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Study of doped carbon nanotubes by Raman spectroscopy

I. O. Maciel[(1)*], Neil Anderson[(2)], J. Campos-Delgado[(3)], L. Novotny[(2)], M. Terrones[(3)], A. M. Rao[(4)], A. Jorio[(1,5)]

(1) Departamento de Física, Universidade Federal de Minas Gerais, Belo Horizonte, MG, 31270-901 Brazil.
(2) Institute of Optics and Department of Physics, University of Rochester, New York 14627, USA.
(3) Advanced Materials Department, IPICYT, San Luis Potosí, SLP, 78216, Mexico.
(4) Department of Physics and Astronomy and Center for Optical Materials Science and Engineering Technologies, Clemson University, Clemson, South Carolina 29621, USA.
(5) Divisão de Metrologia de Materiais, Instituto Nacional de Metrologia, Normalização e Qualidade Industrial (INMETRO), Duque de Caxias, RJ, 25250-020, Brazil.
* indhiramaciel@gmail.com

Abstract - Raman spectroscopy is a straightforward technique, that requires no sample preparation, no special environmental conditions and it doesn't destroy the samples. In this work we study doped SWNTs doped with boron, which is an electron acceptor to nanotubes, and phosphorous and nitrogen, which are electron donors to nanotubes, by using this technique. We find that the Raman spectroscopy opens possibilities of detecting very small doping concentrations and understand better the dopants in SWNTS.

Carbon nanotubes are interesting systems to develop basic science, since they are stable systems and can be computationally studied easily as they have only carbon atoms in its structure. Besides, nanotubes have varied technological applications, from their use in large scale, to produce special compounds, from small scale uses, as scanning probe microscopy tips [1]. Bus as nanoscopic systems, they are very sensitive to the environmental conditions. It is important then, to understand the changes in their physical and chemical properties due to doping molecules from air, surfactants in solutions, etc. The use of Raman spectroscopy to study doped single-wall carbon nanotubes (SWNTs) is found to be a very powerful route since it is able to detect very small amounts of dopants. In this work we study boron doped SWNTs grown by laser ablation [2], and nitrogen and phosphorous doped SWNTs grown by chemical vapor deposition [3]. Boron is and electron acceptor to nanotubes while phosphorous and nitrogen are electron donors. This *p*- or *n*-type behavior can be easily distinguished by the study of the G´ band, which comes from a second order process involving two phonons in the sp^2 carbon materials. In our work we find that, when there is a *n*-type doping, there is an extra peak in the G´ feature in smaller frequencies and when there is a *p*-type doping, the extra peak appears in higher frequencies as compared to the pristine G´ band (see Figure 1). We study the G´ band in the doped carbon nanotubes cited above and explain this two-peak feature as coming from the renormalization of the energies of the electrons and the phonons near charged defects in the SWNT network. We also find that the G´ band can be used to compare the degree of charge localization in the defective sites [4]. We also discuss diameter distribution changes due to doping and thermal dissipation of bundled doped SWNTs.

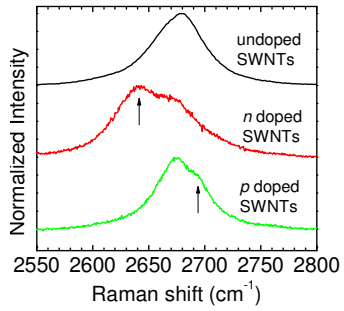

Figure 1 – G´ band for undoped, *n*-doped and *p*-doped SWNTs.

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