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Abstract
Since the discovery of carbon nanotubes, carbon nanotubes (CNTs) have attracted intensive interest in nanotechnology due to their unique properties, such as high Young modulus, high tensile strength, and high field emission efficiency at low turn-on voltage. Many potential applications use their unique properties, ex. Field emission display (FED). Methods for the synthesis of CNTs include arc-discharge, laser vaporization, thermal chemical vapor deposition (CVD), plasma enhance chemical vapor deposition (PECVD) and electron cyclotron resonance CVD (ECR-CVD). In consideration of the advantages of high dissociation percentage of the precursor gases and high uniformity of plasma energy distribution, the ECR-CVD is adopted for this study.
The purpose of this work is to find out the optimized process parameters concerning the yield, the morphology and microstructure of CNTs. In the course of experiment, different parameters such as microwave power, growth time, the position of substrate, mixed gases ratio, process pressure and carry gases were varied. The main carbon feedstocks were methane and propane. According to research of predecessors, it has been found that CNTs grown at low temperature is possible. Under the optimized condition, we have succeeded in synthesizing carbon nanotubes at low temperature. However, the carbon nanotubes grown at high temperature (500℃) are better than at low temperature (unheated substrate). At low temperature, large number of carbon compounds include carbon ball, carbon slice, carbon membrane and carbon fiber were also found in the films. Besides, the structure and yield of carbon nanotubes grown with methane are better than with propane.
In the instrument analyses, the morphology and microstructure of carbon nanotubes were observed by the scanning electron microscopy (SEM) and by transmission electron microscopy (TEM). From the analysis of TEM, CNTs exhibit the multi-wall character, of that inter-wall distance is 0.34 nm. The inner and outer diameters are about 15 nm and 50 nm, respectively. The average diameter is estimated to be 30~50 nm for CNTs grown on the 3-nm-thick. Under the optimized condition, the deposition rate is 240 nm / min.
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