Lambda Solutions, Inc. LSI Dimension Raman Systems
Now, You Have the Power

A COMPLETE SOLUTION FOR CARBON NANOTUBE ANALYSIS

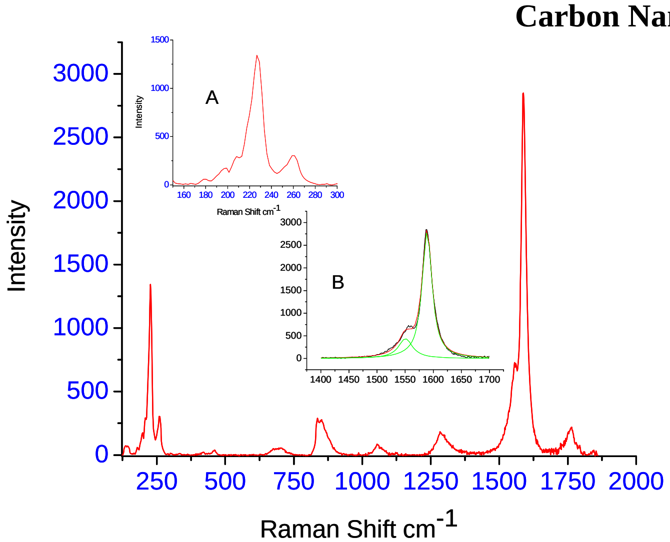
Introduction: Raman spectroscopy reveals the structural and electronic properties of single-walled, and multi-walled carbon nanotubes. For CNT's the structural elements of diameter, chirality and phonon structure, are the foundation of mechanical/electrical properties, i.e., tensile strength and metallic or semi-conductive capacity. The key first and second order Raman frequencies are: the radial breathing mode (RBM) from 150-350 cm^{-1} that reflects both tube diameters and is indicative of single versus multiwalled structures; the G mode (1565-1595 cm^{-1}) represents carbon-carbon stretching in the graphene plane; the G-mode is diameter-sensitive in multiwalls and the nature of its complex structure in SWCNT's is an indicator of conductive properties (1).The G-mode in multiwalls has a substructure that causes an overall broadening of the G-mode peak that reflects changes in tube diameter distribution. The ability to obtain clear data on D, G, D' and G' in multiwalls peaks permits structural analysis of tube variability as well as tube diameters , both necessary for correlation with MWCNT function and defect density (2).

In this application note we demonstrate the versatility of the LSI Dimension-P2 Raman system and its high performance sampling accessories to meet the most demanding applications while providing extraordinary value.

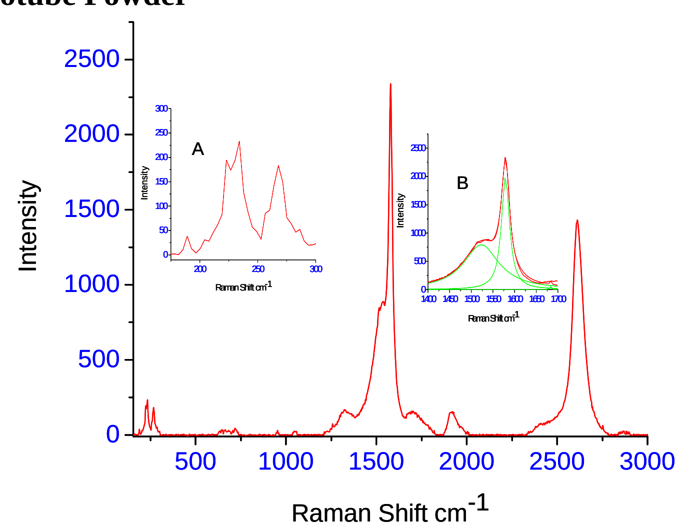
Samples & Methods: Raman spectroscopy was carried out with a Lambda Solutions, Inc.(LSI) Dimension-P2 Raman Spectrometers. The systems used were the LSI Dimension-P2-HR-785 Raman spectrometer (124 to 1900 cm^{-1}); data collected at 532nm used an LSI Dimension-P2-532 (155 to 3000 cm^{-1}). All systems were equipped with LSI Raman Vector Probe (200 micron spot size) and LSI XYZ Probe Mount for precise focal positioning. Spectra were auto-efficiency and baseline corrected with LSI RamanSoft data acquisition and processing functions. The samples examined were SWCNT powders (Nano-C Norwood MA), composite films (Nanocomp Technologies), coated Si wafers and MWCNT "forests" kindly provided by Dr. John Hart of The Department of Mechanical Engineering, University of Michigan.

Results

Carbon Nanotube Powder

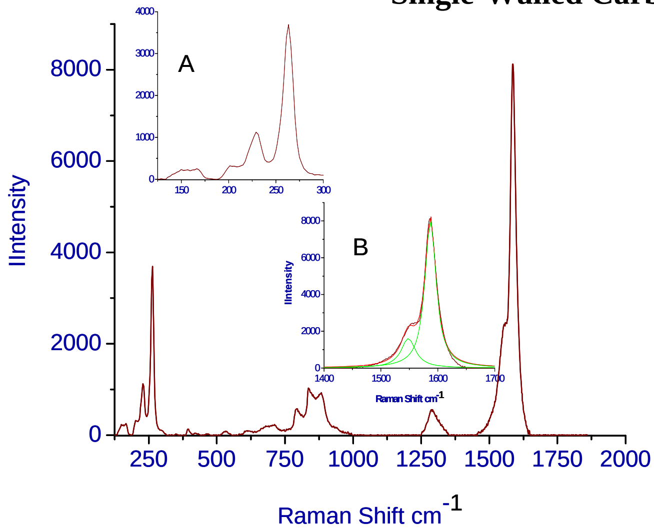


Raman Spectrum using Dimension-P2 785-HR. Insert A, RBM region; Insert B, G-Mode region with Lorentzian deconvolution

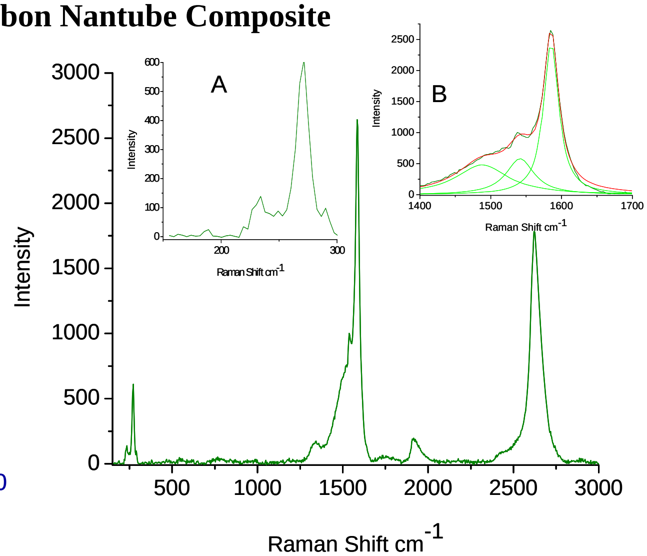


Raman Spectrum using Dimension-P2 532-SR. Insert A, RBM region; Insert B, G-Mode region. with Lorentzian deconvolution

Single-Walled Carbon Nantube Composite

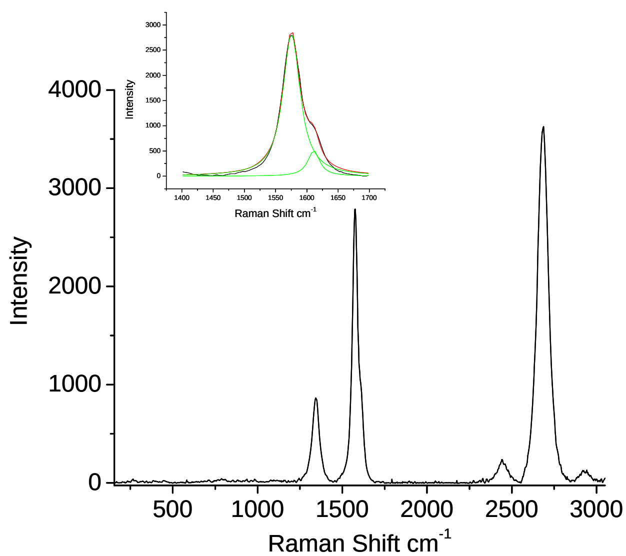


Raman Spectrum using Dimension-P2 785-HR.
Insert A, RBM region; Insert B, G-Mode region
with Lorentzian deconvolution



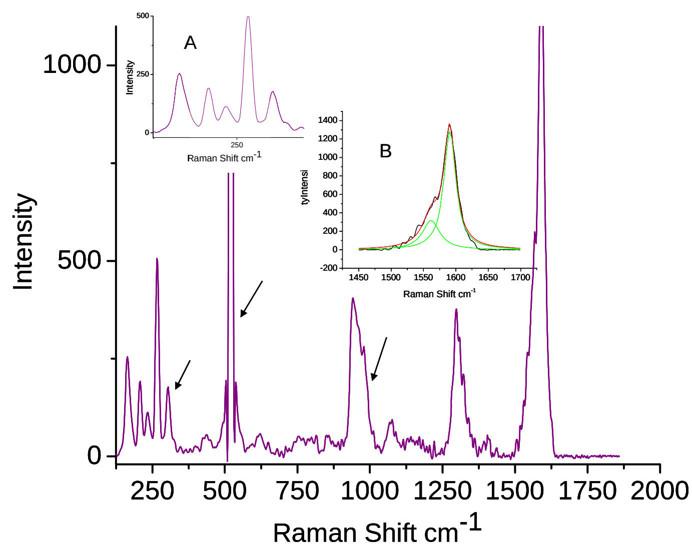
Raman Spectrum using Dimension-P2 785-HR.
Insert A, RBM region; Insert B, G-Mode region.
with Lorentzian deconvolution

Multi-walled Carbon Nanotubes



Raman Spectrum using Dimension-P2 532-SR.
Insert G-Mode region with Lorentzian deconvolution

SWCNT film on Silicon wafer



Raman Spectrum using Dimension-P2 785-HR.
Insert A, RBM region; Insert B, G-Mode region.
with Lorentzian deconvolution. Arrows show peaks
from underlying Si wafer including 520 Si peak.

1.Raman Spectroscopy of Carbon Nanotubes.
M.S. Dresselhaus, G. Dresselhaus, R Saito and A. Jorio. Physics Reports 409: 44-99 (2005)

2.Influence of Diameter in the Raman Spectra of Aligned Multi-walled Carbon Nanotubes.
E.F. Antunes , A.O. Lobo b, E.J. Corat a, V.J. & Trava-Airoldi. Carbon 45: 913–921, (2007)