

# The Synthesis of Carbon Nanotubes on Silicon Nanowires by Thermal Chemical Vapor Deposition

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## ABSTRACT

In this work, thermal chemical vapor deposition was utilized to grow carbon nanotubes (CNTs) on Si nanowires. CH<sub>4</sub> was the main source for carbon, and argon was used as the carrier gas. CNTs were synthesized from carbon atoms obtained from catalytic thermal decomposition of silane. In this research, we study the effect of catalyst metal thickness and deposition temperature and different catalyst on structural properties and field emission characteristics of carbon nanotubes (CNTs) which were synthesized by thermal chemical vapor deposition of methane.

Raman spectroscopy and SEM、TEM、EDS were employed to study structural properties of CNTs, whereas field-emission characteristics of CNTs were measured in high vacuum. From SEM and Raman spectroscopic studies, it is found that as catalyst nickel thickness gets thicker, the size of nickel balls formed in the nucleation period gets larger. Hence, the number of CNTs gets smaller, and the diameters of synthesized CNTs get larger. It is suspected that the supplied thermal energy at low temperatures is not high enough to activate catalytic reaction to synthesize CNTs. At high temperatures, thermal energy supplied has already cross the threshold for nucleation, and the diameter of CNT reach a saturation value.

From Fowler-Nordheim tunneling analysis, it was found that the increase in nickel thickness indeed increases the work function of CNT. Hence, we arrive at the conclusion that the decrease in the number of CNT, the decrease in the field enhancement factor, and the increase in the work function of CNT are three main factors that causes the decrease in the field emission current for larger nickel metal thickness. It is found that this change in field emission current is caused not only by the change in number and diameter of CNTs, but also by the change in crystalline structure and work function of CNTs. The increase in the work function of CNTs make it difficult for electrons to emit from CNTs which can play an important role in the emission current.

Keywords : carbon nanotubes (CNTs)、field emission、thermal chemical vapor deposition (thermal CVD)、silicon nanowires

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