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Effects of reversible metastable defect induced by illumination on Cu(In,Ga)Se2 solar cell with CBD-ZnS buffer layer

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Typical Cu(In,Ga)Se2 (CIGS)-based solar cells have a buffer layer between CIGS absorber layer and transparent ZnO front electrode, which plays an important role in improving the cell performance. Among various buffer materials, chemical bath deposition (CBD)-ZnS is being steadily studied to alternative to conventional CdS and the efficiency of CBD-ZnS/CIGS solar cell shows the comparable values with that of CdS/CIGS solar cell. The intriguing thing is that reversible changes occur after exposure to illumination due to the metastable defect states in completed ZnS/CIGS solar cell, which induces an improvement of solar cell performance. Thus, it implies that the understanding of metastable defects in CBD-ZnS/CIGS solar cell is important issue.

In this study, we fabricate the ITO/i-ZnO/CBD-ZnS/CIGS/Mo/SLG solar cells by controlling the NH4OH mole concentration (from 2 M to 3.5 M) of CBD-ZnS buffer layer and observe their conversion efficiency with and without light soaking for 1 hr. From the results, NH4OH mole concentration and light exposure can significantly affect the CBD-ZnS/CIGS solar cell performance. In order to investigate that which layer can contain metastable defect states to influence on solar cell performance, impedance spectroscopy and capacitance profiling technique with exposure to illumination have been applied to CBD-ZnS/CIGS solar cell. These techniques give a very useful information on the density of states within the bandgap of CIGS, free carriers density, and light-induced metastable effects. Here, we present the rearranged charge distribution after exposure to illumination and suggest the origin of the metastable defect states in CBD-ZnS/CIGS solar cell.

Keywords: Cu(In,Ga)Se2, CBD-ZnS, impedance spectroscopy, capacitance profiling, metastable defect