11th International Conference on Advanced Materials

ICAM2009

Rio de Janeiro Brazil
September 20 - 25

Raman spectroscopy of carbon nanotube serpentines

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Abstract – Carbon nanotube organization into well-defined structures is important for their integration into functional devices. Recently, combined surface- and flow-directed growth enables the controlled formation of carbon nanotube serpentines. In this work we study these carbon nanotube serpentines using Raman spectroscopy. The tangential G band and the double-resonance G' band are observed to change in frequency and lineshape along the same serpentine formed by one specific (n,m) nanotube, as evidenced by one single RBM mode frequency observed along the whole serpentine. We look for dependences of the Raman bands in the tube-substrate interactions.

Carbon nanotube organization into well-defined structures is important for their integration into functional devices. Recently, combined surface- and flow-directed growth enables the controlled formation of carbon nanotube serpentines [1]. The carbon nanotubes are grown on top of a miscut quartz using ferritin catalyst nanoparticles. The growth is performed by catalytic chemical vapor deposition (CVD). Each serpentine (Fig. 1) consisted of a series of straight, parallel and regularly-spaced segments, connected by alternating U-turns. The serpentines propagated in the direction of the gas flow, which was perpendicular to the steps.

In this work we study single wall carbon nanotube-substrate interaction. To study this interaction we have used the carbon nanotube serpentines, which are well-defined and modulated SWNT-substrate system, using Raman spectroscopy. We have imaged the G band intensity of different serpentines using confocal Raman microscopy excited with a He-Ne (632.8 nm) laser (Fig. 1). In these serpentines, we have observed the Raman spectra for the RBM, G and G' bands and their laser polarization dependence. The tangential G band and the double-resonance G´ band are observed to change in frequency and lineshape along the same serpentine formed by one specific (n,m) nanotube, as evidenced by one single RBM mode frequency observed along the whole serpentine. In one case, the position and intensity of the G and G' bands change consistently, the G and the G' peaks shifting together to higher frequencies. In other case, the G band Raman spectra are different, clearly related to the morphology we have probed, i.e. flat vs. curved segments. We look for dependences of the Raman bands in the tube-substrate interactions.

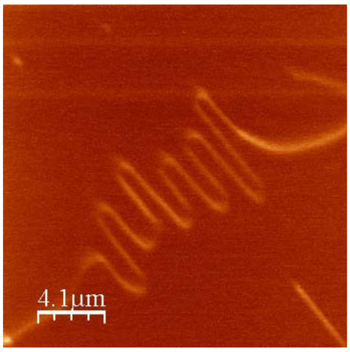

Figure 1: Confocal image of a nanotube serpentine on miscut quartz using laser wavelength λ_{laser} = 632.8 nm (E_{laser} = 1.96 eV). The image is confocal Raman measurements of the G band integrated intensity.

Reference

[1] Geblinger, A. Ismach and E Joselevich, Nature Nanotechnology 3, 195 – 200 (2008).