Synthesis and Characterization of Plasma Polymerized 3,4-Ethylenedioxythiophene Thin Films

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Abstract

Plasma polymerized 3,4-ethylenedioxythiophene (PPEDOT) thin films onto glass substrates have been deposited at room temperature under AC (50 Hz) and RF (13.56 MHz) power sources by using the plasma polymerization (PP) technique. 3,4-ethylenedioxythiophene (EDOT) has been chosen as a monomer precursor. The thicknesses of the films measured by Multiple-Beam Interferometer, are observed to depend on different power sources. The field emission scanning electron microscopy (FESEM) images exhibit that the surface morphology of both the AC and RF thin film is immaculate and pinhole-free. Energy Dispersive X-rays study confirmed the purity of the thin films where the at% of C and S in the thin films increases with increasing film thickness. The Fourier transform infrared spectroscopy analysis represented that the chemical compositions of the as deposited PPEDOT films are different from that of the EDOT monomer indicates some structural rearrangement. The energy band gap values of the PPEDOT (AC) thin films decrease from 3.75 to 3.54 eV with the increase of film thickness, while the PPEDOT (RF) film shows 3.77 eV band gap energy. The Urbach energy, steepness parameter, extinction coefficient, refractive index, and other optical properties that describe significant differences between AC and RF thin films, and these results indicate their suitability for use in various electrical and optoelectronic devices, such as optical coatings and photovoltaic cells. DC electrical analysis exhibits that space charge limited conduction (SCLC) mechanism is active in the PPEDOT (AC) thin films. The activation energy, ΔE, values of the PPEDOT (AC) thin films in the Ohmic region are found to be around an average value of 0.076 eV in whereas, the non-Ohmic region, ΔE were found to be around 0.119 eV.