

Toward Chiral-Control Growth of Carbon Nanotubes: Achievements and Challenges

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Carbon nanotubes continue to surprise with unprecedented applications [1-3]. Yet, the lack of homogeneous single walled carbon nanotube (SWNT) product became a major obstacle that hinders their broad application. The main challenge remains the knowledge of carbon nanotube formation mechanism, which despite two decades of extensive efforts is not fully understood yet. The origin of this challenge is related to the broad diversity of energetically close nanotube structures that can be transformed from one to each other by small structural perturbation. In this regard, understanding the very early stage of nucleation when the chirality is set becomes a crucial event in nanotube growth. The catalyst particle plays key role [4], especially taking into account the possible epitaxial relationship between catalyst facet structure and grown carbon nanotube chirality. Recent successes on selective growth of SWNTs by tuning of catalyst particle morphology [5] partially support this hypothesis. In the meantime in the course of *in situ* environmental scanning/transmission electron microscope studies we observe that carbon cap nucleation and following lift off from catalyst surface were accompanied by the remarkable reconstruction of catalyst surface structures [6] via step motion mechanism. This fact makes controllable growth even more challenging. The thermodynamics and kinetics of various nucleation mechanisms of carbon nanotubes on metal clusters and their implications for the controllable growth will be discussed.

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