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Nickel three-dimensional Nano-Networks with a single transversal channel interconnexions plane: Magnetization reversal experiments and simulations

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Understanding the interactions between magnetic nanostructures is one of the most important factors in predicting and controlling the advanced functionalities of Three-Dimensional (3D) integrated magnetic nanostructures[1].

In this work, we focus on interconnected Ni nanowires forming a controlled 3D magnetic nanonetworks[2,3]. This type of system exhibits striking anisotropic magnetic responses[3] and interaction between nanowires. To understand their collective magnetic behavior, we studied the magnetization reversal processes in the 3D-nanonetworks composed of 55/65 nm diameter/distance nickel nanowires with a single interconnection between all the nanowires at 480 nm from the top surface (Fig. 1 a). We have characterized the system at different angles using first magnetization curves, hysteresis loops, and First Order Reversal Curves techniques (Fig. 1 b), which provided information about the key features that enable macroscopic tuning of the properties of the 3D magnetic nanonetwork. In addition, micromagnetic simulations (Fig. 1 c) provided and accurate modeling of the magnetic response of the system. The results revealed important and intense anisotropic magnetic interactions. These interactions arise as capital for controlling the collective response of the system. The results pave the way for the design and realization of 3D novel metamaterials and sensors based on the nucleation and propagation of ferromagnetic domain walls. We acknowledge PID2020-118430GB-100, PID2019-108075RB-C31, PID2020-115325GB-C31 and RYC-2017-22820 funded by MCIN/AEI/ 10.13039/501100011033 and Intramural 2D-MESES 201950E057 founded by CSIC.

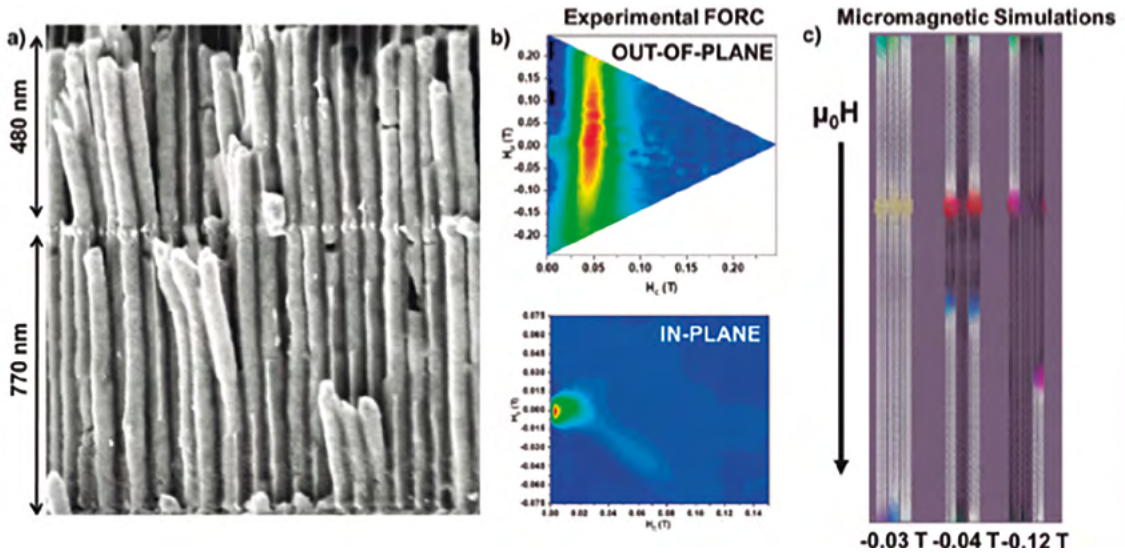

Fig.1. a) SEM image of 3D-Ni magnetic nanonetwork. b) Out-of-plane and In-plane FORC diagrams c). Magnetization reversal simulations.

References:

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