Studies on the influence of temperature on the optical properties and electrical conductivity changes of PEDOT:PSS thin solid films

H. Bednarski, B. Hajduk, J. Jurusik, M. Domański, H. Janeczek and M. Łapkowski

Centre of Polymer and Carbon Materials, Polish Academy of Sciences, ul. M. Curie-Skłodowskiej 34., 41-819 Zabrze, Poland

Poly(3,4-ethylenedioxythiophene) (PEDOT), a low band gap organic semiconductor, belongs to the family of conjugated polymers and is known for its good electrical conductivity and good thermal stability. Practical applications in organic optoelectronics of PEDOT are strongly limited by its poor solubility in organic solvents. An alternative, free of this deficiency, gives poly(4-styrenesulfonate) (PSS) doped PEDOT system. Conductive thin solid films of Poly(3,4-ethylenedioxythiophene):poly(4-styrenesulfonate) (PEDOT:PSS) can be easily prepared from commercially available aqueous colloidal dispersion of these polymers blend. Electrical conductivity of PEDOT:PSS films depend primary on the content of conductive PEDOT. Whereas, highly hygroscopic PSS acts as doping agent which enables preparation of aqueous dispersion of the whole system. For this reason, the solid films of PEDOT:PSS are also highly hygroscopic.

In this work we study the influence of temperature on optical properties and electrical conductivity changes of PEDOT:PSS thin solid films at temperatures from 290 K to 490 K. The optical properties are studied within spectroscopic ellipsometry equipped with the heated sample support. Whereas, electrical conductivity changes are measured using Keithley electrometer. The ellipsometric results are interpreted consistently within our uniaxial optical model of PEDOT:PSS, which base on the effective medium approximation in order to accounts for PSS contribution within the Tauc-Lonentz optical model and for PEDOT part within the Drude-Lorentz model. Correlations between electrically and optically determined conductivity are analyzed in details. As expected, dominating thermal effect, at temperatures from 290 to 370 K, is pronounced change in the sample thicknesses connected with loss of water in the heating cycle and uptake of water in the cooling cycle. This effect has been additionally confirmed by the differential scanning calorimetry (DSC) and the gravimetric measurements. At higher temperatures week influence on optical and electrical properties is observed.

Work supported by the NCN grant (Poland) No. DEC-2013/09/B/ST8/01629.