Realistic modeling of tandem cells formed by low temperature PECVD epitaxy of silicon-germanium on gallium arsenide

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Multijunction solar cells based on III-V compounds have by far the highest conversion efficiency. However, the fabrication cost is very high. An attractive solution to lower the cost while maintaining high efficiencies is to design multijunctions on cheaper substrates such as silicon [1]. Different routes have been taken to cope with lattice mismatch issues between Si and III-Vs: epitaxial growth of GaAs on Si with or without buffer layers or non-epitaxial techniques such as mechanical stacking. A novel approach has been recently presented consisting in direct epitaxial growth of thin Si or SiGe layers on GaAs by low temperature PECVD [2], where the high crystal quality reported opens a new way for making III-V/Si tandem solar cells. For a given thickness of the epi-Si or epi-SiGe bottom cell (typically less than 5  $\mu$ m), it is crucial to find the optimum composition of the III-V top cell. This depends on both optical and electrical properties of the entire structure. Actually, the common efficiency calculations are based on the ideal radiative limit [1] and suffer from limiting assumptions, e.g. complete absorption in the sub-cells, no non-radiative recombination in the bottom cell. In this paper we thus propose an extensive numerical simulation study using TCAD tools to calculate realistic maximum efficiencies and facilitate the design of III-V/epi-SiGe tandem cells.

[1] J. Connolly et al., Prog. Photovolt: Res. Appl 22 (2014) 810

[2] R. Cariou et al., 40th IEEE PVSC (2014)