Inkjet-printed transparent photo-electrodes for Dye-Sensitized Solar Modules

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Inkjet printing (IJP) is a highly versatile technique for low-cost thin film depositions, with good scalability and no material waste. Moreover, it guarantees good printing reproducibility and accurate deposition of different patterns. Not only for these reasons, in recent years, IJP is growing as a valuable technique to produce new generation photovoltaic cells and modules, including Dye-Sensitized Solar Modules (DSSMs). The latter are devices based on earth-abundant materials for the direct conversion of sunlight into electricity; they are commonly produced by screen-printing, a well-known fabrication process in this field, that has some advantages and limitations, such as the deposited geometry and the time needed for the initial set-up. Finally, DSSMs are nice aesthetic devices displaying a respectable range of coloring and semi-transparency capable of properly work in diffuse light-conditions thus, if compared with traditional photovoltaics, they can be seen as interesting substitutes or “teammates” in added-value applications like, i.e. Building Integrated Photovoltaics (BIPV). About the latter, the main aspect to focus on is developing highly transparent devices. In this work, aiming to demonstrate the benefits and real applicability of IJP for innovative PV applications, transparent large area photo-electrodes (up to 10x10 cm2) were successfully realized. In particular, the negative photo-electrode architecture was designed considering the stacking of two different TiO2-based films, one acting as blocking-layer to reduce recombination phenomena, and the other one as electrons transport layer. Both were deposited by inkjet printing, starting from a commercial product and an ad-hoc formulated ink respectively. About the latter, after an initial deep characterization (viscosity, surface tension, and so on), it was used to optimize the IJP process to obtain homogenous layers that were analyzed in terms of microstructure and transmittance. The obtained results demonstrate that IJP represents a suitable process for the production of highly transparent anodes for DSSMs.