Raman Spectra of Single Walled Carbon Nanotubes between 300 and 800 K

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In carbon nanotubes the experimental determination of Raman spectra is one of the most used tool for their characterization and the temperature-induced changes in the stronger bands of the spectra have been widely studied [1,2]. However, the temperature dependence of some weaker features is missing [3]. On the other hand, the results of Raman spectroscopy can be employed to provide the temperature dependence of other properties such as the diameters, the thermal expansion, the Young modulus, among others, of the carbon nanotubes.

In the present work, we have carried out an experimental study of the temperature dependence of the Raman signatures of a commercial sample of single walled carbon nanotubes (SWCNTs). We have used a confocal microscope spectrophotometer (BWTEK Voyage™ BWS435-532SY) with a laser excitation at 532 nm. Measurements were taken between 300 and 800 K with a high temperature stage system (Linkam TS1500 with a T95 system controller).

We have studied the temperature-dependence of Raman shift of the main signatures: radial breathing modes (RBMs), D, G, M, 2D and 2G bands. In spite RBMs are the most common way to estimate the SWCNTs diameter, their temperature dependence cannot directly be used to obtain the temperature change of the diameters. The reason is that the variation of the RBMs is not only due to the diameter variations, but to other factors too [4]. In this work, the frequency difference between the tangential modes G^+ and G^-, related with the C-C vibration on circumferential direction and the C-C vibration on the nanotube direction, respectively, has been used to obtain a reliable estimation of the temperature dependence of diameter of the nanotubes [5]. Finally, our results have been employed to determine other properties, as those above mentioned.

References

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Figures

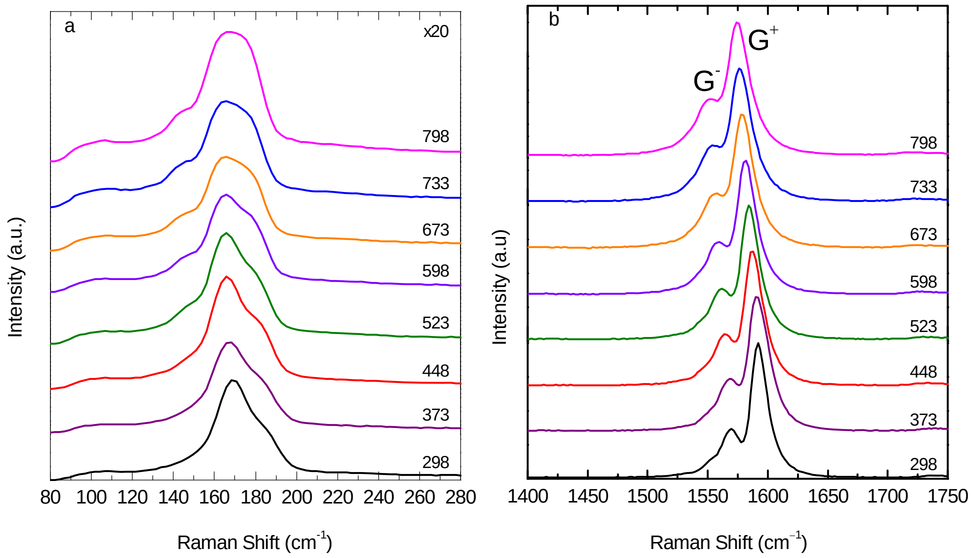

Figure1. (a) Raman spectra of SWCNTs in the region between 80 and 280 cm^{-1} between room temperature to 798 K. (b) Raman spectra of SWCNTs in the region between 1400 and 1750 cm^{-1} between room temperature to 798 K.

Figure 2. Confocal micro-Raman spectrometer and high temperature stage system (Linkam TS1500 with a T95 system controller) used for the experiments.