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Carbon nanotubes/polypyrrole film as a gas sensor for the volatile organic compounds

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This research concerns the physical and structural properties of carbon nanotube/conductive polymer composites and their use in gas sensors. A good sensor should be sensitive, reliable and low cost, with fast response and a short recovery time. Carbon nanotubes (CNTs) are well-suited because of their unique properties; their small size, hollow center, large surface area and good electric conductivity. However, it has been shown that pristine carbon nanotubes have a low response for volatile organic compounds–our target analyte-therefore we attempted to improve this property of CNTs by templating pyrrole on CNTs. TEM, Raman spectroscopy, I-V characteristics and voltammetry were used to study the structural properties of CNTs/Polypyrrole. Polypyrrole is simple to prepare by oxidation of the monomer and its resistance is very sensitive to organic vapors, although much larger than that of CNTs. TEM of polypyrrole/CNT composites prepared from single-walled carbon nanotubes (SWCNTs) and multi-walled carbon nanotubes (MWCNTs) show polypyrrole coated the CNTs successfully. There are significant changes in the range of diameters of nano tubes for SWCNTs from (7-10) nm to (8-35) nm and from (2-10) to (21-50) nm for MWCNTs. The composites were tested for the variation in their resistance upon exposure to a range of organic vapors (acetone methanol and chloroform). The sensing devices comprised simple two-terminal devices over which a layer of the composite was applied by drop-coating. We investigated the effect of the CNT: polypyrrole ratio on the sensor response, $S=(R-R_0)/R_0$ where R_0 is the resistance in an air atmosphere and R is the resistance at steady-state after exposure to an air/analyte mixture. In general, bare CNTs show a rapid response time, but very low response (typically $S<0.1$) at room temperature. As the amount of polypyrrole in the composite is increased, S increases, the response time deteriorates. Interestingly, the response of the composites may even change sign as a function of target analyte concentration; this suggests that a simple mechanism based on swelling and its effect on the percolation behavior of CNTs in the polypyrrole matrix is insufficient to explain the data.

Biography

Shams B Ali has completed her MSc from University of Technology, Laser Physics Department, Iraq and now studies PhD at Newcastle Upon Tyne University, UK. She has published 5 papers in reputed journals.

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