INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

It has become utmost necessary to address the energy crisis and reduce the carbon emission simultaneously. Therefore, exploration of various renewable energy sources is now the need of the hour. Among all the renewable energy sources, solar energy is considered to be the most sustainable owing to its ample availability on the surface of earth. The first and second generations of solar cell has been already commercialized and is being utilized to reduce the load on the current method of energy production through fossil fuels. However, to further consolidate the efforts, commercial utilization of the third and fourth generations of solution processable solar cells are also important. The organic solar cell (OSC) and perovskite solar cell (PSC) are the front runners among all the solution processed photovoltaic technology owing to its various advantages and PCE reaching beyond 18% and 25% respectively. Further, both these solar cells offers ease of fabrication with low-cost and abundant materials ensuring that they can be significant contributor to commercial photovoltaic technology in the near future.

This thesis is broadly organized into two parts. The first part (comprising of one chapter) and second part (comprising of three chapters) focuses on fabrication of OSC and PSC, respectively. Two techniques have been employed in this thesis work for the fabrication of solar cells: (i) hot-casting technique in the first two working chapters, and (ii) room temperature anti-solvent method in the remaining two working chapters. At first, hot-casting technique is used to develop OSC through regulation of morphology and thickness. Highest power conversion efficiency (PCE) of 9.13% was obtained for a thick active layer film. Thereafter, hot-casting technique is again implemented to fabricated mixed-halide PSC by varying the ration of methyl ammonium bromide in the precursor solution. The modified PSC resulted in PCE of 18.08% which also displayed large micrometer sized grain and reduced nanometer sized grain boundaries to minimize the recombination of the photo-generated charges. Further, trifluoro acetic acid is used as additive in perovskite solution to regulate the crystallization, minimize ion migration and charge recombination in PSC. As a result, champion 20.10% PCE was obtained in the modified device. Finally, p-toluene sulphonic acid is utilized to control the crystallization kinetics of the perovskite bulk and also passivate the traps. Simultaneously, polystyrene is used to increase the moisture resistance and reduce the surface defects of the perovskite films. This dual-passivation strategy resulted in champion PCE of 20.62% with superior ambient stability.

The efforts made in this thesis highlights the usefulness of various device engineering to develop OSCs and PSCs to regulate the morphology and crystallization of the photo-active layer to achieve highly efficient, stable and repeatable solar cells. The thesis provides the basis for facilitating the commercialization of OSC and PSC in the near future.