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MS-12-P-1426 Magnetic force microscopy investigation of arrays of nickel nanowires and nanotubes

Tabasum M. R.[1], Piraux L.[1], Nysten B.[1]

[1]Université catholique de Louvain, Belgium

Email of the presenting author: MUHAMMAD.TABASUM@UCLOUVAIN.BE

The magnetic characteristics of NWs have been studied from various viewpoints such as magnetization reversal, magnetostatic interactions, microwave properties and calculations of their intrinsic switching field distributions (SFD).On the other hand manufacturing magnetic NTs is more difficult compared with NWs: it is the reason why their magnetic properties, magnetization reversal for instance, have not been extensively explored despite their potential advantages, such as tunable geometry and reduced magnetic materials, over NWs. In particular, interwire interactions have been proven to affect the magnetic properties of arrays of NWs, specifically their magnetization reversal process and SFD.

It has been shown that NTs exhibit core-free magnetic configuration resulting in uniform switching fields so leading to controllable magnetization reversal process. Recently, experimental researches on magnetic NTs have become an attractive field to be investigated. The knack to tune NWs/NTs geometries, interwire distance permit to control the magnetostatic energies in order to get the desired magnetic properties. However, their integration into novel devices necessitates to fully understand their properties, in particular magnetostatic interactions. Major hysteresis loops of M(H) curves provide basic understanding of the magnetic properties. However, this technique is not sufficient for in depth quantitative determination of the magnetic interactions of the nanoscopic materials entities. Magnetic Force Microscopy (MFM) has proven to be suitable for the determination of the magnetization hysteresis curves at a local scale and to gain insight into the interwire dipolar interactions.

The magnetization reversal process of Ni NWs and NTs arrays in PC template have been investigated using MFM and AGFM. The comparison of the nanoscopic magnetic force microscopy (MFM) imaging and the macroscopic hysteresis loops measurements is made, Figure 1.By comparing the magnetizations curves obtained from both techniques, it has been demonstrated that they are complimentary if one wants to get an insight of the domain configuration, dipolar coupling and the magnetization reversal process. The presented results helped us understanding their magnetization reversal. For instance the mismatch of the magnetization curves in both the cases reveals that the micromagnetic configurations inside the NWs and NTs are not coherent. NWs array demonstrated stronger magnetic interactions than the NTs arrays. These results may serve as a benchmark for comparing the behavior of NWs and NTs and their use in various applications accordingly.

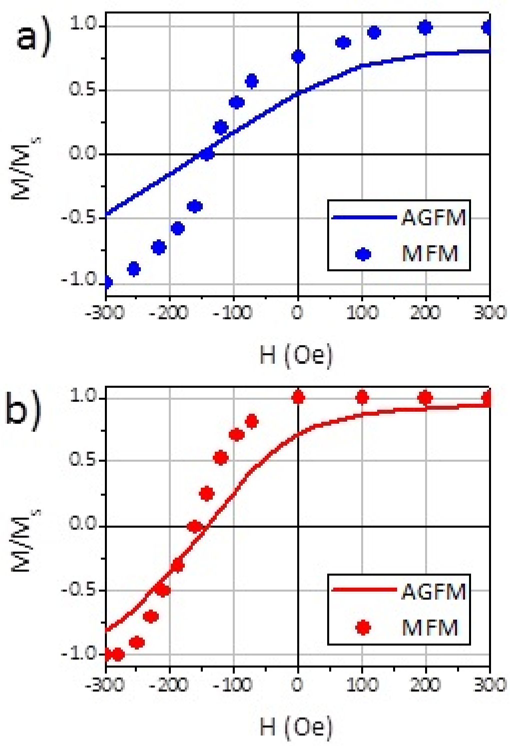

Fig. 1: Comparison of the in-field MFM magnetization curves with the ones obtained by AGFM.Measurements from the array of NWs (a) and NTs (b), respectively.