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Synthesis and Characterisation of CNT/Metal Nanoparticles/Polymer Nanocomposite

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ABSTRACT

We report the synthesis of Multiwalled Carbon Nanotubes (MWCNTS) incorporated metal nanoparticles of silver and nickel. The MWCNTs were synthesized by chemical vapour deposition (CVD) method. Metal nanoparticles were synthesized by reduction method. Solvent evaporation method is used to prepare composite films. Scanning electron microscopy (SEM), X-ray diffraction analysis (XRD) were used to study the structure and morphology of the composite films.

Keywords: Carbon nanotubes; PVDF; Metal Nanoparticles; XRD; SEM

INTRODUCTION

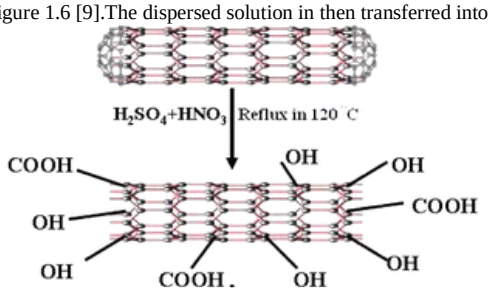
Carbon nanotubes possessing unique physical, chemical, mechanical, and electrical properties are arousing interest both in the academic and industrial areas in terms of their stiffness, high Young's modulus, flexibility, and high electrical conductivity these properties can be attributed to the high degree of organization and high aspect ratio of CNTs [1]. However, owing to the rigidity, chemical inertness, and strong interactions of nanotubes, pure CNTs cannot be processed, as they are difficult to dissolve or disperse in common organic solvents or polymeric matrices. Therefore, the side walls of CNTs must be chemically modified to improve their dispersion or solubility in solvents or polymers [2]. CNT-conducting electro active polymer (CEP) composites are one of the most important, based on their electron donor and acceptor interactions. Many recent efforts have focused on the synthesis of CEPs with metal oxides because of their superior performance. Metal such us Ni, Ag containing nanoparticles have received a great deal of attention due to their unique electrical, catalytic, optical and sensing characteristics as well as their potential use in wide variety of applications ranging from optical and electronic nano devices[3].

In this work we have synthesized hybrid nanocomposites consisting of MWCNTs functionalized with PVDF and Metals (Ag, Ni) nanoparticles.

MATERIALS AND METHODS

In this work MWNTs were prepared by pyrolysis of acetylene over Mm based [Mm-Mischmetal, AB3 alloy hydride catalyst] using thermal CVD technique. The alloy hydrides were obtained through hydrogen decrepitation route. The as-synthesized MWCNTs contain some amorphous carbon and catalytic impurities [4].Uniform silver nanoparticles can be obtained through the reduction of silver ions by sodium borohydride (NaBH4) [5]. Reaction conditions including stirring time and relative quantities of reagents (both the absolute number of moles of each reactant as well as their relative molarities) must be carefully controlled to obtain silver nanoparticles[6].Nickel nanoparticles are prepared by reduction method using Hydrazine hydrate as a reducing agent [7].

Preparation of Functionalized CNT film:
CNTs were opened by 100 mg of MWCNTs were milled and dispersed in 3:1 mixture of H_2SO_4: HNO_3 i.e. 75 ml of H_2SO_4 and 25ml of HNO_3 and sonicate for 10 h in an ultrasonic bath [8].The mixture was subjected to vacuum filtration using a 0.2 Micro pore cellulose nitrate filter that was then washed several times with distilled water until the pH of the filtrate was 7.0. The filtered solid was dried under vacuum for 24 h at 120°C to give MWCNTs functionalized with carboxylic acid (MWCNTs-COOH) as shown in the figure 1.6 [9].The dispersed solution in then transferred into the Petri-dish and dry at 60°C.



Opening the walls of CNTs. (New Nanocomposite containing metal nanoparticles, carbon Nanotube and polymer by Reza Sepahvand)

Preparation of CNT/Ag/PVDF and CNT/Ni/PVDF Composite using the Solvent evaporation method:
There are two ways to prepare composites, 1) just mix the metal nanoparticles with CNT and sonicate, till the nanoparticles gets uniformly dispersed on the CNTs. The above mixture was then mixed to the PVDF and stirred well[10]. Finally the solution should be transferred into the petri-dish and dried it at 60°C for 10 hrs.2) Preparing the CNT nanoparticles i.e. CNTs were mixed with metal precursor and the latter was reduced to metal nanoparticles/CNTs by reducing agents[11].In this work the former method was used to prepare composite films.

RESULTS AND DISCUSSION

The Crystalline nature of CNTs is confirmed by XRD studies. Peaks indexed to (002), (100), (101) reflects hexagonal structure (Fig 1). The presence of 002 peak in the XRD data, suggests multiwalled nature of carbon nanotubes. The X-ray pattern of (Fig 2) showed both the characteristic peaks of CNT and PVDF. The hkl planes of 111, 200, 220, 311, 222 shown in (fig 3) were compared with the standard JCPDFWIN value and hence it is matched with the PDF No: 89-3722 perfectly. Thus the formation of silver nanoparticles is confirmed and it has face centered cubic structure. The fig (4,5) shows the peaks of CNT,PVDF which then confirmed the formation of nanocomposite.

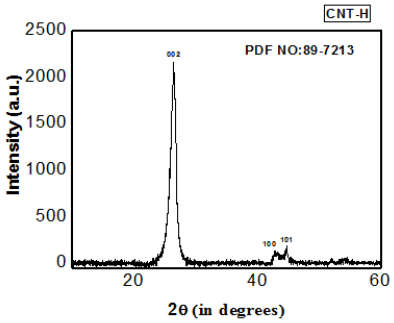


Fig. 1 XRD spectrum for CNT

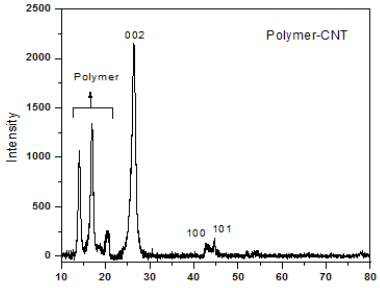


Fig.2 X-ray diffraction pattern of MWCNTs-PVDF composites

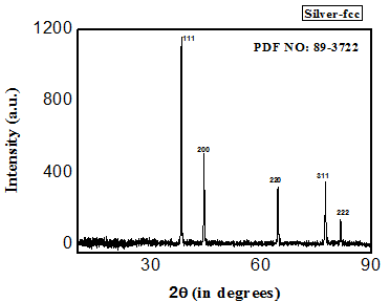


Fig. 3 XRD spectrum for Ag Nanoparticles

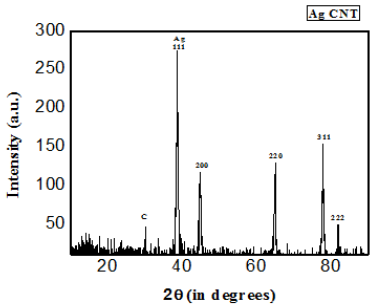


Fig. 4 XRD spectrum for Ag/CNT

The hkl planes of 111, 200 and 220 shown in (fig 6) were compared with the standard JCPDFWIN value and hence it is matched with the PDF No: 870-712 perfectly. Thus the formation of nickel nanoparticles is confirmed and it has face centered cubic structure. The fig (7,8) shows the peaks of CNT,PVDF which then confirmed the formation of nanocomposite.

The SEM images of purified MWCNTs and MWCNT-PVDF composite were shown in fig 9 and 10.From the images we could interpret that the MWCNTs were uniformly dispersed in PVDF matrix.
The SEM micrograph of fig 11 and 12 shows the nicely decorated Ag and Ni nanoparticles on functionalized CNTs. The diameter of Silver and Nickel nanoparticles are found to be 26nm and 17nm.

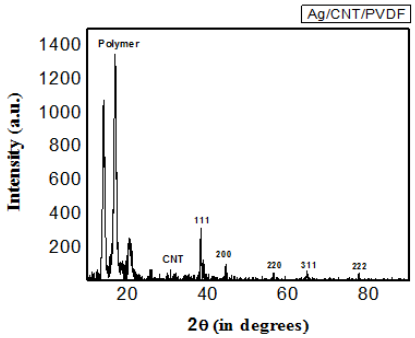


Fig. 5 XRD spectrum for Ag/CNT/PVDF

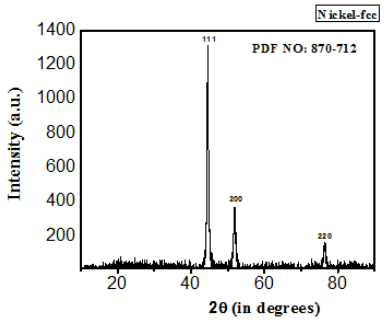


Fig. 6 XRD spectrum for Ni Nanoparticle

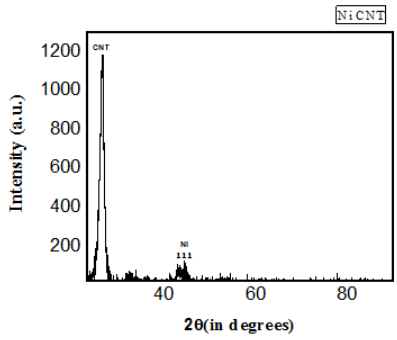


Fig. 7 XRD spectrum for Ni /CNT

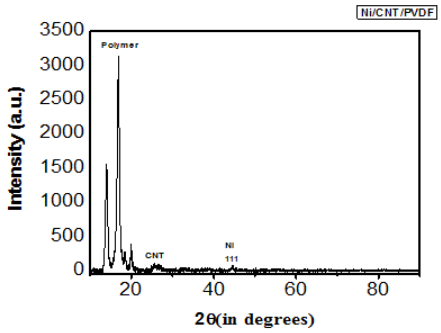


Fig. 8 XRD spectrum for Ni/CNT/PVDF

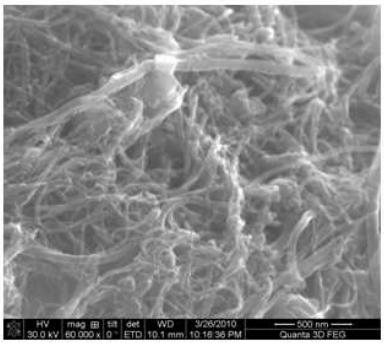


Fig. 9 SEM micrograph for CNT

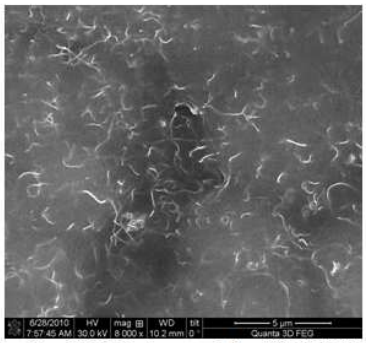


Fig. 10 SEM micrograph for CNT/PVDF

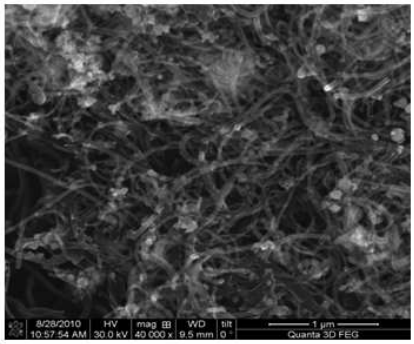


Fig. 11SEM micrograph for Ag/CNT

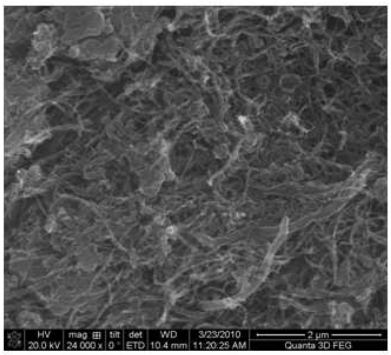


Fig. 12SEM micrograph for Ni/CNT

CONCLUSION

The nanocompositecomprising of Multiwalled Carbon nanotubes, Metal nanoparticles and Pvdf were successfully synthesized by solvent evaporation method.

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