Fabrication of embedded silver grid electrodes for ITO-free organic solar cells applications

Nikolaos Kehagias[1], Ignasi Burgués-Ceballos[2,3], Mariano Campoy-Quiles[3], Paul D. Lacharmoise[2] Clivia Sotomayor M. Torres[4,5]

[1] *Catalan Institute of Nanoscience and Nanotechnology, ICN2 Building, UAB Campus, 08193 Bellaterra, Barcelona, Spain*
[2]*Cetemmsa Technological Centre, Av. Ernest Lluch 36, 08302, Mataró, Spain*
[3] *Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Esfera UAB, 08193, Bellaterra, Spain*
[5] *ICREA, Institució Catalana de Recerca i Estudis Avançats, 08010 Barcelona, Spain*
nikos.kehagias@icn.cat

Although Indium Tin Oxide (ITO) has been widely used as a transparent electrode in rigid organic photovoltaic (OPV) the high energy consumption required during sputtering, the necessity to pattern the ITO electrodes and the low abundance of the Indium element in Earth’s crust make ITO a major contributor to the overall OPV module cost as well as to the module embedded energy. Moreover, the use of ITO in flexible devices may not be recommended due to possible cracking or delamination and loose of conductivity with bending.
In this paper we present a novel nanofabrication approach to fabricate embedded metal grid electrodes for OPV applications. Our fabrication approach consists of the combination of inkjet printed silver grids and reverse imprinting transfer as illustrated in Figure 1. 2.5 x 2.5 cm glass substrates were cleaned by O_2 plasma at 400 W for 30s. The samples were coated (Figure 1a) with Ormoprime08 to increase the surface adhesion towards our printable material (Ormocomp). A drop of Ormocomp was dispensed (Figure 1b) on our pre-patterned glass substrates which contained the 250 nm thick Ag grids structures. The two substrates were then brought into contact while a pressure of 2 bars was applied for 1 min. The assembly was exposed to ultra-violet light for 10 sec (Figure 1c). After separation of the two substrates the Ag grid structures are embedded within the Ormocomp material and transferred to the pre-treated glass substrate (Figure 1d).
Due to the nature of the reverse imprinting transfer process we realised more than > 90% embedding of the grids electrodes resulting in a smooth interface between the Ag grid and the transparent semiconductor polymer PEDOT:PSS film (Figure 2a). The substrate characterisation showed a comparable transmission towards ITO/glass substrate (Figure 2b) while an overall photovoltaic performance including a high fill factor (FF > 60 %) of the fabricated solar cell device was observed.

Acknowledgment

This work was financially supported by the Spanish Ministry of Science and Innovation through projects MAT2009-10642, MAT2012-37776 and Cetemmsa Technological Centre (project number CSIC-20091449).

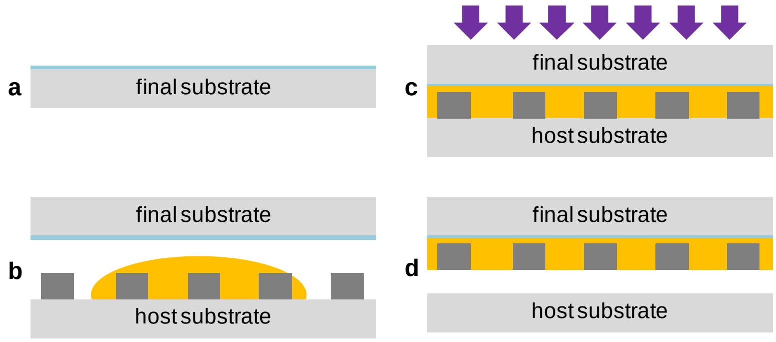
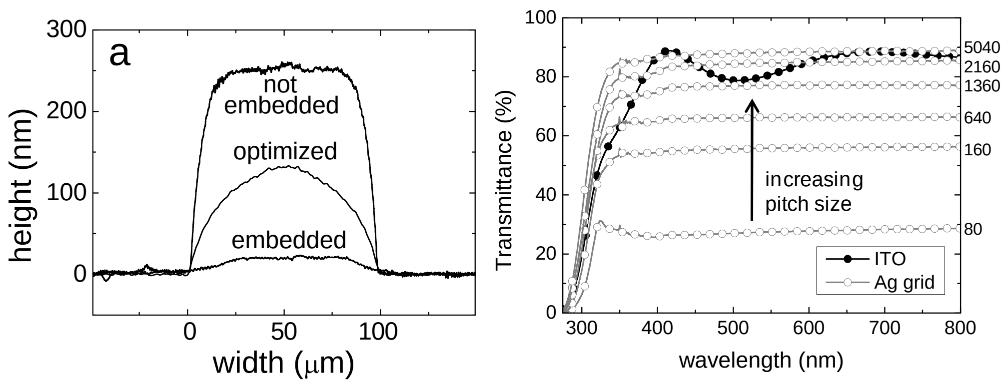


Figure 1: Schematic of the fabrication steps towards ITO free embed Ag grid structures.



(a) (b)

Figure 2: a) Cross section profiles of inkjet printed silver lines. An optimized process enabled to reduce the height of the line from 250 nm (top) to 130 nm (middle), while its width remained 100 nm. After embedding the non-optimized line, only 20 nm of Ag still raised out from the surface (bottom). b) Transmission through embedded Ag grids with different line separation (labeled in right axis) compared to ITO on glass.