NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

Cycle 17
January 2023

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Project Title.
Additive Manufacturing of Advanced Magnets for Power Systems ((AM)²PS)

Abstract.
Electric motors are ubiquitous in our technological society, powering everything from washing machines to hard disk drives to traction drive motors in electric vehicles. About half of the U.S. electricity usage is by electric motors; thus, even small improvements in efficiency will be impactful. Magnetic materials are the most critical component of electric motors, and thus improvement in the material or magnet design (improving flux concentration) offers a path to improved motor performance. Permanent magnet (dc) motors, the most efficient of the electric motors, utilize permanent magnets to produce the required flux. The strongest class of permanent magnets are rare earth permanent magnets, and specifically neodymium-iron-boron (Nd-Fe-B)—"neo magnets." This project will develop additive manufacturing (AM) processes for the fabrication of Nd-Fe-B-based permanent magnets. AM will allow near-net-shape or net-shape fabrication, resulting in less waste, as well as novel magnet design, revolutionizing motor design. One major challenge in AM is adequate control of the microstructural evolution. With Nd-Fe-B-based permanent magnets, this is particularly challenging given the small microstructure window in which to achieve optimum properties—careful control of grain size, shape, and crystallographic orientation as well as phase content and distribution is necessary. In this project, alloy design, optimizing composition to the solidification conditions of selective laser melting (SLM), will be combined with process design in order to obtain optimized microstructures. The project team of Jeff Shield (PI) and Qilin Guo (co-PI) combine the necessary expertise in the materials science of permanent magnet materials, solidification, and AM processing to ensure success. This joint expertise is unique in the U.S., UNL is equipped with singular, state-of-the-art facilities, and SLM of functional materials is in its infancy. This combination is expected to provide a path to significant results and external funding.