Up-scaling Perovskite growth using hybrid methods for Silicon/Perovskite tandem solar cells

Authors : Kristell CARRERIC[1], Polyxeni TSOULKA[1], Louis GRENET[2], Elodie TESTARD[2], Solenn BERSON[1]

Affiliations : [1] Univ. Grenoble Alpes, CEA, Liten, INES, 73375 Le Bourget du Lac, France

[2] Univ. Grenoble Alpes, CEA, Liten, DTNM, 38000 Grenoble, France

kristell.carreric@cea.fr

In the last ten years, tandem solar cells based on perovskite (PK) materials have shown promising results, surpassing the theoretical limits of single junction Silicon (Si) solar cells. Even though Si/PK tandem solar cells appear capable of achieving 40% of power conversion efficiency, we need to overcome many challenges in order to upscale the PV devices and pass from the 1 cm² laboratory scale to larger areas. With that perspective, vapor deposition of the absorber layer seems promising in order to deposit a conformal and high quality perovskite on top of textured Si wafers. In the literature, the main industrially compatible techniques to grow the PK layer can be divided into two axes: i) PK deposition by full vapor deposition techniques and ii) PK deposition by hybrid process (mix of a dry and wet process).

In this work, we focus on two different hybrid deposition processes where the first inorganic layer is grown by either i) thermal co-evaporation or ii) Close Space Sublimation. The organic precursors are then deposited by spin coating to convert the initial scaffold into the desired perovskite layer.

Using X-ray Diffraction, Raman Spectroscopy, Scanning Electron Microscope we firstly investigate the structural and chemical properties of the inorganic scaffold. The goal of this preliminary study is to understand how the characteristics of the first layer (homogeneity, porosity, composition) will affect the growth of the final PK.

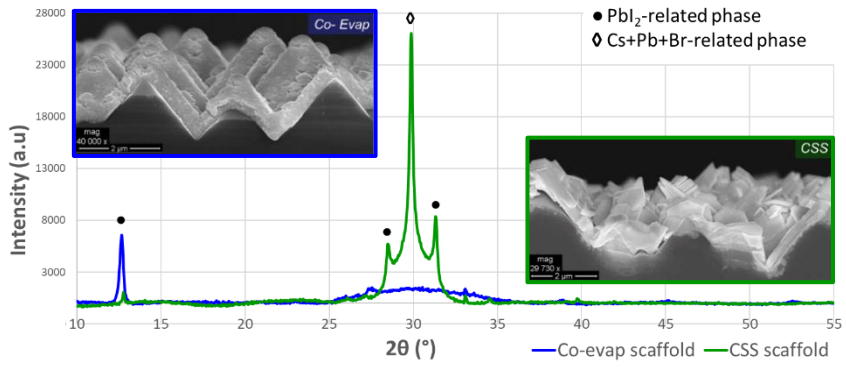

Figure 1 : XRD and SEM images of inorganic scaffold deposited by co-evaporation and Close Space Sublimation (CSS)

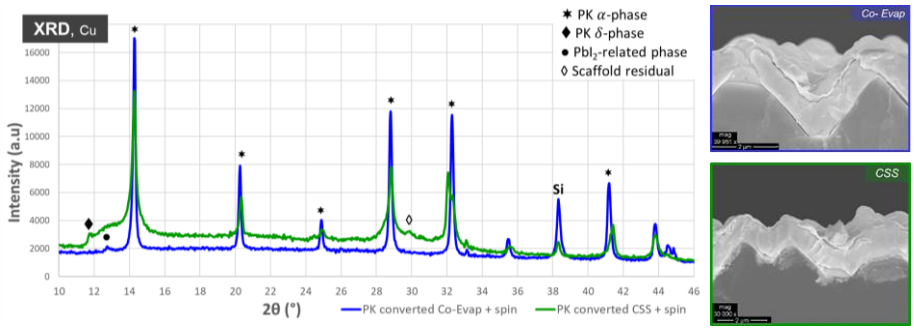

Figure 2 : XRD and SEM images of converted Perovskite based on co-evaporation and CSS scaffold followed by a spin-coating process for conversion

Simultaneously, studies on the critical parameters for the crystallization of the PK are also conducted : impact of the ratio of organic precursors, annealing temperatures etc.

Finally, we associate the material properties of the PK layer to the optoelectronic response of the PV devices. Our preliminary results show that both methods exhibit efficiencies above 15% with a record co-evaporated + spin cell at 21,7 %.

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