Petr Slobodian et al., J Material Sci Eng 2018, Volume 7
DOI: 10.4172/2169-0022-C8-114

19th World Congress on

Materials Science and Engineering

June 11-13, 2018 | Barcelona, Spain

Stretchable and flexible thermoelectric polymer composites for self-powered volatile organic compound vapors detection

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Statement of the Problem: Thermoelectric devices generate an electrical current when there is a temperature gradient between the hot and cold junctions of two dissimilar conductive materials typically n-type and p-type semiconductors. Consequently, also the polymeric semiconductors composed of polymeric matrix filled by different forms of carbon nanotubes with proper structural hierarchy can have thermoelectric properties which temperature difference transfer into electricity. In spite of lower thermoelectric efficiency of polymeric thermoelectrics in terms of the figure of merit, the properties as stretchability, flexibility, light weight, low thermal conductivity, easy processing and low manufacturing cost are advantages in many technological and ecological applications. Methodology & Theoretical Orientation: Polyethylene-octene copolymer based highly elastic composites filled by multi-walled carbon nanotubes (MWCTs) were prepared by sonication of nanotube dispersion in a copolymer solution followed by their precipitation pouring into non-solvent. The electronic properties of MWCNTs were moderated by different treatment techniques such as chemical oxidation, decoration by Ag clusters or addition of low molecular dopants. In this concept, for example, the amounts of oxygenated functional groups attached on MWCNT surface by HNO3 oxidation increase p-type charge carriers. p-type of charge carriers can be further increased by doping with molecules of triphenylphosphine. For partial altering p-type MWCNTs into less p-type ones, Ag nanoparticles were deposited on MWCNT surface and then doped by 7,7,8,8-tetracyanoquino- dimethane. Both types of MWCNTs with the highest difference in generated thermoelectric power were combined to manufacture polymeric based thermoelectric module generating thermoelectric voltage when temperature difference is applied between hot and cold ends of the module. Moreover, it was found that the generated voltage by the thermoelectric module at constant temperature gradient was significantly affected when exposed to vapors of different volatile organic compounds representing then a self-powered thermoelectric sensor for chemical vapor detection.

Acknowledgement This work was supported by the Ministry of Education, Youth and Sports of the Czech Republic – Program NPU I (LO1504) and with the support of the Operational Program Research and Development for Innovations co-funded by the European Regional Development Fund (ERDF) and the national budget of the Czech Republic, within the framework of the project CPS-strengthening research capacity (reg. number: CZ.1.05/2.1.00/19.0409). This project was also supported by the internal grant of TBU in Zlin No. IGA/CPS/2017/002 funded from the resources of the Specific University Research. P. R. would like to acknowledge financial support from the Fund of the Institute of Hydrodynamics AV0Z20600510.

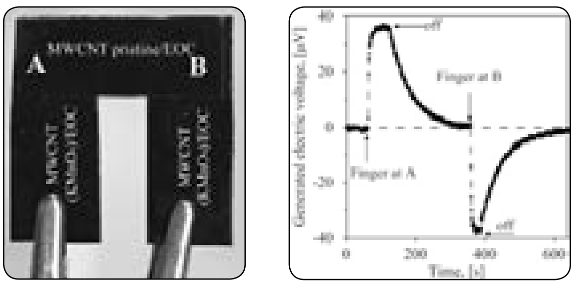

Figure 1: Energy harvesting button assembled from two kind of MWCNT/EOC composites. And time-dependent generation of voltage after finger touching

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Biography

Petr Slobodian received the Ph.D. degree in polymer science from the Faculty of Technology, Tomas Bata University (TBU), Zlin, Czech Republic and the Ms. degree from the Brno University of Technology, Brno, Czech Republic. He is a Scientific Researcher at the Centre of Polymer Systems, TBU. He is the associate professor at the Faculty of Technology since 2008. He is author or co-author of 76 scientific articles all published in the impacted journals. His main interests are polymer composite materials, carbon nanotubes and their use in the organic vapor sensors, strain sensors and stretchable thermoelectric materials.

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