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Recent progress on the growth mechanism and structure control of vertically aligned SWNT arrays by alcohol CVD

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Vertically aligned single-walled carbon nanotube (SWNT) arrays[1], which we first synthesized by alcohol catalytic CVD (ACCVD), provide a good platform to study the growth process and mechanism of SWNTs since all the nanotubes in an array have almost the same length and orientation. It becomes more convenient after passing a laser through the quartz substrate to obtain real-time, in situ monitoring of the film thickness.[2] The exponential growth decay and influences of growth parameters on the growth behavior have been recently reported.[3]
In this study, we introduce different molecules into the CVD chamber during the growth stage of vertically aligned SWNT arrays. Abrupt changes in growth rate can be directly observed following such changes to the growth environment. For example, when 5 sccm acetylene was introduced into a growth initiated by 500 sccm of ethanol, this 1% of acetylene was able to accelerate the growth rate of SWNT arrays by 10 times. This convenient technique not only allows us to qualitatively understand the influences and activities of different molecules, but also reveal some hidden species in ACCVD (formed by thermal decomposition of ethanol) which are also contributing to SWNT formation. With the analysis of the gas composition during a CVD, we get a clearer picture of the real carbon sources (not always alcohol) in ACCVD. Moreover, the ratio of SWNTs synthesized from alcohol versus decomposed molecules is found to be critical for the quality of the produced SWNTs. Clean SWNTs are only obtained when alcohol is the most abundant carbon precursor, as clearly shown from transmission electron microscope (TEM) observations.

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