Using Carbon Nanotubes/Polypyrrole Film as a Gas Sensor for the Volatile Organic Compounds

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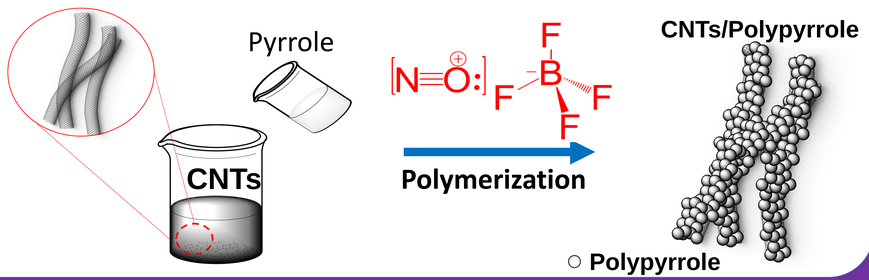
1. INTRODUCTION

Carbon nanotubes (CNTs) are seamless cylinders of one or more layers of graphene (denoted single-wall, SWCNT, or multiwall, MWCNT), with open or closed ends. This project focus on the preparation of composite films from CNTs and polypyrrole (Ppy) to use them in sensing application. Pristine carbon nanotubes have a low response (fractional change in resistance) to volatile organic compounds (VOCs) therefore we attempted to improve the analytical performance of resistance based sensors by templating the conductive polymer Ppy on CNTs.

2. AIM

The aim of the project is prepared nanocomposite film contains carbon nanotubes and conductive polymer in order to improve the response of films in sensing applications.

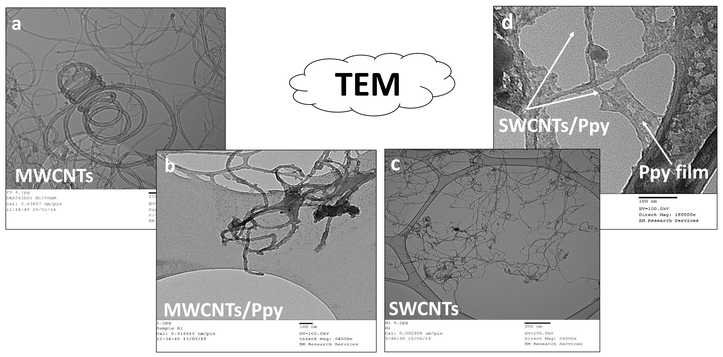
3. SYNTHESIS OF CNTS/POLYPYRROLE



4. RESULTS

4.1 TRANSMISSION ELECTRON MICROSCOPY

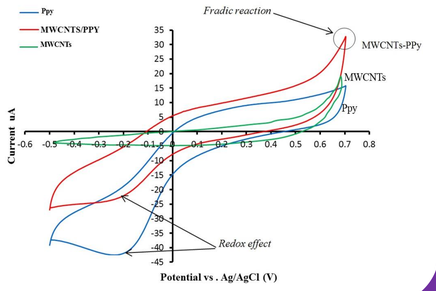
The morphology of carbon nanotubes and CNTs/Ppy was examined by transmission electron microscopy (TEM). The results show that the multi wall and single wall carbon nanotubes were nanocomposites effectively synthesised using the oxidative polymerization method.



TEM images of (a) multiwall carbon nanotubes before coated by Ppy (Mag 92000x), (b) hybrid MWCNTs (Mag 64000x), (c) bare SWCNTs (Mag25000x), (d) SWCNTs after tamplated by Ppy (Mag1800000x).

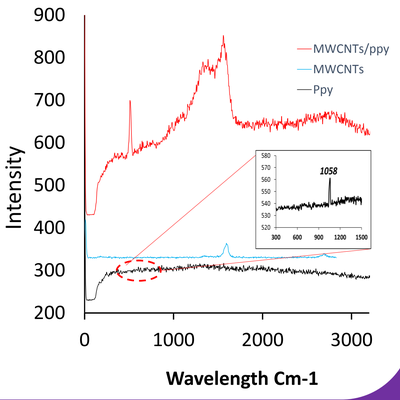
4.2 I-V CHARACTERISTICS

There is a difference between CNTs-hybrids and CNTs- pristine in the output current and the similarity between the curves a and b indicates that Polypyrrole coated the surface of the nanotubes successfully. However, some concavity appeared in the curves, which may be due to the complex oxidation and reduction process of the electrodes.



4.3 RAMAN SPECTROSCOPY

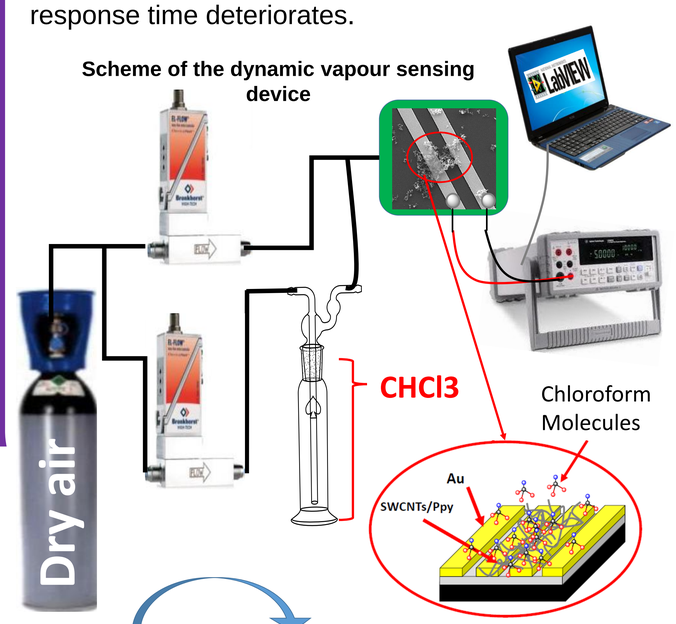
Raman spectroscopy has been used to investigate the surface properties of Ppy/carbon nanotubes composites .From the room temperature Raman spectra of MWCNT , Ppy/MWCNT and Ppy. The typical peak of pristine MWCNT at 1612 cm-1. The band at . Obviously, after the Ppy coating forms on MWCNTs surface, three additional Raman peaks appeared at around 514, 1328 and 1,063, cm−1 are found. The Raman spectra of pure Ppy the band at approximately 1058 cm−1 due to C-H stretching.

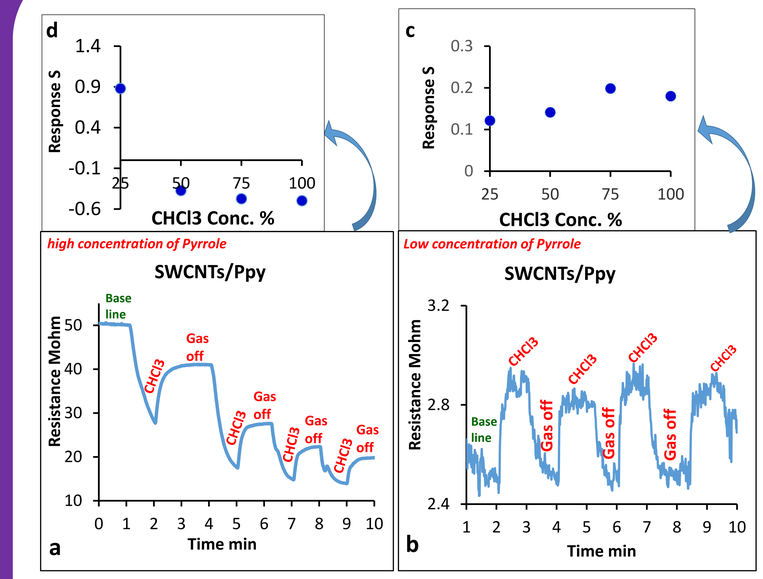


4.4 SENSING MEASUREMENTS

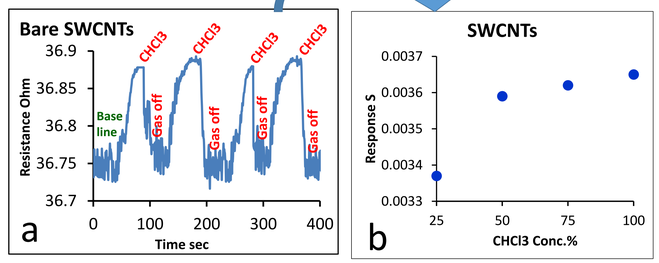
The composites were deposited as films on microband electrodes in order to measure the resistance by a standard DMM. The sensing response is defined as S = (R-R0)/R0 where R0 is the resistance in an air atmosphere and R is the resistance at steady-state after exposure to an air/analyte mixture. Pure 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, the magnitude of S increases, but its sign changes and the response time deteriorates.

Scheme of the dynamic vapour sensing device





(a&b)The sensitivity of the electrical resistance R of SWCNTs/Ppy films to chloroform (0-100) % exposure at 17ºC; (c&d) The device sensitivity S=(R-R0)/R0 as a function of chloroform. Fig (a) shows the swelling effect of pyrrole on the gas response.



a)The sensitivity of the electrical resistance R of SWCNTs films to chloroform (0-100)% exposure at 17ºC. b) The device sensitivity S=(R-R0)/R0 as a function of chloroform.

5.CONCLUSIONS Polypyrrole/CNTs were synthesised successfully using the in situ chemical oxidative Polymerization method. CNTs/Ppy can be used as sensitive for organic vapour compound. That exhibit fast response and excellent recovery time with positive response (S) for low PC concentration and negative response (S) for the high concentration of conductive polymer.

6.FUTURE_WORK Focus on the effect of the temperature on the sensing response and on the electrical properties for the nanocomposite films.

7.REFERENCES1. King, V.B. (2007) Nanotechnology research advances. New York: Nova Science Publishers. 2. Matei, R., Alina, P. and Luisa, P. (2013) 'Supercapacitance of Single-Walled Carbon Nanotubes-Polypyrrole Composites', Chemistry, 2013.