Prospects for High Efficiency Si/CIGS tandem solar cells

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A new concept is proposed to develop efficient tandem cells based on silicon bottom cells and wide band gap Cu(In,Ga,Al)(S,Se)$_2$ (noted CIGS) top cells. It consists in introducing an epitaxial III-V buffer layer at the interface. The benefit of this configuration is discussed in terms of lattice and band offsets matching between CIGS and III-V's. Selected combinations are proposed, with AlGaAs and GaAlP buffer layers. Preliminary results with $CuGaSe_2$ on various substrates confirm the influence of the substrate on the growth of CGS and PV properties. Epitaxial growth on GaP and possible selective back contact effect with GaAlAs are evidenced. Preliminary results on using advanced characterization methods are presented (SIMS, nanoAuger, cathodoluminescence).

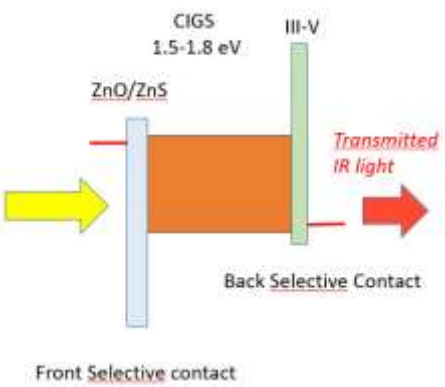

Figure 1. Scheme of an ideal CIGS solar cell, with front and IR transparent back selective contacts.

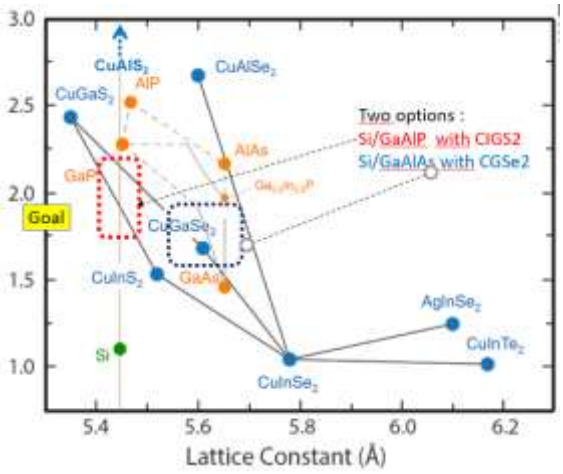

Figure 2. Energy gap (in eV) versus lattice constant for III-V's and chalcopyrites. The red and and blue rectangular zones are adapted for optimal lattice matching and band gap for CIGS top cells.

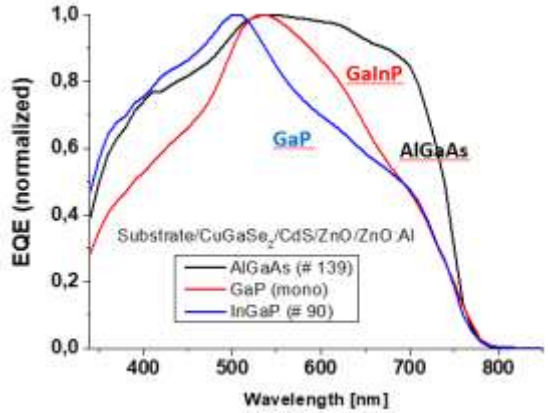

Figure 3. Relative spectral responses for $CuGaSe_2$ cells with different III-V's substrates

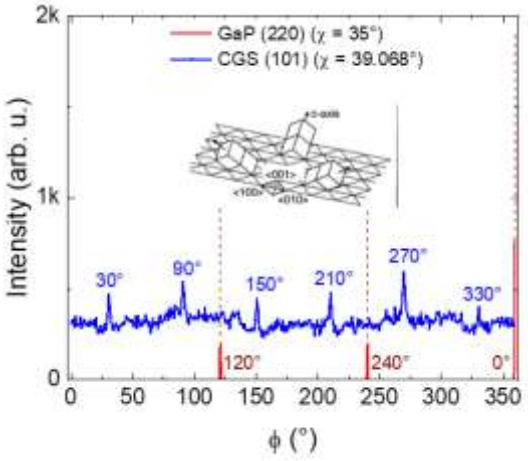

Figure 4. ϕ scans recorded on bare GaP (111) substrate and after deposition of a $CuGaSe_2$ layer.