Size determination of water soluble CdTe quantum dots

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Quantum dots (QDs) are defined as semiconductor structures with physical dimensions that are smaller than the exciton Bohr radius, what makes these materials exhibit a strong quantum confinement effect. This effect causes the appearance of size-dependent optical properties in these nanomaterials, which has attracted great attention for their application in different technological areas, including biological labeling, light-emitting diodes and photovoltaic devices [1]. The synthetic methods of semiconductor nanocrystals have progressed in recent years, and several protocols were developed to synthesize monodisperse nanocrystals with good optical properties, different compositions and morphologies. Up to now, the most successful method to prepare highly luminescent II-VI colloidal semiconductors is the synthetic approach based on coordinating or non-coordinating organic solvents. However, high temperature is needed in this method and the resulting nanoparticles are insoluble in water, limiting their biological applications. Therefore, quantum dots have been prepared in aqueous media because this synthetic approach is simpler, reproducible and produces nanocrystals soluble in water. Nevertheless, this method produces nanoparticles with low quantum yields that are attributed to defects and traps on the surface of nanocrystals. For this reason, surface ligands have been used to remove these defects and improve the optical properties of these materials [2]. In this work, CdTe semiconductor nanocrystals have been synthesized in aqueous media using mercaptopropionic acid and glutathione as ligands. The quantum dots were characterized by ultraviolet-visible (UV-Vis), infrared (FTIR) and photoluminescence (PL) spectroscopies, X-ray diffraction (XRD) and also by X-ray photoelectron spectroscopy (XPS). The measure of the size of the nanocrystals plays a key role in the study of quantum dots because these materials have optical properties that can be modified by changing the size of nanoparticles. The sizes of the nanocrystals were determinated by transmission electron microscopy (TEM) and dynamic light scattering (EDL) and a correlation between these measurements was obtained. The results showed that the growth rate of glutathione capped CdTe nanocrystals was the quickest under the same refluxing conditions. The reason for quicker growth rate is perhaps because glutathione provides extra sulfur into the growing nanoparticles, which is consistent with the growing trend of CdTe/CdS.

Keywords: quantum dots, semiconductors, surface ligands.

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