INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Design and Development of Efficient Electrodes for Rigid and Flexible Solar Cells**

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SHORT ABSTRACT

Photovoltaic technology has been regarded as a renewable power source which converts sunlight directly into electricity with least impact on the environment. Dye sensitized solar cells (DSSCs) is one such 3rd generation photovoltaic technology which drawn a significant attention due to its low manufacturing cost, simple preparation methodology compared to other technologies. It is an electrochemical cell consist of working electrode/photoanode, dye, electrolytes and counter electrodes. The electrodes in DSSCs play a significant role in charge transport and collection during operation. Dye (N719) in DSSCs harvests solar energy and transfer electrons to a semiconductor material (TiO_2) for the generation of electricity. DSSCs assembled with abundant and cheap materials seems to be a substantial contributor for commercial development in the near future. The thesis focuses on the development of economically competitive rigid and flexible electrodes with the motivation to further enhance energy conversion efficiency of DSSCs.

The experimental works in this thesis has been broadly divided into three parts. The first part focus on development of efficient working electrodes for conventional DSSCs. Basically, the working electrode made of a Titanium dioxide (TiO_2), treated with UVO_3 system and doped with Cesium Bromide (CsBr) to further enhance the performance of DSSCs. The study revealed that UVO_3 treatment increases oxygen vacancies, conductivity, and surface energy that leads in enhancing dyes absorption. As a result, the UVO_3 exposure working electrode outperformed with a power conversion efficiency (PCE) of 8.31%. With an aim to design an efficient electrode for DSSC, the bandgap of TiO_2 ETL is tune through doping with different concentration of cesium bromide (CsBr). An attractive PCE of 9% was achieved for TiO_2-CsBr doped photoanode based device. The results demonstrated that bandgap engineering of TiO_2 ETL provide an efficient electron extraction and improves charge transfer properties. The second part deal with an inexpensive polyaniline (PANI), carbon nanotubes (CNTs) and their composite as a counter electrodes material to replace traditionally used Platinum (Pt). The PANI-PSSNa and CNTs-PANI CEs enhanced effective surface area of the catalytic film that improved electrocatalytic activity, faster electron transfers and suppressed charge recombination. As a result, the PCE of 7.15%, and 6.67% are achieved for the fabricated devices based on PANI-PSSNa and CNTs-PANI CEs respectively.

The third part deals with the fabrication and characterization of flexible DSSCs. The objective of fabricating DSSCs on polymer substrates enables cost-effective and speedy roll-to-roll (R2R) processing systems along with making the device light-weight and flexible. However, flexible plastic substrates set restrictions to their materials and annealing processes. So, extensively studied have been carried out concentrating on the factors related to colloid binder free paste preparation, deposition and processing of ETL to improve the photovoltaic properties of FDSSC. The ETL

processed with UVO_3 system improved inter-particle connectivity and hence better solar cell performance was found with maximum PCE of 2.5%.
The efforts made in this thesis highlights an efficient development of electrodes for rigid and flexible DSSCs.