228d Fet Based Conducting Polymer Coated Carbon Nanotube Bio/Chemical Sensor

Adam K. Wanekaya, Wilfred Chen, Nosang V. Myung, and Ashok Mulchandani

The unique electronic and mechanical properties of nanotubes have promised much potential for a vast range of applications. Recently, much attention has been given to the use of nanotubes in composite materials, to harness their exceptional mechanical and electronic properties. A wide range of host materials has been used, including polymers, ceramics, and metals. Most recently, the research [1, 2] has focused on composites of electronically active conjugated polymers and carbon nanotubes (CNTs), which demonstrate a number of advantages. Conjugated polymers show potential for electronic device applications with the incorporation of carbon nanotubes promising to greatly enhance transport properties in these systems. Furthermore, incorporation of nanotubes should also increase the mechanical properties of polymeric materials and, by increasing their thermal conductivity, improve their environmental stability. We present a simple method to fabricate, characterize and demonstrate the applications of micrometer-scale electrical circuitry based on a self-assembled aligned single walled carbon nanotube (SWNT) network. The SWNTs were electrochemically coated with conducting polymers (CP). The benign bio-friendly conditions of electropolymerization[3] enable the sequential deposition of conducting polymer with embedded bioreceptors onto SWNTs across patterned electrode platforms. Detection of bioanalytes is achieved by the extremely sensitive modulation of the electrical conductance of the conducting polymer coatings on SWNTs brought about by the change in the electrostatic charges from binding of the analyte to receptors. This procedure leads to direct, real-time, rapid and label-free sensing. Furthermore the electrical properties the sensor can be controlled using Field Effect Transistor (FET) configurations. Using an extra electrode as a Gate, the properties of the functionalized conducting polymer material can be tuned for better sensitivity. Preliminary results from pH studies indicate that the conducting polymer coated SWNTs are extremely sensitive materials for real time pH sensing.

Effects of monomer concentration, dopant type and concentration and electrochemical polymerization mode on the sensitivity, selectivity and durability of biomolecule-functionalized conducting polymer coated CNTs as label-free bioaffinity sensors will be investigated to establish optimum fabrication and analysis protocols.

Acknowledgement

This work was supported by DOD/DARPA/DMEA (DME90-02-2-0216).

References

1. Curran, S. A., Ajayan, P. M., Blau, W. J., Carroll, D.L., Coleman, J.N., Dalton, A.B., Davey, A.P., Drury, A., McCarthy, B., Maier, S., Strevens, A., Adv. Mater. 1998:1091-1093.

2. Wang, J., Dai, J. H., Yarlagadda, T., Langmuir 2005, 21:9-12.

3. Ramanathan, K., Bangar, M. A., Yun, M., Chen, W., Mulchandani, A., Myung, N. V., J. Am. Chem. Soc., 2005, 127:496-497.