Design of magnetic nano-architecture

Davide Peddis
ISM-CNR, Area della Ricerca Roma1, Via Salaria km 29.300, C.P. 10, 00016 Monterotondo Scalo (RM), Italy

A physical property depends on the size of an object, if its size is comparable to a dimension relevant to that property. In magnetism, typical sizes are in the nanometer range, leading to a drastic change of magnetic properties at the nanoscale. In particular, magnetic nanoparticles have generated much interest because of their possible applications in high density data storage, ferrofluid technology, catalysis and biomedicine (drug delivery, contrast enhanced MRI). In addition NPs play an important role in nature, as they are commonly found in soils, sediments and rocks and may store information on the past Earth's magnetic field as well as environmental conditions at the time of sediment deposition

For this reason in the last two decades great attention is directed towards these materials, mainly discussing physical properties in term of their dependence on particle size. However, recent studies have demonstrated that besides the particle size, other factors such as, chemical composition, magnetic structure, and magnetic interactions strongly influence magnetic features of nanocrystals. On the other hand, changing the physical properties without significant variation of the particle size is not trivial and for this reason few examples of comprehensive studies are present in literature. In this view, this contribution focuses on the design of magnetic nanostructured in order to govern the magnetic properties beyond the effect of particle size. Particular attention will be devoted to discuss interparticle magnetic interactions and magnetic structure (e.g. cationic distribution and spin canting) as a tool to modify magnetic properties of nanoparticle based materials.

Magnetic Structure

Magnetic properties of spinel ferrite nanoparticles are strictly dependent on the magnetic structure that is due to the complex interplay between cationic distribution and spin-canting. An overview of such interplay will be given, showing as a careful control of the magnetic structure allows tuning the saturation magnetization and magnetic anisotropy. [1,2] Cobalt ferrite ($CoFe_2O_4$) will be used as a model system, being it attractive in the biomedical field for its high magnetic anisotropy and saturation magnetization.

Magnetic Interactions

In the physics of nanostructured magnetic materials, interactions between nano-objects play an important role. The strong advances to create suitable nano-architectures (e.g core shell and structure, particle embedded in host materials) allows one to modulate magnetic properties of nanostructured materials by tuning interparticle interactions. The dependence of static and dynamic magnetic properties on interparticle interactions will be discussed, showing that these properties can be tuned by designing a suitable magnetic nano-architecture. Some example of magnetic interactions between different magnetic phase (e.g. exchange bias) will be also given[3–5].

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Bio - Sketch

Davide Peddis (DP) graduated *magna cum laude* in Physical Chemistry (2003) and obtained his PhD in Physical Chemistry (2007) at the University of Cagliari. In the years 2007-2009 he worked as Research Fellow at University of Cagliari and at ISM – CNR and he was Senior Scientist at Vinca Institute, University of Belgrade between December 2014 and February 2017. Research activity of DP is developed in the framework of Solid State Physical-Chemistry and Condensed Matter Physics, studying the relationship between physical properties, crystalline structures and morphological features of magnetic nano–hetero-structures (nanoparticles, particles embedded in matrix, core shell structures, hollow nanoparticles, anisometric particles). Particular attention has been devoted to the investigation of fundamental properties of magnetic nanoparticles (static and dynamical properties) with particular interest in materials for applications in biomedicine (MRI, drug delivery, hyperthermia), catalysis, and energy field (permanent magnets, hydrogen production). DP research activity is presented over 70 peer reviewed papers (google scholar citations: ~1370; h-index:19) and 5 book chapter in the period 2006-2017. DP personally gives 34 tnvited talks and 33 oral communication to national and international conferences. DP has been co-supervisor of 1 master students, 1 PhD student, 3 post-docs, 5 researchers in formation and he was also appointed for one international PhD committee (February 2015, Unppsala University). DP won as principal investigator several national and international competitions for research mobility, experiments at large scale facilities and research projects. Now DP is responsible of the Italian unit of the FET-Proactive Project, MAGnetic nanoparticle based liquid ENergy materials for Thermoelectric device Applications (MAGENTA) [2016-2020, Total Budget 5 milion of euro; CNR budget: 720 Keuro].