Development of a Bioactive, Biodegradable, and Variable-Density 3D Printer Filament for Patient-Specific Bone Reconstructive Implants

Rose, Jacob (School: North Carolina School of Science and Mathematics)

Current orthopedic implants are restricted in the level of patient specificity and biological interaction they can achieve. The demand for more effective and less intrusive reconstructive orthopedic implants has been increasing with an aging population. This project aims to develop a bioactive, biodegradable, and variable density 3D printer filament for use in patient-specific bone implants. Using Polylactic-acid (PLA) as a biodegradable structural polymer, hydroxyapatite (HA) as a bioactive agent to increase osteoblast integration, and a chemical-foaming-agent (CFA) as a temperature-sensitive foaming agent, a 3D printer filament was produced with properties of each component. This filament was assayed to determine how physical properties of 3D printed parts change based on manufacturing temperature. The filament was demonstrated to have controllable density, modulus of elasticity, and ultimate tensile stress when printing at temperatures chosen based on the decomposition temperature of the CFA. The ability to tune these properties on a patient-specific scale can greatly improve the efficacy of orthopedic implants as surrounding bone tissue will more readily accept material that matches its properties.

Awards Won:

Fourth Award of $500