Fabrication and characterization of perovskite mini modules for Tandem application

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In the past decade, perovskite solar cells (PSC) have demonstrated high efficiency and formidable improvement. Their characteristics have drawn the interest of researchers and industrials in the photovoltaic field. Moreover, its tunable gap enables its use as top cell in a tandem configuration. Several approaches exist and are developed nowadays for tandem implementation. One consists in two submodules, fabricated independently, stacked on top of each other and individually contacted. In this context, our teams have made efforts on the upscaling, the interconnexion and the transparency [1] of PSC to avoid extensive losses that occur during modularization.

First, we present experimental work on interconnexions of PSC. Our approach relies on the well-known P1 P2 P3 scheme for monolithic interconnexions. By using a picosecond pulsed laser and a mechanical scriber, we managed to scribe locally thin film in order to connect PSCs and enhance voltage of the final object which is a perovskite module (PSM). We substantially investigated interconnexions between cells by electrical and optical means to tackle large losses of fill factor and so of PCE.

We report here devices, composed of 8 cells and demonstrating PCE up to 15 % on a 16 cm² aperture area. Thanks to extensive work on laser scribing we increased GFF up to 95%, and reduced P2's contact resistance. Besides, empowered by parallels works on indium tin oxide, we fabricated semi-transparent perovskite modules with reduced hysteresis and improved efficiency.

In addition, PSMs characterization have been taken one step further using electroluminescence (EL). We focused our study on thin film uniformity and interconnexion quality. Through this method, we managed to identify regions source of losses.

Theses first results on perovskite modularization are really promising and underline feasibility of tandem devices which are expected to be highly efficient.

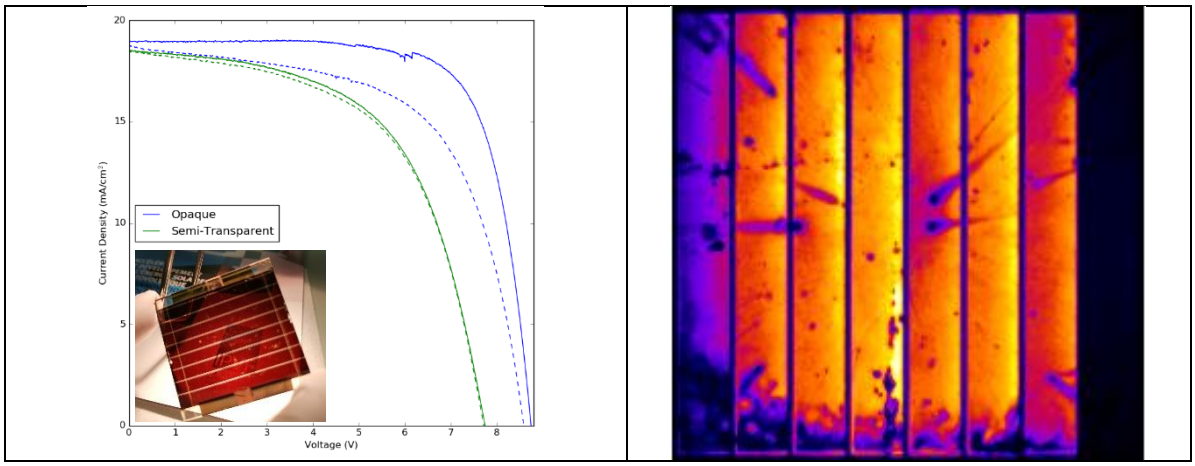

Figure 1 – Left : JV measurements of opaque and semi-transparent PSM. Right : EL measurements of opaque PSM.

[1] F. J. Ramos et al., "Highly efficient MoOx-free semitransparent perovskite cell for 4 T tandem application improving the efficiency of commercially-available Al-BSF silicon," Sci. Rep., vol. 8, no. 1, p. 16139, 2018.