DESCRIPTION OF COLLECTIVE MAGNETIZATION PROCESSES WITH MACHINE LEARNING MODELS

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ABSTRACT

High performance permanent magnets play a key role in many technologies of today's life. Especially the markets of electrical cars and sustainable energy production are emerging quickly and therefore the need of magnets will grow significantly in future. However, the state of the art intermetallic phase of high performance permanent magnets is based on rare-earth elements. Since the widely used Neodymium is rare, it is essential to reduce the amount of this element while keeping sufficiently high magnetic properties for their applications [1].
Physical experiments are difficult, or even impossible, to proceed and this is why accurate simulation strategies are necessary. Although micromagnetic simulations can accurately calculate the properties of interest, modern research introduces machine learning models which are considered to be more efficient [2]. This talk introduces a proof of concept of a machine learning algorithm to model the hysteresis of multigrain microstructures. The method is based on a convolutional autoencoder and a deep learning regressor. The autoencoder is used for nonlinear dimensionality reduction and the predictor is operating in the latent space of the autoencoder. Due to the dimensionality reduction, the algorithm is expected to significantly reduce the computation time of large microstructures which eventually shows ways to reduce the use of rare-earth elements.

References

[1] J. Fischbacher, A. Kovacs, M. Gusenbauer, H. Oezelt, L. Exl, S. Bance, and T. Schrefl. Micromagnetics of rare-earth efficient permanent magnets. *J. Phys. D: Appl. Phys.*, 51(19):193002, Apr. 2018.

[2] A. Kovacs, J. Fischbacher, H. Oezelt, M. Gusenbauer, L. Exl, F. Bruckner, D. Suess, and T. Schrefl. Learning magnetization dynamics. *J. Magn. Magn. Mater.*, 491:165548, Dec. 2019.

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