Functionalized Polylactide Filament for Additive Manufacturing

Sundararajan, Suvin (School: Westfield High School)

This project designs the manufacturing and polymerization process for synthesizing filament in fused deposition modeling. The purpose was to enhance the flame-retardant properties of polylactide (PLA) through additives to be viable for commercial applications. To manufacture filament, deoxybenzoin, a novel flame-retardant, was synthesized in a lab and incorporated into PLA through a four-step procedure. Batches were created with a control group of PLA, systematic amounts of deoxybenzoin, and industry standard flame-retardant for benchmarking. A self-developed robotic puller kept filament diameter consistent at 1.75mm. The deoxybenzoin was tested with nuclear magnetic resonance to verify the polymer. The blends underwent FT-IR for spectrum analysis. Thermogravimetric analysis and differential scanning calorimetry analyzed thermal properties. Mechanical analysis was done through tensile tests. Properties were benchmarked with mainstream polymers. Results indicated that incorporating deoxybenzoin and PLA in the manufacturing process increased the charring residue by 400%, enough to pass ISO vertical flame-test standards. The polymer improved the tensile strength from 37 mPa (PLA) to 50 mPa, outperforming most commercial polymers. The new filament prints more precisely than PLA and has a lower print-fail rate, qualifying it for implementation in high-precision aerospace parts and the construction industry.

Awards Won: