11th International Conference on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Chemical Vapor Detection using Conducting Polymers

S. P. Surwade, V. Dua, S. Agnihotra, S. Ammu and S. K. Manohar*

Department of Chemical Engineering and Department of Chemistry, University of Massachusetts Lowell, Lowell, Massachusetts 01854, U.S.A.
* Corresponding author.

Abstract – We describe a lightweight, flexible chemiresistor using thin films of conducting polymer nanofibers deposited on plastic substrates to reversibly detect chemically aggressive vapors like NO_2, SO_2 and Cl_2 in the 100ppm to 250ppb concentration range. Conducting polymer nanofibers are obtained in one step on flexible plastic substrates. Sensor response can be tailored by optimizing synthesis conditions, dopant type, and solvent used during film processing.

Chemical vapor sensing using organic thin films as chemiresistors or ChemFETs is a promising research area because it is possible to incorporate many attractive design features like lightweight, flexibility, low power consumption, etc., based on the application. Thin films of conducting polymers deposited on rigid and flexible supports have been used to detect common organic solvent vapors, nerve agent simulants and chemically aggressive vapors and explosives.[1,2] However, irreversible signal responses are observed when these films are used to detect highly oxidizing vapors like NO_2, Cl_2, SO_2, etc., consistent with strong chemisorption along the polymer backbone (chlorination, nitration, etc.).

We previously reported synthesis of bulk quantities of various conducting polymers using a seeding approach.[3] We have modified this procedure/approach to deposit conducting polymer nanofiber films on plastic substrates and have used these films as chemiresistors to detect a variety of chemical warfare agents (CWAs). All three major classes of CWAs can be detected reliably and reversibly. The sensor response is dependent on the various factors, such as, the dopant used, conformation of polymer chains in the solvent used to cast films, and ring substituents on the polymer backbone. By leveraging these factors we can selectively and reversibly detect (even) chemically aggressive vapors like NO_2, Cl_2, SO_2, etc., with minimum backbone degradation. The sensor response can be coupled with pattern recognition software to develop a robust and rugged e-nose detector array.

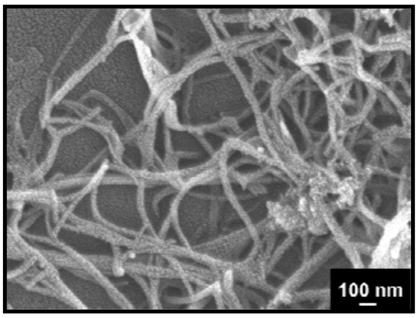

Figure 1: SEM image of PEDOT nanofibers deposited on flexible plastic substrates.

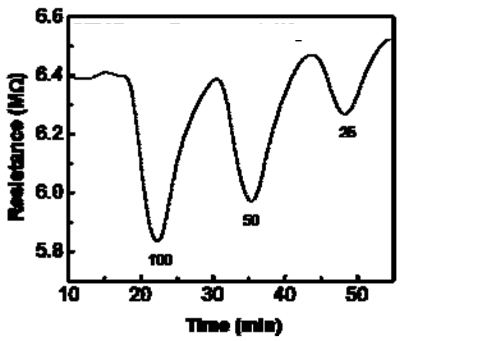

Figure 2: Plot of resistance *vs.* time of PEDOT nanofiber films when exposed to NO_2 vapor (100ppm – 25ppm).

References

[1] D.T. McQuade, A.E. Pullen, T.M. Swager, Chem. Rev. 100 (2000) 2537.
[2] H. Bai, G. Shi, Sensors 7 (2007) 267.
[3] X. Zhang, W.J. Goux, S.K. Manohar, J. Am. Chem. Soc. 126 (2004) 4502.