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Coating Carbon Nanotubes with Europium Oxide

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Abstract: Carbon nanotubes (CNTS) coating with europium oxide by a simple method is reported in this letter for the first time. The CNTS were refluxed in a solution of nitric acid containing europium nitrate, and the pH value was subsequently ajusted with ammonia solution. At last, the mixture was filtered and annealed. The TEM micrograph showed that the CNTS were covered with a uniform thin layer with thickness of about 15 nm. The XRD results revealed that the CNTS were coated with europium oxide.

Keywords: Coating, carbon nanotubes, europium oxide.

Since CNTS were discovered, they have attracted a great deal of interests for their unique structures and exceptional properties, and have been predicted for many potential applications in various fields of material research[1,2]. In recent years, more and more researchers have focused on the coating of CNTS, because coating CNTS exhibit better physical and chemical properties and will lead to an even more diverse range of applications[3-5]. Unfortunately, the surface of a nanotube is often not ideal for coating, and therefore the nanotube has to be treated before coating. Previous reports referred that boilling the CNTS with oxidizing acids is an effective way for coating CNTS with CeO_2, while the CNTS were dispersed into nitric acid and heated at 500°C for 2h in air, they were found that only few CeO_2 particles absorbed on CNTS[6]. In this letter, the CNTS were covered with a uniform layer of Eu_2O_3. On the other hand, the use of ammonia solution could avoid the positive ion impurities to enter the system. Such a CNTS have the potential applications in the field of emission display materials and luminescent materials. At the same time, europium oxide nanowires may be prepared by using CNTS as removable templates[7]. Y_2O_3: Eu and other rare earth metal oxides could be used in this method.

Coating CNTS were prepared as follows: CNTS were produced by catalysis and dissociation of hydrocarbon compounds as original material at high temperature. The average diameter of CNTS was found to be about 20 nm by TEM. The CNTS were suspended in a solution of concentrate nitric acid containing europium nitrate and

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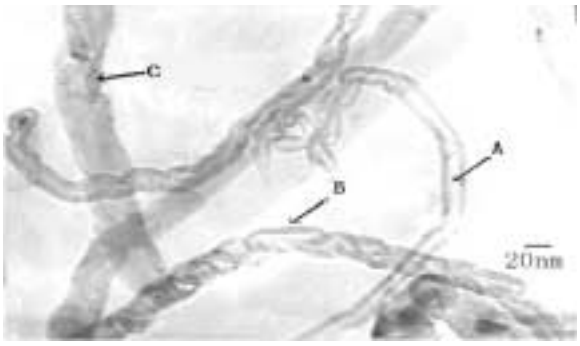
refluxed for 4.5 hours[5]. When the mixture was cooled to room temperture, the ammonia solution with a concentration of 2.5wt% was added dropwise until the pH value reached 9[7]. Then the mixture was filtered and annealed in a stream of N_2 at 700°C for 2 hours. After the sample was washed with distilled water, the solvent was removed and the samples were dried at 100°C for 5 hours.

Figure 1 TEM micrograph of a group of empty CNTS



The micrograph of TEM in **Figure 1** shown a group of empty CNTS. The diameter of the CNTS was 20~40 nm. A was a single CNT with a light center. The light region was hollow cavity and the dark region was about one third of the tube diameter, this showed that the nanotube wall was about 6 nm. B indicated a few of CNTS winding up each other, and some tubes are overlapped as shown by C. It was noticed that both of the outer and inner surfaces of CNTS do not have the additional surface layers.

The TEM micrograph of samples in **Figure 2** revealed that the CNTS were covered with a uniform thin layer. The whole nanotube surfaces were surrounded by the coating layer. The diameter of coating CNTS was about 60 nm. Because the diameters of the original CNTS were not equal; we thought the thickness of the thin layer was about 15 nm.

Figure 2 The TEM micrograph of CNTS coating with europium oxide

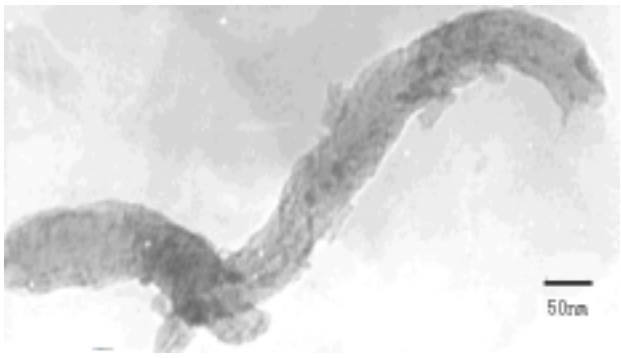
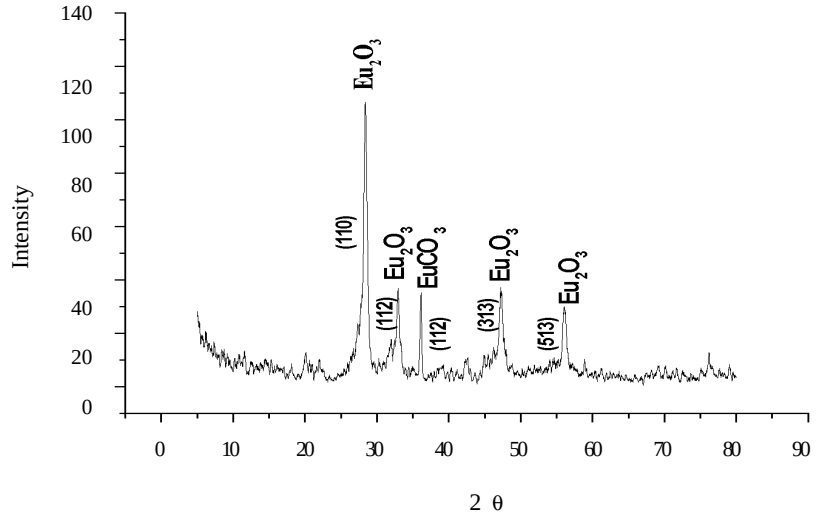


Figure 3 presented the X-ray diffraction (XRD) pattern of coated nanotubes. The

characteristic peaks arising from europium oxide in the X-ray spectrum are in agreement

Figure 3 The X-ray diffraction pattern of coated CNTS



with JCPDS (34-72). The value of d is 3.14, 1.92, 2.72, 1.64 respectively. So the solid layer coating CNTS was mainly Eu_2O_3. At the same time we have detected a peak with a value of 2.48, revealing that the existence of $EuCO_3$. The crystal of $EuCO_3$ possibly was formed in the process of the treatments.

In conclusion, the CNTS were coated by a simple method. The TEM micrograph of CNTS showed that CNTS were covered with a thin uniform layer. The XRD result revealed that the material of coating was europium oxide. The thickness of the thin layer was about 15 nm.

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