, a roughness (Ra) of 2.01 microns, a surface hardness of 83.89, and maintained chemical structure integrity. However, it experienced a 25% reduction in strain at break compared to pure polyurethane acrylate resin.

Keywords: 3D Printing, Polymer nanocomposite, Thermal conductivity, Thermal stability, Boron nitride, Aluminum oxide, Mechanical properties.