ABSTRACT

“Synthesis & Characterization of the hybrid material ZnO:PVP and their application as electron transport layer in gravure printed inverted organic photovoltaic structure”

The research in organic photovoltaics (OPVs) is rapidly growing worldwide, as it provides a development process at low temperature, low cost and the final manifacture of lightweight, flexible solar cells in mass production. Specifically, the latter can be achieved by the combination of low cost materials and high rate fabrication techniques such as roll-to-roll (R2R). However, in contrast with silicon or other inorganic semiconductors (e.g. CdTe, CIGS) developed with vacuum techniques, the development of OPVs is complicated with the requirement for multiple materials and layers, which must be incorporated in the solar cell in order to operate. Thus, compared with vacuum techniques, a process such as R2R, has much more difficulties, e.g. the wetting of materials on substrates and controlling the self- organization of molecules. The present master thesis deals with the development and characterization of zinc oxide nanoparticles (ZnO NPs), which in combination with the polymer polyvinyl pyrrolidone (PVP) will be used as a layer for transporting electrons (ETL) to the electrodes of an organic photovoltaic. Firstly, the composition and characterization of ZnO NPs was carried out, followed with the addition of PVP as capping agent, to achieve better dispersion of NPs and thus, a more uniform and continuous film, in the meantime we used a solution of ZnO NPs that was commercially available. Optimization of ZnO:PVP solution was initially performed with the use of spin-coating and then the same proportions were used for Gravure Printing (a R2R technique) onto a Polyethylene terephthalate (PET) substrate, which was coated with 120nm Indium tin oxide (ITO). The latter is the cathode of organic photovoltaic. During the next step, the photoactive layer, comprising a mixture of Poly(3-hexylthiophene-2,5-diyl) (P3HT) and the fullerene derivative of [6,6]-phenyl-C61-butyric acid methyl ester (PCBM), was coated with Gravure printing. Then, PEDOT:PSS layer was developed, as the hole transport layer (HTL). Finally, the process was completed with the developed of Silver (Ag) onto the PEDOT:PSS layer with thermal evaporation to form the anode. In this way, an inverted organic photovoltaic was fabricated, prepared entirely with R2R techniques and the anode could be printed using silver ink.