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In the context of energy transition, development of efficient and cost-effective solar cells is a major objective to establish an optimal energy mix. The 3rd generation of photovoltaic cells emerged to develop high efficient and low-cost cells combining the use of abundant materials and easy processes. Among them, photovoltaic cells based on perovskite materials demonstrated several significant advances with power conversion efficiencies up to 22% [1][2].

Nevertheless, efforts remain to be performed to improve the charge generation and collection of this kind of cell. Titanium dioxide mesoporous layer, while remaining an important component for perovskite structuration and electron transport in high efficiency devices, can indeed still promote charge trapping and recombination. As carbon nanostructures are good electron transporters, the use of TiO_2/graphene nanocomposites seems to be a relevant strategy to reduce recombination phenomena and thus improve electron collection [3].

To achieve high quality of nanocomposites presenting well-controlled physical properties suitable for efficient and stable solar cells, we use the singular technique of laser pyrolysis, which enables to synthetize nanoparticles in a single step with a continuous flow. Attention is payed to the materials properties and their role and effect within solar cells.

Tests were conducted with a MAPI-Cl perovskite deposited in a single-step following a reported procedure [4]. Our first results show a better electron injection efficiency from the perovskite to the mesoporous TiO_2 layer with graphene, observed through steady-state photoluminescence spectroscopy. This tendency has been reinforced by devices performance that show larger photocurrents and smaller series resistance under standard illumination. More generally an increase in power conversion efficiency from 14.1 % to 15.1 % for these devices is reached for perovskite solar cells containing graphene in the mesoporous layer, demonstrating the benefit of the laser pyrolysis process for the production of high quality electron transport layer.

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[2] H. Zhou et al., Science 2014, 345, 542-546
[3] J. Wang et al., ACS Applied Materials & Interfaces 7 (2015) 51-56
[4] Gheno A, et al. Solar Energy Materials & Solar Cells 2017, 161, 347–354