

## **Water - Assisted Efficient Growth of Multi-walled Carbon Nanotubes by Thermal Chemical Vapor Deposition**

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**Abstract** : Vertically aligned arrays of multi-walled carbon nanotube (MWCNT) on layered Si substrates have been synthesized by water-assisted thermal chemical vapor deposition (CVD). We studied changes in growth by parameters of growth temperature, growth time, rates of gas and annealing time of catalyst. Also, We grew CNTs by adding a little amount of water vapor to enhance the growth of CNTs.  $H_2$ , Ar, and  $C_2H_2$  were used as carrier gas and feedstock, respectively. Before growth, Fe served as catalyst, underneath which Al were coated as an underlayer and a diffusion barrier, respectively, on the Si substrate. The water vapor had a greater effect on the growth of CNTs on a smaller thickness of catalyst. When the water vapor was introduced, the growth of CNTs was enhanced than without water. CNTs grew 1.29 mm for 10 min long by adding the water vapor, while CNTs were 0.73 mm long without water vapor for the same period of time. CNTs grew up to 1.97 mm for 30 min prior to growth termination under adding water vapor. As-grown CNTs were characterized by using scanning electron microscopy (SEM), high resolution transmission electron microscopy (HRTEM), and Raman spectroscopy.

**Key Words** : Super growth, Water, Thermal CVD, Carbon nanotubes