Characterization of the Magnetic Anisotropy of Hard Magnetic Nanoparticles by Singular Point Detection Technique

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In this presentation we show the application of the singular point detection (SPD) technique to determine the magnetic anisotropy of different hard nanomaterials. This property, described in terms of the anisotropy constants or in terms of anisotropy field, is the key property for many applications, in particular for magnets. It is correlated to the structure and chemistry configuration, the magnetocrystalline anisotropy, the morphology and structural strains, the magnetostriction. The magnetocrystalline anisotropy is determined from the analysis of the magnetic field dependence of the magnetization in different directions of a single crystal. In the case of polycrystalline materials indirect techniques, like approach-to-saturation or ferromagnetic resonances, have been employed. The singular point detection (SPD) is an unique technique for the direct measurement of magnetic anisotropy fields and critical fields of magnetic phase transitions, by the use polycrystalline samples [1-3]. This was employed to determine the anisotropy field of most state-of-art materials considered for magnets.
We have investigated the novel properties of several hard materials in the nanometric scale. It is well known, that in nanoparticles the anisotropy is linked to more complex features, like the surface and exchange coupling effects, and the weight of different anisotropy contributions cannot be easily discerned. Several examples will be presented in which the anisotropy of magnetic nanoparticles has been investigated with SPD: Cobalt ferrite (CFO), Strontium hexaferrites (SFO), doped SFO and hard/soft composites. The study of several SFO nanoparticles with different morphologies shows that this compound goes on to exhibiting an uniaxial anisotropy even at nanoscale. However, the anisotropy fields appear correlated to the structural features and to the particle shape. The fingerprint in the SPD technique of the anisotropy field of hard Cobalt ferrite and Al- doped Strontium ferrites nanoparticles is not observed. In a first hypothesis, this indicates a multifold anisotropy configuration. Finally, the correlation between the measured magnetic anisotropy and the coercive fields in of the different nanostructures will be discussed. This research was supported by EU- H2020 AMPHIBIAN Projects (n. 720853).

References

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