CHARGE TRANSPORT PROPERTY OF ONE DIMENSIONAL GOLD-POLYANILINE COMPOSITE NETWORKS

Kaushik Mallick[1, 2], *Andre Strydom*[2], *Michael Witcomb*[3]

[1] *Advanced Materials Division, Mintek, Randburg 2125, South Africa.*

[2] *Physics Department, University of Johannesburg, Auckland Park 2006, South Africa.*

[3] *Electron Microscope Unit, University of the Witwatersrand, WITS 2050, South Africa.*

Contact: kaushikm@mintek.co.za,

Over the last two decades considerable efforts have been focused on fabricating nanostructures. Mechanisms to organize inorganic nanoparticles into diverse structures for their use in optical, electronic, magnetic and catalytic applications have been of special interest. Metal nanoparticles have been assembled into one-, two- and three-dimensional architectures and the colloidal aggregates have been used in diverse applications such as sensing and imaging.

The incorporation of the metal nanoparticles in polymers has attracted much attention and research interest over the last few years. Composite architectures of polymer and metal nanoparticles synergistically provide both useful functionality and mechanical integrity. Such composites show various properties directly relevant and of benefit to dielectrics, energy storage and catalytic activity. We have employed a coupled redox synthesis system with molecular pre-cursors for the synthesis of nanometal-polymers, specifically employing gold [1], copper [2] or palladium [3] compounds with various anilines and substituted anilines as starting materials. The resulting nanometal-polyaniline structures can be controlled at the nanoscale by manipulation of the synthesis variables.

A facile synthesis route is described for the preparation of a gold-polyaniline nanocomposite material by polymerization of aniline hydrochloride using $HAuCl_4$ as the oxidant. The oxidative polymerization of aniline hydrochloride leads to the formation of polyaniline with a fiber-like morphology, while the reduction of $HAuCl_4$ results in the formation of gold nanoparticles (2-7 nm). The gold nanoparticles were highly dispersed and stabilized throughout the polyaniline fibers that formed a metal-polymer composite material. The resultant composite material was characterized by means of different techniques, such as UV-vis, IR and Raman spectroscopy, which offered information about the chemical structure of the polymer, whereas electron microscopy images provided information regarding the morphology of the composite material and the distribution of the metal particles in the composite material. We furthermore performed temperature-dependent measurements of the electrical conductivity of the metal-polymer composite material. We obtained conductivity values supportive of a thorough dispersion of metallic conducting centers within the composite, while the interpretation of the temperature dependence of the conductivity is commensurate with the 1-dimentional geometry of the polymer matrix. The temperature dependence of the Hall coefficient of the metal-polymer composite is evidence of a possible contribution of a charge carrier deficit and a temperature dependent mobility in this material.

References:

[1] K. Mallick, M. J. Witcomb, M. S. Scurrell, Journal of Physics: Condensed Matter 19 (2007) 196225.
[2] K. Mallick, M. J. Witcomb, M. S. Scurrell, Physica Status Solidi (a) 204 (2007) 2263.
[3] K. Mallick, M. J. Witcomb, A. Dinsmore, M. S. Scurrell, Langmuir 21 (2005) 7964.