

# IN-SITU PREPARATION AND CHARACTERIZATION OF POLYPYRROLE/GRAPHENE NANOCOMPOSITES

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## Introduction

Graphene, monolayer of carbon atoms arranged in a honeycomb network, has recently gained revolutionary aspirations because of its extraordinary electronic, thermal, and mechanical properties [1, 2]. Graphene can be utilized as inorganic filler from the view point of achieving composite materials having improved electrical, thermal and mechanical properties. Several researchers have prepared graphene/polymer nanocomposites by in situ chemical polymerization procedure and accomplished fascinating improvements in electrical properties [3]. However, exploration of graphene as inorganic filler in determining the electrical properties of polypyrrole/graphene nanocomposites has not been addressed till date. Conducting graphene nanosheets, which have been converted from insulating graphite oxide, contain some oxygen-containing groups and in that way facilitating the dispersion of the nanosheets in polar polymers. In the current study, polypyrrole(PPy)/graphene(G) nanocomposites have been prepared via in situ chemical polymerization and the electrically conductive behavior of the resulting nanocomposites has been studied.

## Experimental

### *Preparation of Graphene oxide (GO)*

GO is prepared from natural flake graphite by modified Hummers method [3]. GO thus obtained has been dried under vacuum for 24 hours at 50°C.

### *Preparation of PPy/GO Composites*

Typically, the purified pyrrole (0.2M) has been dissolved in mixture of ethanol and water. GO is dispersed in the resulting solution by ultrasonication for 1 h at room temperature. Another solution of Ferric chloride (0.1M), is poured drop wise to the mixture. Polymerization of pyrrole started

immediately, while the color of the mixture changed into black. The final product is washed with DI water.

### *Preparation of PPy/G Composites*

PPY/GO composite has been heated with hydrazine (1:1) in 50 mL of water at 95°C for 6 h. The reduced composite is then filtered and repetitively washed with DI water to remove excess hydrazine. The final composites are dried at 70°C under vacuum.

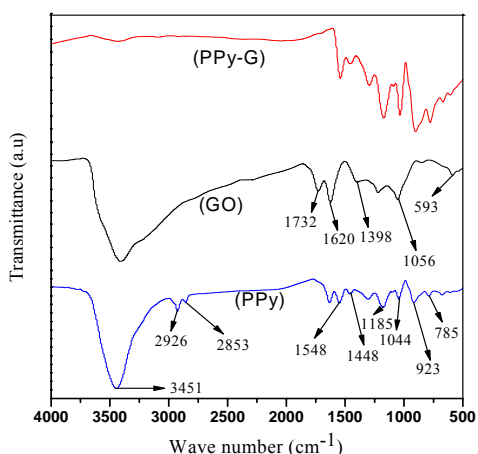
## Results and Discussion

Fig. 1 exhibits the Fourier transform infrared (FTIR) spectra of pure polypyrrole, GO PPy/G composites. Description of the peaks for pure PPy and GO has been shown in table 1.

**Table 1.** Peak description of FTIR spectrum

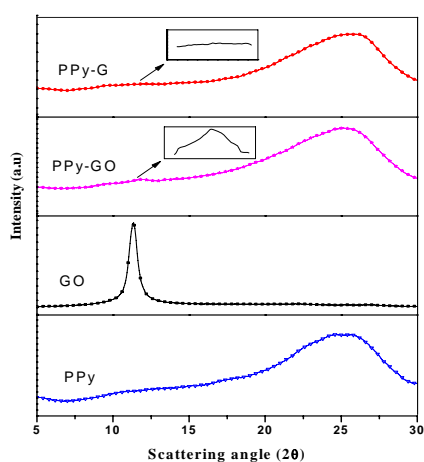
	Peak (cm <sup>-1</sup> )	Peak Description
PPy	3451	N-H stretching
	2926,2853	C-H stretching
	1548,1448	Combination of C-C, C=C, and C-N stretching
	1305,1044	C-H in-plane vibration
	1185, 923	Doping state of PPy
	785, 675	C-H outer bending vibration
GO	1730	-COOH stretching
	1620	Remaining sp <sup>2</sup> character
	1398	-COC stretching
	1056	-COH stretching

However the peak due to -COOH stretching at 1730 cm<sup>-1</sup> has completely disappeared in the FTIR spectrum of PPy/G composites suggesting the reduction of GO to graphene. Furthermore, the intensity of the -OH peak at 3407 cm<sup>-1</sup> has been considerably reduced in PPy/G composites justifying the change in chemical environment after reduction.



**Fig. 1** FTIR of Pure polypyrrole (PPy), graphene oxide (GO), PPY/graphene (PPy/G) composites.

The structure of the composites has been investigated by X-ray diffraction (XRD) measurements. The XRD patterns of pure PPy, GO, PPY/GO and PPy/G has been shown in Fig. 2. Pure PPy exhibits a broad peak at  $2\theta=25.1^\circ$  ( $d=0.35$  nm). GO exhibits a reflection with peak at  $2\theta=11.38^\circ$  ( $d=0.78$  nm), corresponds to (001) reflection peak. The value of interlayer spacing depends upon number of water layers in the gallery space of GO. For PPY/GO composite the peak at  $11.38^\circ$  has shifted to  $11.7^\circ$  ( $d=0.75$  nm) along with a broad peak at  $25.2^\circ$ , corroborating the development of PPY/GO composites. However, it is evident from the XRD pattern of PPy/G composite that the peak at  $11.38^\circ$  (characteristic peak of GO) has been disappeared completely suggesting the reduction of GO.



**Fig. 2** XRD pattern of pure PPy, GO, PPY/GO and PPY/G composites.

The electrical conductivities ( $\sigma$ ) of pure PPy, PPY/GO, and PPY/G composites are determined by using Keithley four-probe resistivity measurement system. Pure exhibits the conductivity of 0.19 S/cm. whereas PPY/GO composite shows an improvement in conductivity (0.51 S/cm) suggesting the  $\pi$ - $\pi$  stacking between polypyrrole and GO layers. After reduction of PPY/GO composite the conductivity of the resultant composite (PPY/G) has increased to 14.28 S/cm which may be due to recovery of the graphene like structure.

## Conclusion

Polypyrrole/graphene nanosheets have been successfully prepared by reduction of in-situ formed PPY/GO composites. XRD study reveals the change in structural pattern of the developed composites. FTIR study justifies the change in chemical atmosphere after reduction. The conductivity of the reduced composite (14.28 S/cm) shows a significant difference from that of PPY/GO composite (0.51 S/cm) reflecting the formation of graphene like structure.

## Acknowledgement

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