

[SS-10]

Atomic-scale electron spectroscopy of carbon nanotubes

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Single wall carbon nanotubes are either metallic or semiconducting, depending on their atomic structures. We have studied atomic and electronic structures of various nanotubes with low temperature scanning tunneling microscopy and scanning tunneling spectroscopy. We found that atomic defects, junction structures, and encapsulated molecules strongly modify the electronic structures as well as geometrical structures of nanotubes. We obtained bias-dependent images of modified structures. We were able to correlate bias-dependent behavior with measured local electronic spectra. We measured position dependent electronic states, as we move a tip along the nanotubes axes. Measured electronic structures will be discussed with the help of theoretical calculations.