Synthesis of PEG-Thiolate Monolayer Protected CdSe Nanoclusters with Unique Solubility Properties

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Abstract

Ligands protected metal chalcogenides have shown potential applications in bionanotechnology and device fabrication due to their unique optical properties. However, most metal chalcogenides suffer from solubility problems, which hinders their applications. To overcome the solubility issue of metal chalcogenide nanoclusters, we have demonstrated the aqueous phase synthesis of polyethylene glycol thiolate (PEG-S-) protected CdSe nanoclusters for the first time. The CdSe nanoclusters displayed a first absorption peak ~430 nm, which indicated formation of magic-sized nanoclusters with possible composition of $(CdSe)_{33,34}$. The PEG-thiolate protected CdSe nanoclusters demonstrated unique solubility properties. The resulting nanoclusters can easily be transferred to organic solvents from an aqueous medium by a simple solvent extraction method. The organic-phase extracted CdSe nanoclusters can readily be redispersed in a wide array of organic solvents such as CH_3CN, CH_2Cl_2, DMF, THF, and CH_3Cl. Most importantly, the CdSe nanoclusters, soluble in organic solvents, can also be redispersed in aqueous medium as well. We investigated different chain length PEG_n-thiols, e.g., PEG_4-SH, PEG_6-SH, PEG_{12}-SH, and PEG_{18}-SH and found that the PEG-chain length significantly influenced the aqueous to organic phase transfer properties. Successful transfers were accomplished for PEG_n-SH (n = 6, 12, 18). Future studies will be performed on the synthesis of PEG-SH stabilized various metal chalcogenide nanoclusters (CdS, CdTe, ZnS, ZnSe, and CdSe/ZnS nanoclusters).