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RESEARCH ARTICLE

SYNTHESIS AND TEMPERATURE DEPENDENT ELECTRICAL CONDUCTIVITY STUDY OF HYBRID MULTIWALL CARBON NANOTUBES WITH METAL NANOPARTICLES

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A R T I C L E I N F O

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A B S T R A C T

We report the electrical studies of nanocomposites of Multiwalled Carbon Nanotubes (MWCNTs), Ag CNT and Ni CNT.The MWCNTs were synthesized by chemical vapour deposition (CVD) method. Solvent evaporation method is used to prepare Ag CNT/ Ni CNT composite films. Scanning electron microscopy (SEM) and X-ray diffraction analysis (XRD) were used to study structure and morphology of the composites. The temperature dependant conductivity measurements and I-V Characteristics for thenanocomposites were taken using fourprobe method.

INTRODUCTION

Carbon nanotubes are single sheets of graphite called as Graphene rolled into cylinders. The diameter of the tubes is typically of nanometre dimensions, while the lengths are typically micrometres. This huge aspect ratio leads to unusual electrical transport. [1]. However, owing to the rigidity, chemical inertness, and strong interactions of nanotubes, pure CNTs cannot be used, as they are difficult to dissolve or disperse in common organic solvents or polymeric matrices. Therefore it has to be chemically modified to improve their dispersion or solubility in solvents or polymers. The CNTcomposites contribute in many fields. Many recent efforts have focused on the synthesis of CNT with metal nanoparticles because of their superior performance [2]. Metal such us Ni, Ag containing nanoparticles have received a great deal of attention due to their unique characteristics.

In this work we have synthesizednanocomposites consisting of MWCNTs incorporated Metals (Ag, Ni) nanoparticles

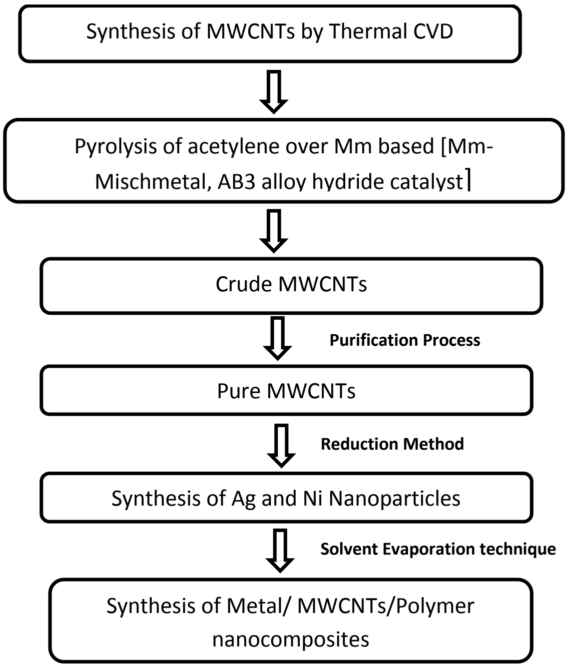
LITERATURE REVIEW

1. **M.S. Dresselhaus, G. Dresselhaus**et al has done a review of the electronic, thermal and mechanical properties of nanotubes with particular reference to properties that differ from those of the bulk counterparts.
2. **KannanBalasubramanian, Marko Burghan**has explained how the chemically functionalised CNTs allow the alteration of electronic structures.
3. **PitamberMahanandia and KarunaKar Nanda**have developed to synthesize aligned arrays of multi-walled carbon nanotubes (MWCNTs) without using any carrier gas in a single-stage furnace which eliminates nearly the entire complex and expensive machinery.
4. **Giselle G. Couto a, Joan J. Kleinb, Widoet al**has synthesised nickel nanoparticles using PVP as a protective agent.
5. **Reza Sepahvandet al**has synthesisedcarbon nanotube grafted by block copolymers containing silver nanoparticles.
6. **Kakarla Raghava Reddyaet al**have reported the synthesis of conducting polyaniline-functionalized multi-walled carbon nanotubes containing noble metal (Au and Ag) nanoparticles composites and this hybrid nocomposite to have numerous applications in nanotechnology, gas sensing, and catalysis.

MATERIALS AND METHODS

The MWNTs were prepared by pyrolysis of acetylene over Mm based [Mm-Mischmetal, AB3 alloy hydride catalyst] using thermal CVD technique [3]. The alloy hydrides were obtained through hydrogen decrepitation route. The as-synthesized MWCNTs contain some amorphous carbonandcatalytic impurities [4]. It has been purified and functionalised by air oxidation and acid treatment.Silver nanoparticles can be synthesised by the reduction of silver ions by sodium borohydride (NaBH4).Nickel nanoparticles are prepared by reduction method using Hydrazine hydrate as a reducing agent [5].

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[6]. 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 [7].In this work the former method was used to prepare composite films.



RESULT 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 hkl planes of 111, 200, 220, 311, 222 shown in (fig 2) 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 facecentered cubic structure. The fig (3) shows the peaks of CNT as well as Ag Nps which then confirmed the formation of nanocomposite.

The hkl planes of 111, 200 and 220 shown in (fig 4) 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 facecentred cubic structure. The fig (5) shows the peaks of CNT and Ni confirms the nanocomposite.

The SEM image of purified MWCNTs were shown in figure 6.The SEM micrograph of fig 7 and 8 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.

The specific electrical conductivity measurements of the compositesprepared from CNT/metal nanoparticles/PVDF were performedusing the well established four probe method.Measurements were performed as a function of temperaturefrom 77 K to 300 K. fig 11 and 12 represents the experimental results ofelectrical resistance as a function oftemperature for CNT/metal nanoparticles composites of 1.5 wt% and fig 13 and 14 shows its I-V characteristics. For comparison, the measurements of CNT without metal nanoparticlesis also shown. The temperature dependant values of resistance for Ag/CNT with 1.5 % is given in table 1. Hence we obseve that the material is showing the negative temperature coefficent (NTC) i.e. the the resistance decreasing on increasing temperature and the corresponding conductance increases.

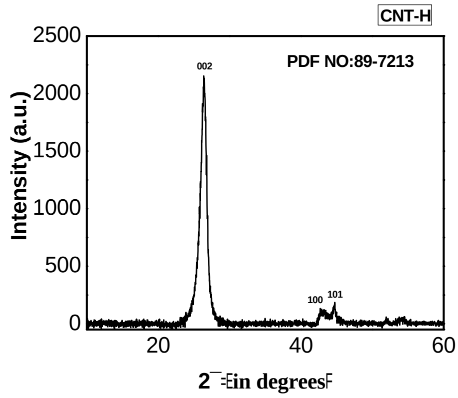


Fig. 1 XRD spectrum for CNT

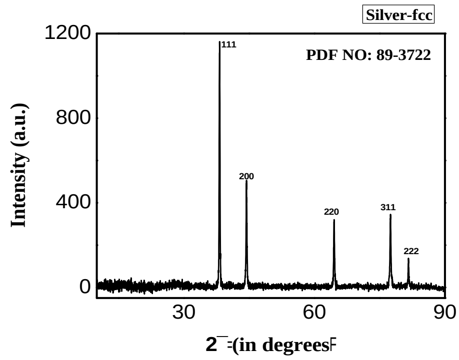


Fig. 2 XRD spectrum for Ag Nanoparticles

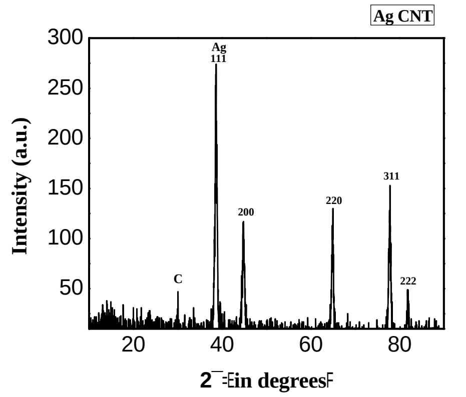


Fig. 3 XRD spectrum for Ag/CNT

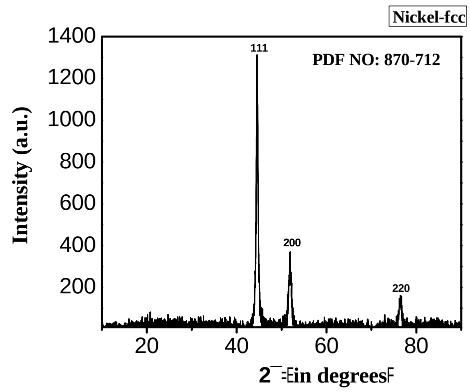


Fig4 XRD spectrum for Ni Nanoparticle

Like wise the temperature dependant variation with resistance of Ni/CNT/PVDF of 1.5 wt% is tabularised in table 2.

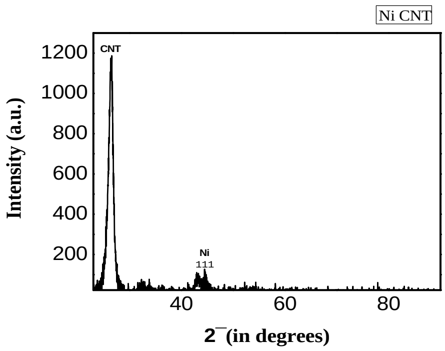


Fig. 5 XRD spectrum for Ni /CNT

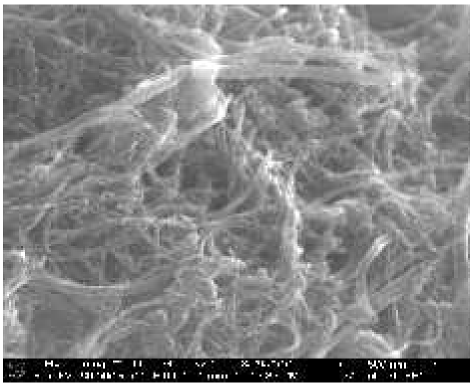


Fig. 6 SEM micrograph for Ag

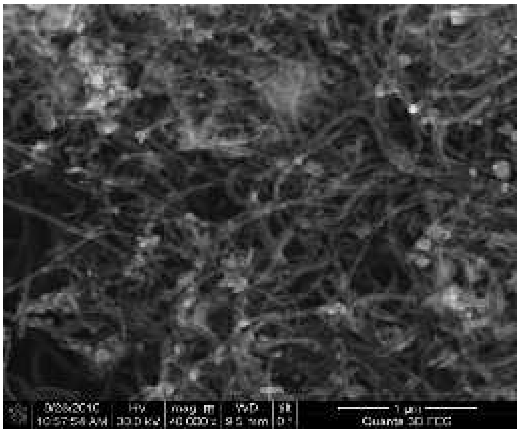


Fig.7 SEM micrograph for Ag/CNT

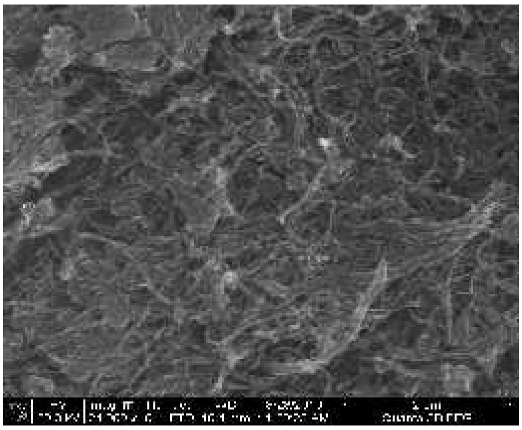


Fig. 8 SEM micrograph for Ni/CNT

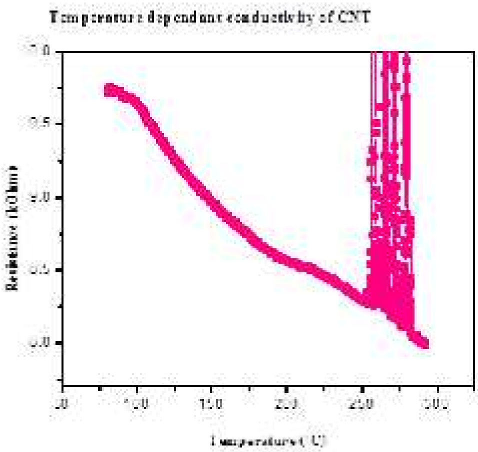


Fig. 9 conductivity measurement of CNT

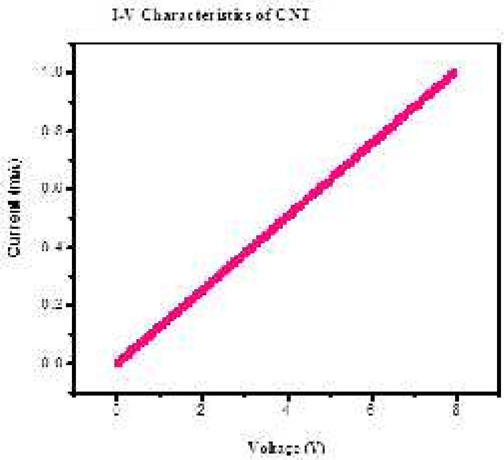


Fig. 10 I-V measurement CNT

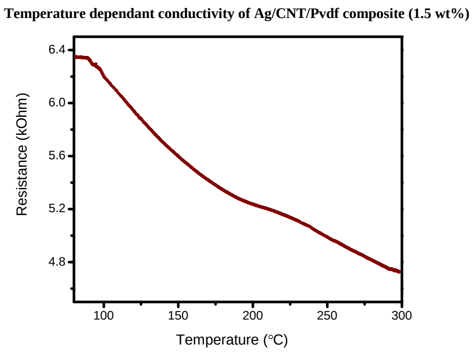


Fig. 11 conductivity measurement of Ag/CNT

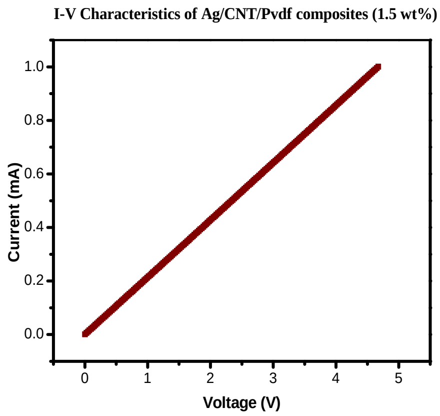


Fig. 12 I-V measurementAg/CNT

Table 1 Variation of Resistance with increasing temperature for Ag/ CNT with 1.5%

Temperature(K)	Resistance(K Ω)
79.5	9.7
157.1	8.8
224.2	8.4
278	8.13

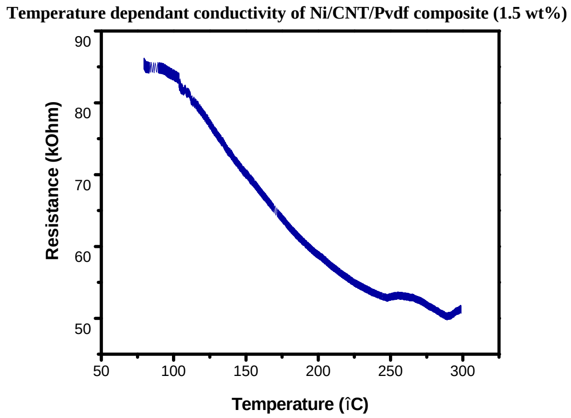


Fig. 13 conductivity measurement of Ni/CNT

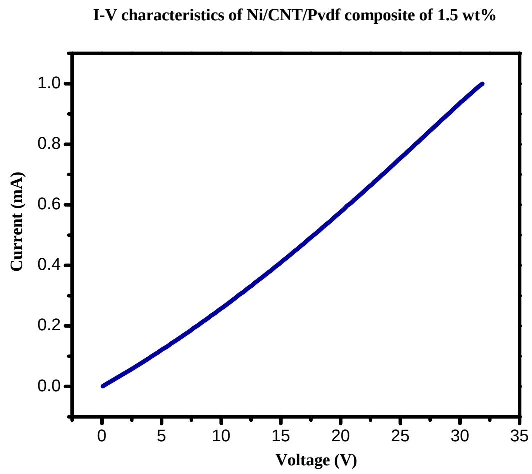


Fig. 14 I-V measurementNi/CNT

Table 2 Variation of Resistance with increasing temperature for Ni/ CNT with 1.5%

Temperature(K)	Resistance(K Ω)
80.7	84.9
151.8	69.7
212.9	56.7
250.7	53.1
298.2	51.3

CONCLUSION

The nanocomposite comprising of Multiwalled Carbon nanotubes, Metal nanoparticles were successfully synthesized and its electrical conductivity measurements were done. It shows the negative temperature coefficent property which then contributes the future work.

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