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Feasibility of semi-transparent solar cells using a wide bandgap Zinc Telluride absorber

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Abstract:

With crystalline silicon dominating the photovoltaic market thanks to high efficiencies and low manufacturing costs, the pathways for solar energy to go forward will involve either disrupting concepts for ultra-high efficiencies such as tandem structures and new concepts (intermediate bands, hot carriers….), or innovative ways to deploy photovoltaic devices such as building integration through transparent and semi-transparent cells. Using a wide bandgap material holds many assets in that regard with potential applications in tandem devices, (semi-) transparent photovoltaic even new concepts like intermediate band solar cells.

In this poster, we use numerical modeling to investigate on the feasibility of solar cells based on II-VI ZnTe material. Boasting a large 2.25 eV bandgap, natural p-doping (n also possible), the possibility to create an intermediate band through O incorporation, and being already used as a back surface field in CdTe devices, ZnTe ticks many boxes for being an interesting semi-transparent photovoltaic absorber. However, reports of ZnTe solar cells since the 80s have been seldom and efficiencies remain below 2% so far. Here, we demonstrate that the current state of the art solar cells have been inherently limited by the conduction band offset at the PN interface due to the use of inadequate buffer layers. Several buffer layer candidates are evaluated, and ZnS is found as the most promising material. Moreover, the influence of a front selenization is studied (figure 1) by simultaneously varying the amount of Se at the front interface and the thickness of the $ZnTe_xSe_{1-x}$ layer. Se incorporation at the interface is found beneficial for the performances if it does not extend further than the space charge region, where it creates a barrier for the electrons and damages the Fill Factor of the cell. Finally, shallow n-doping of the front interface is also considered in our model, as such doping has previously been reported using Al of Cl. This homojunction-like solar cell has a markedly improved voltage, and this approach should be seriously considered for future experimental devices. The complete set of results, including J-V curves, relevant figures of merit and Capacitance analysis will be presented in this poster.

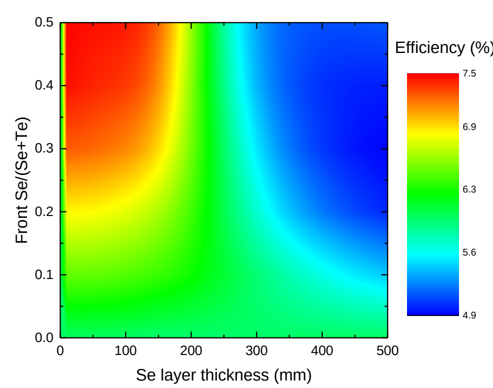

Figure 1 Modeled efficiency as a function of the selenized layer depth and front Se content.