INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The prime aim of the present thesis is to pursue complexation reaction on the surface of a quantum dot (Qdot). This is deemed to be useful in fabricating a single component biocompatible white light emitting (WLE) nanocomposite, having properties close to day bright light, with an aim to detect human disease responsive molecules at single particle level. In response to the recent demand of reducing the global energy consumption, the fabrication of the single component WLE materials, with high brightness, longer photostability, in comparison to multicomponent based WLE generation, is necessary. The conventional WLE materials, fabricated based on either the mixing of different color emitting material or coating of phosphor on a blue emitting lamp suffer from the drawbacks like color aging, self-absorption, nonradiative energy transfer, undesirable changes in chromaticity color coordinates and complicated processing technique, and consequently their application potential is limited. That is the motivation of this thesis to fabricate a single component WLE nanocomposites using the simple, unique, greener and cost-effective idea of decorating the surface of a Qdot with different luminescent inorganic complex. While there is vast literature available on the uses of a WLE nanocomposites in light emitting applications; however, their use as sensing platforms for the detection human diseases is not yet explored. The concept of using single WLE nanocomposite as a sensing platform for the detection of human disease responsive molecule is entirely based on the selective chemical interaction of the analyte with any of the emitting species present in the WLE nanocomposite – which would lead to change in their visual color chromaticity and blinking profiles. The current thesis addresses the following two main challenges. (i) The fabrication of single component biocompatible photostable WLE nanocomposite, with properties close to day bright light, based on the concept of complexation on the surface of presynthesized nanoscale emitters, especially Qdots. (ii) The use of the single WLE nanocomposite towards sensing of human disease responsive molecules at single particle level by observing the changes in their color, chromaticity and blinking pattern. The present thesis is divided into six chapters. Brief discussion of each chapter is as follows. Chapter 1 consists of the introduction of the thesis and literature review of quantum dot, WLE materials, single particle probe and sensors. Chapter 2 describes the formation of a single component photostable WLE nanocomposite based on the simultaneous formation of two different inorganic complex (blue emitting metal acetylsalicylate ($M(ASA)_2$ where M:Mn^{2+}/Zn^{2+} and ASA= acetyl salicylic acid) and green emitting zinc quinolate (ZnQ_2) on the surface of a presynthesized orange emitting Mn^{2+} doped ZnS Qdot. The complexed Qdot is called herein as quantum dot complex (QDC). Chapter 3 discusses the fabrication of a bio-friendly white light emitting nanocomposite by incorporating green emitting QDC (composed of ZnQ_2 complex and ZnS Qdot) in a blue protein matrix – consisted of red emitting gold nanoclusters. Chapter 4 demonstrates the fabrication of a high temperature sustainable single component WLE nanocomposite, with properties close to day bright light in terms of the chromaticity, color rendering index (CRI) and correlated color temperature (CCT), by forming a greenish blue ZnQ_2 complex on the shell surface of a red emitting $CuInS_2$/ZnS core/shell Qdot. Chapter 5 describes the utilization of a nontoxic WLE nanocomposite, fabricated based on the formation of blue emitting $Zn(MSA)_2$ complex on the surface of a yellow emitting ZnO Qdot, toward detection of the neurotransmitter dopamine at possibly single particle level. This was achieved followed by monitoring the changes in the visual color, chromaticity and on/off blinking characteristics of the single WLE QDC.