Preparation of highly conductive PEDOT:PSS film under magnetic field

M. A. Guziak, T. Nishizaki, Y. Honma, K. Hashimoto, H. Masunaga, A. Fujiwara, K. Watanabe and T. Sasaki

Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan

Japan Synchrotron Radiation Research Institute, Spring 8, Hyogo 679-5198, Japan

e-mail address: mguziak@imr.tohoku.ac.jp

Through experimental studies, it has been established that for conducting polymers, the electrical conductivity are being enhanced in a correlated manner, as the degree of chain extension, chain alignments and inter-chain order are improved. In case of poly(3,4-ethylenedioxythiophene):poly(4-styrenesulfonate) (PEDOT:PSS), one of the many approaches that has been commonly used for invoking these structural changes is addition of secondary dopant that acts as screening agent among PEDOT poly-cations which are entangled to PSS poly-anion by strong electrostatic interactions. Recent studies on PEDOT:PSS film structure doped with ethylene glycol (EG) show presence of nanometre-size crystal of PEDOT chains inside the hydrophobic core region of PEDOT:PSS through wide angle X-ray scattering experiment (WAXS) [1]. In the present studies, in addition to secondary doping approach we use magnetic field effect, hoping for magnetic orientation of PEDOT chains within the hydrophobic zone of PEDOT:PSS particle, hence improved electrical conductivity.

We have succeeded in preparation of both PEDOT:PSS Pristine (PH1000P) and PEDOT:PSS doped with 3%wt. of EG (PH1000/EG3%) films from PEDOT:PSS water dispersion under \( H=6T \) with direction being parallel (\( H|| \)) and perpendicular (\( H\perp \)) to surface of the sample. Fabricated films under aforementioned conditions were compared with films prepared under \( H=0T \) by the WAXS measurement. Improvement of orientation for the films with \( H|| \) for both PH1000P and PH1000/EG3% was observed. On the other hand when comparing PH1000P with PH1000/EG3% film under \( H|| \), the former exhibit higher degree of orientation. To further investigate the magnetic field effect, PH1000P and PH1000/EG3% films were prepared under \( H=10T \) at two different position, namely at the center of the magnetic field (\( z=0mm \)) and away from magnetic field center (\( z=90mm \)). In this case, the degree of alignment was investigated by the FT-IR reflectivity measurement. Surprisingly, the results of this measurement indicate enhancement of degree of orientation for PH1000P at position \( z=90mm \) in comparison with \( z=0mm \). In turn the sample PH1000/EG3% does not show this sort of enhancement. In order to explain the observation on the magnetic field induced orientation of the PEDOT:PSS, multiple factors e.g. magnetic anisotropy of PEDOT nanocrystal, viscosity of the surroundings medium need to be considered. We will discuss the possible causes.