

DEVELOPMENT OF STRONTIUM FERRITE/POLYAMIDE 12 COMPOSITES FOR MAGNETIC DEVICES USING ADDITIVE MANUFACTURING

by

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ABSTRACT

Among several advantages, additive manufacturing facilitates the rapid prototyping and the realization of end-use objects that cannot be made with traditional manufacturing methods. Recently, additive manufacturing of permanent magnetic structures through inkjet, Fused filament fabrication (FFF) and Stereo Lithography (SLA) methods is being investigated. Soft or hard magnetic particles are included in the binder to build objects of high interest for magnetic shielding, magnetic flux guiding, or permanent magnetic properties. For the latter category, typically upon completion of the printing process the object is magnetized by an external magnetic field. In this study, we follow a different approach and apply an external magnetic field during the printing process. This allows the magnetic particles to be oriented in a well-defined direction resulting in the realization of magnetic structures with complex well-defined easy axis and/or magnetic dipole distribution functions that vary across a mesoscopic scale. Magnetic filaments will be made by mixing Strontium Ferrite powders and Nylon 12 using a co-rotating twin screw extruder. No magnetic field is applied during the realization of the filament. Small elliptical cylinders will be printed with Lulzbot Taz 6 FFF 3D printer. During the printing process, a magnetic field will be applied to the molten compound using a permanent magnet. The magnetic properties, including the sample's magnetic moment and the magnetic anisotropy, will be measured with a MicroSense Biaxial Vibrating Sample Magnetometer. The distribution of the magnetic particles in the printed material and the magnetic material will be studied through a Scanning Electron Microscope, and X-ray diffraction will be implemented to analyze the magnetic powder crystal structure and phase. The effect of viscosity, extrusion temperature, printing speed, and magnetic field direction and magnitude on the magnetic anisotropy will be investigated. Tensile and flexural properties will be evaluated using appropriate ASTM standards.