Photoemission study of S-vapour exposed epi-GaP/c-Si surfaces

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Today the challenging roadmap of photovoltaic sector is to develop high performance, stable and low cost tandem solar cells. One option is to combine the $Cu(In,Ga)(Se,S)_2$ industrial thin film technology with the silicon one in order to develop tandem junctions. Wide band gap $Cu(In,Ga)(Se,S)_2$ top cell can be produced using a pure sulfide $Cu(In,Ga)S_2$ absorber with a GGI (Ga/Ga+In) about 0.3, yielding a bandgap of 1.7 eV. At IMN, a $Cu(In,Ga)S_2$-based cell with performance of 16.0% conversion efficiency on Mo/SLG substrate has already been produced [1].

In this project $Cu(In,Ga)S_2$ absorbers are grown on GaP buffered Si platforms rather than directly on Si substrate allowing to achieve a theoretical optimized control of band offsets. In this device, structural matching is obtained thanks to the excellent lattice matching of $Cu(In,Ga)S_2$ both with Si and GaP.

One of the main scientific and technological challenge of tandem device is to control the interfacial optoelectronic properties at the different interfaces in order to ensure an optimized electronic matching. It is well known that cleaning procedures and passivation of III-V semiconductor surfaces are crucial in epitaxial growth and device fabrication [2–4]. Due to its high chemical reactivity, gallium phosphide exhibits a native oxide film. In this paper we first investigated GaP deoxydation procedures through detailed XPS (X-ray Photoemission Spectroscopy) analysis. Oxide thicknesses reduction were estimated from XPS intensity of gallium oxide and GaP substrate for the different procedures.

$Cu(In,Ga)S_2$ growth on GaP/Si platforms implies GaP exposure to sulfur vapor prior to the co-evaporation of the chalcopyrite film. To get a better knowledge on the $Cu(In,Ga)S_2$ /GaP interface formation, deoxidized GaP surfaces have been exposed to combined high temperature and sulfur vapor in order to mimic early stages of $Cu(In,Ga)S_2$ growth. Modifications of GaP deoxidized surface after sulfur vapor exposure were investigated through S 2p, Ga 2p and P 2p core levels and valence band. Our results demonstrate that a partial sulfurization occurs at the deoxidized GaP surface.

This work is supported by the French National Research Agency project EPCIS (Grant no. ANR-20-CE05-0038) and the PIA (Grant no. ANR-IEED-002-01), by the French Contrat Plan État-Région and the European Regional Development Fund of Pays de la Loire. The authors acknowledge RENATECH+ (French Network of Major Technology Centers) for technological support, and the CIMEN Electron Microscopy Center in Nantes.

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