Chirality selective synthesis of single-walled carbon nanotubes with sputtered Co-W catalyst and its possible mechanism

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The excellent electrical properties have made single-walled carbon nanotubes (SWNTs) one of the most of promising building blocks for future electronics and optics. However, the potential industrial applications are impeded by the mixed chiralities of as-grown SWNT assemblies. Direct synthesis of SWNTs with single chirality is challenging but always attracts considerable attention. Recently, Co_7W_6 clusters were reported to structurally match and thus successfully growing a single chirality SWNT (12, 6), with over 90% and a zigzag SWNT (16, 0), with near 80%, by controlling the catalyst structure and growth conditions with a high-temperature reduction and growth [1, 2].

In this report, we show that (12, 6) can be selectively grown at lower temperatures and with better spatial uniformity by using a sputtered bimetallic Co-W in alcohol catalytic chemical vapor deposition [3]. The enrichment of (12, 6) is 50-70% according to the statistical Raman mapping analysis and optical absorption spectrum. Reduction temperature before growth is found to be critical for the selectivity. At high reduction-temperatures, selective area electron diffraction identified an intermediate structure of Co_6W_6C, which is associated with the selectivity [4]. The details of catalyst structure, and time-dependent selectivity from 10 s to normally 5 min will be discussed.

[1] F. Yang et al., Nature **510**, 522 (2014).
[2] F. Yang et al., J. Am. Chem. Soc. **137**, 8688 (2015).
[3] S. Maruyama et al., Chem. Phys. Lett. **360**, 229 (2002).
[4] H. An et al., Nanoscale, (2016), in press, doi: 10.1039/C6NR02749K

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