The current status and future prospects of chalcogenide thin film solar cells

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A Crystalline silicon (c-Si) based PV technology accounted for about 94% of the total production while the market share of all thin film technologies amounted to about 6% of the total annual production. The reduction in PV module cost progresses with the increase of production, but we are rapidly reaching a stage where a further decrease in cost is conditional on the global availability of raw materials. Thus, PV technologies that involve the use of lesser quantities of cheaper and less refined input materials are favored. Currently, there are several low-cost inorganic thin-film solar cell options, which have potential for high efficiency and high stability. Among them, chalcogenide based thin film are very promising expecially $Cu(In,Ga)Se_2$ (CIGS) since its conversion efficiency reached 23% at laboratory level. Despite the advantages of CIGS technology, the production of CIGS solar cells is expected to be limited as results of indium and gallium scarcity and in the last decade, much attention has been focused on I_2-II-IV-VI_4 thin films as an attractive possibility for the synthesis of In and Ga free chalcogenides. Kesterite photovoltaics utilizing Cu_2ZnSnS_4 (CZTS), $Cu_2ZnSnSe_4$ (CZTSe) and $Cu_2ZnSn(S,Se)_4$ (CZTSSe) are emerging as the most promising replacement for the chalcopyrite absorbers, through the substitution of indium and gallium in the with comparatively abundant and lower cost zinc and tin. Conventional methods for fabricating Kesterite based solar cells involve vacuum processes, even if the most performing devices based on CZTS have been realized using a solution-based methodology. In this context, at MIBSOLAR we develop a chemical procedure to obtain a superior quality CZTS films and its variant like CFTS composed by highly soluble and inexpensive precursors in a non-toxic and environmentally friendly solvent. Furthermore, a new alternative to copper zinc tin sulfide/selenide is copper manganese tin sulfide (CMTS), a p-type semiconductor fully based on Earth-abundant and low-cost elements which shows an important advantage with respect to CZTS. Last but not least Kesterite solar cells can be considered the abundant, nontoxic alternative to perovskites for tandem solar cells. As matter of fact kesterite offers very interesting key material properties, including a band gap that can be tuned between approximately from 2 to 0.9 eV. In this presentation, we will also discuss the potentiality of considered tandem structure using CZTS and its variant as absorber layers.