Transparent and conductive PEDOT films on PET substrate using an epoxy acrylate binder

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Abstract. Flexible and thin conductive films of poly(3,4-ethylenedioxythiophene) (PEDOT) on PET substrate were obtained by an in-situ vapor-phase polymerization (VPP) method using ferric toluene sulfonate as an oxidant. The addition of epoxy acrylate resin used as a binder to provide adhesive strength between PEDOT and PET also afforded the possibility of the surface patterning through UV exposure. The electrical and optical properties of the conductive PEDOT films were characterized by UV-Vis spectroscopy and conductivity measurement. Surface resistance below 150Ω/sq. was achieved for 100 nm thick films with UV-vis-spectrum transparency exceeding 80%. The combination of these properties makes the films highly suitable for numerous device applications.

Introduction

Polythiophene and its derivatives have been at the core of considerable scientific interest for their attractive and superior electrochemical and physical properties.[1-3] Among the derivatives of polythiophene, poly(3,4-ethylenedioxythiophene) (PEDOT) is one of the most successful conducting polymers because of its low bandgap, excellent environmental stability, high electrical conductivity, and transparency in thin oxidized films.[4-5] PEDOT has a number of attractive properties that make it suitable for many applications such as transparent electrodes for polymer light emitting diodes (PLEDs), anti-electrostatic agents, under layers for the metallization of printed circuit boards, and solid electrolytic capacitor, etc.[6-8]. Since PEDOT was first synthesized in 1989, numerous research groups have investigated the syntheses of PEDOT by the electrochemical and chemical oxidative polymerizations of the EDOT monomer. Electro-polymerization can only be used to coat electrode surfaces that are already conducting, which limits the practical use. Alternatively, PEDOT can be produced by direct chemical oxidation of the monomer, which is the most useful for the mass production of bulk polymers. Spin coating of the mixture of EDOT and ferric ion as an oxidant onto various substrates yields conducting PEDOT surface films. However, enormous still is required to get a homogeneous film with excellent quality, and the pot-life of the polymerization mixture is too short to prevent PEDOT from forming insoluble flocculants in the solution. The highest conductivity of the sample prepared by this method was 300 S/cm and the light transmittance was an increase of up to 80% [6]. However, further improvement is necessary for display applications.

In the present study, we investigated the conductive and transparent PEDOT film grown by vapor phase polymerization (VPP) on flexible film substrate. To increase the conductivity of PEDOT film, the VPP technique has been proposed. The method was originally described by Mohammadi et al. as a CVD process using FeCl3 as the oxidizing agents to polymerize the polypyrrole films [7]. The first application of VPP to produce PEDOT employing FeCl3 as an oxidant was reported by Kim et al.[8]