

STRUCTURE AND PHASE TRANSITIONS OF BINARY BLENDS OF POLY(3-HEXYLTHIOPHENE) WITH *N,N'*-ALKYLATED AROMATIC DIIMIDES

This thesis addresses studies on crystallization and phase transitions in the blends of poly(3-hexylthiophene) (P3HT) with *N,N'*-alkylated aromatic diimides (ADIs). The research was performed using a conventional analytical toolset including differential scanning calorimetry (DSC), X-ray scattering, and scanning electron microscopy (SEM). The main part of the study was preceded with an analysis of the properties of pure P3HT and pure ADIs. In the case of pure P3HT, it was found that crystal sizes, their orientation and the degree of polymer crystallinity in thin films can be controlled by polymer-solvent interactions and solution aging time. The crystal structure of P3HT (packing of the unit cell) was found independent of the solvent used for crystallization and solution aging time. It was demonstrated that isotropization of ADI was preceded by several crystal-crystal phase transitions, resulting in rearrangement of the unit cell structure. In some P3HT:ADI blends, the presence of P3HT induced formation of additional ADI's polymorphs. The composition of the blends exerted an influence on the polymer crystallinity and sizes of ADI and P3HT crystal domains. Testing approx. 30 different P3HT:ADI blends allowed creation of phase diagrams showing the structure and thermal range of individual phases as a function of blend compositions. Essentially, the crystal structure of the components of P3HT:ADI blends was identical to the structure of pure compounds. In some blends, additional, unidentified phase transitions were observed. These additional phase transitions did occur neither in pure ADIs nor in pure P3HT. The crystal structure of P3HT:ADI thin films was found generally the same as the structure of isotropic samples discussed above. Recrystallization of thin films under an influence of solvent vapor (the solvent vapor annealing) affected sizes of crystal domains, and, in some cases, also the crystal structure of the components. In order to correlate the structure and morphology with charge carrier transport properties, the blends-based thin films were tested as active layers in organic field effect transistors (OFETs). Based on the measurements of current-voltage characteristics, it was concluded that the chemical structure of ADIs and the compositions of blends affected the charge carriers (holes) transport in the films. The solvent-annealing-induced structure changes had an impact on the hole transport. Experimental findings presented herein enabled correlating the crystal structure of the blends with the charge transport characteristics. It was found that reducing sizes of the P3HT crystal domains had a beneficial effect on the transport of charge carriers in P3HT:ADI blends.