



Séminaire exceptionnel



Mardi 19 Décembre 2017, 11:00
Salle R. Planel, bâtiment D1 - Marcoussis

Electronic Interaction and Chemistry at the Interface between Organic Inorganic Halide Perovskites and Charge Transport Layers

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Hybrid organic/inorganic perovskite-based absorbers define a new class of photovoltaic devices which are quickly taking over the lead in maximum power conversion efficiencies in the field of thin-film solar cells.¹ For the complete device the electronic coupling between the perovskite absorber and adjacent charge extraction and transport layer is a critical parameter to maximize cell functionality. In the past we reported how the open circuit voltage can be affected by the alignment of the frontier molecular orbitals in an organic transport layer with the electronic transport level in the perovskite.² Furthermore, we found that the doping characteristic of the underlying oxide substrate can be used to rigidly tailor the Fermi level position in a subsequently deposited perovskite film. For future applications such as an integration of a perovskite subcell into a tandem device, the precise control over the electronic alignment processes is required.

Here we present a study to elucidate these mechanisms by examining a selection of oxide charge carrier extraction layers on top of methylammonium (MAPbI₃) and formamidinium (FAPbI₃) lead iodide perovskite films in this present study. The choice of transparent conductive oxide layers employed ranges across functional n-type (e.g. TiO₂), p-type (e.g. NiO_x), high work function oxides (e.g. MoO_x) and intrinsic oxides (e.g. Al₂O₃) using pulsed laser and atomic layer deposition techniques. Using ultraviolet and X-ray photoemission spectroscopy (UPS/XPS) we determine the electronic energy level alignment at the oxide/perovskite interface and at the same time track chemically induced changes. Using this approach we are able to explain band offset changes induced in the perovskite layer by either a chemical interaction with the oxide on top and changes in the electrostatic potential.^{3,4} The results are not only used to give a guideline on how to integrate charge extraction layers into perovskite photovoltaic devices but also explain to what extent the electronic structure of the perovskite is subject to extrinsic perturbations on a universal scale.

Eventually, I will present our current results on conductive carbon contacts. In particular our work on semiconducting single walled carbon nanotubes demonstrates a preferential energetic alignment which results in rapid charge carrier collection at the absorber/transport layer interface.^{5,6}

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[3] P. Schulz, L. L. Whittaker-Brooks, B. A. MacLeod, D. C. Olson, Y.-L. Loo, A. Kahn, Adv. Mater. Interfaces 2015, 2, 1400532

[4] P. Schulz, J. O. Tjepelt, I. Levine, E. Edri, E. M. Sanehira, G. Hodes, D. Cahen, A. Kahn, ACS Appl. Mater. & Interfaces 2016, 8, 31491-31499

[5] P. Schulz, A.-M. Dowgiallo, M. Yang, K. Zhu, J. L. Blackburn, J. J. Berry, J. Phys. Chem. Lett. 2016, 7, 418-425

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