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Magnetic nanoparticles: The effect of chemico-physical parameters on their fundamental and biomedical applicative properties

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In the last two decades, much attention was devoted to novel multifunctional nanostructures based on magnetic nanoparticles (MNPs) useful as agents for magnetic resonance imaging (MRI), optical imaging and magnetic fluid hyperthermia, carriers for drugs and molecular targeting vectors. Most of the magnetic nanoparticles systems reported in literature by a lot of research groups have been shown to be useful as MRI contrast agents and magnetic fluid hyperthermia (MFH) mediators, displaying high nuclear relaxivity and specific absorption rate (SAR). For these compounds, the possibility to collect images of the regions where the MNPs are delivered through MRI and eventually optical imaging (if functionalized with a luminescent molecule), is joint to their use under radio-frequency fields, with frequency of the order of 100 KHz, which causes a local release of heat directed to tumour cells (the MFH effect), possibly inducing their death. By such materials, theranostic agents can be obtained. On the other hand, in the field of drug delivery and molecular targeting, few examples of reproducible experiments using superparamagnetic nanoparticles are actually present in literature. Thus, the application of MNPs to nanomedicine is currently of growing interest in the world. The main objectives of my research group in the last decade was to contribute to the knowledge of physical mechanisms at the basis of MNPs uses in biomedicine (especially MRI) and to propose some novel systems in strict collaboration with different research groups of chemists and biologists. I will present different novel systems able to contrast MRI images, act as good magnetic fluid hyperthermia agent or as multifunctional (magneto-fluorescent) agent and carry antitumoral drugs like e.g. paclitaxel or targeting functionalizations like PNA (peptide nucleic acids). Other examples of biomedical applications of MNPs magnetism will be also illustrated.

Recent Publications

1. Roch A, Muller R N and Gillis P (1999) Theory of proton relaxation induced by superparamagnetic particles. Journal of Chemical Physics 110:5403.
2. Vuong Q L, Berret J F, Fresnais J, Gossuin Y and Sandre O (2012) A universal scaling law to predict the efficiency of magnetic nanoparticles as MRI T2-contrast agents. Adv. Healthcare Mater 1:502-512.
3. Bordonali L et al. (2013) NMR-D study of the local spin dynamics and magnetic anisotropy in different nearly monodispersed ferrite nanoparticles. J. Phys.: Condens. Matter, 25(6):066008.
4. Orlando T et al. (2016) On the magnetic anisotropy and nuclear relaxivity effects of Co and Ni doping in iron oxide nanoparticles. Journal of Applied Physics 119(13):134301.
5. Linot C et al. (2017) PEGylated anionic magnetofluorescent nanoassemblies: impact of their interface structure on magnetic resonance imaging contrast and cellular uptake. ACS Appl. Mater. Interfaces 9:14242–14257.

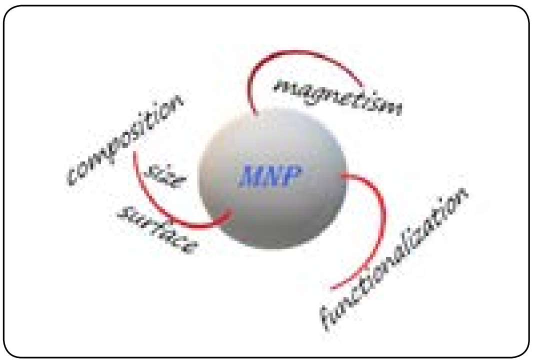

Figure 1: A magnetic nanoparticles and its crucial characteristics.

Biography

Paolo Arosio is currently a fixed-term Researcher at Physics Department of Universita' degli Studi di Milano. His main research activity regards the magnetism of nanoparticles and magnetic materials and the morpho-dimensional studies on biological samples in the AFM/NMR group of the Physics Department, that collaborates with numerous Italian and European research groups. Since 2011 he is responsible of NMR experimental activity of his research group.

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