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Design of magnetic nano-architecture for application in biomedicine and thermoelectricity

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Abstract

Magnetic Nanoparticles (MNPs) are unique complex objects whose physical properties differ greatly from their parent massive materials. In fact, the magnetic properties are particularly sensitive to the particle size, being determined by finite size effects on the core properties, related to the reduced number of spins cooperatively linked within the particle, and by surface effects, becoming more important as the particle size decreases. [1–3] MNPs 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. In addition, 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). Design of magnetic nano-architecture (MNA) for specific applications entails the control of matter at the nanoscale, correlating magnetic properties, micro- and meso-structure and molecular coating. These MNA are typically of core-shell morphology, with a magnetic core and a shell that may be composed of polymers surfactants or mesoporous silica, which typically serve for embedding the therapeutic agents within their framework. Selectivity of the treatment is ensured through employing magnetic field responsive homing of the nanocarriers to the therapeutic area, along with possibilities for alternating magnetic field hyperthermia-resulted treatment of the ill tissues. The induced hyperthermia may be therapeutically active through causing denaturation of biomolecules in the treatment area, or/and through mediating release of the cargo therapeutic agents. Taking into account all of these points, this communication will focus on the design MNA for application in biomedicine discussing some recent results synthesis and functionalization of magnetic nanomaterials[4–6]. Finally, preliminary results and some perspectives are given.

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The speaker

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. Since 2012 he is researcher at ISM-CNR (Rome). He has extensive experience in collaborations with international groups: he was visiting professor at the Le Mans University (collaboration Prof. J.M. Grenèche), Extended Guest Lecturer at the Uppsala University (collaboration with Prof. P. Nordblad and Dr. R. Mathieu) and visiting scholar at the University of Delaware (Collaboration with Prof. G. Hadjipanayis).

The research activity of DP is 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's research activity is documented in over 80 peer reviewed papers (google scholar citations: ~1800; h-index: 24) and in 5 book chapters in the period 2006-2017. DP has personally given more than 40 invited talks and 33 oral communications in national and international conferences. DP was awarded as principal investigator several national and international competitions for research mobility, experiments at large scale facilities and research projects. Currently, DP is responsible of the Italian unit of the FET-Proactive Project, MAGnetic nanoparticle based liquid ENergy materials for Thermoelectric device Applications (MAGENTA) [GA 731976 2016-2020, Total Budget 5 M€; CNR budget: 720 Keuro].