World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:17, No:02, 2023

Investigation of Polymer Solar Cells Degradation Behavior Using High Defect States Influence Over Various Polymer Absorber Layers

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Abstract : The degradation phenomenon in polymer solar cells (PCSs) has not been clearly explained yet. In fact, there are many causes that show up and influence these cells in a variety of ways. Also, there has been a growing concern over this degradation in the photovoltaic community. One of the main variables deciding PSCs photovoltaic output is defect states. In this research, devices modeling is carried out to analyze the multiple effects of degradation by applying high defect states (HDS) on ideal PSCs, mainly poly(3-hexylthiophene) (P3HT) absorber layer. Besides, a comparative study is conducted between P3HT and other PSCs by a simulation program called Solar Cell Capacitance Simulator (SCAPS). The adjustments to the defect parameters in several absorber layers explain the effect of HDS on the total output properties of PSCs. The performance parameters for HDS, quantum efficiency, and energy band were therefore examined. This research attempts to explain the degradation process of PSCs and the causes of their low efficiency. It was found that the defects often affect PSCs performance, but defect states have a little effect on output when the defect level is less than 1014cm-3, which gives similar performance values with P3HT cells when these defects is about 1019cm-3. The high defect states can cause up to 11% relative reduction in conversion efficiency of ideal P3HT. In the center of the band gap, defect states become more noxious. This approach is for one of the degradation processes potential of PSCs especially that use fullerene derivative acceptors.

Keywords : degradation, high defect states, polymer solar cells, SCAPS-1D
Conference Title : ICEPGTT 2023 : International Conference on Electric Power Generation Technologies and Techniques
Conference Location : Istanbul, Türkiye
Conference Dates : February 16-17, 2023