Simultaneous Measurements of Electrical and Thermal Conductivity as well as SAXS/WAXS during Crystallization of Polycaprolactone/MWCNT Composites

Andreas Wurm[C]
Institute of Physics, University of Rostock, Rostock, Germany
andreas.wurm@uni-rostock.de

Dirk Lellinger
Division Plastics, Fraunhofer Institute for Structural Durability and System Reliability LBF, Darmstadt, Germany

Alexander A. Minakov
Institute of Physics, University of Rostock, Rostock, Germany

Tetyana Skipa
Division Plastics, Fraunhofer Institute for Structural Durability and System Reliability LBF, Darmstadt, Germany

Petra Pötschke
Leibniz Institute of Polymer Research Dresden, Dresden, Germany

Radu Nicula
EMPA-Swiss Federal Laboratories for Materials Science and Technology, Thun, Switzerland

Ingo Alig
Division Plastics, Fraunhofer Institute for Structural Durability and System Reliability LBF, Darmstadt, Germany

Christoph Schick[S]
Institute of Physics, University of Rostock, Rostock, Germany

In situ crystallization of poly(ε-caprolactone) (PCL) filled with different contents (0.2 - 5 wt.%) of multiwalled carbon nanotubes (MWCNTs) was investigated in X-ray (SAXS/WAXS) synchrotron experiments simultaneously with thermal and electric conductivity measurements. The combined study provides information on nucleation ability of MWCNT, crystallization and melting kinetics, degree of crystallinity as well as the evolution of thermal diffusivity and electrical conductivity of PCL/MWCNT composites during isothermal and non-isothermal crystallization. MWCNTs act as strong nucleation agents. Two separate melting peaks in calorimetric experiments indicate (i) nucleation by the nanotubes and (ii) heterogeneous nucleation by the polymer itself.Electrical conductivity measurements showed for MWCNT contents above 0.5 wt% an increase in electrical conductivity by more than one order of magnitude, which can be related to the formation of a conductive nanotube network. At the same time, thermal conductivity of the composite is increasing only slightly, which is rather related to the increase of the crystalline phase than to heat transfer in a percolated structure. The dependence of thermal conductivity on MWCNT content can be related to the addition of filler with high thermal conductance and does not show a simple correlation to the electrical conductivity.