FedPV
Fédération de recherche PhotoVoltaïque

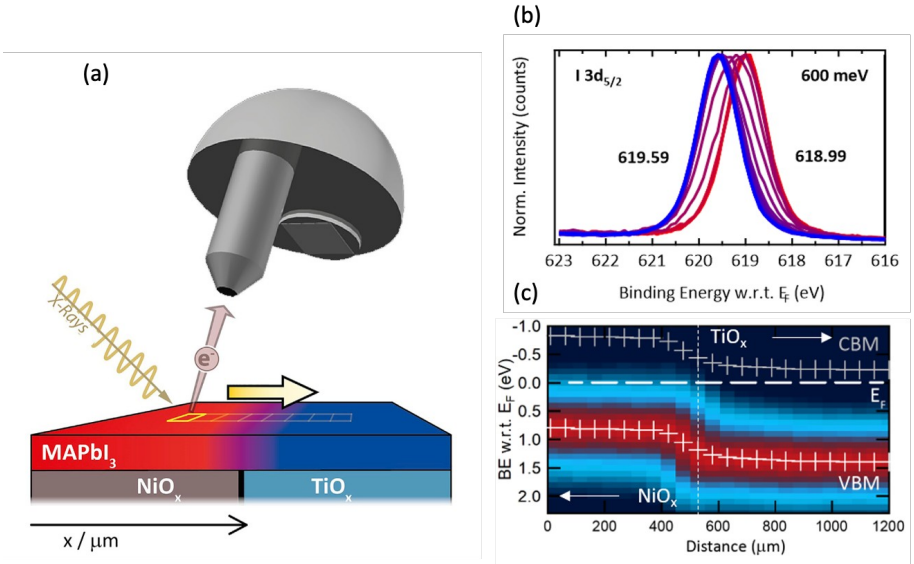
Highlights 2021

Carrier Gradients and the Role of Charge Selective Contacts in Lateral Heterojunction All Back-Contact Perovskite Solar Cells

Reference : ***Cell Rep. Phys. Sci. 2 (2021) 100520***

Collaborations : GeePs, IPVF, ILV, NREL, SLAC
DOI : https://doi.org/10.1016/j.xcrp.2021.100520
Contacts : jean-paul.kleider@geeps.centralesupelec.fr, Philip.schulz@cnrs.fr

Realizing photovoltaic devices that achieve the full potential of the metal halide perovskite material will require improved insight regarding the role of selective contacts and how key interfaces operate when mobile defects are present. However, measuring interface properties in typical device stacks where the perovskite layer is thin and sandwiched between two contacts has been a challenge. Here, we fabricate p-i-n and p-n lateral heterojunctions with nickel oxide/titanium oxide all back contacts, permitting us to employ a comprehensive analysis approach, including ultraviolet and X-ray photoemission spectroscopy (UPS/XPS), angle-resolved X-ray absorption spectroscopy (XAS), Kelvin probe force microscopy (KPFM), surface photovoltage (SPV), hyperspectral imaging (HSI), and time-resolved fluorescence lifetime imaging microscopy (TR- FLIM) to discern the role of selective contacts. Specifically, we tune the selectivity of the contacts, changing the gradient in the carrier concentration across the surface of the active layer, which is connected to carrier extraction at the buried interface, and thus the device functionality.



(a) Sketch of the XPS scanning on the lateral heterojunction device; (b) A shift of the iodine I $3d_{5/2}$ core level (and of other core levels, not shown here) is observed when scanning along the channel region defined by the two bottom layers; (c) extracted band bending along the channel. Modeling shows that the change of surface potential over >60 µm is only possible if the perovskite material is almost defect free and with doping density less than 10^{13} cm^{-3}.