Some new information from the inside of single wall carbon nanotubes

H. Kuzmany[1], R. Pfeiffer[1], P. Knoll[1,2], M. Holzweber[1], T. Pichler[3], H. Kataura[4]

[1] Inst. für Materialphysik, Universität Wien, A
[2] Inst. Für Experimentalphysik, Universität Graz, A
[3] IFW Dresden, D
[4] Tokyo Metropolitan University, JP

The inside of carbon cages has been attracting the interest of scientists ever since the discovery of endohedral fullerenes. This interest was dramatically enhanced when the possibility to fill single wall carbon nanotubes (SWCNT) with fullerenes was discovered. The best way to get information from the inside of the tubes is to study properties of encaged species. We have recently used resonance Raman spectroscopy to study C_{60} fullerenes and reaction products of the fullerenes inside of the nanotubes. More than 20 different laser lines were used for the excitation of the spectra in order to record the modulation of the tubes and their resonance profiles. The analysis Raman response from the C_{60} peas and from the nanotube pods is demonstrated to reveal the concentration of the filling. Furthermore, the C_{60} molecules are subjected to a total symmetry breaking as they accept the site symmetry of the center of the SWCNT. Finally, a splitting of the totally symmetric modes of the C_{60} molecules is observed. This is demonstrated in Fig. 1 on the left side column. The splitting is traced back to the motion of the C_{60} molecules in the tubes.

Heating the peapods for several hours to temperatures as high as 1500 K causes a rearrangement of the carbon atoms from the C_{60} molecule to a new tube inside the original tube. Again this process of the transition from the C_{60} molecules to the inside tube was analyzed by studying the characteristic Raman modes of the encaged molecule and of the tube. Finally some quite unexpected details of the response from the inner tubes will be discussed.

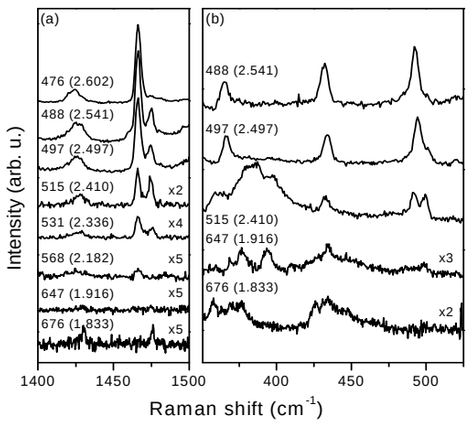

Fig. 1. (a) Tangential part and (b) radial part of the Raman spectrum of C_{60} peapods excited with different lasers. One can see the splitting of the two totally symmetric A_g modes.