Nouveaux contacts sélectifs pour des cellules à pérovskites hybrides très efficaces

By

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April, 25th 2019

Indonesian Embassy in Paris

Number of Publication in Perovskite Solar Cells

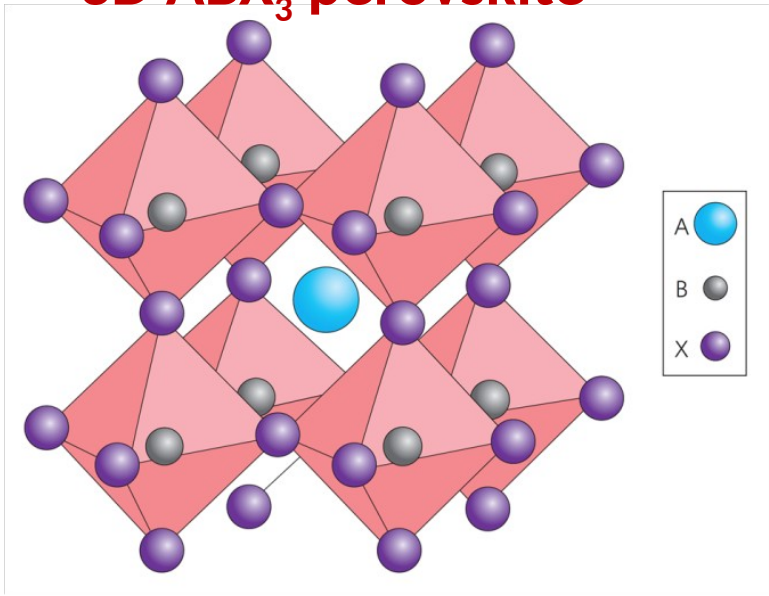
Si Solar Cell

Crystalline Si : 26.3±0.5% of PCE [1]
- band gap (~1.1 eV)
- effective to absorb in visible and NIR region

Perovskite ABX_3

- **Direct bandgap**
- **Tunable (I^- → 1.5-1.6 eV)**
- **Low exciton E_b ~10 meV**
- **High Diff. Length (1 µm)=> thin film**
- **Preparation low T°C (~ 100°C)/ solutions**

3D ABX_3 perovskite



MA^+:Methylammonium
FA^+:Formamidinium & Cs^+

B: Pb^{2+},Sn^{2+},Ge^{2+}

X: Cl^-,Br^-,I^-

[1] Green *et al*. Solar Cell Efficiency Tables (Version 49). Prog. Photovoltaic: Res. Appl. 2017; 25:3–13

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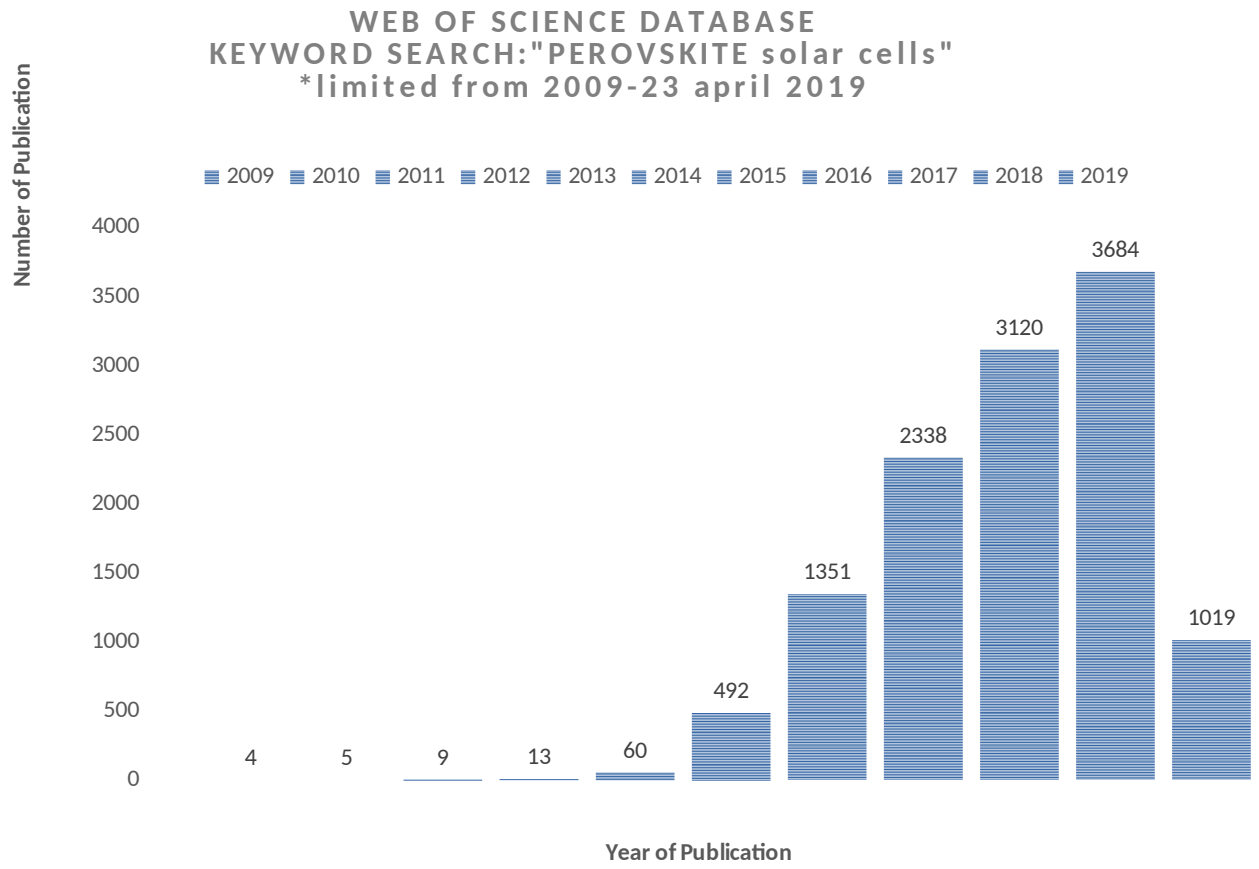
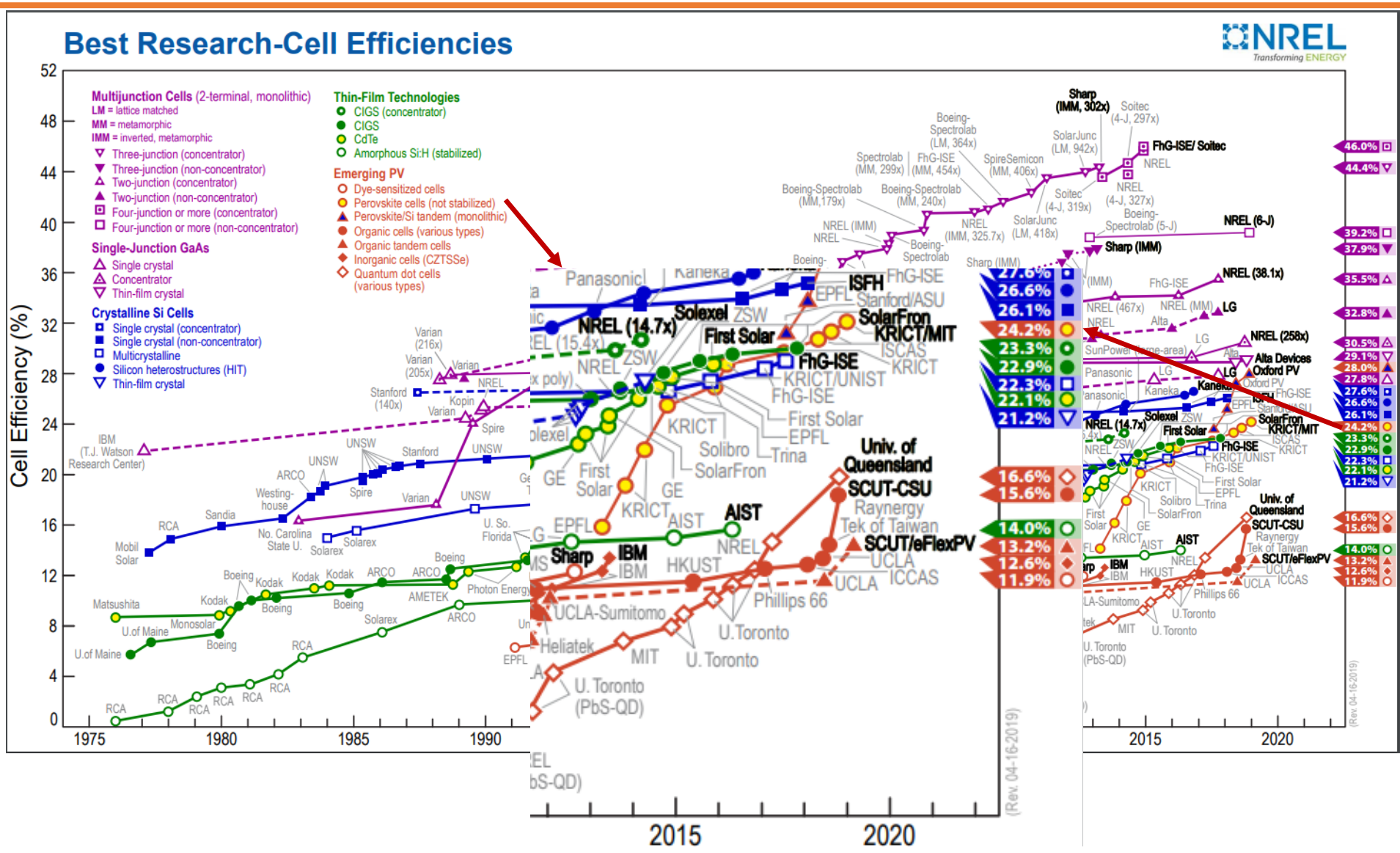


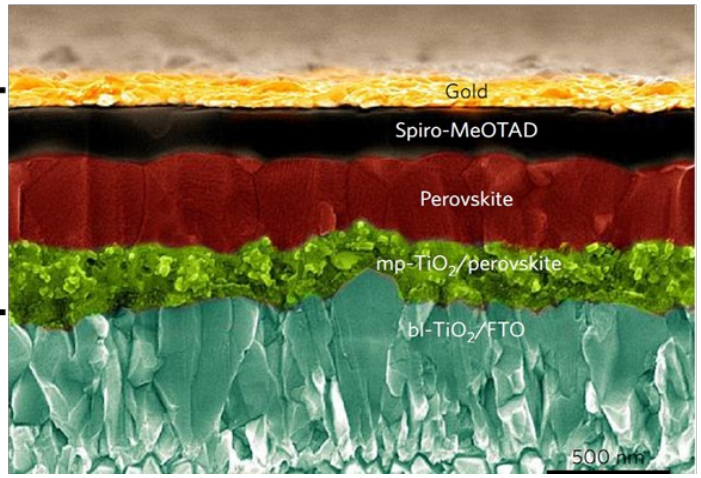
Best Research-Cell Efficiencies



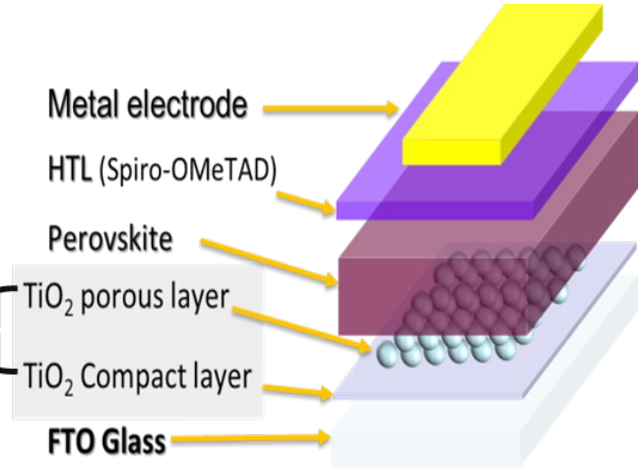
Perovskite Solar Cells (PSC)

PSC's components

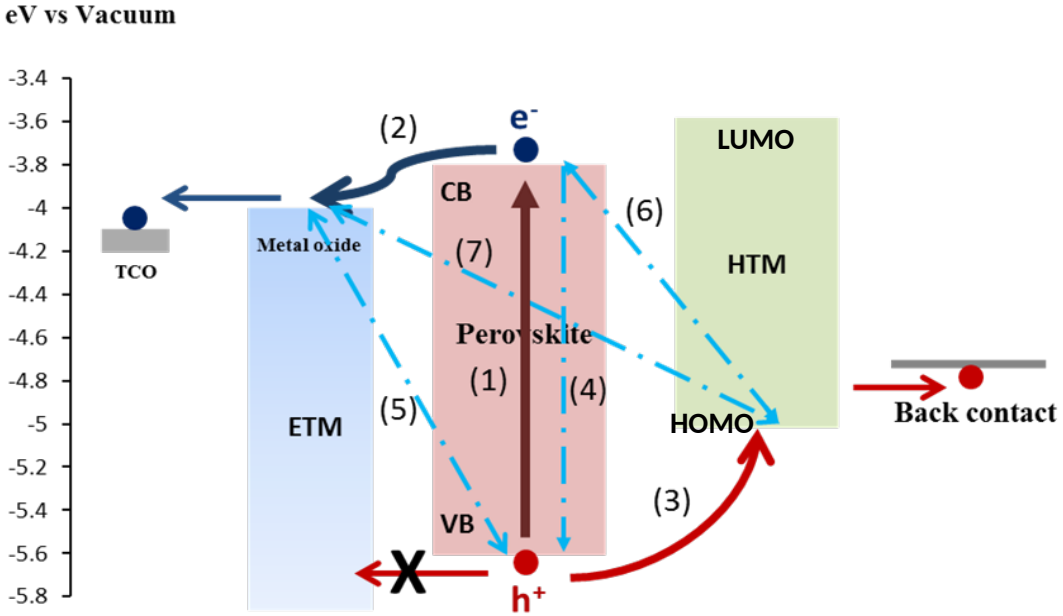
Total thickness around 1 µm



ETL



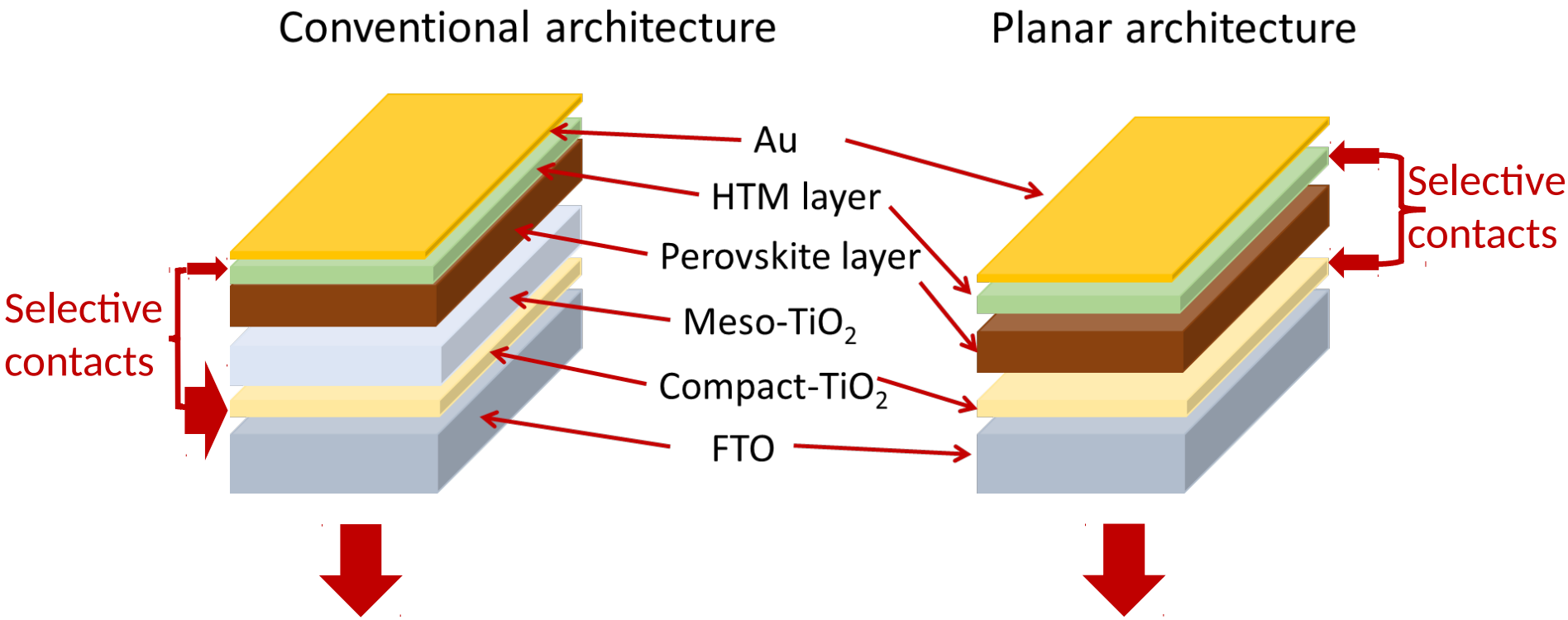
Working mecanism



Drawbacks

- Stability (HTM, multiple monocations…)
- Cost (HTM, plastic substrates…)
- Toxicity (Lead-less or lead-free PSC)
- Understanding the electrical response (IS)

Objective of Our Work



HTM studies
High efficiency and stability
Cost effective

SnO_2 as blocking layer
Simplified structure at low temperature

Our study

New HTM

- Polymer vs Molecular HTM
- Carbazole based HTM
- Carbazole polymer-based

ETM

- SnO_2 used planar architecture
- NiO

Best performance for new HTMs

Sample	V_{oc} / V	J_{sc}/ mA.cm^{-2}	FF/ %	PCE/ %
Spiro-OMeTAD	0.99	22.25	81.20	17.94
PCz1	0.95	21.88	80.87	16.84

Best performance for planar cells

		V_{oc} (V)	J_{sc} (mA.cm^{-2})	FF (%)	PCE (%)
SnO_2 planar (FAMA)	**Max (Rev)**	**1.05**	**23.03**	**75.44**	**18.22**
	Max (For)	**1.04**	**23.02**	**71.21**	**17.03**
SnO_2 planar (MAPI)	**Max (Rev)**	**1.01**	**21.92**	**68.84**	**15.28**
	Max (For)	**0.97**	**21.98**	**56.40**	**12.08**
TiO_2 planar (FAMA)	**Max (Rev)**	**1.01**	**22.49**	**77.50**	**17.65**
	Max (For)	**0.90**	**22.43**	**50.86**	**10.28**
TiO_2 meso (FAMA)	**Max (Rev)**	**1.02**	**24.05**	**76.1**	**18.67**
	Max (For)	**1.01**	**23.24**	**55.02**	**12.92**

Intensively studied by Impedance Spectroscopy in order to understand the electrical response in the cells

List of Publications

1. **Maria Ulfa**, Pengjiu Wang, Jie Zhang, Jiawen Liu, Willy Daney de Marcillac, Laurent Coolen, Sébastien Peralta, and Thierry Pauporté. Charge Injection and Electrical Response in Low-Temperature SnO2-Based Efficient Perovskite Solar Cells. ***ACS Appl. Mater. Interfaces***, 2018, 10 (41), pp 35118–35128.
2. **Maria Ulfa,** Tao Zhu, Fabrice Goubard, and Thierry Pauporté. Molecular versus polymeric hole transporting materials for perovskite solar cell application. ***J. Mater. Chem. A***, 2018,6, 13350-13358.
3. **Maria Ulfa,** Thierry Pauporté, Thanh-Tuan Bui, and Fabrice Goubard. Impact of Organic Hole Transporting Material and Doping on the Electrical Response of Perovskite Solar Cells. ***J. Phys. Chem. C***, 2018, 122 (22), pp 11651–11658.
4. Thanh-Tuân Bui, **Maria Ulfa**, Federica Maschietto, Alistar Ottochian, Mai-Phuong Nghiem, Ilaria Ciofini, Fabrice Goubard, and Thierry Pauporté. Design of dendritic core carbazole-based hole transporting materials for efficient hybrid perovskite solar cells. ***Organic Electronics***, September 2018, 60, pages 22-30.
5. Pengjiu Wang, **Maria Ulfa**, and Thierry Pauporté, Effects of perovskite monovalent cation composition on the high and low frequency impedance response of efficient solar cells. ***J. Phys. Chem. C***, 2018, 122 (4), pp 1973–1981.
6. Pengjiu Wang, Zhipeng Shao, **Maria Ulfa**, Thierry Pauporté, Insights into the hole blocking layer effect on the perovskite solar cell performance and impedance response. ***J. Phys. Chem. C***, 2017, 121 (17), pp 9131–9141.
7. **Maria Ulfa**, Pengjiu Wang, Zhipeng Shao, Bruno Viana, Thierry Pauporté. Oxide hole blocking selective contacts in perovskite solar cells. Proc. SPIE 10533, ***Oxide-based Materials and Devices IX***, 105332R.
8. Nicolai Ababii, Mathias Hoppe, Sindu Shree, Alexander Vahl, **Maria Ulfa**, Thierry Pauporté, Bruno Viana, Vasilii Cretu, Nicolae Magariu, Vasile Postica, Victor Sontea, Maik-Ivo Terasa, Oleksandr Polonskyi, Franz Faupel, Rainer Adelung, Oleg Lupan. Effect of film thickness and noble metal functionalization on UV and gas sensing properties of sprayed TiO2 thin films. (Submitted to ***Sensors & Actuators: A. Physical***).

Thank you