INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Understanding the chemistry of the surface of the zero-dimensional semiconductor nanocrystals - otherwise known as quantum dots (Qdots) - and their manipulation are critically important to achieve their desired applications, following optimization of their remarkable optical properties. However, little attention has been given to exploiting chemical reactions performed on the surface of the Qdots following their syntheses. It is expected that altering the structure of the surface or generating new species on the surface would provide a new way of achieving enhanced physicochemical properties of Qdots. The present thesis focuses mainly on two types of chemical reactions; one is ion-exchange reaction and the other one is complexation reaction involving the Qdots. We sincerely hope this will bring a new paradigm in terms of achieving the best of the optical properties of Qdots and thus improving their potential applications.

Specifically, the present thesis addresses the following issues.

(i) What is the role of surface ions in the emission properties of Qdots, which were synthesized at comparatively low temperatures? (ii) How do the surface labile metal ions of Qdot react to form inorganic complexes with an external organic ligand and what are the consequent influences on the optical and thermal properties and solubility of Qdots following complexation reaction? (iii) How will the Qdots - following complexation on their surface –be made useful for devices such as light emitting devices and in biological imaging over their independent constituents' precursors (Qdots and bare inorganic complexes)?

The present thesis is divided into seven chapters. Brief discussion of each chapter is given below.

Chapter 1 includes the introduction and the literature review. This will provide a brief and general idea about the Qdots, the importance of their surface followed by manipulation using various chemical means/reactions in order to achieve the desired optical properties, for making them more advantageous in optoelectronic devices and biodiagnostic applications. Chapter 2 describes the role of surface ions in the emission characteristics of the Qdots (synthesized at comparatively lower temperature) as probed from the results of a simple cation exchange reaction. Chapter 3 reports the complexation reaction on the surface of a Qdot with an external organic ligand leading to formation of a new species - called herein as quantum dot complex (QDC) – which exhibited high quantum yield (QY), longer emission life time and extraordinary thermal stability in comparison to bare inorganic complexes. Chapter 4 demonstrates a new, rapid and facile phase transfer process of hydrophobic Qdots from nonpolar to polar medium, following formation of light emitting inorganic complexes on the surface of Qdots out of the biphasic medium. Chapter 5 reports the formation of a single component, redox active, thermally stable QDC nanocomposite - which exhibited independent double channel emissions and has excitation dependent tunability in chromaticity color coordinates. Chapter 6 describes the fabrication of a new magnetofluorescent nanocomposite – composed of a super paramagnetic iron oxide nanoparticle (SPION) and QDC –which exhibited higher QY, photostability, stability in human blood serum and sufficient magnetism and also their magnet guided cell imaging application. Chapter 7 contains an overview of the thesis and future prospects.