Mechanical Engineering Thesis Defense

Rheology and Dispersion Study of Printing Ink for Ultrafast Layer-less Fabrication of 3D Metal Objects Using Vat Photopolymerization with Continuous Liquid Flow

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Abstract

Stereolithography (SLA) is an innovative additive manufacturing technique that has gained immense popularity in recent times due to its ability to produce complex and precise three-dimensional objects. However, the quality of the final product depends on the stability and homogeneity of the photocurable metallic slurry used, which is crucial for manufacturing high-quality parts with good surface finish and higher density. To achieve homogeneity in the photocurable metallic resin, the study conducted on optimizing the printing ink for ultrafast layer less fabrication of 3D metal objects investigated the effectiveness of different dispersants such as KH560, Triton X-100, BYK 2013, BYK 2030, and BYK 111. The use of dispersants plays a vital role in optimizing the ink and enhancing the surface finish and density of the final product. The rheology results showed that the appropriate dispersant has the potential to improve the properties of the printing ink and benefit the integrity of the printed green bodies and their surface finish. By using the optimized suspension, the study was able to fabricate parts with high metallic loading at an ultrafast speed using the Continuous Liquid Interface Production technique. FTIR analysis, sedimentation testing and rheology study has been carried out which demonstrates the effects of utilization of various dispersants optimally to improve the homogeneity and manufactured part's integrity. Power law has been used to understand the viscosity behavior of dispersants in a photocurable slurry with copper sulphate keeping the parameters such as shearing rate, stress, torque intact. The microscopic images of the sintered parts showed high precision and an extremely smooth surface finish, which underscores the technique's potential to produce high-quality 3D metal objects. The solubility of dispersants significantly influenced the structural quality after washing and debinding processes. This study provides valuable information to design photocurable metallic suspensions for metal salts like copper sulphate pentahydrate.

April 14, 2023; 1 PM; ECG G315