Anshul Kumar Sharma et al., J Material Sci Eng 2016, 5:9(Suppl)
http://dx.doi.org/10.4172/2169-0022.C1.052

Enhancement of sensitivity in gas chemiresistors based on carbon nanotube surface functionalized with substituted phthalocyanines

Anshul Kumar Sharma, R K Bedi and **Aman Mahajan**
Guru Nanak Dev University, India

Carbon nanotubes (CNTs) possessing unique structure and properties are attractive building blocks for novel materials and devices of important practical interest. Particularly, multi wall carbon nanotubes (MWCNTs) have attracted extensive attention in sensing application owing to their unique one-dimensional carbon nanostructure and electrical properties. However, the insolubility or poor dispersibility of pristine CNTs in common solvents poses a serious obstacle to their further development. Various attempts have been made to obtain homogeneous CNT dispersions in both aqueous and organic media. Among those approaches, chemical modification of side walls, defect sites and open ends are often found to result in changes of the structural, mechanical and electronic properties of CNTs. Generally, carbon nanotubes are very sensitive to many types of target molecules showing an apparent lack of selectivity. This drawback of carbon nanotube sensors can be overcome through functionalization of nanotube surface in order to provide molecular specificity or unbalanced promoted sensitivity to a class of chemical species. Introduction of functional groups, such as carboxyl and amino groups, not only can improve CNTs solubility in various solvents, but also are useful for the further chemical link with other compounds. Recently, in order to improve the sensing performance of these MWCNTs based sensors, many sensing materials such as conducting polymers metals and metal oxides have been anchored on the surface of MWCNTs and play important roles in the improvement of the sensitivity and selectivity of the resultant gas sensors. Phthalocyanine (Pc), as an excellent sensing material, has been extensively studied based on its high sensitivities, excellent thermal and chemical stability. Substituting functional groups on phthalocyanine molecules make them soluble in various organic solvents and thus enable them for low cost solution processing techniques such as spin coating and self-assembly, etc. Therefore, we expect that combining the nanoscale CNTs with gas sensing active Pc would feature not only the intrinsic properties of CNTs and Pc arising from the mutual interaction between CNTs and Pc but also enhance the gas sensing behavior of CNTs. In this work, we have prepared a hybrid material of MWCNTs-COOH and hexa-fluorinated copper phthalocyanine ($F_{16}CuPc$). The formation of $F_{16}CuPc$/MWCNTs-COOH hybrid was confirmed by UV-Visible, Raman and FT-IR spectroscopy. SEM, TEM and AFM studies revealed that $F_{16}CuPc_8$ molecules were successfully anchored on the surface of MWCNTs-COOH through π-π stacking interaction. Subsequently, a chemi-resistive sensor has been fabricated by drop casting $F_{16}CuPc$/MWCNTs-COOH hybrid onto alumina substrate. The gas sensing potential of the fabricated hybrid materials has been tested upon exposure to different hazardous gases like NO_2, NO, Cl_2 and NH_3 at different operating temperatures. It has been demonstrated that $F_{16}CuPc$/MWCNTs-COOH hybrid is highly selective towards Cl_2 with minimum detection limit of 100 ppb. The response of sensor increases linearly with increase in Cl_2 concentration. The results obtained emphasize on the application of $F_{16}CuPc$/MWCNTs-COOH hybrid material in Cl_2 sensing applications.

Biography

Anshul Kumar Sharma received his MSc degree in Physics from Department of Physics, Himachal Pradesh University, Shimla, India in the year 2009 and did MPhil degree in Physics in the year 2011 from Department of Physics, Guru Nanak Dev University, Amritsar, India. Presently, he is working towards his PhD degree at the same department. His research interests are preparation and characterization of carbon nanotubes based functional hybrid materials and their application as gas sensors.

dramanmahajan@yahoo.co.in
anshulsharma.phy@gmail.com

Notes: