Graphene-based large area dye-sensitized solar cell module

Alessandro L. Palma, Simone Casaluci, Babak Taheri, Mauro Gemmi, Vittorio Pellegrini, Aldo Di Carlo and Francesco Bonaccorso

b. Center for Nanotechnology Innovation@NEST, Istituto Italiano di Tecnologia, Piazza San Silvestro 12, 56127 Pisa, Italy.
c. Istituto Italiano di Tecnologia, Graphene Labs, Via Morego 30, 16163 Genova, Italy.

Abstract

In this work, we report the use of graphene nanoflakes, produced by liquid phase exfoliation of graphite [1], as a catalyst material for the realization of large area dye-sensitized solar cell (DSSC) module.

We report the electrochemical performances of graphene flakes-based ink used as counter electrode in small area DSSCs targeting the replacement of the standard catalyst material i.e., platinum [2], an expensive noble metal. Our results demonstrate that pristine graphene flakes can be used as catalyst, offering advantages in term of cost, scalability and easier production/processing with respect to other low-dimensional materials such as reduced graphene oxide, which require post-processing treatments, and carbon nanotubes, transition metal di-chalcogenides and oxides, etc., which are instead expensive if compared with pristine graphite. The graphene-based ink was spray coated onto FTO-glass substrate to obtain a large area (>90cm²) semi-transparent (transmittance 44%) counter-electrode[3]. As a proof of concept, we have fabricated the first graphene-based large area (43.2 cm² active area) DSSC Z-type connection module with ad-hoc vertical contacts layout, exhibiting a power conversion efficiency (PCE) of 3.5% at 1 Sun and 4.6% at 0.17 Sun. The graphene-based DSSC module demonstrated good response to diffuse light and low illumination conditions[3]. We have also demonstrated the viability of our approach on flexible substrates. We spray coated graphene-based ink onto a PET-ITO used as front electrode in flexible DSSC. A fine tuning between efficiency and transparency was carried out to optimize the PCE of the cells. These results pave the way for the realization of all-printed and (semi)transparent graphene based large-area and cost-effective DSSCs on arbitrary substrates by proving the possibility of enhancing the performance of large area printed DSSCs, under ambient conditions, upon the exploitation of graphene-based inks.

References


Figure: Spray coating of graphene-based ink for the realization of DSSC modules. The as produced module has shown a PCE of 3.5%.