Magnetic soft X-ray transmission tomography: a tool to reveal complex magnetic textures

6. Magnetic thin films, multilayers, surface and interfaces

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Traditionally, magnetism has been linked to the imaging and study of magnetic domains within ferromagnets as their behavior is critical to understand the magnetic properties of the systems under investigation [1]. Nowadays, with the increased complexity of the magnetic textures to be used in Spintronics [2] and at the beginning of the novel field of 3D Nanomagnetism [3], magnetic imaging techniques face the challenge of moving from the characterization of magnetization textures in planar systems to the study of complex 3D magnetic configurations within heterostructures and 3D nanomagnets. In this framework, magnetic X-ray transmission tomography allows the user to reconstruct the full magnetization configuration within the volume of the sample with high spatial resolution [4,5].

In this work we have experimentally demonstrated the potential of soft X-ray magnetic tomography by reconstructing the complex magnetization configuration of a $Ni_{80}Fe_{20}/NdCo_5/Ni_{80}Fe_{20}$ heterostructure. Soft X ray transmission tomography permits to reveal the 3D magnetization of a ferromagnetic material thanks to the angular sensitivity of the magnetic dichroism. Several interesting magnetic singularities appear as a result of the weak perpendicular magnetic anisotropy character of the $NdCo_5$ magnetic layer [6,7].
The experiment was carried out at the Mistral beamline of the ALBA Synchrotron. The heterostructure consisted on 80nm $Ni_{80}Fe_{20}$/80nm $NdCo_5$/80nm $Ni_{80}Fe_{20}$. Two different tilt series were recorded from the same sample area in order to be sensitive to the three components of the magnetization vector. Each projection was recorded with positive and negative circular polarized photons at the Fe L_3 absorption edge energy. As described in ref. 5, by using this approach the pure XMCD signal can be extracted forming the magnetic tomogram to be reconstructed. The reconstructed configuration experimentally confirms the reversal topological rules described in ref. 7. Moreover, a Bloch point and a Meron-like texture have been identified within the central layer due to the magnetization behavior close to the interfaces in the $Ni_{80}Fe_{20}$. The results show the potential of the technique as a unique tool for the magnetic 3D characterization of arbitrary systems and heterostructures which is of great interest for Spintronics and 3D Nanomagnetism.

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