A LATERAL HETEROJUNCTION DEVICE AS A TOOL TO STUDY PEROVSKITE-BASED SOLAR CELLS

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Hybrid perovskite solar cells have experienced a strong increase in efficiency in the last decade thanks to promising properties that have attracted great interest from the scientific community. These solar cells combine a highly crystalline sub-micrometric absorber with transparent and selective carrier transport layers (SCTLs).

In our study, we aim at quantifying the SCTL-perovskite interactions employing a lateral heterojunction device (LHJ). The device is composed of a glass substrate, on which two different SCTLs are selectively deposited. To complete the structure, a perovskite layer is deposited on top, creating a p-i-n-like device developing in the horizontal direction (Figure 1a).

In a previous study, we had a device with a channel length between the two SCTLs of ≈60 µm, and we locally probed this device employing X-ray photoemission spectroscopy. We measured a ≈500 mV - amplitude gradual decrease of the surface potential across the perovskite channel [1]. This difference has been ascribed to the presence of the SCTLs, which modify the work function of the perovskite. Employing drift-diffusion simulations, we evaluated the defect-induced doping level in the perovskite to be lower than 10^{12} cm^{-3} [2].

To confirm the previous experimental results and to improve both measurement resolution and channel morphology, a new LHJ device is under development. This device is produced employing photolithography and features different channel lengths. Photolithography allows to reach micrometric resolution on the channel width while maintaining low roughness. These improvements make it possible to perform higher-resolution Kelvin probe force microscopy (KPFM) measurements of the surface potential across the channels, both in-dark and under illumination.

On the LHJ samples produced employing photolithography, we managed to create a ≈500 mV work function difference between the TiO_x and the NiO_x side (without the presence of the perovskite). As visible in Figure 1b and 1c, the deposited SCTLs cover completely the electrodes and extend for few microns inside the glass channel. A perovskite layer will be deposited onto these structured samples and KPFM will be measured again after perovskite deposition. The results will be presented at the conference.

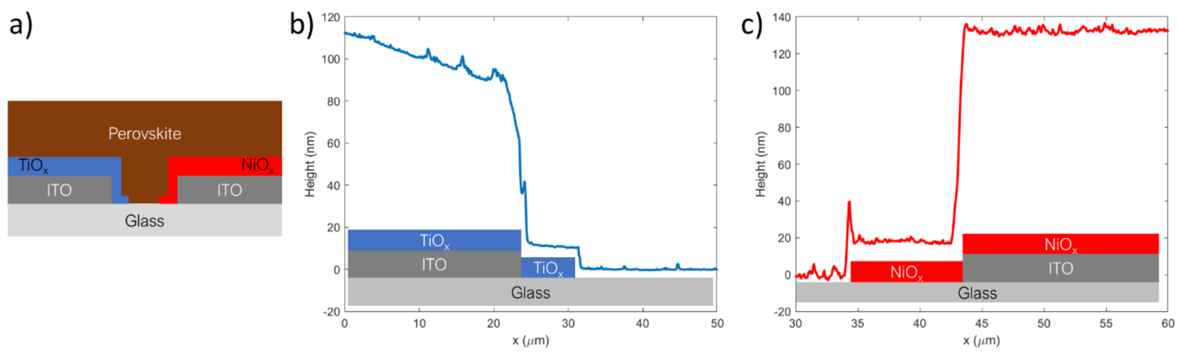

Figure 1: (a) Perovskite LHJ layout, side view, with TiO_x and NiO_x at the two sides of the channel, acting as electron and hole transport layers respectively. Surface topography across the channel of the substrate (without perovskite) measured by KPFM on the TiO_x (b) and the NiO_x (c) side.

[1] S. P. Dunfield *et al.*, (2021).
[2] D. Regaldo *et al.*, Prog. Photovoltaics Res. Appl. (2021) 1.