Krzysztof Winkler et al., J Phys Chem Biophys 2017, 7:4(Suppl)
DOI: 10.4172/2161-0398-C1-025

Experimental and theoretical studies of coordination fullerene polymers conductivity

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In coordination fullerene polymers, fullerene moieties are covalently bonded to transition metal atoms or their complexes to form a polymeric network. The polymer of fullerene C_{60} and palladium, poly ($C_{60}Pd_3$), was most intensively investigated. This polymer can be synthesized electrochemically or chemically. The electrochemical synthesis results in the formation of thin and uniform film on the electrode surface. The film is electrochemically active at negative potentials due to the fullerene cages reduction. During switching between neutral and reduced state, the polymeric film is doped with supporting electrolyte cations. Such transition also results in sharp increase of the film conductivity. The conductivity of poly ($C_{60}Pd_3$) thin films was experimentally investigated with interdigitated array electrodes. The poly ($C_{60}Pd_3$) doping level and, therefore, charge carrier density depends on the size of counter-ions incorporated into polymeric structure during its reduction. The negative polaron-type carriers generated during the film reduction are responsible for film conductivity. The charge propagation through the polymeric film can be quantitatively described by electron-hopping model. The specific conductivity of poly ($C_{60}Pd_3$) and electron diffusion coefficient are in the same order of magnitude as these values reported for typical p-doped conducting polymers. The conductivity properties of the composite of poly ($C_{60}Pd_3$) polymer and palladium nanoparticles were also investigated. Metallic nanoparticles participate in the charge transport within the film also in the potential range of the polymer neutral state. Therefore, poly ($C_{60}Pd_3$)/Pd composite exhibits large potential window of good conductivity. The structure and conducting properties of poly ($C_{60}Pd_3$) polymers were also predicted applying DFT calculations. The isolated negative polarons are the preferred electronic states for reduced polymers.

Biography

Krzysztof Winkler completed his MSc (1982) and PhD (1989) degrees in Chemistry at Warsaw University, Poland. He was a Post-doctoral fellow at University of Saskatchewan, Saskatoon (1989-1991) and University of California, Davis (1995-1997). He is currently a Professor at Institute of Chemistry, University of Bialystok, Poland. He served as Head of this Institute (2004-2017). His research interests include "Kinetics of electrochemical processes, electro-deposition and properties of low-dimensional crystals, the synthesis, properties and application of fullerene-based polymers.

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