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Chiral quantum dots

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Abstract

Over last years the area of chiral metal nanoparticles (e.g. Au and Ag) has received a great deal of attention due to the range of potential applications offered by these materials in chiral sensing and as metamaterials in advanced optical devices. Recently, the use of stereospecific chiral stabilising molecules has also opened another avenue of interest in the area of quantum dot (QD) research. The main goal of our research is to develop new types of technologically important quantum dot materials containing chiral defects, study their properties and explore their applications. For the first time chiral QDs (penicillamine stabilised CdS) have been prepared by us using microwave induced heating with the racemic (Rac), D- and L-enantiomeric forms of penicillamine as stabilisers. Circular dichroism (CD) studies of these QDs have shown that D- and L-penicillamine stabilised particles produced mirror image CD spectra, while the particles prepared with a Rac mixture showed only a weak signal. It was also demonstrated that all three types of CdS particles (D-, L-, and Rac penicillamine) show very broad emission bands between 400 and 700 nm due to defects or trap states on the surfaces of the nanocrystals. Our DFT calculations of electronic states have demonstrated that the longer-wavelength circular dichroism is associated with near-surface Cd atoms that are enantiomerically distorted by the penicillamine ligands. More recently, we have reported chiral CdSe QDs and chiral CdS nanotetrapods. Both of these chiral nanostructures also showed a very broad distribution of photoluminescence which originates from emissive defect states. Our studies have also shown that chiral QDs demonstrate selective chiral sensing of DNA. We expect that this research will open new horizons in the chemistry of chiral materials and their application in chiral sensing and asymmetric synthesis.

Biography

Yurii Gun'ko has received his Ph.D. degree in Inorganic Chemistry from Moscow State University in 1990. Currently he is a Professor of Inorganic and Materials Chemistry in the School of Chemistry and a Principal Investigator in CRANN institute in Trinity College Dublin (Ireland). Prof. Gun'ko has published over 160 journal publications, 12 patents and 8 book chapters. His main research interest and activities are: polymer composites, photovoltaics, magnetic and quantum dot based nanomaterials.