Doctoral positions
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Thesis supervisor

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Thesis topic : Photonic and plasmonic methods for perovskite solar cells optimization

Hybrid organometal halide perovskites have recently emerged as a promising active medium for photovoltaic solar cells due to their favorable optical and electric properties and their versatile solution-process manipulation. By understanding the materials optoelectonic properties (band structure, charge generation and transport) and optimizing the chemical composition and deposition methods, very fast progress has been made and a power conversion efficiency as high as 23.7 % has been demonstrated recently. Further progress are expected by optimizing the optical properties of the solar cells : tuning the thickness of the different cell layers, introducing metallic nanoparticles with plasmonic resonances or patterning the layers with a nanophotonic structure are different ways that could help to trap light inside the solar cell and enhance the electromagnetic field so that it could be better absorbed and generate a higher photocurrent. This requires a precise experimental characterization and optical modelling of the different components of the solar cell, and an in-depth understanding of the different optical as well as electric mechanisms at play.

The thesis will be part of a new collaboration between the group of Thierry Pauporté at the Institut de recherche de Chimie Paris (UMR8247) ENSCP, who fabricates and characterizes perovskite solar cells, and the group Nanostructures and Optics at INSP which has a great expertise on the characterization and modelling of light propagation in nanostructured optical media and light absorption/emission enhancement by photonic and plasmonic structures. The PhD student will fabricate perovskite solar cells with various plasmonic or photonic nanostructurations, and characterize their optical and electrical properties in order to analyze the various optical and electrical effects which

contribute to improved or decreased photovoltaic efficiency. While the main work will be experimental, part of the thesis will be devoted to optical modelling of the light propagation and absorption in the solar cell.

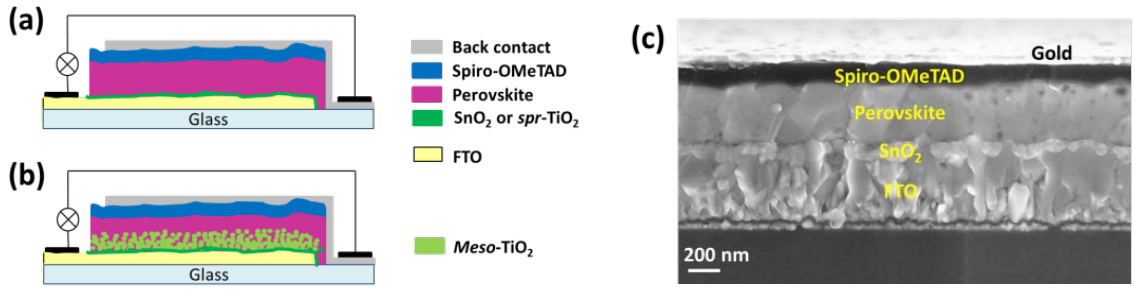

Figure : (a,b) Schematics of 2 photovoltaic solar cell architectures ; (c) SEM profile of a perovskite solar cell structure. Light is incident from the bottom. The charges are produced by light absorption at the perovskite layer, electrons are transported by the SnO2 or TiO2 layer to the FTO electrode, while the holes are transported by the spiro-OMeTAD layer to the metallic back contact. Different photonic or plasmonic strategies will be considered during the thesis such as insertion of metallic nanoparticles in the perovskite layer or etching of a lattice in the TiO2 layer.

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