



## MASTER IN PHOTONICS – “PHOTONICS BCN” ERASMUS+ “EUROPHOTONICS”

### MASTER THESIS PROPOSAL

**Dates: April - September 2019**

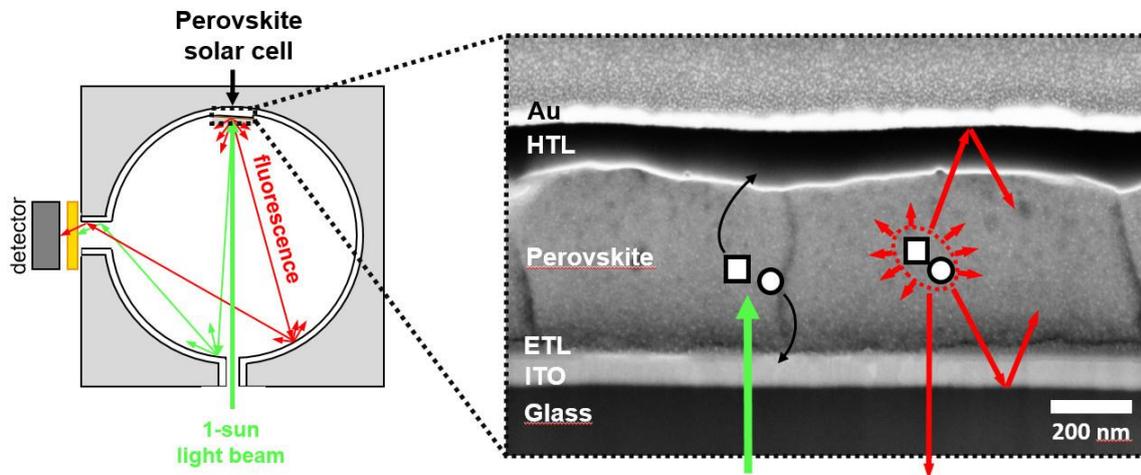
**Research Group :** Prof. Jordi Martorell  
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**City, Country :** Castelldefels (Barcelona), Spain

**Title of the master thesis:** Nanophotonic fluorescence manipulation to achieve the ultimate performance in perovskite solar cells

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**Keywords :** Perovskite solar cells, fluorescence, open-circuit voltage, nanophotonics

**Summary of the subject (maximum 1 page):** Hybrid organic-inorganic perovskite solar cells have recently focused the attention of scientists interested in renewable energy solutions, because of their potential for providing power conversion efficiencies above 20% while being fabricated by a facile self-assembly solution processing route. Such performance is enabled by the excellent optoelectronic properties of perovskites, which in addition to absorbing efficiently the sunlight to generate photo-carriers (electrons and holes), present a strong fluorescence resulting from the radiative recombination of such carriers. Managing the emitted photons is a promising, yet mostly unexplored way to boost the performance of the cells. For instance, it has been proposed that avoiding the escape of such photons so that they get re-absorbed to generate more photo-carriers (an effect called “photon recycling”) could enhance the open-circuit voltage of the cells. Therefore, this Master thesis will aim at making a step toward the management of fluorescence in perovskite solar cells to enhance their open-circuit voltage. To reach this goal, innovative solar cell designs including nanophotonic structures will be developed. The fluorescence of such cells (especially their fluorescence quantum yield) will be characterized and correlated with their structure and photovoltaic properties.



**Figure 1:** (left) Scheme of one of the setups used to characterize the fluorescence of the perovskite cells, and (right) cross-section of a standard cell (without integrated nanophotonic structures) seen with an electron microscope. The fundamental optoelectronic effects involved in such cell are depicted (sunlight photon absorption to generate electron and holes, electron and hole extraction to selective transport layers – ETL and HTL - to generate voltage, fluorescence by electron-hole radiative recombination: an emitted photon can escape from the cell or be re-absorbed by the perovskite).

### Additional information :

\* Required skills : interest for experimental work in optics, wave optics, nanophotonics, solar cells