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Polyaniline Based Polystyrene Decorated MWCNTs Composites with Improve Electrical Character

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***Abstract*— Multi walled carbon nanotubes (MWCNTs) polymer composites has wide spread applications in various fields. As far as the boost up in electrical properties of the semi conducting polymer is concerned, MWCNTs are the best choice as filler. Polystyrene (PS) decorated MWCNTs (PS-MWCNTs) and simple MWCNTs were used as filler for synthesis of polyanilne (PANI) based polymer composites i.e. PS-MWCNTs/PANI and MWCNTs/PANI, respectively. Decoration of the PS at the surface of MWCNTs have been characterized by UV-Visible spectroscopy. To study the electrical character of the PS-MWCNTs/PANI and MWCNTs/PANI composites, electrical properties were measured through LCR meter. Regarding the study of electrical behavior, conductivity was studied as function of filler. Comparison of conductivity values of MWCNTs/PANI and PS-MWCNTs/PANI as a function of filler concentration encouraged the modification of MWCNTs by PS in order to use MWCNTs as filler for the synthesis of polymer composites.**

***Keywords*— Composites, Conductivity, MWCNTs, PANI, Polystyrene.**

I. INTRODUCTION

There is huge surge of interest in developing and exploring the polymer composites because of their fundamental importance in electronic industry [1-3]. In this field a considerable progress has been made [4]. Lot of research groups aimed synthesis of quality products in this field by changing the main structure of the matrix [5]. Many of the papers have been published on modification of fillers used for the composites synthesis in order to have versatile products [3,6]. For synthesis of such polymer composites, choice of the polymer mainly depend upon the utility of the polymer composites. As far as the use of polymer composites in electronic industry is concerned, both types of polymer, conducting and non conducting, have their importance [3,5]. At various places, polymers are used for the synthesis of polymer composites without modification and after modification [5,6]. Similarly nonconducting polymers are vastly used for synthesis of such materials [7-8]. On the other hand, fillers has vital position in the characteristic of the polymer composites.

Various kind of fillers like ceramics, carbon based materials, and metal in various forms have been used[8-10]. As far as the electrical properties of the polymer composites are concerned, carbon nanotubes and graphene are the potential contender for filler to be used in the polymer composites. Khurram et.al. reported work in which PANI incorporated into poly (vinylidine floride) in the presence of dodcylbenzene sulphonic acid. In that work, electrical and dialectic properties were measured at wide range of temperature and frequencies for composites having varied amount of filler PANI. They found interesting and different dependence of electrical properties on temperature and frequencies for low and high concentration of fillers[5]. Similarly, Tajamal et.al prepared Ag decorated MWCNTs incorporated polyanilne based polymer composites. They found that decoration of Ag at the surface of MWCNTs played an important and effective role in boosting the electrical character of the polymer composite as compared to pristine MWCNTs[3]. Top of all this, a serious problem adhered by the community working in this field is non homogeneous dispersion of filler especially when synthesis of polymer composites with high concentration of filler is targeted.

In the present work, a try was done to get out of this problem. Polystyrene decorated MWCNTs are used as filler for the synthesis of polymer composites. For this study PANI based polymer composites have been prepared. Simple solution mixing technique was used for the synthesis of composites. Synthesis process was monitored through UV-Vis spectroscopy. LCR meter was used to measure the conductivity of the prepared composites.

II. EXPERIMENTAL

A. Chemical and Instruments

Polystyrene, toluene, ammonium per sulphate, multi walled carbon nanotubes were used as purchased without purification. Aniline was distilled before use. UV-Vis spectrophotometer (T90+) of PG Instruments Limited was used to characterize the synthesis of PS-MWCNTs.

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Precision LCR meter (ST2817B) of Sourcetronic was used to measure the conductivity of the synthesized composites.

B. Synthesis of PS decorated MWCNTs (PS-MWCNTs)

Certain amount of MWCNTs was dispersed in the given amount of toluene with help of sonicator at room temperature. To avoid any breakage of MWCNTs, sonication was done only for 30minutes. In other beaker, a solution of PS was prepared in toluene. Amount of the PS was taken equal to the amount of MWCNTs dispersed. Solution of the PS was put into the dispersion of MWCNTs while sonication was continued. After 10mins, solvent got evaporated and solid product was obtained. Characterization of modified MWCNTs by PS was done by UV-Vis spectroscopy.

C. Synthesis of PANI based PS-MWCNTs and MWCNTs composites

By dissolving 5mL of aniline in 100mL of 1M HCl solution, solution of aniline was prepared in round bottom flask. Temperature of the solution was maintained between 0-5^{o}C. During the continuous mechanical stirring, 1.96gm of APS was put in the solution of aniline. Mechanical stirring was continued for 4hrs at temperature between 0-5^{o}C. This reaction mixture was kept at a temperature of around 0^{o}C for 24hrs so that complete polymerization was taken place[11]. At the end green color product was filtered and further process was done for study by LCR meter. Similarly series of composites have been prepared by varying the amount of fillers i.e. PS-MWCNTs. In the same way composites of PANI with simple MWCNTs (MWCNTs/PANI) were also prepared with same range of filler percentage.

III. Result And Discussion

A. UV-Vis spectroscopic study

UV-Vis spectrum of PS-MWCNTs is shown in figure 1. Characteristic absorption peak with maximum intensity is given in the spectrum in the range of 300 to 400 nm. Whereas λ_{max} of PS is normally present at wavelength value of less than 300nm[12]. This major shift in the maximum absorption intensity is due to decoration of PS on MWCNTs . Therefore, UV-Vis spectrometer clearly indicates the decoration of PS on MWCNTs.

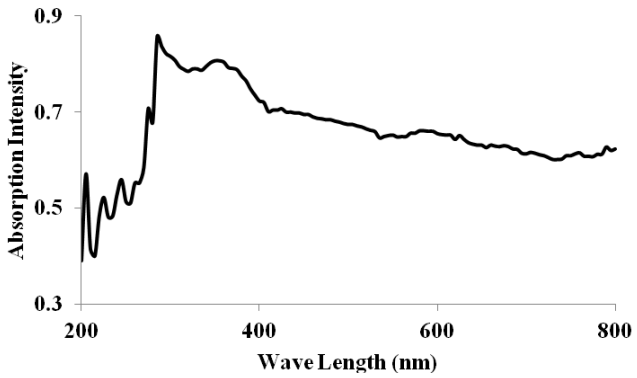

Figure 1 UV-Vis spectrum of PS-MWCNTs

B. Electrical Properties of the Polymer composites

Electrical conductivity of the PS-MWCNTs/PANI was measured for whole series of composites and compared with those of MWCNTs/PANI composites. Results of these conductivity values are shown in figure 2. Conductivity values of the PS-MWCNTs/PANI composites is higher for all the percentage values of the filler as compared to MWCNTs/PANI composites. This difference in the values of the conductivity for MWCNTs/PANI and PS-MWCNTs/PANI composites got increase as the amount of the filler increased. For lower and higher values of concentration of filler over all conductivity of the composites was lower but the difference is more prominent for higher values of filler. This clearly indicates that decoration of PS at the surface of the MWCNTs helped in avoiding the agglomeration at higher concentration of MWCNTs.

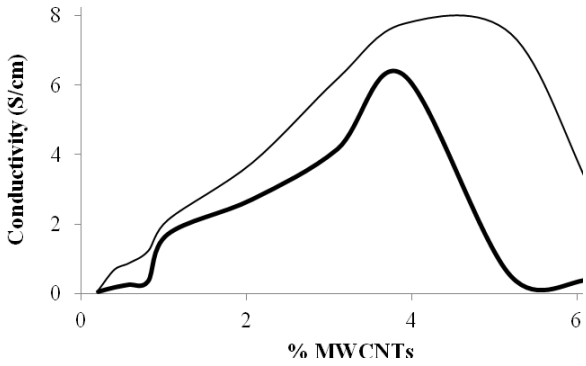

Figure 2 Plot of conductivity of MWCNTs/PANI (thick line) and PS-MWCNTs/PANI (thin line) as a function of percentage of MWCNTs

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Moreover, considerable difference in the values of conductivity for both composites can also been seen in the medium concentration range of filler. Figure 3 shows the relative percentage values of maximum conductivity of PS-MWCNTs/PANI and MWCNTs/PANI. Maximum conductivity value of MWCNTs/PANI composite is 80% of the PS- MWCNTs/PANI composite.

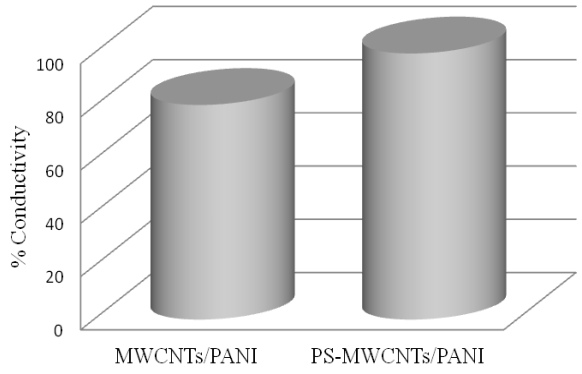

Figure 3 Relative percentage of maximum conductivity of composites

IV. Conclusion

Series of polymer composites of PANI have been prepared. In these series of PANI based composites, PS decorated MWCNTs have been used as filler in order to increase the interaction of filler and matrix. Effective interaction played an important role in complete transfer of characteristics' of filler to the matrix. UV-Vis spectroscopic study clearly indicate the successful synthesis of PS-MWCNTs. Comparison of the conductivity values of PS-MWCNTs/PANI and MWCNTs/PANI composites have been encourages the used of PS-MWCNTs as compared to simple MWCNTs. Maximum conductivity value of MWCNTs/PANI composite is 80% of the PS-MWCNTs/PANI composite. Moreover, effect of decoration of PS at the surface of MWCNTs was more pronounced at higher concentration of filler.

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