$Si_{1-x}Ge_x$ alloys on III-V (100): first steps in film growth by low temperature PECVD epitaxy

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In this work, an innovative approach for III-V on Si multijunction photovoltaic (PV) solar cells is studied. The targeted device is a tandem junction composed of a III-V top cell (AlGaAs) and a group IV bottom cell (SiGe). The choice of $Al_yGa_{1-y}As$ as the top material is justified because it provides the optimum bandgap combination with $Si_{1-x}Ge_x$, namely 1.63eV / 0.96eV, which can achieve theoretical power conversion efficiencies in excess of 42% in a tandem configuration [1]. In our inverted metamorphic approach, we first use MOVPE to grow the AlGaAs top cell lattice matched on a GaAs substrate, and then perform low temperature (LT)-PECVD hetero-epitaxial growth of $Si_{1-x}Ge_x$ for the bottom cell. We have already demonstrated high quality Si monocrystal epitaxy on GaAs by PECVD at 200°C [2,3]. The tandem stack can be easily detached from the GaAs wafer and transferred to a host substrate. In addition, the GaAs wafer can be reclaimed for further cost reduction.

Here, we will present first steps in $Si_{1-x}Ge_x$ alloys growth on $Al_yGa_{1-y}As$ by LT-PECVD. By dilution of GeH_4 in SiH_4/H_2 plasma using a standard RF-PECVD reactor, we show for the first time epitaxial $Si_{1-x}Ge_x$ alloys, with variable Ge fraction, grown at such low temperature (fig. 1). To quantify the quality of epitaxial layers, optical and structural properties are investigated using spectroscopic ellipsometry, Raman, DRX and AFM.

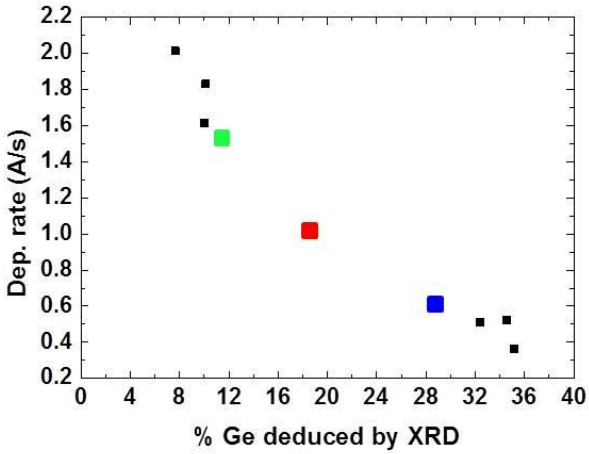

Fig. 1: Deposition rate of $Si_{1-x}Ge_x$ versus percentage of germanium deduced by XRD

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