Poster

DEVELOPMENT OF A NOVEL MAGNETIC-FLUORESCENT COLLOIDAL NANO-CLUSTER

Riccardo Di Corato[†], Philomena Piacenza[†], Raffaella Buonsanti[†*], Roberto Cingolani[†*], Giovanna Barbarella[‡], Liberato Manna[†*] and Teresa Pellegrino[†*]*

[†] National Nanotechnology Laboratory of CNR-INFM, 73100 Lecce, Italy
[‡] CNR, Area di Ricerca, ISOF, I-40129 Bologna, Italy
** Unità di Ricerca IIT, Lecce, Italy*

riccardo.dicorato@unile.it

The idea of the present work is to assemble iron oxide nanoparticles to develop super-structures with a faster response to an external magnet. In addition, functionalization of these composites with organic fluorophores, based on oligothiophenes, allows to obtain a final product suitable for a multiplexing cell sorting and for other kinds biomolecule separations.[1]

Magnetic nanocrystals of iron oxide have some well-defined characteristics, like superparamagnetic behaviour and high biocompatibility. However, iron oxide nanocrystals with diameters below 15 nm, have a low magnetization per particle, thus it is difficult to separate them from solution or to promptly accumulate them within few minutes by using moderate magnetic fields. This limits their use in applications such as cell sorting and drug delivery. On the other hand, increasing the nanocrystal size, increases the magnetization of saturation, but also induces the superparamagnetic–ferromagnetic transition (at a dimension of about 30 nm for Fe_3O_4), so that nanocrystals are no longer well disperse in solution.

Recently, our group reported a study on the water-solubilization of monodisperse nanoparticles using poly(maleic anhydride-*alt*-1-octadecene) polymer.[2] By using the same polymer it was possible to induce a partial agglomeration of iron oxide nanoparticles coordinated by the polymer in solution. In this case we have exploited the hydrophobic interaction between the poly(maleic anhydride-*alt*-1-octadecene) polymer and the surfactant coated iron oxide nanoparticles to favour in the reaction conditions, the formation of beads in a controlled way.

In a colloidal cluster the inter-particle distance is reduced to the thickness of the surfactant shell around the single nanocrystals; this feature can simulate the mass effect that determines the speed of the magnetic response in a concentrated sample. Moreover, the advantage to work still with a nano-scale cluster is the high ratio surface area / volume, that allow to have an higher level of functionalization.

The final nano-objects show a layer of polymer that prevents the degradation of the structure and equipped their surface with carboxylic groups that allows to solve the nano-clusters in polar solvent, like ethanol or water, having high stability (Figure 1). To control the size and the shape of the beads we have been changing the parameters that induce the bead formation, such as the solvent for creating the gradient, the gradient time, the amount of polymer added, the nanoparticles concentration and we show we were able to control the total diameter of the beads between 70 and 350 nm but also the thickness of the polymer shell and the core of the inorganic nanoparticles.
Recently, the Parak W.J. group reported a studies on the functionalization of poly(maleic anhydride *alt*-1 octadecene) with different moieties.[3] With a similar approach we functionalized the poly(maleic anhydride *alt*-1 octadecene) with different oligothiophene molecules (OTFs) to obtain a fluorescent polymer able to coordinate the formation of a fluorescent-magnetic cluster. In comparison to the organic dyes commonly used in bio-imaging and more similarly to colloidal quantum dots, OTFs have broad optical absorption spectra, and therefore fluorophores

emitting at different colours can be excited with a single excitation source, allowing for easier multiplexing analysis.
The characterization of the nanocrystals was carried out by means of transmission electron microscope (TEM), spectroscopy analysis (absorption spectra, FT-IR analysis), gel electrophoresis, dynamic light scattering and zeta-potential measurements.

References:

[1] Quarta A., Di Corato R., Manna L., Ragusa A., Pellegrino T., IEEE Transaction on nanobiocience, **6** (2007) 298.
[2] Di Corato R., Quarta A., Piacenza P., Ragusa A., Figuerola A., Buonsanti R., Cingolani R., Manna L. and Pellegrino T., Journal of Materials Chemistry., **18** (2008) 1991.
[3] Lin C.A., Sperling R.A., Li J.K., Yang T., Li P., Zanella M., Chang W.H., Parak W.J., Small, **4** (2008) 334.

Figures:

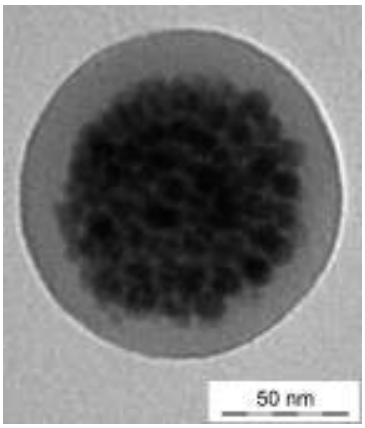

Figure 1. Low resolution TEM image of a magnetic-fluorescent nano-cluster. The synthesis was carried out by assembling γ-Fe_2O_3 nanocrystals (13 nm in diameter) with a poly(maleic anhydride *alt*-1 octadecene) functionalized with oligothiophene fluorophores.

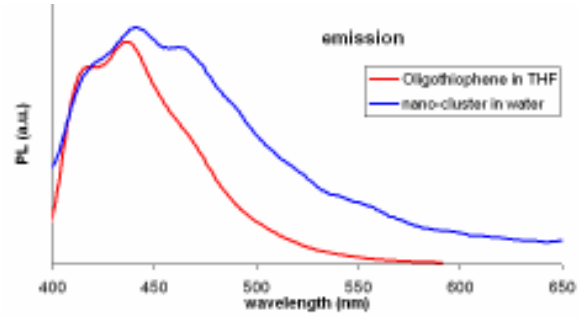

Figure 2. Photo-luminescent spectra of magnetic-fluorescent nano-cluster as compare to free oligothiophene. The red line corresponds to oligothiophene molecules solved in THF while the blue line corresponds to magnetic-fluorescent nano-cluster solved in water.