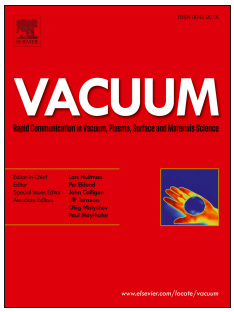
Accepted Manuscript



Spectroscopic and electronic properties of polyallylamine functionalized graphene oxide films

Pooja Saini, Manjri Singh, Surinder P. Singh, Ajit K. Mahapatro

PII: S0042-207X(17)31863-8

DOI: 10.1016/j.vacuum.2018.04.056

Reference: VAC 7961

To appear in: *Vacuum*

Received Date: 15 December 2017

Revised Date: 28 April 2018

Accepted Date: 30 April 2018

Please cite this article as: Saini P, Singh M, Singh SP, Mahapatro AK, Spectroscopic and electronic properties of polyallylamine functionalized graphene oxide films, *Vacuum* (2018), doi: 10.1016/j.vacuum.2018.04.056.

Spectroscopic and electronic properties of polyallylamine functionalized graphene oxide films

Pooja Saini[a†], Manjri Singh[b†], Surinder P. Singh[b]*, and Ajit K. Mahapatro[a]*

[a] *Department of Physics and Astrophysics, University of Delhi, Delhi 110007, India*

[b] *National Physical Laboratory, Dr. K. S. Krishnan Marg, New Delhi 110012, India*

Received ….. ; accepted …..

† Equal Contributions

* Corresponding Authors: E-mail: amahapatro@physics.du.ac.in, and singh.uprm@gmail.com

Abstract

Functionalization of polyallylamine (PAA) on graphene oxide (GO) surface is demonstrated using the optical spectroscopic measurements. The disappearance of C-OH and C-O vibrational modes of GO, and appearance of new N-H peak in the Fourier transform infrared spectra of PAA, indicates the chemical interaction of GO with PAA to form GO-PAA composite. The optical behavior of GO-PAA composite recorded through the UV-Vis absorption and photoluminescence for different optical excitations show individual properties of GO and PAA. The enhanced electrical conductivity through GO-PAA thin film based aluminum (Al)/GO-PAA/indium-tin-oxide (ITO) device structure is attributed to the reduction of GO sheets after functionalization with PAA.

Keywords: Graphene oxide (GO), polyallylamine (PAA), GO-PAA composite

1. Introduction

Surface functionalization of carbon based nanostructured materials with various organic and bio-molecules have attracted much attention of the scientific and industrial research community for designing futuristic electronic, optoelectronic, healthcare and environmental devices. Graphene has been of great interest in recent technological applications because of its 2D structure consisting of single layer sp^2 hybridized carbon atoms. However, functionalization of molecules directly onto the graphene sheet is unrealistic because of the saturated sp^2 carbon bondings. The only possible way to interact organic/bio-molecular entities on graphene sheet is through functional groups in the carbon (C) network of graphene akin to the derivatives of graphene, such as graphene oxide (GO) that has oxygen containing groups which can easily bind with the organic and biomolecular entities.

The capability of broad range bandgap engineering [1] and processability [2-3] of GO in aqueous solutions and organic solvents provide easy processing of GO nanosheets over desired substrates, facilitating ease in fabrication and designing of high-end electronic devices [4-6]. The GO nanosheet consists of epoxide, hydroxyl, and carboxyl functional groups attached to the hexagonally networked carbon basal plane. The control on varying the oxygen containing functional groups renders band gap tailoring and leads to desired optical and electrical properties [1-4]. The presence of these functional groups in GO could act as target binding sites for interaction with other organic, inorganic, and biomolecules, providing an efficient test-bed for various electrochemical, and chemical/bio-sensing applications [1,6,7].

Recently, the hybrid nanostructured materials of GO with polymers have been emerged as new class of nanocomposites with improved sensing properties, and demonstrated improved physio-chemical and sensing properties [2-7]. Polyallylamine (PAA) consists of $–NH_2$ group that could be used to bind biomolecules and other functionalizations. Binding of PAA to GO may impart required physicochemical properties in GO-PAA composites for electronic devices especially for sensing applications.

In this paper, we report synthesis of PAA functionalized GO (GO-PAA) nanocomposite using one pot reaction that allows interaction of diamines in PAA with epoxy groups of GO. The interaction of GO with PAA, and the physical and chemical properties of the newly formed GO-PAA composite are understood by studying the morphological, optical, spectroscopic, thermo gravimetric (TGA) measurements. A small increase in electrical conductivity of GO-PAA thin-films in Al/GO-PAA/ITO structures compared to GO is attributed to the conversion of GO to rGO.

2. Experimental Details

2.1 *Synthesis of GO*

GO in powder form is prepared by modified Hummer's method [8-12]. All reagents i.e. Graphite powders (500 mesh), sodium nitrate ($NaNO_3$), potassium permanganate ($KMnO_4$), sulphuric acid (H_2SO_4), and hydrogen peroxide (H_2O_2; 30%) are procured from Sigma Aldrich, USA, and used as precursors. Graphite powder (2 g) is added to concentrated H_2SO_4 (50 mL) in a 250 mL flask placed in an ice-bath to maintain the temperature at 0°C. Subsequently, $NaNO_3$ (1g) is added slowly in the flask under stirring and the resulting mixture is stirred continuously for 2 h while adding 7.3 g of $KMnO_4$ in small portions to prevent the