Towards two-terminal bonded CIGS/Si tandem solar cell

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As part of the European SITA project, the aim is to develop two-terminal tandem solar cells combining two mature PV technologies, Cu(In,Ga)(S,Se)2 (CIGS) and silicon, each with proven stability and well-established supply chains in Europe. However, temperature constraints prevent a direct deposition of CIGS on Si solar cells. To overcome this limitation and keep independent fabrication of the top and bottom cells, we have developed a new 2-terminal tandem architecture made of a wide bandgap CIGS top cell bonded on a silicon heterojunction (SHJ) bottom cell. This concept is based on a multifunctional conductive and transparent interface and requires a current matching between the top CIGS and bottom SHJ cells.
In this contribution, we will present the design principles and the first experimental results. Our top wide-bandgap CIGS solar cell exhibits a decent short-circuit current of J_{sc} = 16.7 mA/cm^2. The bonding process is achieved with a proprietary process that can accommodate rough surfaces and was successfully applied to bonding on textured silicon cells. Both the transparent contact and the conductive interface are optimized to favor transmission of infrared light towards the Si bottom cell. We will present a detailed analysis of the electrical and optical properties of the different components of the tandem stack. Optical simulations have been carried out to analyze the current matching between sub-cells (Figure 1a)). A proof-of-concept of small-area (1cm^2) bonded tandem devices reaching V_{oc}>1.1V has been fabricated (above the individual V_{oc} of each sub-cell) (Figure 1 b)). A detailed losses analysis of the final cells will also be presented.

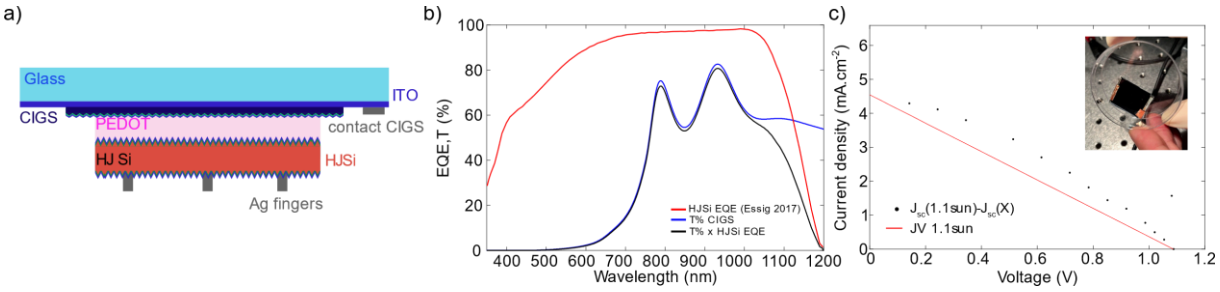

Figure 1: a) Sketch of the 2T bonded CIGS/Si tandem cell design. b) Simulated transmission (blue) of the top CIGS cell compared to the EQE of a HJSi (red), to determine the EQE of a HJSi through the CIGS top cell (black). b) IV characteristic (red) under 1.1 sun illumination of a bonded tandem solar cell and pseudo IV characteristic of the same cell (black dot). Inset: image of a pre-prototype device with Copper tape contacts on the side.