Asian Journal of Chemistry Vol. 20, No. 5 (2008), 3401-3407

Transport Phenomena on Single Walled Carbon Nanotubes

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One of the most fascinating properties of carbon nanotubes is the predicted interplay between geometrical and electronic structure. The topics include a giant Aharonov-Bohm effect on the band gap and landau-level formation and Hall effect in magnetic fields. Individual large diameter (8 to 15 nm) semi conducting single-walled carbon nanotube is found to exhibit are bipolar field-effect transistor behaviour. The effect of temperature and ultraviolet radiation on their electrical properties is elucidated. We also discuss recent development in contacting nanotubes, which should soon allow study of their intrinsic transport properties. In this research electrical properties and transport phenomena on single-walled carbon nanotubes have studied with measurement of Raman spectroscopy, XRD, ESR, I -V curve, C-V hardness and band gap methods in the UV-Vis area and suitable results obtain from analyses device in the field of electron transport phenomena in carbon nanotubes.

Key Words: Single walled carbon nanotubes, Transport phenomena.

INTRODUCTION

Following the discovery of carbon nanotubes in 1991-1993[1,2] a washed activity has ensued to establish the chemical and physical properties of these novel carbon forms. Raman spectroscopy has proved to be useful in this field. However, the understanding of carbon nanotubes Raman spectra is based on vibration and electronic properties of pure sp^2 and sp^3 hybridized carbon allotropes, of graphite and diamond. Whereas the assignment of the strongest Raman feature to specific vibrational forms has already been much investigation. In addition to Raman spectroscopy, there are a few microscopic methods, which are able to detect and qualify carbon nanotubes selectively. Besides, transmission electron microscopy (TEM) and scanning microscopy (SEM) are widely used to determine the morphology of single-walled carbon nanotubes particles[3,4].

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In this paper, Raman spectroscopy has been used to characterize carbon nanotube samples and measure I-V of one bulk of carbon nanotubes[4].

The electron properties of single-walled carbon nanotubes and band gap related of them has been calculated in UV-Vis area. The value of 1.8 eV suggest that this area located in semiconductors area[5]. ESR method is not used for single-walled carbon nanotubes samples and the reviews represent that the transport phenomena in this type of carbon nanotubes is well and in Raman spectrum sample have been get also review well this transports. From review of represent well transport phenomena property in I-V curve and band gap area.

EXPERIMENTAL

All the common chemicals were on analytical grade and were commercially available. The water used in all experiments was twice distilled with quartz heating tube.

A model Cambridge stereo scan 360 scanning electron microscopy (SEM) of nanotubes. A model Philips FEG 200 kv transmission electron microscope (TEM) was used to take photo of the nanotubes fragments. A model I-V Curve Tracer model: TCT- 2001C, A model hall effect Oxford Instruments-august 1992, A model Raman spectroscopy Almega Dispersive Raman manufactory Thermo Nicolet Made in USA, A model ESR was used.

After growing single-walled carbon nanotubes with chemical vapour deposition (CVD), transmission electron microscopy has been taken and found diameter of tubes are about 1-15 nm. Then, Raman spectroscopy was examined and compared it with other references. It is found that it contained 3-4 peaks and while compared it with graphite Raman spectra, it is found that graphite has only one peak in 1582 cm^{-1} but single-walled carbon nanotubes have two peaks in this region at 1573 and 1537 cm^{-1}. The first one corresponds to D mode and second corresponds to P mode and completely conformed with single-walled carbon nanotube (SWNT). One cylinder bulk of single-walled carbon nanotube were made and measured the I-V with two methods one with electrical circle and change volt of power supply and measure current and then form I-V curve, another with one system that work automatically and give I-V curve, both of them was overlapped and found that these single-walled carbon nanotubes are semiconductors.

Synthesis

Chemical vapour deposition method involves thermal decomposition of hydrocarbons (usually CH_4) at temperatures ranging from 500 to 1000 ºC in the presence of a catalyst containing transition metals such as Fe and Mo. This process, which is more energy efficient than the electric arc-discharge and laser ablation methods, is ideal to generate well-defined structure of nanotube. The yield and structure of nanotubes are affected by the type, purity and porosity of the catalyst. It has been shown that methane CVD process can be used to obtain *ca.* 200 % yield (2 g of SWNTs/g catalyst) of high quality nanotubes. The methane CVD process shows promises for long-scale production of defect free carbon nanotubes.

Carbon nanotubes produced in a typical process are closed ended and are usually associated with other carbonaceous species such as nanoparticles, fullerenes and catalyst.

From C-V study of carbon nanotubes observed reversible state in their electronical performance and transport. This reversible performance adapted completely with study and review of ESR spectrum samples and clearly represent metallic state of single-walled carbon nanotubes.

RESULTS AND DISCUSSION

Single-walled carbon nanotubes provided from CVD and used from them for review of transport phenomena. In SEM (Fig. 1) observed and clearly have seen exist of single-walled carbon nanotubes under 50 nm, since SEM device is in limit of 50 nm then we can not used from it for determine of correct dimension. Fig. 2 shows TEM spectrum sample of single-walled carbon nanotubes suggest that carbon nanotubes have provided in about 8 nm for next studies and reviews.

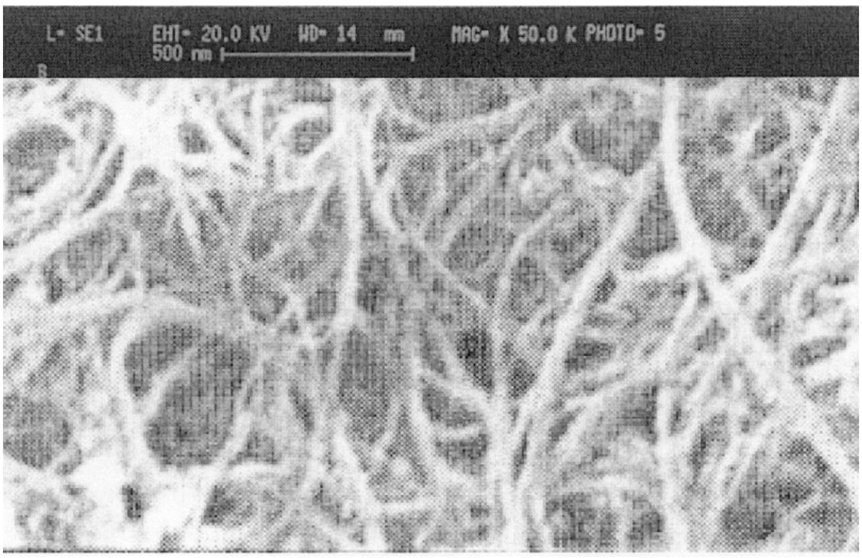

Fig. 1. SEM spectrum of samples

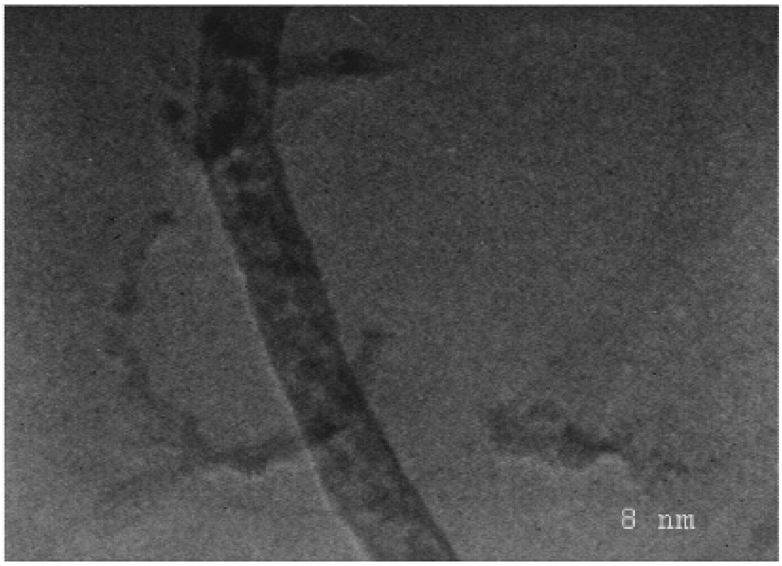

Fig. 2. Transmission electron microscopy (TEM) of samples

Transmission electron microscopy of different samples show that seed scales of catalyst have essential role in status and grow of single-walled carbon nanotubes. Anything seed scales of catalyst from sol-gel way are smaller and about nanometer, provided single-walled carbon nanotube samples will be desirable by scale. In image clearly scale of single-walled carbon nanotubes is about 8 nm. Fig. 3 show I-V curve of carbon nanotubes that determined completely linear relation in I-V curve and this linear show that provided carbon nanotubes are conductor.

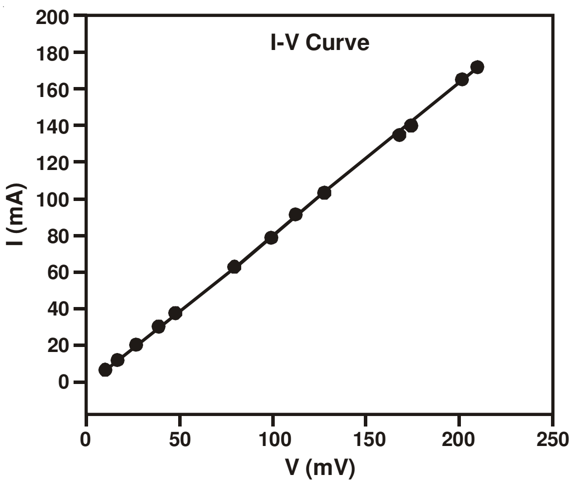

Fig. 3. I-V curve of samples

Fig. 4 show C-V curve of single-walled carbon nanotube samples that curve in -2.0 - 0.09 v area show own completely status of reversibility and show reversibility of system in that area would be a reason for correctness I-V curve.

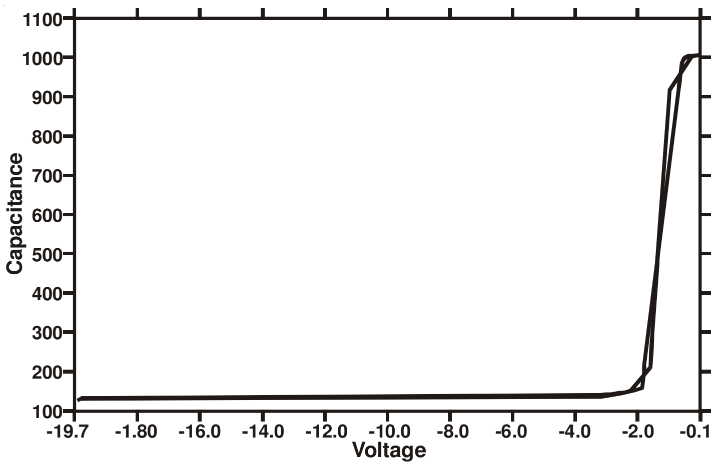

Fig. 4. C-V curve of samples

Fig. 5 shows XRD of nanotubes that curve show carbon nanotubes with seed scales about nanometer.

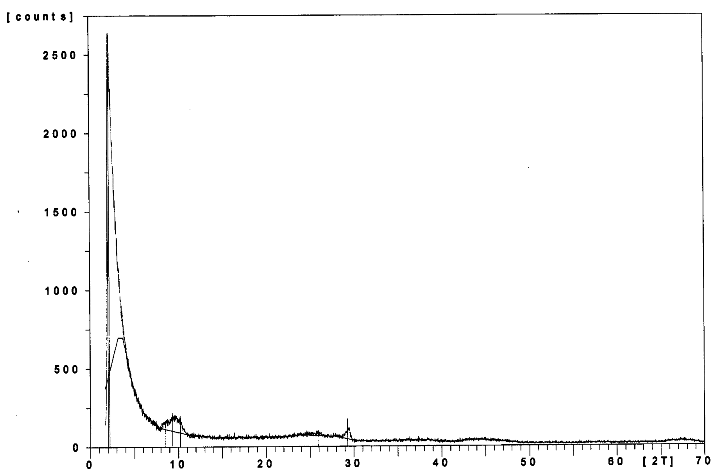

Fig. 5. XRD of samples

Fig. 6 show Raman spectrum of carbon nanotubes which determine curves of type D that first state is related to single-walled carbon nanotubes and next curve is marker of acidic corrosion in surface of carbon nanotubes. This spectrum also show that the spectrum in area above transport phenomena is in expected area. Fig. 7 show ESR spectrum of carbon nanotube samples that can see a composition is metallic and transport of single electron is from lower layer to upper layer.

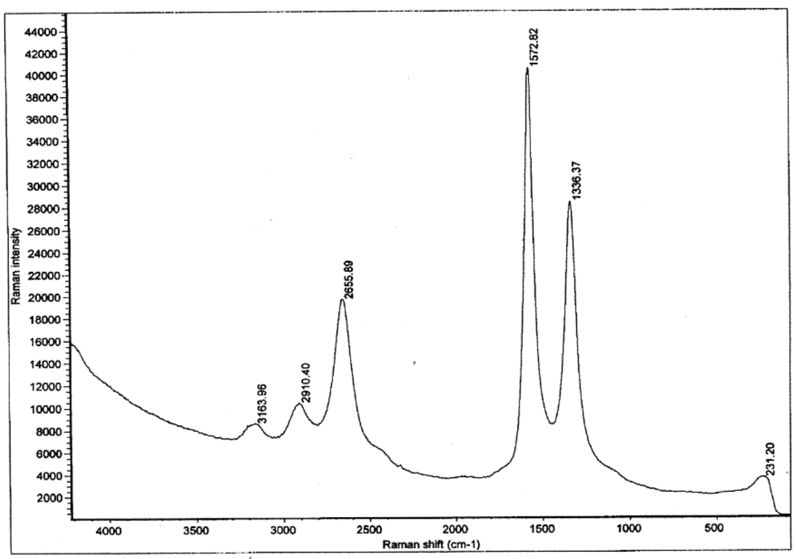

Fig. 6. Raman Spectroscopy of samples

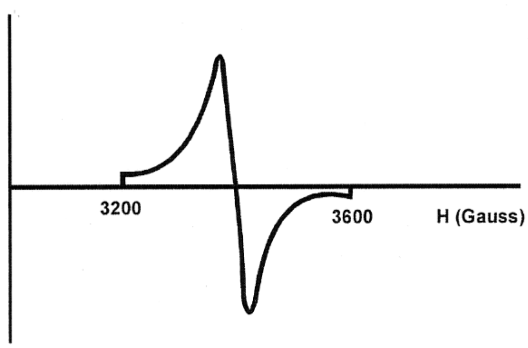

Fig. 7. ESR of samples

The present results from study of hall effect in carbon nanotubes show that these sample located on area of conductor elements and some of them is in semiconductor area and can confirm how nanotubes is provided and related on transport phenomena, according to calculates of hall effect electron movement (mobility) of them locate about 30000.

In general, it is concluded that either single-walled carbon nanotubes is produced or review of transport phenomena show that single-walled carbon nanotubes adapt with transport phenomena.

Conclusion

In this paper, a summary of single walled carbon nanotubes provided and prepared by chemical vapour deposition method in area of 1-15 nm based on sol-gel catalyst. Device studies show desirability of sintered materials and ability applications, In review of provided transport phenomena on single-walled carbon nanotubes studies show that C-V, I-V, Raman, XRD and ESR spectrums, study of Hall effect phenomena, semiconductor and conductivity of provided single-walled carbon nanotubes that can have very well of repeatability, high-level purity of material and development and bring ability of application in most of the industries.

ACKNOWLEDGEMENT

The authors are thankful to the Materials & Energy Research Center for the support of this work.

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(*Received*: 23 March 2007; *Accepted*: 1 February 2008) AJC-6269