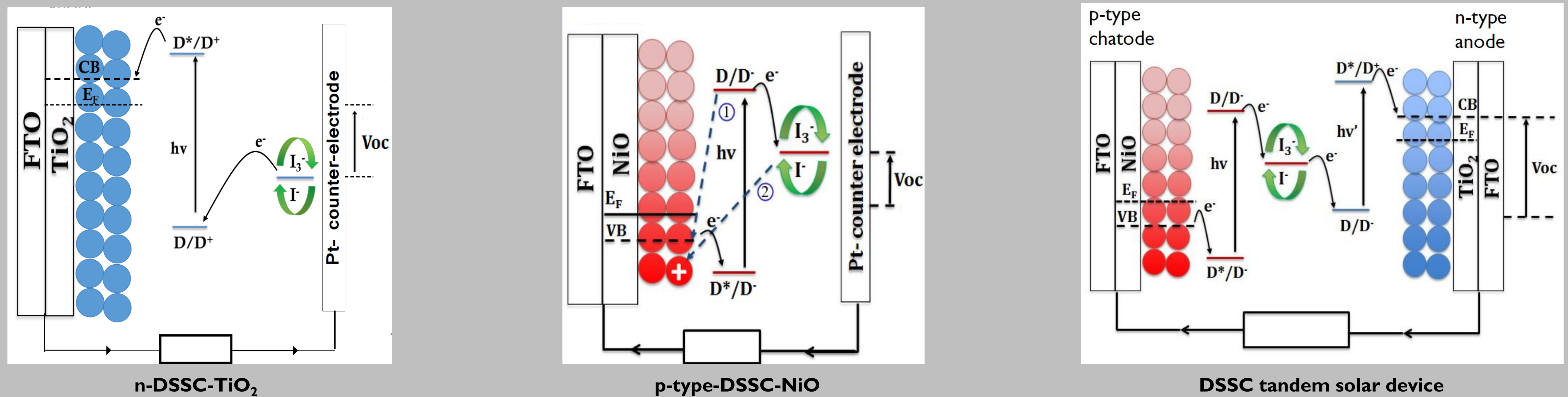


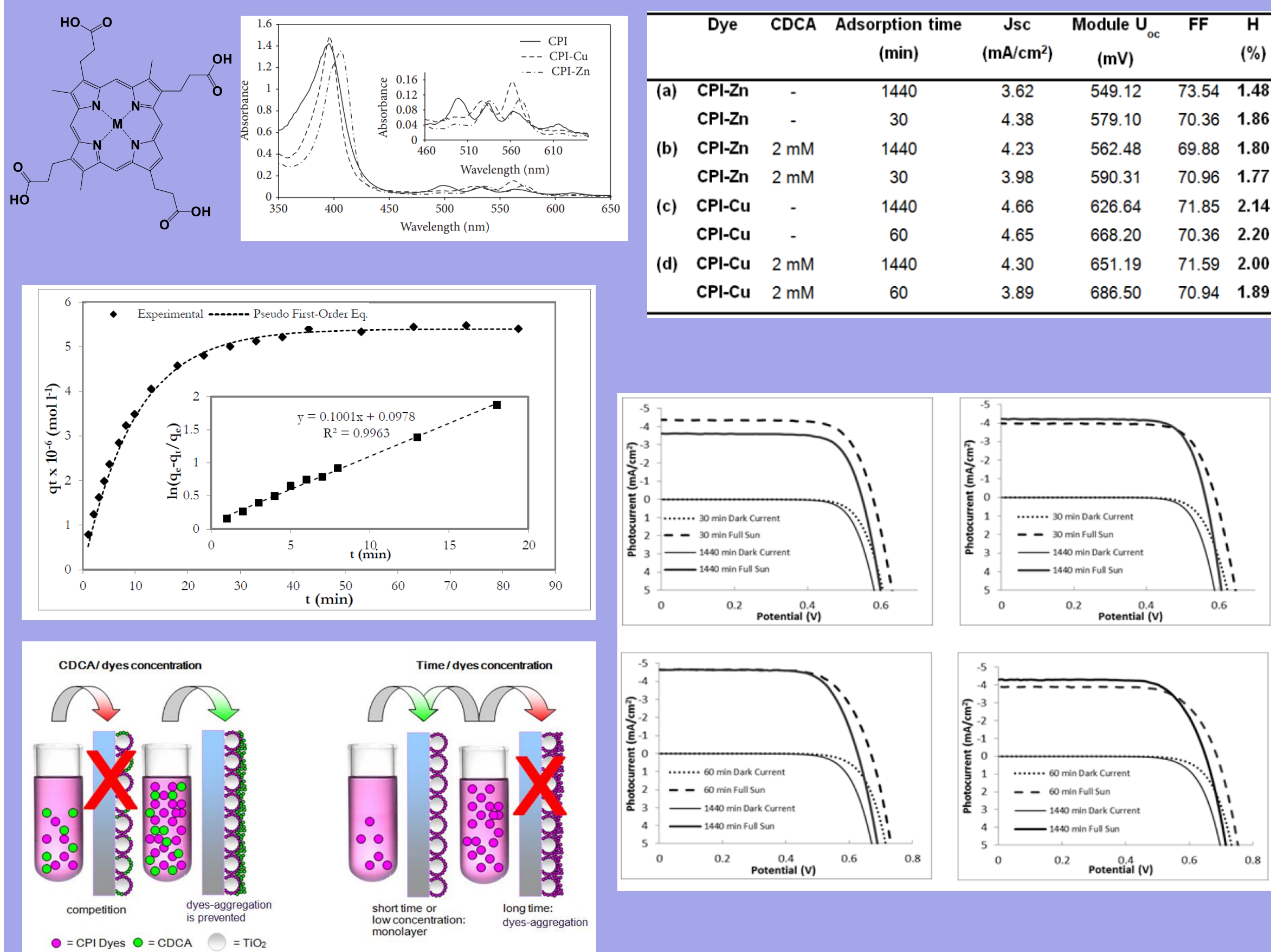
## Introduction

Solar energy is one of the most important removable and free energy source, and, despite the large use of silicon solar cells, the use of dye sensitization devices for light harvesting remains of great interest for the next generation solar devices. Dye sensitized solar cells (DSSCs) was introduced for the first time in 1991 Grätzel and O'Regan [1]. The working principle of this device, is the charge separation made by a fast electron injection from the photoexcited dye molecule into the semiconductor surface, like TiO<sub>2</sub>, the use of counter electrode and a redox electrolyte at interface. This type of device are interesting due to their semi-transparence, low costs and color, that can be tuned by the use of different dyes and have reached efficiencies of about 15% [2]. Along the conventional Grätzel solar cell with TiO<sub>2</sub>, other DSSC device is prepared by using a p-type semiconductor, like NiO, where, in this case, the semiconductor work as photocathode, and the electrons transfer is from the Valence Band of the NiO to the excited photosensitizers, in presence of redox electrolyte. The combination of TiO<sub>2</sub>-DSSC (n-type) and a p-type photocathode in a tandem cell could give an energy conversion device with a theoretical efficiency in excess of 30% [3]. Two electrodes are used which are sensitised with complementary dyes that collect higher energy photons on one electrode (n-type) and lower energy photons on the other (p-type).

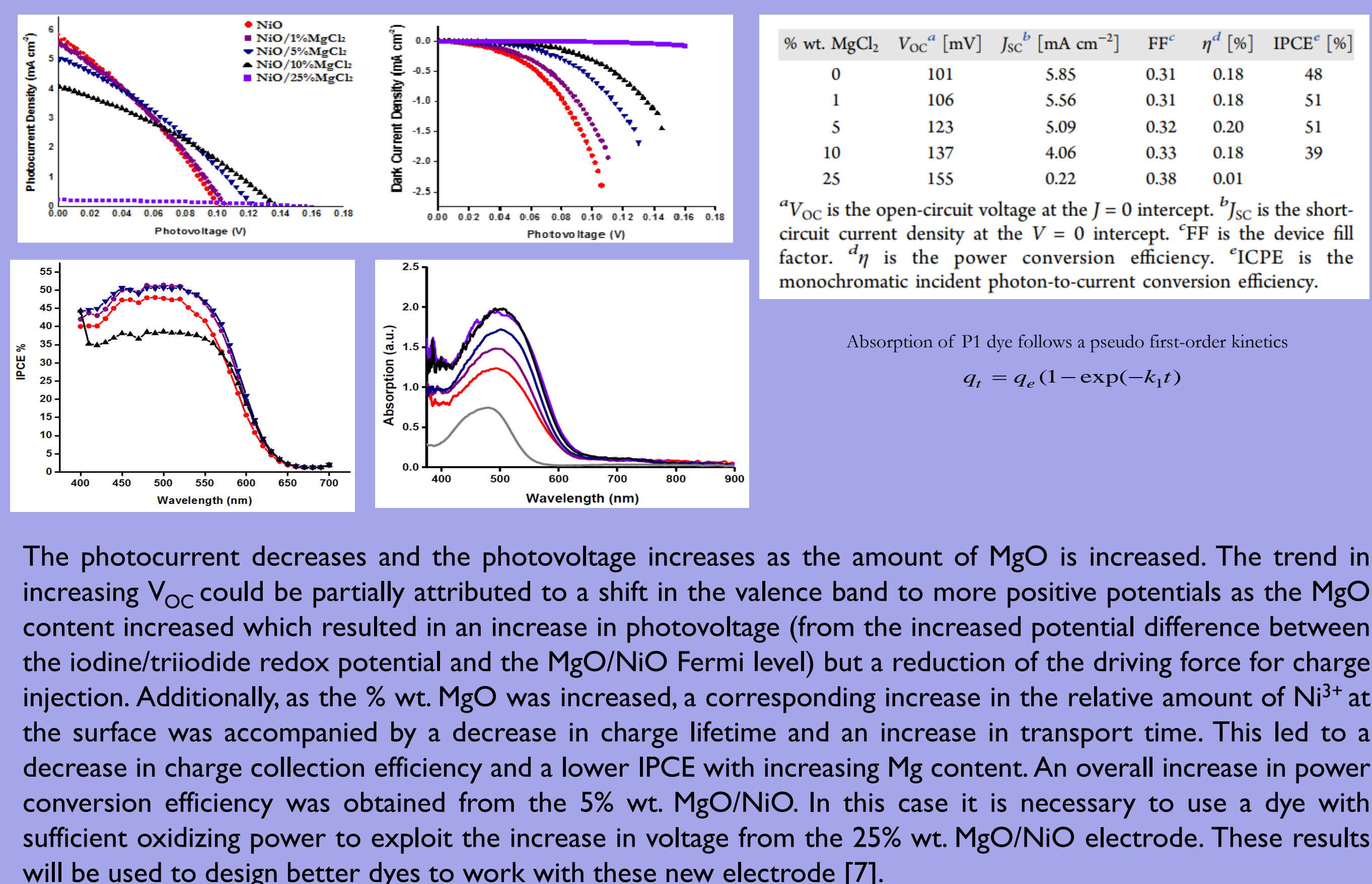
At present, the lower photo-conversion efficiency of a p-DSSC limits the performance of tandem devices; in particular the major problems are the charge recombination between reduced dye and NiO, limiting the photocurrent, and the charge recombination between the electrolyte and NiO holes, limiting the Open circuit voltage [4].



## SENSITIZATION OF TiO<sub>2</sub> THIN FILMS WITH PORPHYRIN DYES FOR DSSC APPLICATIONS



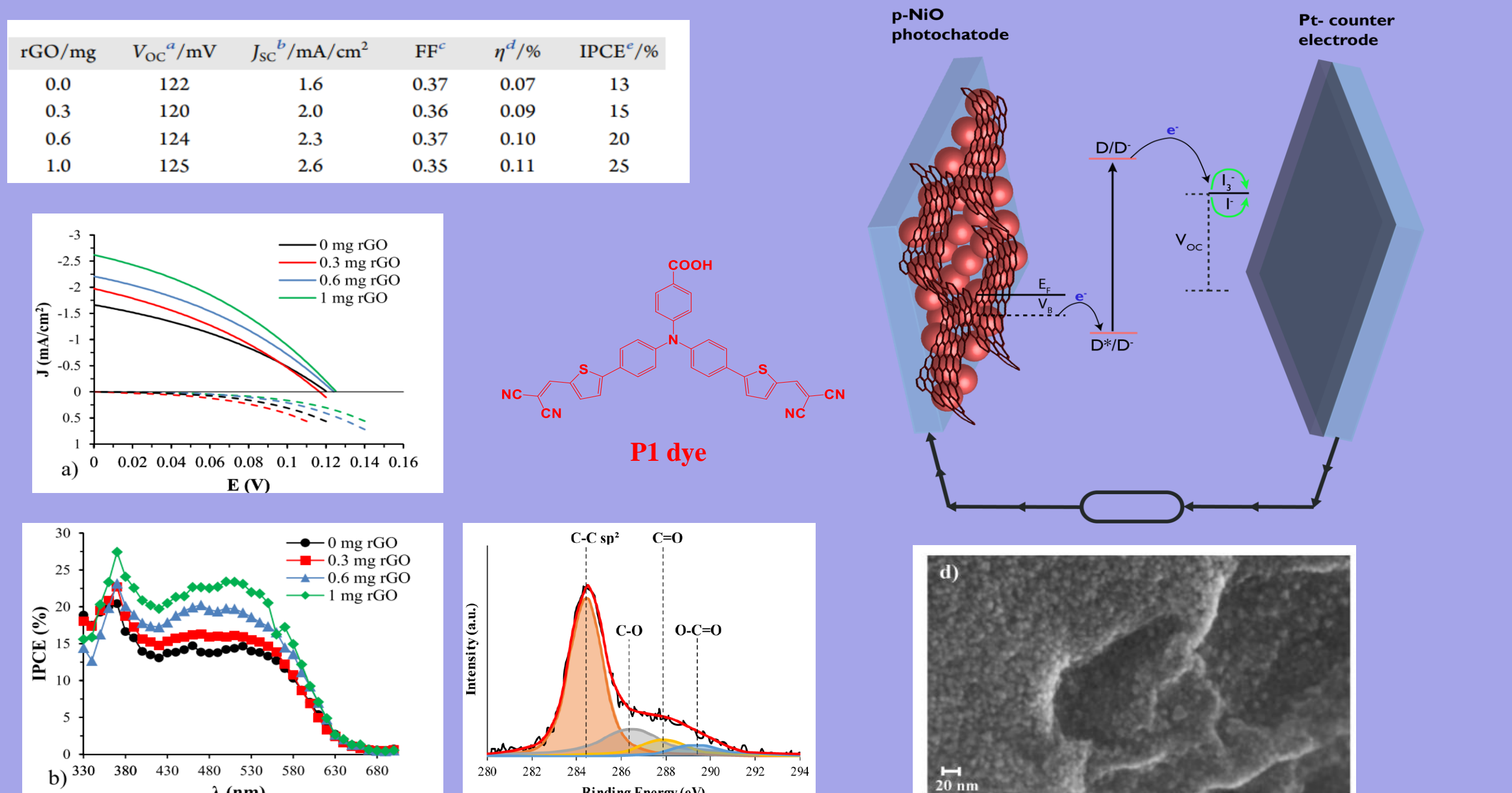
## Ni-Mg OXIDE ELECTRODE FOR P-TYPE SOLAR CELL



The photocurrent decreases and the photovoltage increases as the amount of MgO is increased. The trend in increasing V<sub>oc</sub> could be partially attributed to a shift in the valence band to more positive potentials as the MgO content increased which resulted in an increase in photovoltage (from the increased potential difference between the iodine/triiodide redox potential and the MgO/NiO Fermi level) but a reduction of the driving force for charge injection. Additionally, as the % wt. MgO was increased, a corresponding increase in the relative amount of Ni<sup>3+</sup> at the surface was accompanied by a decrease in charge lifetime and an increase in transport time. This led to a decrease in charge collection efficiency and a lower IPCE with increasing Mg content. An overall increase in power conversion efficiency was obtained from the 5% wt. MgO/NiO. In this case it is necessary to use a dye with sufficient oxidizing power to exploit the increase in voltage from the 25% wt. MgO/NiO electrode. These results will be used to design better dyes to work with these new electrode [7].

Kinetic studies, in the CPI-dyes adsorption on TiO<sub>2</sub> show that the adsorption follows a first order kinetics, and the rate of dyes adsorption linearly increase with the growing of initial solutions concentrations of dyes. To avoid dyes aggregation, for the higher concentration, Chendodeoxycolic acid (CDCA) is used. The stoichiometry of the process has been evaluated indicating that the CDCA concentrations affect negatively the dyes adsorption on TiO<sub>2</sub> surfaces. The change in photovoltaic properties of DSSC devices, with different experimental conditions such as adsorption time and coadsorbent, was evaluated. In the presence of CDCA 2 mM the Voc values increased but, only at long adsorption times, resulting in an increase in efficiency. The equilibrium and kinetic data presented for adsorption of CPI-dyes onto TiO<sub>2</sub>, also in the presence of CDCA as coadsorbent, has allowed us to establish the best experimental conditions for the adsorption of these dyes and has demonstrated that the CPI-dyes, according to the Langmuir model and with pseudo-first-order kinetics, are adsorbed effectively on the TiO<sub>2</sub> without chemical changes [5,6].

## GRAPHENE DOPED NiO FOR SOLAR CONVERSION



Reduced graphene oxide (rGO) was prepared from commercial graphene oxide using a thermal reduction method and characterized by UV-Vis and XPS analysis. rGO increase the dye uptake possibly because of a π-stacking interaction between dye and graphene sheets. The higher dye loading leads to increased occurrences of photoexcitation events for more free charges to be generated in the photocathode when tested in p-type DSSCs. Indeed, when the graphene amount in the photocathode gradually reaches 1 mg, the J<sub>sc</sub> and V<sub>oc</sub> of the p-DSSCs increased up to 2.6 mA cm<sup>-2</sup> and 125 mV, leading to 0.11% efficiency, which is almost 2 times higher with respect to that of p-DSSC with NiO-only as photocathode [8].

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