INVESTIGATION OF p-TYPE SEMICONDUCTOR MATERIALS FOR FABRICATING AND SENSITIZING TiO_2 NANO-POROUS SOLID-STATE PHOTOVOLTAIC CELLS.

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ABSTRACT

The aim of this study was to investigate p-type semiconductor materials to fabricate dye sensitized nano-porous solid-state (NDP) photovoltaic cell as well as to study the semiconductor sensitization by low band gap p-type semiconductor materials. Selecting a p-type semiconductor material to fabricate NDP cell is severely restricted. Therefore the study was confined only to two semiconductor materials, p-CuI and p-CuCNS. In our search for some other p-type semiconductor materials to fabricate the NDP cell, it was found that low bad gap semiconductor materials could also be used as sensitizer for high band gap semiconductors which replaces the dye in the NDP photovoltaic cells.

The first chapter of this thesis is a general discussion of the history and theoretical background of solar cells as solar energy converters. It also emphasizes the importance of finding some other alternative energy source for energy demand in the next century, because of the impending energy threat already caused by the exhaust of fossil fuel.

The characteristic properties of p-CuI and P-CuCNS are studied in detail in the second chapter. It also discusses the fabrication methods, calculation of band edges and band positions etc. of these materials.

The third chapter is based on a study of utilization of low band gap semiconductor materials for sensitization of photovoltaic devices. Regarding low band gap semiconductor sensitization, large number of p-type semiconductor materials were tested (p-CdTe, p-$CuInSe_2$ p-CuS etc.) and best results were obtained for n-TiO_2/Se/p-CuCNS sandwich structure. This device generates photovoltage of 600 mV and photo current of 3 mA/cm^2 at 800 W/m^2 simulated sunlight. The stability of this cell is very high compared with NDP cell as there is no degradation process in sensitizing material. The moisture and oxygen do no harm to the cell, therefore perfect sealing of the cell is not required. Though semiconductor sensitized photovoltaic devices long last compared with dye sensitized cells the short circuit photocurrent produce in the former one is less. But it should produce short circuit photocurrent greater than that of thin film solar cell devices because of the enormous effective surface area of nano-porous nature of high band gap semiconductors (eg.TiO_2) when the bulk recombinations are suppressed.