INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Moore's Law, which predicts the rise in processing performance of semiconductor chips due to downsizing of device dimensions, has primarily driven advances in semiconductor technology during the last few decades. As the physical device scales approach atomic dimensions, further downsizing is limited due to quantum – mechanical effects and inter-atomic interactions. Hence, nanoelectronics emerged as a promising complementary technology, that provided novel methods and architectures in order to bring in atomic scale interactions to macroscopic functionalities.

This dissertation work is focused on exploring functional properties of quantum dots and nanoparticles modified through ligand interactions and fabricating semiconducting devices for applications such as thin film transistors, UV-photodetectors and multi-stimuli responsive mechanoreceptors in flexible frameworks. Chapter 1 presents a brief introduction to nanomaterials, their functional properties and different approaches to tailor their physical and chemical properties. A short insight is given on nanomaterial deposition techniques for fabrication of semiconducting devices. Successively, brief description on thin film transistors, photodetectors and self-powered detectors are presented. An insight is presented on different categories of tactile sensors and in addition, recent advancements in this arena are discussed. At the end, we present an overview of the challenges and scopes for developing

multifunctional devices targeting different applications. Chapter 2 presents synthesis of Mn^{2+} -doped ZnS quantum dots and surface complexation of these quantum dots with 8-hydroxyquinoline 5-sulphonic acid ligand. Herein photoluminescence characteristics of surface complexed quantum dot due to the formation of bluish green emitting zinc quinolate ($Zn(QS)_2$) complex are discussed. Thin film transistors were fabricated and device characteristics such as carrier mobilities, carrier densities, trap state densities and carrier hopping characteristics at variable temperatures were studied. Chapter 3 presents fabrication of Mn^{2+} doped ZnS quantum dot complex photodetectors (QDC-PD) for efficient and ultrasensitive detection of UVA radiations. In the same context, effect of Mn^{2+} doping in ZnS Qdot and surface modification of doped Qdot in the detector performance were studied. A shift in the detection band from UVC in Qdot to UVA in QDC was observed due to the formation of a luminescent moiety at the Qdot surface. UV- photodetection under self-powered mode was demonstrated. Also, the dual emitting feature of QDC was utilized as an anti-counterfeiting ink for data encryption. In Chapter 4, a highly sensitive tactile sensor developed from a crosslinked gold nanoparticle network and a micro-structured PDMS layer is demonstrated. Herein, the device responses to mechanical deformations and external stimuli were recorded and piezo-resistive nature of gold nanoparticle network was studied under applied mechanical strain. The tactile sensor enabled recognition of physical activities such as jogging, leg movements, standing, tapping action and also to identify weight and vibration. To enhance the multifunctional attributes of the tactile sensor, the piezo-phototronic nature of the assembled nanoparticles was also explored. Chapter 5 summarizes the works carried out in the dissertation and highlights the key objectives achieved. It also presents future prospects of this dissertation work especially the novel application potential in diverse fields.