

Abstract

In the current PhD thesis, the development and study of organic and inorganic thin films by printing and vacuum technologies have been conducted. These thin films are used as active or passive layers in Flexible Organic Electronic devices (OH), such as Flexible Organic Photovoltaics (OPVs). In general, the thesis is based in three thematic axes:

The first axis is related to the development by printing technologies of photoactive layers such as P3HT:PCBM and the investigation of their properties. These materials are essentially the core of the OPVs absorbing sunlight and giving the charge carriers, and thus electricity. We have proceeded to the printing by Roll-to-Roll (R2R) Gravure of P3HT:PCBM thin films and we have studied the effect of process parameters (e.g. printing speed, drying conditions) on the morphology and the optical, structural etc. properties.

The second axis deals with the conductive organic and inorganic thin films that are used as electrodes in OH. The material that is mainly used as electrode in OH is the transparent conductive indium tin oxide (ITO), which however, is very expensive and fragile. So, we have proceeded to the development and study of alternative conductive materials, both organic and inorganic, towards ITO layer replacement. In particular, we have printed by R2R Gravure various types of aqueous solutions of PEDOT:PSS either monolayers or multilayer structures, and we have studied the optical, structural etc. properties with respect to the printing conditions, in order to enhance the conductivity and increase the efficiency of the OPVs. As regards the inorganic conductive materials, Al-doped zinc oxide thin films (AZO) have been deposited by Magnetron Sputtering on flexible substrates and the optical, structural, electrical etc. properties, as well as the growth mechanisms, have been investigated.

The third and most important pillar of the current PhD thesis includes the utilization of the results from the study of the thin films for the production of functional OPV devices. We have fabricated OPV cells and modules, that consist of interconnected cells in series, by printing processes and we have studied their properties in relation to process parameters, in order to optimize the processes and improve OPV efficiency. The ultimate goal is the development of the production technology for OPVs. Furthermore, the ability to print OPVs by using PEDOT:PSS as electrode has been investigated, while also semitransparent OPVs have been fabricated by utilizing the optical and electrical properties of Ag/AZO system.

In conclusion, with the current PhD thesis, the materials and processes for the fabrication of OH such as OPVs have been investigated, aiming at increasing the devices efficiency and reducing production costs through the adoption of mass production processes such as R2R printing, and by employing alternative to ITO materials. In parallel, the fabrication of functional OPVs by printing processes has been achieved demonstrating the potential for the production of useful OH in a variety of applications such as energy, lighting, electronics, etc.