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Large Negative Thermal Expansion of an Individual Carbon Nanotube[1] J. ZHANG, L. JI, J. ZUO, Univ. of Illinois — It is of fundamental value to understand the thermo-mechanical properties of individual carbon nanotubes (CNTs). The coefficient of thermal expansion (CTE) of CNTs has been a subject of considerable debate in the literature with more recent works predicting thermal contraction. Because of the small size, experimental measurement of individual CNTs is very difficult; So far only limited data was reported by X-ray diffraction that measured the average CTE of many tubes. Here, we use nanoarea electron diffraction to measure the CTE of an individual Multi-walled carbon nanotube (MWCNT) and correlate the CTE with the tube atomic structure. All the 4 walls of this individual MWCNT show apparent radial diameter thermal contraction from 297 to 827k, and thermal expansion from 827 to 1027k. The radial CTE has strong diameter dependence between 297 and 827k; It changes from (-6.48±0.46) E-5 (1/K) for the wall with the theoretical diameter 16.4 A to (-2.37±0.77) E-5 (1/K) for the wall with the theoretical diameter 37.3 A, which means smaller diameter wall contracts more. On the other hand, all the 4 walls of this individual MWCNT show apparent axial thermal contraction from 297 to 1073k. The axial CTE is independent of the diameter, and the average axial CTE for different walls is (-1.30±0.07) E-5 (1/K).

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