

Pairs of gap states in a semiconducting carbon nanotube

S. Lee^{*,***}, G. Kim^{*}, H. Kim^{*}, B.-Y. Choi^{*}, J. Ihm^{*}, Y. Kuk^{*}, S. Kahng^{**} and K. H. Chung^{***}

^{*}서울대학교 물리학과, ^{**}고려대학교 물리학과, ^{***}한국표준과학연구원 진공기술센터

We studied the local electronic structures of semiconducting single wall carbon nanotubes with scanning tunneling microscopy. Several paired, localized gap states were observed in semiconducting single-wall carbon nanotubes using position-resolved scanning tunneling spectroscopy. A pair of gap states is found far from the band edges, forming deep levels, while the other pair is located near the band edges, forming shallow levels. With the help of a first-principles study, the former is explained by a vacancy-atom complex while the latter is explained by a pentagon-heptagon structure. Our experimental observation indicates that the presence of the gap states provides a means to perform local band-gap engineering as well as doping without impurity substitution.