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Optimization of CIGSe bottom cell for spectral splitting device application

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In the scope of further increasing the efficiency of thin film solar cells, a design using spectral splitting filters has been proposed to significantly reduce the optical losses inherent to stack-type multijunction solar cells. A narrow bandgap CIGSe solar cell is considered to be used as a bottom cell owing to the high efficiency of such material and easy tuning of the bandgap. Two designs are considered: one using a splitting filter with a cut-off wavelength of 620nm (two junctions type, figure 1) and another using a splitting filter with a cut-off wavelength of 880nm (three junctions type design, figure 1). A trade-off exists between the light absorption and the optimization of other parameters such as recombinations, and we use state-of-the-art material parameters to simulate the behavior of a CIGSe solar cell using SCAPS 3.201, and investigate on the optimum band configuration depending on the type of multijunction design (2 or 3 cells, i.e. splitting filter of 620nm and 880nm). The minimum bandgap is varied simultaneously with the thickness of the narrow bandgap region (figure 2). The numerical simulations allow us to determine the optimum band diagram conditions for each configuration, and thus depth chemical composition; as expected, a minimum bandgap of about 1.2eV leads to the highest efficiency under AM 1.5 illumination (figure 3a), while the optimum minimum bandgap using the 620nm splitting filter becomes comprise in the 1.1-1.15eV, and finally a minimum bandgap of 1.02eV (pure CISe) is required to achieve the highest efficiency when using a 880nm splitting filter. Similarly, our simulations allow determining an optimum depth for the narrow bandgap region (low Ga). The simulations will be compared to the photovoltaic performance under AM 1.5 and multijunction conditions of real devices with similar bandgap configurations and adequate filters.

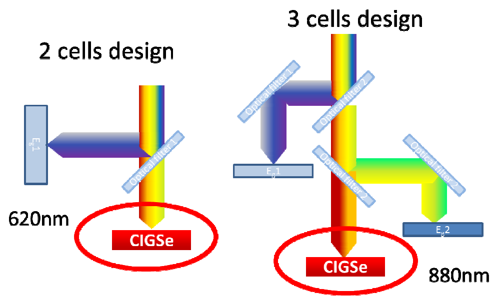

Figure 1.

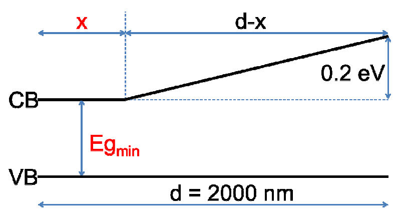

Figure 2.

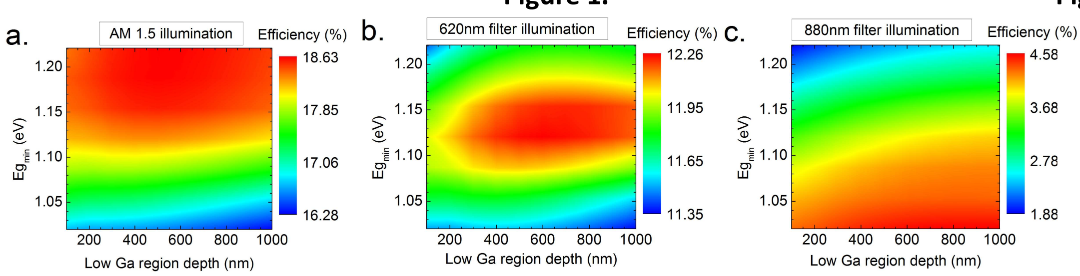

Figure 3.

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