Area: Area 2 Thin-Film Compound Semiconductor PV

FLEXIBLE CU(IN,GA)SE_2 BASED SOLAR CELLS USING MOLYBDENUM SUBSTRATE

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Flexible solar modules have the potential to serve specialized consumer markets, such as lightweight mobile device chargers, building-integrated photovoltaic systems (BIPV), transport-integrated PV, space flight, or deployable systems. In these market segments, thin film CIGS based solar modules are much more relevant than traditional PV technologies. Cu(In,Ga)Se_2 (CIGS) solar cells have reached record efficiencies of 20.4% on polyimide foils and 18.7% on stainless .

The advantage of metallic substrates compared to polyimide foils is that the first one have excellent temperature tolerance due to their high melting point and hence are well suited for the deposition conditions of CIGS cells. However, in this system the conversion efficiency remains crucial for cost-competitiveness, and it is necessary to develop devices on flexible substrates that perform as well as those obtained on rigid substrates. Our work focuses on the use of 0.1mm thick Mo foils as substrates which has not received much attention compared to other metals such as Ti and Stainless Steel although the coefficient of expansion of Mo better matches that of CIGS. Interestingly, Mo foil can be used as both the substrate and back contact which reduces the manufacturing steps. Our first studies on this topic shows that whatever the deposition conditions efficiencies hardly exceed 14% without anti-reflexion coatings.

In order to improve the efficiency of these solar cells the technological aspects of using Mo thin foils as substrates for CIGS solar cells will be discussed. By combining different characterization techniques such as X-ray diffraction (XRD), Glow Discharge Optical Emission Spectroscopy (GD-OES), SEM, EQE and IV measurements it will be shown that even if the addition of alkali metals, such as Na and K and the Ga gradient can highly improve the cell performances, the crucial point on the increase of the efficiencies will be the impact of the back contact. A test to evaluate the effects of an additional layer of sputtered Mo showed that these layers are detrimental to cell performance at a low substrate temperature of 480°C but beneficial at 550°C. Furthermore, at 480°C, the orientation of the CIGS absorbers is unaffected by a layer of sputtered Mo but at 550°C, with increasing Sputtered Mo thickness, the CIGS preferential orientation becomes (220)/(204).

The impact of these variations on the cell performance will be discussed and compared to other substrate and improvement paths in terms of passivation of the back contact will be presented.

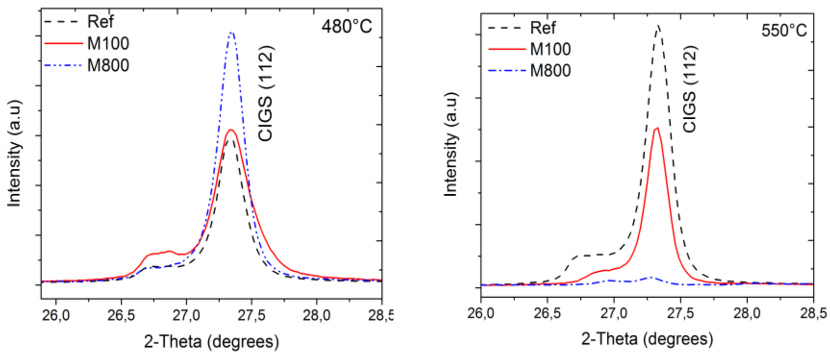

Figure 1. XRD diffractograms comparing the orientation of the CIGS absorbers deposited at 480°C and 550°C on a plain Mo foil, 100nm of sputtered Mo/Mo foil (M100) and 800nm of sputtered Mo/Mo foil (M800)