TLM versus temperature investigation of Ag and Au direct contacts with MAPI and 3CP halide perovskites

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Perovskite solar cells (PSCs) drew a lot of attention in the field of photovoltaics. As a matter of fact, they hold excellent photovoltaics properties, such as high absorption coefficient, tunable bandgap and long carrier diffusion length. This technology showcases one of the fastest increases in conversion efficiency, which jumped from 4% to over 25% in one decade [1]. However, PSCs show actually insufficient stability for commercialisation and present hysteresis effects in current-voltage characteristics [2]. It is accepted that hysteresis behaviour is due to ionic migration within the halide perovskite material [3]. To increase their performance even further, the nature of the Metal/Semiconductor interface, or Metal/extraction layer/Semiconductor interfaces and their potential impact on device stability, has still to be better understood.

For this purpose, we have developed an advanced electrical characterization tool based on the Transmission Line Method (TLM) in vacuum environment, allowing measurements in the temperature range from 80 K to 450 K. Eleven identical coplanar fingers with increasing separating distances from 100 μm to 1000 μm are used to measure the dc IV characteristics between the ten pairs of adjacent fingers, in the same temperature run. The total resistance derived from the IV characteristics between each pair of adjacent fingers can then be plotted as a function of their respective spacing to derive both the resistivity of the active material and the contact resistance between a finger and the active material. Performing these measurements in a large temperature range should allow to investigate the different transport mechanisms controlling the finger/active material contact as well as those inside the active material, and additionally the stability of the different combinations.

Here we will illustrate the potentiality of this technique presenting preliminary results obtained for two combinations of metallic fingers and perovskite films, namely Ag/MAPI and Au/3CP-perovskite. MAPI stands for the perovskite prototype methylammonium (MA) lead tri-iodide $CH_3NH_3PbI_3$ and 3CP being $Cs_{0.05}(MA_{0.17}FA_{0.83})_{0.95}Pb(I_{0.83}Br_{0.17})_3$ where FA is Formamidinium ($CH(NH_2)_2$). Triple cation perovskite (3CP) has shown to improve device stability [4].

References
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