ABSTRACT

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Thesis Title: "Charge transfer dynamics and conduction kinetics within photo-electronic junction devices based on some inorganic semiconductor nanocomposites: Theoretical Insights and Experimental Studies".

The dissertation is mainly focused upon the original synthesis technique and characterization processes of semiconductor nanomaterials. The ternary I-III-VI_2 Semiconductor $CuInSe_2$ has been synthesized and characterized and their potential applicability in thin film Schottky barrier diodes have been examined and demonstrated accordingly. In later part, Cadmium Oxide (CdO) has been synthesized by hydrothermal route and the morphological impact of the derived CdO on charge conduction and relaxation within Schottky diode is investigated by using bias-dependent impedance spectroscopy (IS). This thesis work has focused not only on the synthesis and characterizations of the above semiconductors but also focused on the optoelectronic device fabrication followed by the investigation of the charge transport properties via impedance spectroscopy (IS) and analysis of current-voltage (I-V) data.

In the prolonged course of these experimental studies, the charge transport mechanism through Al/$CuInSe_2$ is extensively analyzed by employing space charge limited current (SCLC) theory. It has been observed that after illumination of light the mobility is increased ~5 fold. Over all, the experimental analysis involved me to get insights into the charge transport mechanism, and the physics of Schottky interfaces.

The successful energy quenching and resonance energy transfer process from P3HT to $CuInSe_2$ via Fluorescence Resonance Energy Transfer (FRET) analysis by compositing P3HT:$CuInSe_2$ is established. The photo-induced charge transport phenomenon has been successfully examined through estimation of band structures along with proper band diagram. The estimate value of the Förster distance (R_0) of critical energy transfer and thorough studies of absorption and emission spectra highly ensured the possibility of resonance energy transfer from P3HT to $CuInSe_2$ in context to fabricate efficient photovoltaics.

Meticulous computational investigations revealed that, the hetero-junctions of the configuration TiO_2/$CuInSe_2$ and HF-TiO_2/$CuInSe_2$ junctions show p-n diode like behavior in compare to the first kind of device, the second one is more efficient towards the light response.

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