DEVELOPING HIGH-PERFORMANCE POLYAMIDE BONDED MAGNET FOR MAGNETIC FIELD ASSISTED ADDITIVE MANUFACTURING (MFAAM) PROCESS

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ABSTRACT

Thermoplastic bonded magnetic composites combine the cost-effectiveness, low density, and manufacturing flexibility of conventional thermoplastics with the unique characteristics of magnetic powders/fillers to form multifunctional magneto polymeric composites that offer superior properties to conventional materials. At elevated temperatures, the magnetic properties change significantly and the particles within the magnetic powders experience sporadic motion due to the heat which causes misalignment of the magnetic domains, leading to a decrease in magnetism. Due to this adverse thermal effect, high-performance polymers such as polyetheretherketone (PEEK), polyetherimide (PEI), or high-performance polyamides (HPPA) have been considered suitable binders for magnetic fillers, thereby creating a much wider usage for magneto polymeric composite in applications that requires higher temperature (typically above 175 ºC). Thus, this research focuses on developing high-performance polyamide bonded magnets with a good combination of magnetic, mechanical, and thermal properties for the additive manufacturing process. Hard ferrite powders (Strontium ferrites) will be subjected to ball milling for particle size reduction prior to surface functionalization using silane agents. The surface-treated ferrite powders will be compounded with a polyamide 4.6 matrix using the twin screw extrusion technology to produce bonded magnet monofilaments. This monofilament will be 3D printed into test samples under a magnetic field to demonstrate a magnetic field-assisted additive manufacturing process. The morphological investigation will be done via SEM to evaluate the

quality of dispersion of the ferrite powders in the bonded magnets. Mechanical testing will be conducted on the test samples to evaluate the tensile and flexure properties of the bonded magnets. Thermal analytical techniques such as thermogravimetry and differential scanning calorimetry will be used to evaluate the thermal stability and transition temperatures of the bonded magnets. The magnetic properties of the bonded magnets will be evaluated using a biaxial vibrating sample magnetometer (VSM) to determine its hysteresis curves and a torque magnetometer (TM) will be used to measure the anisotropy of the bonded magnets. Magnetic properties as a function of temperature will be performed with the VSM to explore the orientation of the magnetic particles in a magnetic field and determine their dynamic behavior. These materials' characterization properties will be correlated to evaluate the multifunctionality of the developed high-performance polyamide bonded magnets.