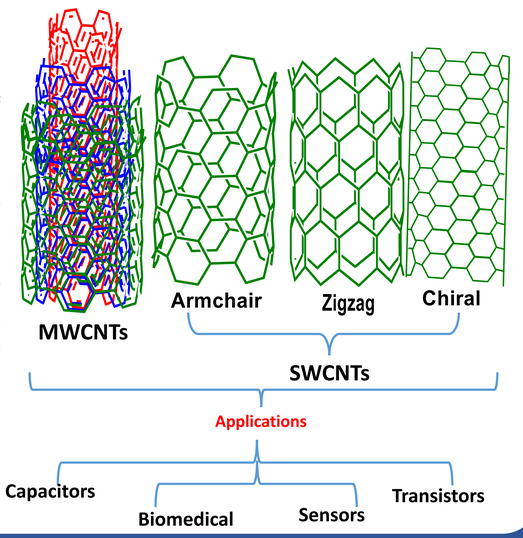
Nanocomposite Films as Gas a Sensor for Organic Compounds

Shams B. Ali, Dr Benjamin R. Horrocks and Prof Andrew Houlton

Chemical Nanoscience Laboratories/School of Chemistry/ Bedson Building/Newcastle University/ UK .e-mail: s.ali2@newcastle.ac.uk

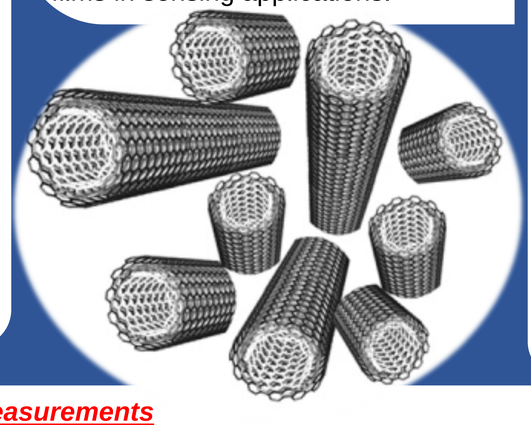
1. INTRODUCTION

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. The focus of the current project is on the preparation of composite films from CNTs and polypyrrole (Ppy). 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.

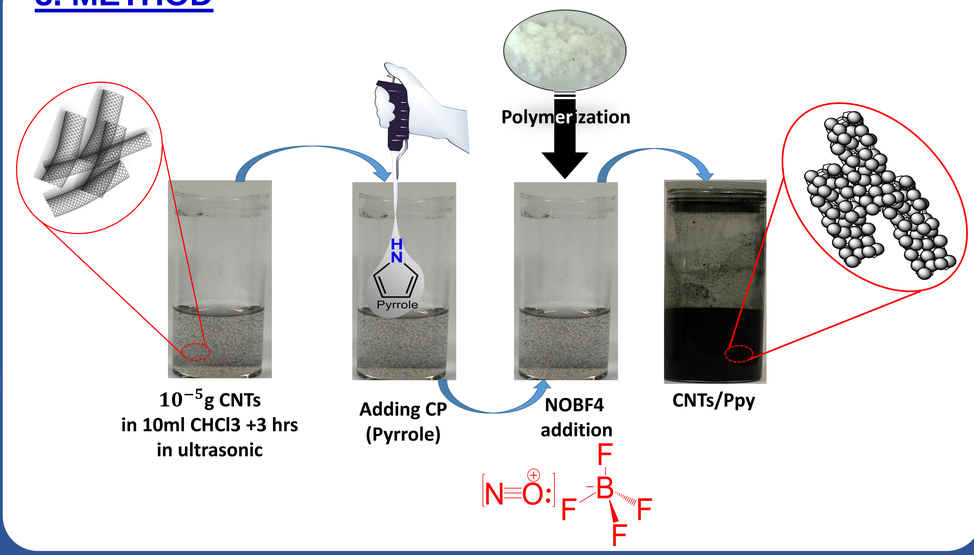


2. AIM

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.

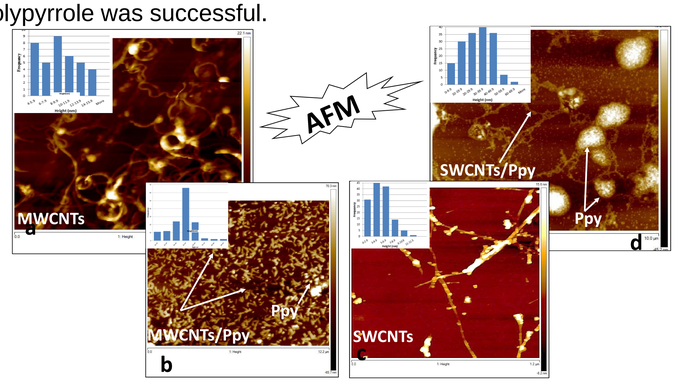


3. METHOD



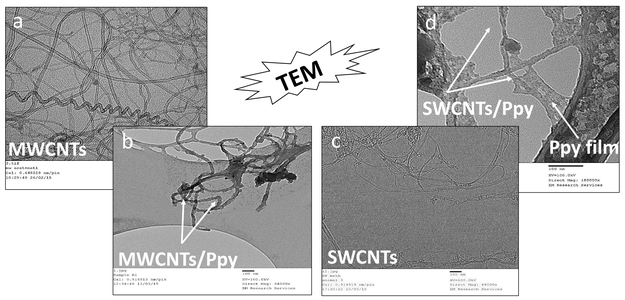
4.RESULTS

3.A. AFM imaging was carried out before and after the CNTs were templated with polypyrrole to investigate if the coating of CNTs by polypyrrole was successful.



AFM height images of (a) MWCNTs, (b) MWCNT/Ppy composite, (c) SWCNTs, (d) SWCNT/Ppy composite.

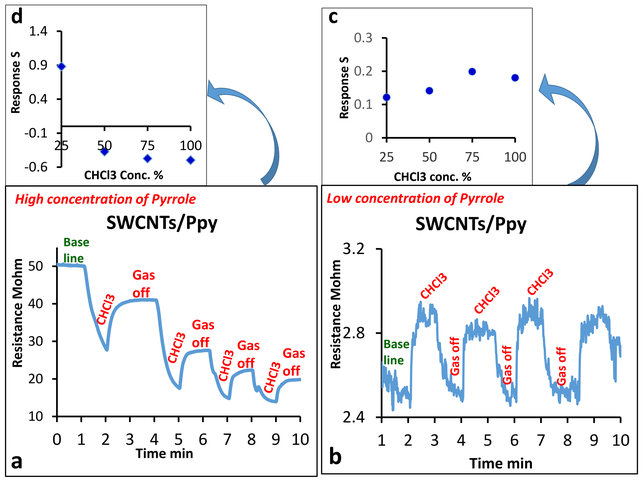
3.B. TEM The morphology of carbon nanotubes and CNTs/Ppy was examined by transmission electron microscopy (TEM). The results show that the multi wall and single wall carbon nanotubes were nanocomposites effectively synthesised using the oxidative polymerization method.



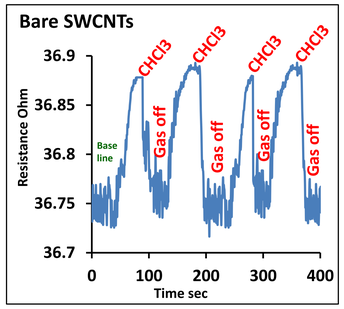
TEM images of (a) multiwall carbon nanotubes before coated by Ppy (Mag 130000x), (b) hybrid MWCNTs (Mag 64000x), (c) bare SWCNTs (Mag64000x), (d) SWCNTs after tamplated by Ppy (Mag1800000x).

3.C. Sensing measurements

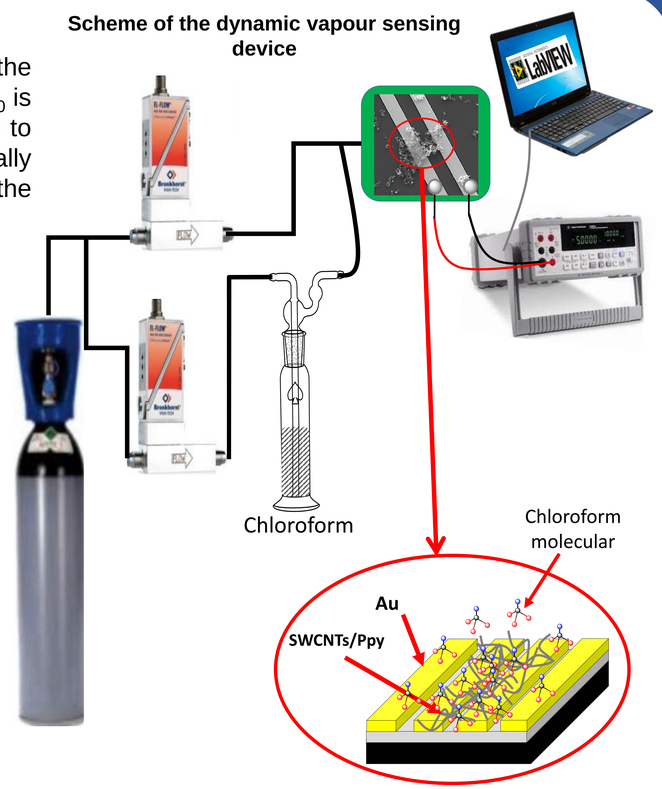
The composites were deposited as films on microband electrodes in order to measure the resistance by a standard DMM. The sensing response is defined as $S = (R-R_0)/R_0$ where R_0 is the resistance in an air atmosphere and R is the resistance at steady-state after exposure to an air/analyte mixture. 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.



(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.



The sensitivity of the electrical resistance R of SWCNTs films to chloroform (0-100)% exposure at 17ºC.



6.CONCLUSIO

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.

7.FUTURE WORKS

Focus on detect more types of organic compounds for instance Methanol, Ethanol and Acetone and compare among them and study the sensing mechanism of the nanocomposite films.

8.REFERENCES

1. 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.