Role of magnetic anisotropy in magnetic nanostructures: From spintronic to biomedical applications

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The research on magnetic nanostructures has experienced fascinating progress in the last few decades and continues as an exciting research field, aiming to benefit society helping to considerably improve many technology and industry sectors: information technology, energy, and medicine, among many others. The understanding and control of magnetic nanostructures are required in order to achieve high performance magnetic-based systems. Magnetic symmetry, dimensionality, and interfacial effects promote much of the properties observed in complex magnetic nanostructures. The competition between different anisotropy contributions can result in different magnetic configurations, reversal processes, and/or transport phenomena, in which the temperature may, in addition, play a crucial role. Here, we will introduce open issues related to spintronics, permanent magnets, and cancer therapy, providing the keys to develop potential improved devices with tailored properties.

Despite the enormous market moving around the *spintronic* technologies, the microscopic understanding of magnetoresistive effects in low dimensional structures has not been fully addressed experimentally so far. We have recently shown that anisotropic magnetoresistance effects are generic notion and that only detailed angular-dependent studies combining magnetoresistive and vectorial-resolved magnetic hysteresis loops provide its origin.[1,2] For instance, the magnetoresistive response presents different fingerprints that depend sensitively on the details of the magnetic field value and orientation, for both single and multilayered systems, and on the current direction in the case of single films. *Permanent magnets* (PMs) have become essential to daily-life products, but the fear of a rare-earth supply limitation has recently motivated numerous efforts on rare-earth free PMs. We have developed nanocomposite ferrite-based PMs exploiting nanostructuration and artificial interfacing, with a larger energy product by comparison with currently used ferrites and, consequently, with practical applications.[3] One of the main challenges faced by *nanomedicine* is to deliver the cancer treatment at the right place, at the right dose and at the right moment. In this sense, functionalized superparamagnetic nanoparticles can be used as "*therasnostic*" tools, for selective cancer cell imaging, targeting, and removing by magnetic hyperthermia. The guidelines to optimize their heat dissipation power via tailoring dynamic magnetization reversal and heating mechanism will be given,[4] opening the way for this minimal-invasive and efficient diagnosis and therapeutic approach.

1.- P. Perna, D. Maccariello, C. Rodrigo, J.L.F. Cuñado, M. Muñoz, J.L. Prieto, M.A. Niño, A. Bollero, J. Camarero, R. Miranda, *Appl. Phys. Let.s* **104** (2014) 202407.
2.- P. Perna, F. Ajejas, D. Maccariello, J.L.F. Cuñado, R. Guerrero, M.A. Niño, M. Muñoz, J.L. Prieto, R. Miranda, J. Camarero, AIP Advances **6** (2016) 055819.
3.- A. Bollero *et al.*, FP7-NANOPYME project, Nanocrystalline permanent magnets based on hybrid metal-ferrites.
4.- A. Somoza *et al.*, H2020-NoCanTher project Nanothecnology for cancer therapy.