Chirality-specific growth of single-walled carbon nanotubes on solid alloy catalysts

Single-walled carbon nanotubes (SWNTs) have shown great potentials in various fields attributing to their unique structure-dependent properties, therefore, the structure-controlled preparation of SWNTs is a crucial issue for their advanced applications (e.g. carbon-based nanoelectronics) and has been a great challenge for about two decades. To fully utilize the outstanding performance of SWNTs, it is preferred to control the structure of SWNTs during growth rather than in post-synthesis treatments. However, up to date, the direct synthesis of SWNT samples with a single dominating chirality > 60% have never been realized. Here we report a strategy to produce SWNTs with specific chirality, i. e. using a new family of catalysts, tungsten-based bimetallic alloy nanoparticles of non-cubic symmetry, which have high melting points and consequently are able to maintain their crystal structure during the chemical vapor deposition (CVD) process, to regulate the chirality of the grown SWNTs. The (12,6) SWNTs are directly synthesized at an abundance of > 92% by using W-Co catalysts. Experimental evidence and theoretical simulation reveal that the (0 0 12) planes of W_6Co_7 nanocrystals extremely match the structure of (12,6) SWNTs, therefore facilitate the preferential growth of (12,6) tubes. Employing alloy nanocrystals with unique structure as catalysts paves a way for the ultimate chirality control in SWNT growth and thus may promote the development in SWNT applications.