Area: Thin-Film Compound Semiconductor PV

CHARACTERIZATION OF FLEXIBLE CIGS THIN FILM SOLAR CELLS ON STAINLESS STEEL SUBSTRATE

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Cu(In,Ga)Se_2 (CIGS) thin film solar cells based on a rigid substrate such as soda-lime glass (SLG) have reached efficiencies greater than 20%. From the manufacturing point of view, flexible substrates have an advantage in that it can be used for roll-to-roll processing which enables high throughput and cost reduction. The record conversion efficiency of thin film CIGS solar cells on stainless steel substrates is 17.7 % at 0.4 cm^2. The major issue with the use of stainless steel as a flexible substrate is the potential diffusion of detrimental impurities in the CIGS absorber. These impurities severely hamper the performance of CIGS thin film solar cells. Stainless steel is composed of Fe, Ni and Cr elements that can diffuse through Mo layers into CIGS absorbers as impurities. Previous reports mainly focused on the impact of Fe impurities in the CIGS layer. Fe atom is known to have a very detrimental effect on the absorber layer, which is dissolved in the bulk of CIGS grains. Ni atoms are the most detrimental impurities for the performance of CIGS solar cells, even at very small concentrations. It is noteworthy that these impurities induce defects deep within the band gap. Pianezzi et al. studied the effect of Cr and Ni impurities as deep level defects by depositing Cr and Ni layers on glass substrates. However, there are no similar reports that investigate the collective effects of Fe, Ni and Cr diffusion on the performance of CIGS TFSCs. In order to reduce absorber contamination by the diffusion of Fe, Ni and Cr impurities, barrier layers comprised of SiOx, Al_2O_3 or Cr have been deposited on metal substrates. These barrier layers are either expensive or need to be deposited with high thicknesses that considerably increase the cost of solar cells.

In this paper, we introduced a very thin ZnO layer (<200nm) that can be used as a diffusion barrier to avoid absorber layer contamination. To investigate the impact of ZnO layer with different thickness on the properties of CIGS TFSCs, 50nm, 100nm, 150nm and 200nm thickness of ZnO layers were prepared and GD-OES characterization was used which offers faster processing times and a wider measurement area than SIMS. Also, DLTS and impedance analysis were carried out to study about deep level defects.

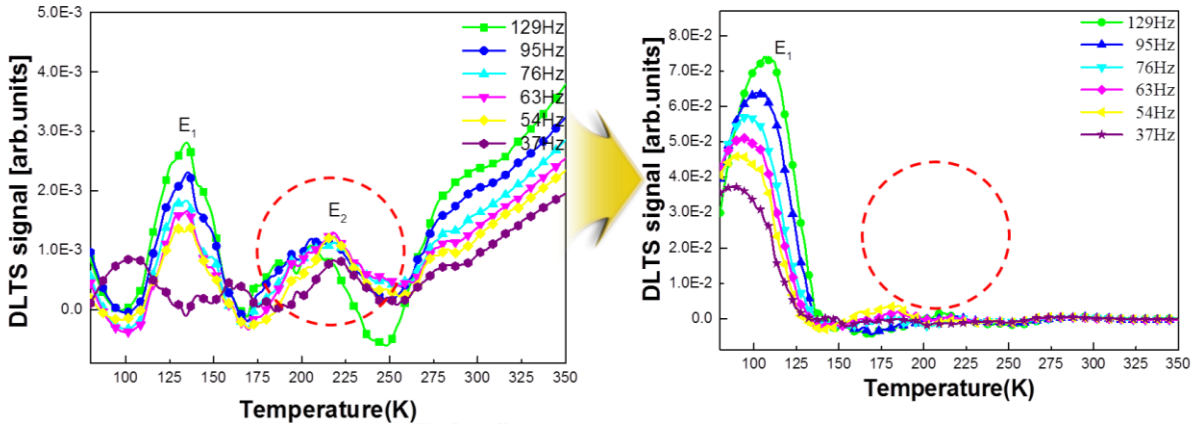

Figure 1: DLTS of CIGS thin film solar cells on stainless steel substrate