CRC/TRR 270

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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 24 March 2023, 10:00 s.t., TU Darmstadt, in person and via Zoom

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Data driven development of magnetic materials for green energy conversions and data storage

Abstract:

Magnetic materials have a broad range of applications from energy conversions to data storage. This includes hard magnetic materials, soft magnetic materials, magnetocaloric materials, and magnetic recording media for hard disk drives. From materials point of view, the main research interest has been focused on improvement of the performance of the existing materials closer to their theoretical limits or search for novel materials with a superior performance than the existing ones. Decades of research on these topics have results in accumulation of huge amount of data that can be efficiently used to accelerate the research on improvement/discovery of magnetic materials with improved performance. Based on this, a new center has launched in Japan with a headquarter at NIMS called digital transformation initiative center for magnetic materials (DXMag). In this talk, I will show some examples on how data science has been used in this new project to develop high coercivity SmFe12-based permanent magnets [1-3] and expanding operation temperatures of Fe2P-based magnetocaloric compounds to the cryogenic regions for liquid natural gas or hydrogen liquefaction applications [4]. Moreover, I will present how machine learning approach has enabled us to propose and demonstrate high-throughput magnetometry-based characterization of FePt granular media for its structural optimization toward higher areal density of HAMR media [5,6].

[1] X. Tang et al. Scripta Mater. “Role of V on the coercivity of SmFe12-based melt-spun ribbons revealed by machine learning and microstructure characterizations”200 (2021) 113925.

[2] J. S. Zhang et al. “Origin of coercivity in an anisotropic Sm(Fe,TiV)12-based sintered magnets” Acta Mater. 217 (2021) 117161.

[3] J. S. Zhang et al. “Microstructure and extrinsic magnetic properties of anisotropic Sm(Fe,Ti,V)12-based sintered magnets” Acta Mater. 238 (2022) 118228.

[4] J. Lai et al. “Machine learning assisted development of Fe2P-type magnetocaloric compounds for cryogenic applications” Acta Mater. 232 (2022) 117942.

[5] A. Bolyachkin et al. “Transmission electron microscopy image based micromagnetic simulations for optimizing nanostructure of FePt-X heat-assisted magnetic recording media”Acta Mater. 227 (2022) 117744.

[6] E. Dengina et al. “Machine Learning Approach for Evaluation of Nanodefects and Magnetic Anisotropy in FePt Granular Films” Scripta Mater. 218 (2022) 114797.

About the speaker:

Navid H. Sepehri-Amin is a material scientist working as a principal researcher at National Institute for Materials Science (NIMS), Tsukuba, Japan. He is also associate professor at Tohoku University and University of Tsukuba. He earned his Ph.D. in material science and engineering from the University of Tsukuba in 2011. His research interest is about magnetic materials, multiscale microstructure characterizations using electron microscopy and atom probe tomography, as well as micromagnetic simulations.