Abstract

The discovery of conductive/semi conductive polymers brought a revolution in optoelectronics and energy. The Nobel prize of chemistry in 2000 was awarded to Alan MacDiarmid, Hideki Shirakawa and Alan J. Heeger for the discovery and synthesis of electrically conductive polymers. The conductive polymers are a new generation of materials that combine the electrical properties of metals and semiconductors with the advantages of plastics and can be used in a variety of applications. The low cost, ease of preparation, good mechanical properties and easy modification of their properties are among the reasons which allow the conductive polymers for use in many technological applications, replacing the usual semiconductors and metals. Such applications are flexible Organic Light Emitting Devices (Organic Light Emitting Diodes, OLEDs) and flexible organic photovoltaic's (Organic Photovoltaic, OPVs). The major advantages of conductive polymers is that they can be manufactured with roll-to-roll (R2R) processes easier, faster and with much lower costs so they can compete or even overcome the conventional systems. Many efforts in the field of flexible organic electronics have been paid on the manufacturing characterized by lower cost, and improving of the properties of conductive/semi conductive polymeric materials. This work aims at studying the growth conditions and optical, structural and nanotopographical properties of the widely used as an electrode material conductive polymer Poly(3,4-ethylenedioxythiophene)poly(styrenesulfonate) (PEDOT:PSS) R2R printed on polymeric substrates such as PET. The first part of the work (theoretical) is divided into four chapters. The first chapter briefly referred to the basic operating principles of OLEDs and OPVs, and gives an introduction to flexible substrates and particularly of PET, but also of conjugated polymers focusing on the PEDOT:PSS material. The second chapter contains a description of the currently used methods for activation of polymer surfaces in R2R processes with Corona. The third chapter contains the general characteristics of the printing techniques focusing on R2R Gravure Printing. Finally, the fourth chapter gives the theoretical background of experimental characterization techniques used in this work. The second part of the work (experimental) contains the results from a series of experiments conducted in this work. The fifth chapter refers to the activated surface of PET substrate with has been studied by Contact Angle as well as the bonding structure of the surface layer by means of IR Spectroscopic Ellipsometry. Then the sixth chapter focuses on the R2R Gravure Printing optimization of PEDOT:PSS thin films. In particular, emphasis is given on the printing conditions and how they affect the optical, electrical, and nanotopographical properties of the printed thin films. Finally, in the last seventh chapter attempts for improving the conductivity of R2R printed PEDOT:PSS films are reported. In particular, the printing of blends of different PEDOT:PSS formulations as well as the treatment of PEDOT:PSS films with solvents are studied.