Engineering Soft and Hard Magnetic Materials for Next-Generation Power and Communication Devices

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Abstract

Magnetic materials play a crucial role in a wide range of applications, including memory devices, filters, and electric motors. However, their integration with semiconductors remains a significant challenge, as does the precise control of their properties through complex synthesis methods that are often inconsistent or environmentally harmful. This talk will explore current and emerging research in engineering both permanent (NdFeB, MnAlCu, e.g.) and soft magnets (YIG, e.g.) using techniques such as grain boundary engineering and ion implantation to enable integration, tunability, and size reduction. Additionally, it will address the urgent need for a robust domestic magnet materials infrastructure in the U.S. to support the growing demand for electric vehicles, spintronic RF and optical components, and a secure rare-earth supply chain for research and manufacturing.

Short Bio

Dr. Piotr Kulik is an Assistant Professor in the Electrical and Computer Engineering (ECE) Department at the University of Central Florida, with a joint faculty appointment in Materials Science and Engineering. He leads the Advanced Integrated Magnetics & Sensors (AIMS) Lab, which focuses on the synthesis of novel bulk and thin-film magnetic materials for sensor, power, and communication applications. Dr. Kulik is also the co-founder of Vulcan Elements (VE), a domestic permanent magnet manufacturing startup based in Raleigh, North Carolina. The company has raised to date $5.2 million in venture capital and secured over $2+ million in government grants. Before, joining UCF and co-founding VE, Dr. Kulik was a principal investigator on multiple Defense Advanced Research Projects Agency (DARPA), U.S. Navy, and U.S. Army research efforts at Metamagnetics. He earned his Ph.D. in Electrical and Computer Engineering from Northeastern University in 2020, following his M.E. and B.E. degrees from Stevens Institute of Technology in 2016. In 2022, he was recognized as one of the Association of Old Crows' "Future 5", an honor awarded for his impact in the Electromagnetic Spectrum (EMS), Electronic Warfare (EW), and Information Operations (IO) industries.