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Filled rubber materials: From filler agglomeration to electrical resistance

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The talk discusses our recent studies of the selected properties of polymer nano-composites. In the first part of the talk, we discuss the problem of the kinetic stability of the filler agglomerates in rubbers and dense polymer melts in the presence of shear, critical for understanding the filler reinforcement in these systems often used in tire technology. By making use of the self-consistent field theory, we develop a pragmatic approach to evaluating the polymer mediated potential and associated filler flocculation stability ratio in rubbers. The obtained polymer mediated potential and stability ratio have been expressed through relevant experimentally accessible quantities: (i) filler immersion free energy, (ii) compressibility, (iii) polymer density correlation length; and evaluated for selected practically important filler and rubber materials used in tire industry. In the second part of the talk, we discuss the electrical resistance R of the elastomeric material polychloroprene filled with multiwalled carbon nanotubes (CNT) dispersed by using an imidazolium based ionic liquid. Both experimental and theoretical results show that the electrical resistance R of the composite exhibits non-monotonic dependence on the compression/decompression force F. By developing theoretical model that accounts for the deformations of the conductive phase that consist of the carbon nano-tube bundles binded by the occluded rubber material, we study the electrical response of filled rubbers in the presence of the applied force varying with time according to given lows. The demonstrated good agreement between the theory and experiment speaks in favor of adequateness of the developed theoretical approach.

Biography

Alexander I Chervanyov obtained his PhD from Kharkov National University in 1995. After earning his PhD, he has held the Research Associate positions at the Max-Planck-Institute of Complex System Dresden, Chemical Engineering Department of Pittsburgh University and Chemistry Department of the University of Virginia. Starting from 2005, Alexander has been working in Leibniz Institute of Polymer Research Dresden as a senior scientist. Currently, Alexander is enjoying research stay in the Centre for BioNano Interactions at UCD Dublin as a visiting researcher. Alexander works on technologically/biologically relevant application of nano-particle-polymer composites.

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Characteristics of PVDF-HFP based nanocomposite gel polymer electrolytes dispersed with CNTs for Li-ion batteries

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Nanocomposites gel polymer electrolytes are gaining more and more attention among the researchers worldwide due to their possible applications in various electrochemical devices particularly in solid-state Li-ion batteries. In this work we have investigated the effect of carbon nanotubes on the electrical properties of PVDF-HFP based gel electrolytes. The length and diameter of CNTs used in the present work are 10-30 μm and 10-20 nm, respectively. The nanocomposites polymer electrolytes have been synthesized by solution casting technique with varying the weight ratio of CNTs. By analysis of impedance spectroscopy, it has been demonstrated that the incorporation of CNTs into PVDF-HFP-(PC+DEC)-$LiClO_4$ gel polymer electrolyte system significantly enhances the ionic conductivity of the electrolyte. The enhancement of ionic conductivity seems to be correlated with the fact that the dispersion of CNTs to PVDF-HFP prevents polymer chain reorganization due to the high aspect ratio of CNTs, resulting in reduction in polymer crystallinity, which gives rise to an increase in ionic conductivity. The decrease of crystallinity of PVDF-HFP due the addition of CNTs has been confirmed by XRD. The interaction of CNTs with various constituents of polymer electrolytes has been studied by FTIR spectroscopy. TEM results show that the fillers (CNTs) has distributed uniformly in the polymer electrolytes. Moreover CNTs added gel polymer electrolytes offer better thermal stability as compared to that of CNTs free electrolytes as confirmed by TGA analysis.

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