Magneto-Optical Properties of Iron Oxide Nanoclusters

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The synthesis of nanostructured magnetic materials has become a particularly important area of research and is attracting a growing interest because of the potential applications in ferrofluids, in biotechnology/biomedicine, such as in directed delivery of drugs and even as contrast agents in magnetic resonance imaging (MRI). Appropriate combination of two different materials in nanoscale range, a magnetic and a metallic, may lead to the development of a multifunctional system that exhibits magnetic and optical (plasmonic) properties at the same time. The key feature for these heterostructures is their solubility in aqueous media, an especially critical property if we wish to achieve optimum functionality in the fields of biology and medicine.

Iron oxide colloidal nanoclusters (CNCs) were synthesized by a high temperature hydrolysis process with glycol as a solvent and $FeCl_3$ as a metallic precursor [1]. A polyelectrolyte (i.e poly(acrylic) acid, PAA) was used as capping agent. The CNCs have a “flower-like” shape (Fig.1) and are consisted of smaller nanocrystals (5-10nm). The polymer in this reaction has a double role, aids the formation of the CNCs and their solubility into the water. The CNCs are superparamagnetic at room temperature and display soft ferromagnetic-like behaviour below the blocking temperature; the latter is also proved to be a size-depended parameter. These CNCs respond to the application of an external magnetic field and form ordered arrays in aqueous media, while at the same time exhibit unusual optical properties. The wavelength of the reflectance maximum intensity shifts to the blue region as the strength of an external magnetic field increases (Fig. 2).

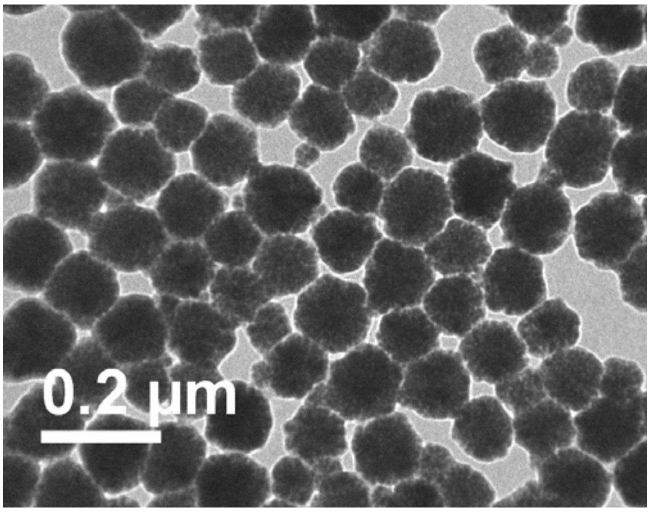

Fig 1. Iron oxide CNCs with mean diameter of ~120 nm.

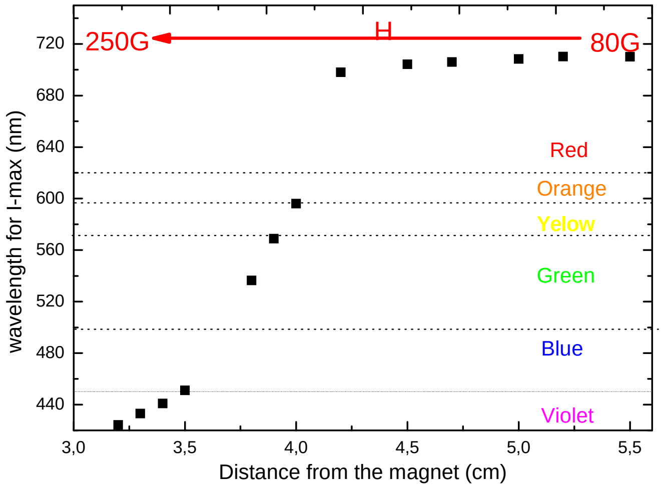

Fig 2. The wavelength (nm) of reflectance maximum intensity as a function of the distance of the sample from the magnetic field.

After the preparation of the heterostructure magnetic component (CNC) there was an effort to use it as seed and grow on it the second component, i.e. the metallic particles. The heterostructure combine the magnetic properties from the CNCs and the plasmonic properties of the metal component. We wanted to investigate the magnetic and the optical properties of the combined system and compare them with those of the pure CNCs.

[1] Ge J., Hu Y., Biasini M., Beyermann W., Yin Y., Angew. Chem. Int. Ed. 46, 4342 (2007)

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