Unbalanced Charge Distribution Inside a Perovskite-Sensitized Solar Cell in Real Space

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Solar cells based on perovskite light absorbing materials reached power conversion efficiencies >20%. The aim of our study is to measure the electrical potentials under working conditions inside the device via scanning force microscopy methods [1]. In particular, we prepared smooth cross sections by means of focused ion beam milling such that the full structure and functionality of the devices were preserved. This way, the internal interfaces between the different materials in the cell are accessible for frequency modulation Kelvin Probe Force Microscopy (Fig. 1a). Our measurements indicated that mesoscopic lead methylammonium tri-iodide solar cells exhibit a homogeneous electric field throughout the device representing a p-i-n type junction. Upon illumination under short-circuit conditions, holes accumulate in front of the hole transport layer, which is proof of an unbalanced charge transport (Fig. 1b). This potential barrier reduces the charge transfer towards the electrode. After light illumination, we measured remaining contact potential differences inside the active device area. These signals can be attributed to charges that are trapped or to dipoles at the mesoporous/ perovskite capping layer interface [2]. Furthermore our studies allow to pinpoint hysteretic effects to a material and interface of the perovskite solar cell. In conclusion, the FM-KPFM method allows us not only to map the local contact potential variation but also to correlate it with the local structure and interface of the functional layers.

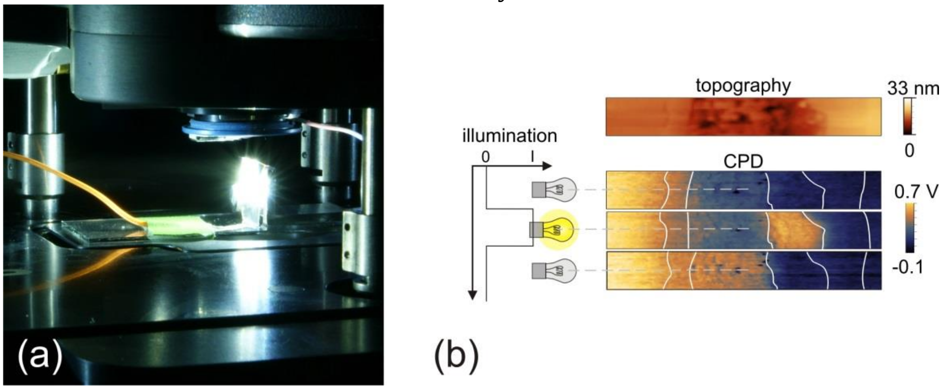

Fig.1 (a): Photography of the Kelvin probe Force Microscopy. (b) Topography and contact potential difference maps of a perovskite solar cell recorded under short-circuit conditions in dark and under illumination.

References

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