

Carnegie Mellon University

Materials Science & Engineering

presents

Advanced Soft Magnetic Materials for High Power Density, High Efficiency Electrical Systems

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ABSTRACT:

Electrical power generation, distribution, and conversion systems are key components of infrastructure technology in several industrial sectors. There is continual demand for electrical systems with higher power density that must also meet aggressive efficiency and reliability requirements. Advanced magnetic materials are critical to the performance of these systems. The complementary needs of high power density and high system efficiency demand components that exhibit low power loss at high frequencies. The trend in power conversion technology is to move away from low frequency transformers to modular power electronic systems with high frequency transformers. New magnetic materials are under development that are operable from the MW-level-20 kHz range up to the kW-level -MHz range with operating temperatures up to 300 °C. Advanced electric machines and drives are being developed to operate at continually higher speeds and temperatures. Novel machine architectures are enabled by newly developed alternatives to traditional electrical steels and rare earth permanent magnets. Advances in the processing of crystalline soft magnetic steels will be discussed that can enable rare-earth-free electric machine topologies to match the performance of machine architectures that depend on permanent magnets. Strategies for improved magnetic material performance will be discussed that include nanoscale structure control, novel device geometries, new alloy and compound development, and advanced manufacturing methods to maintain a sustainable value chain.

BIOGRAPHY:

Dr. Johnson joined GE Global Research in 2005 as a Materials Scientist in the Metals Lab. His research focuses on the development of magnetic materials for power generation, distribution, and conversion technologies. Dr. Johnson's area of expertise is the structure-processing-property relationships of crystalline, nanocrystalline, and amorphous soft magnetic alloys, rare-earth permanent magnets, and magnetocaloric materials. Prior to joining GE, Dr. Johnson was a Post-Doctoral Fellow in the Magnetic Materials Group, Metallurgy Division of the National Institute of Standards and Technology in Gaithersburg, Maryland. While at N.I.S.T. he worked on magnetocaloric materials, magnetic thin-films, and assisted in the development of magnetic Standard Reference Materials. He received his Ph.D. in Materials Science and Engineering from Carnegie Mellon University in 2003, and his thesis topic was in the area of Fe-Co based nanocrystalline soft magnetic alloys (HITPERM). He received an M.S. in Materials Science and Engineering from the Massachusetts Institute of Technology in 1999 and a B.S. in Materials Science and Engineering from Carnegie Mellon University in 1996.

Doherty Hall 2210, 11:30am
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