Combining Electron Diffraction and Resonant Raman spectroscopy for index-assignment and study of few-layered carbon nanotubes

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The essential prerequisite for any basic or applied research in the field of carbon nanotubes (CNTs) is the knowledge of their structural parameters. So far, several distinct methods for the structure analysis of CNTs have been established, which are based on High-Resolution Transmission Electronic Microscopy, Electron Diffraction, Photoluminescence, Rayleigh spectroscopy, Optical absorption, or Resonant Raman spectroscopy. Every method has its advantages and limitations. The limitations are especially evident when index-assigning complex structures such as large few-layered (e.g. double- or triple-walled) CNTs.

In this talk we first present a short review of the structural analysis of nanotubes by different techniques and then show how their combined use can significantly improve (n,m) index-assignments of complex few-layered nanotubes. On the other hand, we applied the combination of Electron diffraction and Resonant Raman spectroscopy for the probing of individual double-walled and triple-walled carbon nanotubes and were able to unambiguously investigate their intrinsic phonon and optical properties. Here we demonstrate that the experimental results can only be understood in a coherent way by considering mechanical and electronic couplings between concentric layers of the few-layered CNTs. These couplings affect frequencies and conditions of observation of the radial breathing-like modes and G-modes in the Raman spectra.

The results emphasize the importance of combining different techniques on individual few-layered carbon nanotubes for the detailed understanding of their intrinsic properties.

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