# Understanding the physics of degradation of polymer solar cell


## Abstract

Polymer solar cell has been an active field of research in recent years. Thin film inorganic and organic solar cells are gaining significant momentum to outperform the already commercialized high efficiency crystalline counterpart. However the fundamental limitation of inorganic solar cell is limited number of active layer material. Organic conjugated polymer presents huge prospect in providing flexibility in designing photo active organic molecules which allows us to have tunable optical as well as electrical properties. Recent use of lower band gap polymer such as PCDTBT(6-7)%, PDTSTPD(6.7%), p-DTS($FBTTh_2$)$_2$(7%), PTB7(9.2%-9.6%) has shown promising future for reaching highly efficient single junction solar cell. By using two different polymer or small molecule in two different tandem structure namely parallel tandem and series tandem were shown to enhance the efficiency in excess of 10.5% - 12%.

However degradation is one fundamental limitation that has crippled the widespread commercialization of OPV. Both in ambient atmosphere as well as under light, organic photo-voltaic tend to degrade rapidly with time. In this work we report on the measurement of fundamental properties such as deep defects and hole mobility in poly-3-hexyl-thiophene (P3HT)/[6,6]-phenyl-C60-butyric acid methyl ester(PCBM) solar cells when exposed to solar radiation without any atmospheric exposure. It was observed that light itself can contribute significantly to the degradation dynamics of organic photovoltaic. It was found that the mid-gap defect density in P3HT and the interface density between P3HT and PCBM increase upon continuous light soaking. Such increase in defect density leads to an increase in reverse saturation current of the diode which can be nicely correlated with the decrease in basic parameters of OPV that determine the efficiency. We also observed a second photo-degradation dynamics related to the active layer morphology effecting solar cell photo current significantly. Thermal treatments on photo degraded solar cells have endorsed the possibility of partial recovering of photovoltaic performance. Some simultaneous processes consisting of metal cathodes are found to influence the post production annealing of organic solar cells. We studied the effect of every interlayer of multi layered solar cell structure systematically ranging from anode to cathode inter layer to see their respective effect on photo stability. Study of different cathode interlayer revealed that only aluminum cathode can introduce more defect states into the active layer which indicates to the involvement of metal cathode interlayer as a possible source of defect creation in the solar cell under prolonged exposure to sun-light. Finally photo stability of inverted organic solar cells was studied and routs to obtain better photo stable organic solar cells were proposed.