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The Study of a factor to the Carbon Nanotubes Film

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Abstract: We do an experiment to prepare the carbon nanotubes. One of the factors affecting the preparation of carbon nanotubes was studied in the article. The experimental results were described by scanning electron microscopy and Raman spectroscopy. The results show that Hydrogen plays important role in the grown of carbon nanotubes and the best Hydrogen Flow of the carbon nanotubes is 30sccm.

Keywords: Carbon nanotube; Preparation; Gas Flow.

1. INTRODUCTION

In 1991, a new type of carbon crystal: carbon nanotubes found CNTs[1] (carbon nanotubes) was found by the Japanese scientist Iijima by observing the arc vaporization of graphite products with high resolution electron microscope. As the structure and properties of singular, it has been attracted worldwide. Therefore, an upsurge of study on CNTs has been seting off. The preparation of carbon nanotubes is more importan.So far, people have studied the preparation process of CNTs, including arc method, laser evaporation method, and chemical vapour deposition method and template method[2]. The equipment and the process of Chemical vapor deposition (CVD) is relatively simple, and the prepared CNTs arranged orderly. Uniform distribution, good orientation, less impurity defects, so the most widely used[3].

In this experiment, the plasma enhanced chemical vapour deposition technology (PECVD), which is developed on the basis of CVD, compared with CVD has obvious advantages:

(1) Plasma contains a large number of highly active chemical groups can significantly reduce the deposition temperature.

(2) Compared with hot CVD technology. The internal self-bias of the plasma deposition of PECVD CNTs thin films of carbon nanotube orientation is good.

(3) Experimental repeatability[4]: In the preparation process of PECVD, the yield and morphology of CNTs were affected seriously by various factors (including catalyst, deposition temperature, reaction gas composition, gas pressure and growth time). r mainly studies The effect of hydrogen flow in the process of preparation of CNTs on the morphology and properties of CNTs respectively were studied by PECVD technology, scanning electron microscopy and Raman spectroscopy were used to characterize the experimental results, and the influence mechanism of in-depth analysis in this article[5].

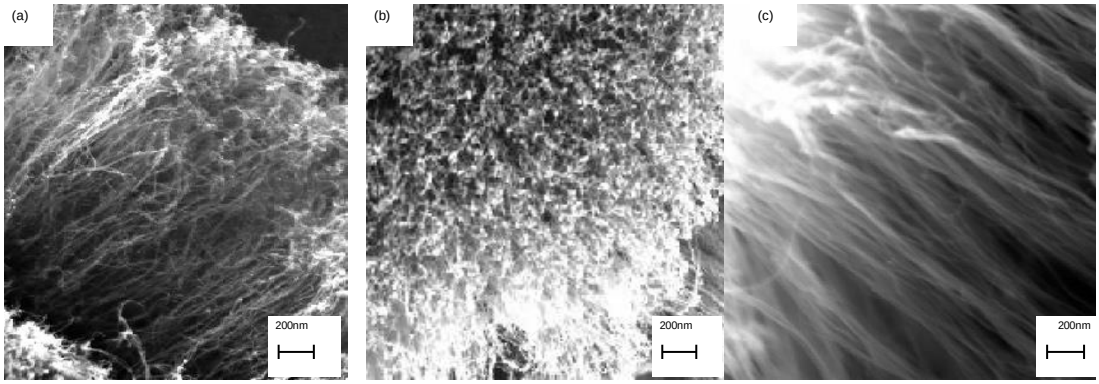
2. EXPERIMENT

Our experimental equipment is the PECVD-450 type plasma enhanced chemical vapor deposition system (the production of China Academy of Sciences Shenyang Scientific Instrument Research Center). C_2H_2 was used as the carbon source gas, and H_2 and n2 were used as auxiliary gas. First, by electron beam evaporation of 10 nm thick thin film deposition on silicon substrate catalyst (Ni in this experiment), cut into small pieces of about 1- 2cm, after loading the ultrasonic cleaning dirt on the surface in the deposition chamber. The vacuum pump group will be pumped into the deposition chamber pressure is 300 PA, and the control of the deposition temperature reaches the set temperature. After entering the H_2 and N_2 of plasma etching the catalyst film. After etching, the reaction gas, deposition of CNTs thin films. Later after the end of the experiment, from the experimental samples. Using scanning electron microscopy and Raman spectroscopy were used to characterize the experimental results.

3. Results and discussion

3.1 Experimental results:

Figure 1 is the characterization results of CNTs films,using SUPRA55 scanning electron microscope produced by Germany Zeiss company (SEM), including 1 (a), (b), (c) is taken from different angles like SEM. They showed clearly that the prepared CNTs distribution uniform vertical arrangement, good orientation and moderate density of.Cnts is about 25 nm in diameter, the length of 3 - 4 μm.

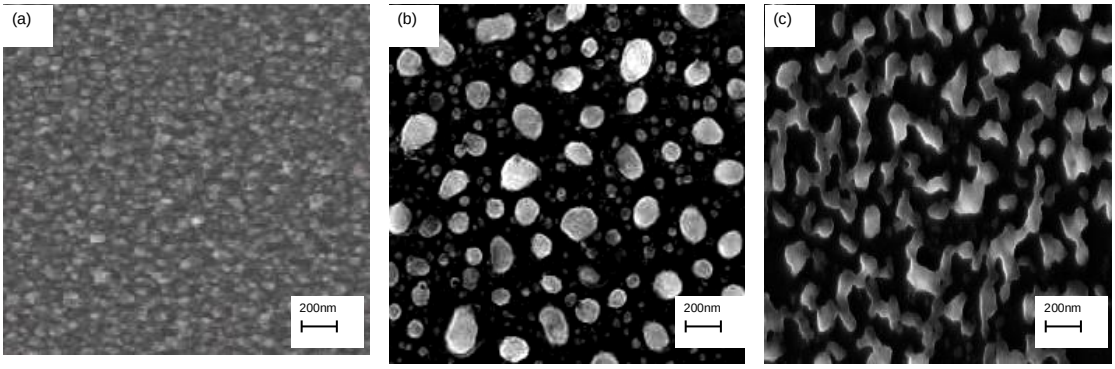


(a) SEM image of the CNTs (b) SEM image of the top view of the CNTs (c) SEM images of the side view of the CNTs

Fig.1: the SEM of CNTs

3.2. Characterization and discussion by SEM:

The pre-treatment of the catalyst is essential to prepare high quality carbon nanotube films, catalyst film is distributed continuously, etching can make continuous film split into particles dispersed. By plasma etching the top or bottom of the catalyst particles to carbon nanotubes, therefore, the pre-treatment process of the catalyst and the catalyst particles strongly influence the morphology of CNTs. Using the SEM figure on the catalyst film characterization results of different flow of hydrogen etching 2 (a) - (c). Obviously, the hydrogen flow rate is small (20 SCCM), the catalyst particle distribution. Especially, conducive to the effective growth of CNTs Catalyst Particles rarely, see Figure 2 (a). The appropriate hydrogen flow rate (30 SCCM), the catalyst particle density decreases and the spacing increases, many smaller size distribution of particles and large particles, as shown in Figure 2 (b). On the contrary, the catalyst is seriously adherent When the gas flow rate is large (40 SCCM), (Figure 2 (c))**.** It is concluded that the catalyst particles with ideal shape and size can be formed when the hydrogen flow rate is appropriate, which is beneficial to the subsequent growth of CNTs[6].



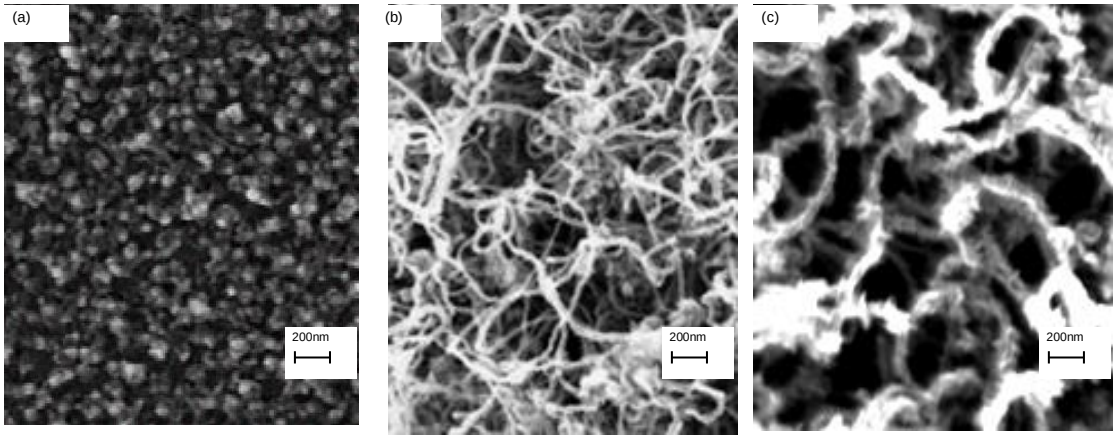
(a).20 sccm (b). 30 sccm (c). 40 sccm

Fig. 2: SEM images of etched at different Hydrogen flow

Figure 3 is a series of CNTs SEM of only changing in the hydrogen flow. **Figure 3 (a),** using 20 SCCM hydrogen, rarely seen in the growth of CNTs, and much more amorphous carbon and other impurities. With the hydrogen flow rate increases to 30 SCCM, obviously see CNTs high yield distribution uniform, less impurities, as shown in **Figure 1 (a - C)** and **3 (b).** When the hydrogen flow rate was continued to increase to 40 SCCM, although a large number of CNTs growth, but CNTs more defects, orientation is not good, the impurity increased, as shown in **Figure 3 (c)** shows.

According to the theoretical analysis, using C_2H_2, H_2 and N_2 as reaction gas layer of CNTs, as auxiliary gas of hydrogen in the growth process of CNTs is very obvious. When the carbon source C_2H_2 by starting the phenomenon, after the formation and decomposition of high frequency waves at this time, there are a large number of carbon atoms, and attached on the surface [7].Catalyst the particles, as shown in Figure 3 (a) shows. In order to slow down the deposition rate of carbon atoms in the surface of the catalyst, pass into the appropriate amount of H_2 (30 SCCM) play a buffering role. The positive effect on the growth of CNTs, reduce the amount of synthesis of amorphous carbon, but also greatly enhance the purity of CNTs growth, the growth of the CNTs tube and clean, with fewer defects and the combined effect of N_2 H_2 increases the etching rate of Ni catalyst layer, the catalyst particle size of Ni decreased, more conducive to the growth of CNTs, as shown in Figure 3 (b) H2. But if the flow is too large (40 SCCM),the more

defect faults in CNTs will be found, because the structure of enhanced plasma treatment on carbon Nano tube wall makes the CNTs wall was destroyed, and began a new growth in the gap appears, as shown in Figure 3 (c) shows the phenomenon. But when the concentration of H_2 increased to a certain amount, etching the role of plasma carbon atoms rarely adsorption on the surface of the catalyst, inhibited the diffusion process of carbon atoms, leading to CNTs growth, so the carbon tube production is reduced.



(a)20 sccm (b) 30 sccm (c) 40 sccm

Fig.3: SEM images of CNTs deposited at different Hydrogen flow

3.3. Characterization and discussion by Raman:

The preparation of CNTs features is two Raman peaks were located at near 1580 near cm-1 and 1350 cm-1 (Figure 4) by using plasma enhanced chemical vapor deposition technology.It shows that the experimental preparation is multi walled carbon nanotubes. Through the test sample analysis shows that,

1. The most samples have D peak at 1620 cm^{-1} was prepared in this experiment shows that the system is aligned multi walled carbon nanotubes.
2. The preparation of carbon nanotubes D peak and G peak intensity ratio of different relative strength and the vast majority of carbon nanotubes D peak height is greater than the peak height of.D peak and G peak (I_D/I_G) can reflect the relative strength of the degree of disorder and the defect density of diffent experimental conditions[8].

Samples by D peak calculation in **Figure 4** samples 1,2,3 curve and G peak (I_D/I_G), was $(I_D/I_G)_2 < (I_D/I_G)_3 < (I_D/I_G)_1$, H_2 of 30 SCCM system the preparation of carbon nanotubes without When the H_2 flow rate is 40 SCCM, the carbon nanotubes have the highest degree of disorder or the most defects, and these results are consistent with the SEM observations[9].

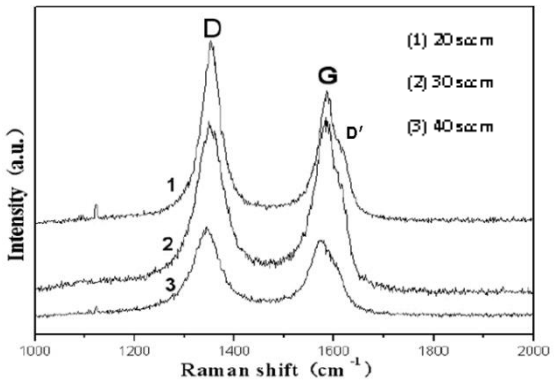


Fig 4: Raman images of CNTs deposited at different Hydrogen

4. CONCLUSION

The aligned carbon nanotube was successfully prepared by PECVD-450 type plasma enhanced chemical vapour systrem, and using the SUPRA55 scanning electron microscopy and Raman spectroscopy of CNTs thin films were investigated. The results show that the carbon nanotubes of uniform, neat, proper density have been prepared with hydrogen flow rate of 30 SCCM,and carbon nanotube has little impurity and defect.

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