NANOPARTICLES AND THEIR BIOLOGICAL APPLICATIONS

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Colloidal inorganic nanocrystals possess peculiar properties that are strongly dependent on their size and on their composition. In particular, semiconductor nanoparticles are fluorescent. Because of their reduced photobleaching, colloidal quantum dots are interesting fluorescence probes for all types of labeling studies. High-quality colloidal nanocrystals are prepared in organic surfactants and are often hydrophobic. To render nanoparticles biocompatible and thus soluble in water, several strategies have been developed to transfer them from hydrophobic environment to aqueous solution. Here we will report the development of a general procedure to transfer nanoparticles of different materials to aqueous solution by means of an amphiphilic polymer. This strategy is based on the decoration of hydrophobic nanocrystals with a hydrophilic polymer shell. It exploits the non-specific hydrophobic interactions between the alkyl chains of poly(maleic anhydride alt-1-tetradecene) and the nanocrystal surfactant molecules. Addition of bis(6aminohexyl)amine results in the cross-linking of the polymer chains around each nanoparticle (figure 1a). The nanocrystals become soluble in water upon hydrolyzation of the unreacted anhydride groups (which effectively leads to an amphiphilic polymer shell) and can be further processed according to a universal protocol that relies solely on the chemistry of the outer polymer shell. This method is easily extendable to a wide range of nanocrystal materials(figure 1b)[1.]
We will also discuss the attachment of biological molecules to water-soluble nanoparticles. Finally, we will focus on two applications of colloidal nanoparticles in biology: the self assembly of nanoparticles-DNA conjugates by means of scaffold molecules such as the DNA strands, and the development of a motility

1. Hydrophobic nanocrystals coated with an amphiphilic polymer shell: a general route to water soluble nanocrystals. Teresa Pellegrino, Liberato Manna, Stefan Kudera, Dmitry Koktysh, Andrey L. Rogach, Giovanni Natile and Wolfgang J. Parak (Nano Lett 4 (4): 703-707 April 2004).

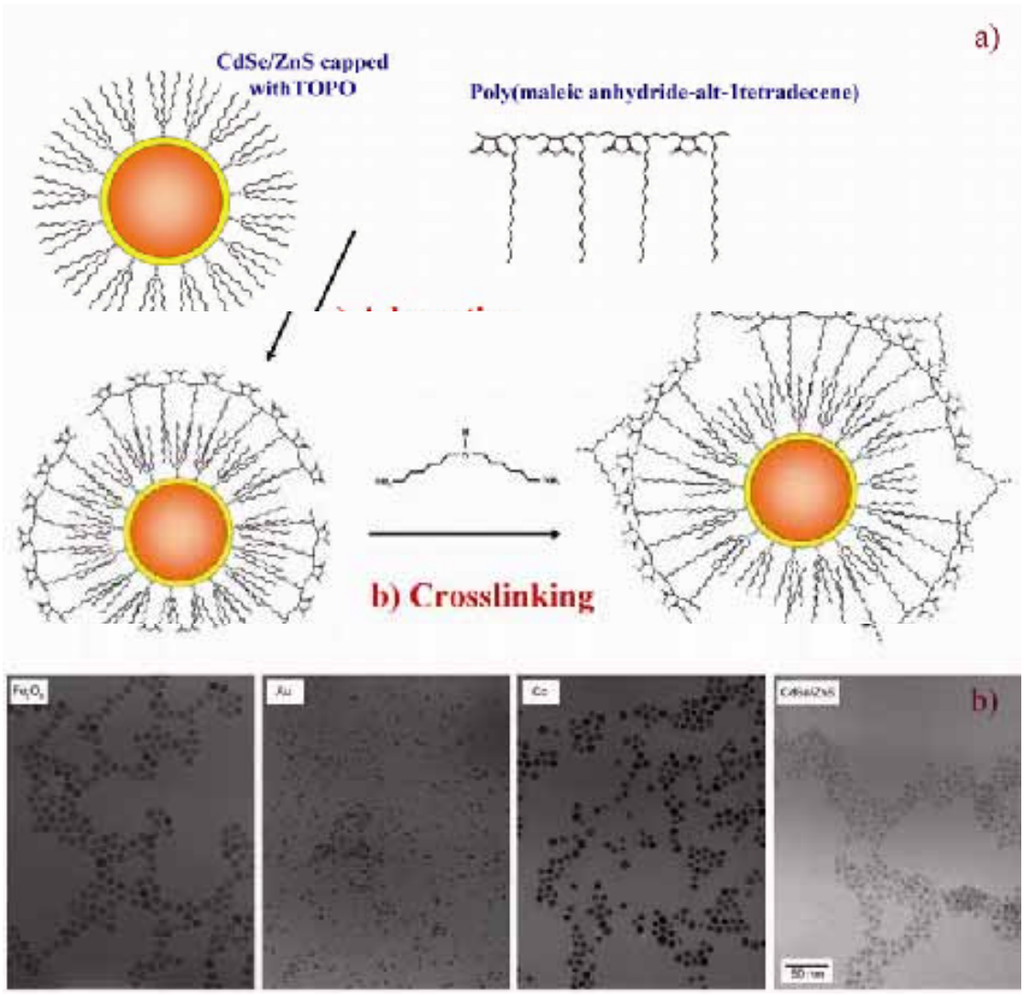

Figure1: a) Scheme of the polymer coating procedure. The hydrophobic alkyl chains of the polymer intercalate with the surfactant coating. The anhydride rings are located on the surface of the polymer-coated nanocrystal. The amino end groups of the cross-linker molecule open the rings and link the individual polymer chains. The surface of the polymer shell becomes negatively charged, stabilizing the particles in water by electrostatic repulsions. b) TEM images of polymer-coated nanocrystals of four different core materials: Fe2O3 (9.2 nm average diameter), Au (4.0 nm), CoPt3 (8.0 nm), and CdSe/ZnS (7.0 nm)nanocrystals.