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TiO_2/graphene-based nanocomposites synthesized by laser pyrolysis: properties and application in perovskite solar cells

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Abstract (No longer than 250 words. Both the abstract and references must fit in this box. Style is Calibri 12, single line spacing)

Since 2012, hybrid solar cells based on perovskite materials demonstrated several significant advances, with power conversion efficiencies now up to 22%, attracting strong interest within the scientific community [Zhou14, NREL efficiency table[1]]. Still, efforts remain to be performed to improve photo-current generation, especially concerning the development of efficient and reliable charge transporting electrodes and selective contacts. Titanium dioxide mesoporous layer, commonly used as electron transport layer, presents defects that trap electrons and favor electron-hole pair recombination. Carbon nanostructures are good electron transporters, therefore the use composites of TiO_2 and carbon nanostructures seems to be a relevant strategy to reduce recombination phenomena and thus to improve electron collection [Wang15].

Here, we combine specific know-hows on both perovskite solar cells processing and production of nano-scaled materials by laser pyrolysis. Our aim is to develop high quality TiO_2/graphene nanocomposites with well-controlled physical properties for an optimal energy conversion.

Particular attention is paid to material characterizations such as morphological and structural analysis as well as physical properties evaluation of the nanocomposites and their role and effects within solar cells. Our results show a larger dark current in presence of graphene, as well as larger photocurrents and smaller series resistance, traducing the benefits of graphene for a better charge collection in the device. More generally, a significant increase in power conversion efficiency is observed for perovskite solar cells containing graphene in the TiO_2 mesoporous layer.

[1] www.nrel.gov/ncpv/

[Zhou14] H. Zhou et al., Science 345 (2014) 542-546
[Wang15] J. Wang et al., ACS Applied Materials & Interfaces 7 (2015) 51-56