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LIQUID SENSORS BASED ON ELECTRICALLY CONDUCTIVE POLYCARBONATE/MULTI-WALLED CARBON NANOTUBE COMPOSITES: PROCESSING, PROPERTIES AND PHYSICAL MODEL

Tobias Villmow, Sven Pegel, Petra Pötschke, Gert Heinrich,

Polymer reactions and blends, Leibniz Institut für Polymerforschung

villmow@ipfdd.de

Electrically conductive polymer composites (CPC) based on carbon nanotubes (CNT) are suitable candidates for sensing applications. Especially the detection of liquids is of great interest. The sensory capacity of CPC is based on the interaction between polymer matrix and the liquid in terms of the swelling kinetic resulting in changes of the electrical resistance, which is commonly expressed as relative resistance change Rrel. For this study, polycarbonate (PC)/multi-walled carbon nanotube (MWNT) composites were melt-mixed based on the masterbatch technique using a twin-screw extruder. A screw profile having a length to diameter ration of 48 containing mixing elements, a rotation speed of 500 rpm, a throughput of 5 kg/h, and a temperature of 260°C were used for both mixing steps to produce composites containing 0.125 to 4.0 wt.% MWNT.
Composites were compression-moulded to plates having different thicknesses. U-shaped samples were cut from these plates and then immersed in solvents (methylene dichloride, tetrahydrofuran, acetone, and ethyl acetate) in order to investigate the time depending Rrel. As these four solvents exhibit differences in the diffusion kinetics controlling their penetration into the PC matrix, different Rrel curves were observed. Light microscopy revealed that the diffusion of solvents can be monitored in terms of a pronounced diffusion front. This diffusion front separates a swollen skin from a dry core having the initial resistivity of the composite.
Based on this observed skin-core morphology, a physical model based on the parallel connection of two time depending resistances was designed using several parameters like, diffusion parameters, composite characteristics, and geometrical values. Simulated Rrel curves based on the physical model were compared to experimental data, which were obtained on the CPC and very good agreements were observed. Using this model the influence of CNT content and kind of solvent could be described exactly.