

Research Topic for the ParisTech/CSC PhD Program

The details about the program and application procedure are given here:

<https://www.paristech.fr/en/international/china/paristech-csc/how-apply>

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2D/3D Perovskites for Stable and High-Efficiency Solar Cells

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Short description of the PhD research topics:

Recently, hybrid halogen perovskites (PVKs) have emerged as fascinating materials and highly versatile semiconductors. These compounds can be prepared as 2D (two-) and 3D (three-dimensional) materials, and their composition can be varied over a quite large extend. This ensures the possible fine tuning of their optoelectronic properties. Their superior properties make them especially attractive for an application in photovoltaic (PV) solar cells. If their PV power conversion efficiency is now reaching impressive values, these devices still suffer from a problem of stability.

The host group, which is leader in France on perovskite solar cells (PSCs) research, has discovered recently precursor solution chemistries that allow the preparation of highly stable of quasi-2D and 2D/3D perovskite layers. Moreover the power conversion efficiency achieved with these perovskites is very promising.

The aim of the PhD will be to get further insights into the preparation of these layers with special stoichiometry and additive. The student will investigate the role of the additives and the effect of the composition on the layers morphological, structural, optical and electronic properties. PV cells based on these new materials will be prepared and characterized by various techniques (*J-V* curves, impedance spectroscopy, spectral response, GD-OES...). The objective

will be to better understand the effect of chemistry and composition on the devices stability and high performances.

Required background of the Master student:

Material science, Chemistry, if possible: Physics of semiconductors, Photovoltaics.

A list of 5 representative publications of the group:

1- D. Zheng, T. Pauporté, Control by Mixed-Chloride Additives of the Quality and Homogeneity of Bulk Halide Perovskite upon Film Formation Process. *J. Mater Chem. A* 9 (2021) 17801-17811. DOI: 10.1039/D1TA04651A

2- F. Cheng, J. Zhu, Th. Pauporté, Chlorides, other Halides and Pseudohalides as Additives for the Fabrication of Efficient and Stable Perovskite Solar Cells. *ChemSusChem* 14 (2021) 3665–3692. DOI: 10.1002/cssc.202101089

3. D. Zheng, T. Zhu, T. Pauporté, A Co-Additives Strategy for Blocking Ionic Mobility in Methylammonium-Free Perovskite Solar Cells and High Stability Achievement. *Solar RRL.*, 5 (2021) 2100010.

4- T. Zhu, D. Zheng, J. Liu, L. Coolen, Th. Pauporté, Electrical Response of High Efficiency and Stable Solar Cells Based on MACl Mediated Grown $\text{FA}_{0.94}\text{MA}_{0.06}\text{PbI}_3$ Perovskite. *ACS Appl. Mater. Interfaces* 12 (2020) 37197–37207.

5- D. Pitarch-Tena, T.T. Ngo, M. Vallés-Pelarda, Th. Pauporté, I. Mora-Seró, Impedance Spectroscopy Measurements in Perovskite Solar Cells. Device Stability During the Measurement and Noise Reduction. *ACS Energy Lett.*, 3 (2018) 1044–1048.