



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The ever-increasing energy demand is a burning question for the modern world as the conventional energy sources are finishing exponentially and cause severe environmental damage. Therefore, it is imperative to explore cost-effective, and renewable energy sources. Solar energy is the most promising competitor of fossil fuels to overcome the present energy needs. Organic solar cells (OSCs) and perovskite solar cells (PSCs) have become one of the most important photovoltaic technologies in terms of efficiency. This thesis was focused on the material engineering of OSCs and PSCs. At first, the microwave synthesis of a well-known conjugated polymer PTB7-Th with high molecular weight and low dispersity was performed to fabricate highly efficient OSCs. A thorough investigation of optoelectronic property and device performance was demonstrated with respect to the structure-property relationship of polymers. Highest power conversion efficiency (PCE) of 8.47 % was obtained with insignificant batch to batch variation for the microwave synthesized polymer. After that, all the other works were based on the improving device efficiency and stability of PSCs by applying suitable passivation molecules. Primarily, the role of several multifunctional molecules on crystallization and grain growth of perovskite was investigated. Chelidamic acid (CA) revealed optimum trap passivation ability among all and the CA passivated film demonstrated improved film morphology and better crystallinity. As a result, a high PCE of 19.06% was attained along with enhanced thermal and long-term ambient stability. Afterward, a conjugated polyelectrolyte (PHIA) was used for perovskite passivation. The PHIA passivated device disclosed a high device efficiency along with outstanding stability in varied conditions. In the subsequent work, the effect of novel triple passivation technique was demonstrated which can simultaneously improve UV and ambient stabilization. The function of each passivation layer was studied carefully for a clear understanding. The triple passivated device exhibited outstanding UV and ambient stability as well as a high PCE of 20.46%. Finally, the fabrication of 2D-3D graded perovskite was demonstrated for improved efficiency and stability. A detailed analysis of the film morphology, trap passivation, device stability in the 2D-3D graded heterostructure was investigated meticulously. This 2D-3D graded perovskite resulted in a champion PCE of 21.18% with superior ambient stability. The efforts demonstrated in this thesis This thesis provides significant insights into the future commercialization of OSCs and PSCs.