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Work function evaluation of thin films for solar cells by Ambient Pressure Photoemission

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We report on the work function characterization of thin films for solar cells, from transparent conductive oxides to hole selective contact to perovskite, that are fundamental in commonly used architecture in perovskite solar cells. In particular, we studied the properties of indium tin oxide, molybdenum oxide thin films with different stoichiometries and perovskite systems by using the ambient pressure photoemission spectroscopy (APS) system. APS measures the absolute work function of a material by photoemission in ambient conditions, no vacuum is required. In particular, the work function will be determined by two methods: Kelvin probe contact potential difference measured by a vibrating Kelvin probe; UV – ambient pressure photoemission, measured by a tunable deep UV light source from 3.4 eV to 7.0 eV. The APS measurements give an absolute value of work function with a spatial resolution up to 50 µm that can be compared with the work functions measured at the nanoscale with kelvin probe atomic force microscopy.
Moreover, we will study the correlation between the work function with the structural film properties. Firstly, ITO films will be investigated Since ITO acts primarily as electron or hole collecting electrode in energy devices, ITO WF control is fundamental to reach a good band engineering. The study of MoO_3 WF as a function of stoichiometry is also fundamental to manage the MoO3 functionality as hole selective contact to be integrated with ITO in perovskite solar cells. Different depositions are conducted to modify the film stoichiometry of MoOx, x moving between 2 and 3, by changing the pressure and ambient during the film growth. The correlation between the film stoichiometry and the WF values will be exposed.
Moreover, since energy level alignment is also very important for perovskite solar cells, we report here some results of the energy levels and Fermi levels of the active layer in a commonly used architecture of perovskite solar cell. We used UV APS to determine the ionization potential of each perovskite system, and Kelvin probe to measure the work function in the dark and under white light illumination. This study was performed in the framework of PNRR Samothrace Project.