ABSTRACT

Thesis Title: Photosensitive device application using Inorganic and Organic semiconducting nano-composites and unique approach of Crystalline Silicon selective emitter solar cell

Due to its prevalence in numerous electronic devices, investigating the Schottky Barrier Diode (SBD) and its device characteristics is crucial for advancing semiconductor technology. The SBD offers benefits such as a low forward voltage drop, fast response, and minimal resistance, making it extensively utilized in RF applications, high-speed logic circuits, integrated circuits, and optoelectronic technologies, including microwave diodes, field-effect transistors, detectors, and solar cells. Understanding SBD parameters is pivotal for the design and production processes. Furthermore, analyzing various characteristics involves examining the energy band profile near the metal-semiconductor junction and elucidating current-voltage (I-V) behaviour resulting from diffusion, thermionic emission, and tunnelling.

As global population and industrialization rates climb, coupled with the finite nature of fossil fuels, the demand for alternative energy sources has surged. Among these alternatives, solar energy emerges as a particularly promising solution to the escalating energy needs. The conversion of sunlight into electricity, known as photovoltaic, presents a viable method for generating electrical power with minimal carbon footprint, especially during use. Crystalline silicon photovoltaic cells dominate the market due to their high efficiency, reliability, and the abundance of silicon. To address challenges like surface recombination velocity and contact resistance, selective emitter solar cells have been introduced. These cells feature a lightly doped emitter region, where light-generated carriers are collected, reducing recombination velocity and enhancing both V_{oc} (open-circuit voltage) and I_{sc} (short-circuit current). Additionally, the emitter region beneath the metal contact is heavily doped to minimize contact resistance, thereby improving fill factor.

In this research, I've synthesized various inorganic and organic materials and explored their use in thin-film SBDs. Additionally, I have conducted a thorough examination of their photo-response and charge transport characteristics. Also in addition, I've introduced an innovative approach to fabricate crystalline silicon selective emitter solar cell. Our findings demonstrate the successful formation of the selective emitter in a single diffusion process, eliminating the need for additional heat treatment or chemical etching. Consequently, this method proves to be cost-effective. Optimization of front contact doping and etching parameters are done by simulation modelling.

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