ISO 17025

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RAMAN ANALYSIS REPORT
Jan 14, 2014

JOB NUMBER S0DKM997
PO NUMBER

for

Canada Carbon Inc.
1166 Alberni St. Suite 605
Vancouver, British Columbia V6E 3Z3
Canada

Prepared by:

Vasil Pajcini, Ph.D.
Sr. Scientist, Raman Services
(Tel. 408-530-3852; vpajcini@eag.com)

Reviewed by:

Angela Craig, Ph.D.
Manager, FTIR, Raman, GC-MS Services
(Tel. 408-530-3642; acraig@eag.com)

RAMAN ANALYSIS REPORT

Requester: Canada Carbon Inc.
Job Number: S0DKM997
Analysis Date: 14 Jan 2014

Purpose:

To acquire a Raman spectrum from flakes of high purity graphite sample.

Summary:

The Raman spectrum was that of a single crystal of graphite. The crystalline quality of the graphite was better than any other industrial graphite sample we at EAG have analyzed to date.

Experimental:

The measurements were performed using a "LabRam" J-Y Spectrometer. An Ar^+ ion laser (514.5 nm wavelength) an 1800 gr/mm grating were used for the measurements. The Raman spectra were collected in the backscattering geometry (180^0) under an Olympus BX40 microscope.

Results and Interpretations:

Spectrum 1 is the raw spectrum as acquired from a flake of the sample. Its baseline corrected spectrum is shown in Spectrum 2. Spectrum 2 also shows band-fitting of the major bands. The main peak in the spectrum is the G band (E_{2G2} symmetry) at 1579 cm^{-1}, theoretically the only allowed Raman band of a single crystal of graphite.

The D band, which characterizes the disorder in a graphite sample was barely detected at 1350 cm^{-1}.The intensity of the D band is a good indicator of the quality of graphite. A stronger D band indicates greater disorder in the *sp2* bonded carbon compared to pure graphite. Spectrum 2 is overlaid with a reference spectrum of industrial graphite of high quality in Spectrum 3. It is important to note that the D band of the industrial graphite is very strong compared to the D band of this sample, which demonstrates that the quality of the graphite of this sample is superior of the other samples of industrial graphite we have measured. Another indicator is the width of the G band (at 1579 cm^{-1}), which is much smaller in the sample than in a typical industrial graphite sample (see Spectrum 3). The Raman spectrum clearly demonstrates that the graphite in this sample is very high quality single crystal graphite.

Note: The unsymmetrical band at 2700 cm^{-1} (which is shown decomposed as a doublet: 2682 & 2725 cm^{-1}) is the so-called G' band (often called also 2D band, since it s wavenumber is twice the D band wavenumber).

Raman spectroscopy is often used for the qualitative identification of functional groups or for the identification of entire organic compounds, typically with the aid of spectral databases.

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Assignment of spectral features to functional groups or the identification of a compound can be made with relative certainty, in some instances. However in many cases the presence of spectral features and functional groups cannot be traced unambiguously to one specific compound, especially in the analysis of mixtures.

If any questions arise as you review the results of this analysis, principal analyst Vasil Pajcini or any other member of our technical staff will be available for consultation.

After reviewing this report, you may assess our services using an electronic service evaluation form. This can be done by clicking on the link below, or by pasting it into your internet browser. Your comments and suggestions allow us to determine how to better serve you in the future.
http://www.eaglabs.com/main-survey.html?job=S0DKM997Ra

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Appendix 1

Raman spectroscopy is the collection of light inelastically scattered by a material or compound. When a light of known wavelength strikes a material, the light is shifted according to the chemical functionalities of the material. The intensity of this shifted light depends on both molecular structure and macrostructure. As a result of these phenomena, the collection of the shifted light gives a Raman spectrum that can provide direct information regarding the molecular vibrations of the compound or material. We can then interpret this information to determine chemical structure, organization, and in some cases, non-covalent intermolecular interactions.

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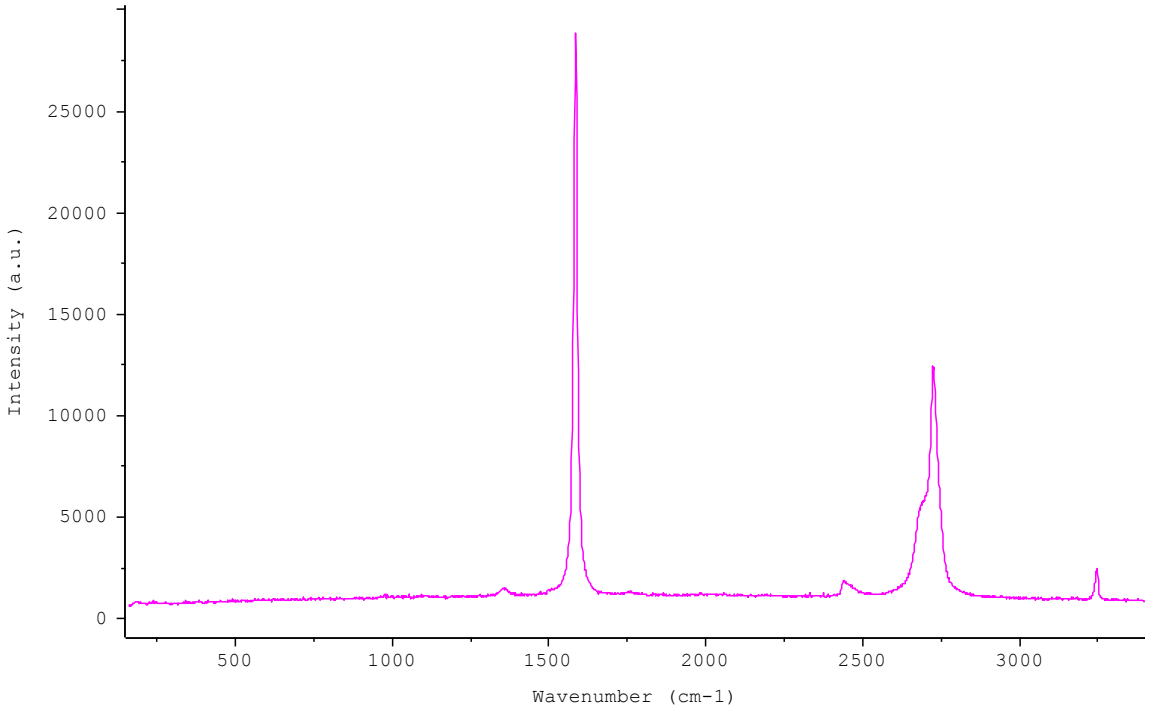

Spectrum 1

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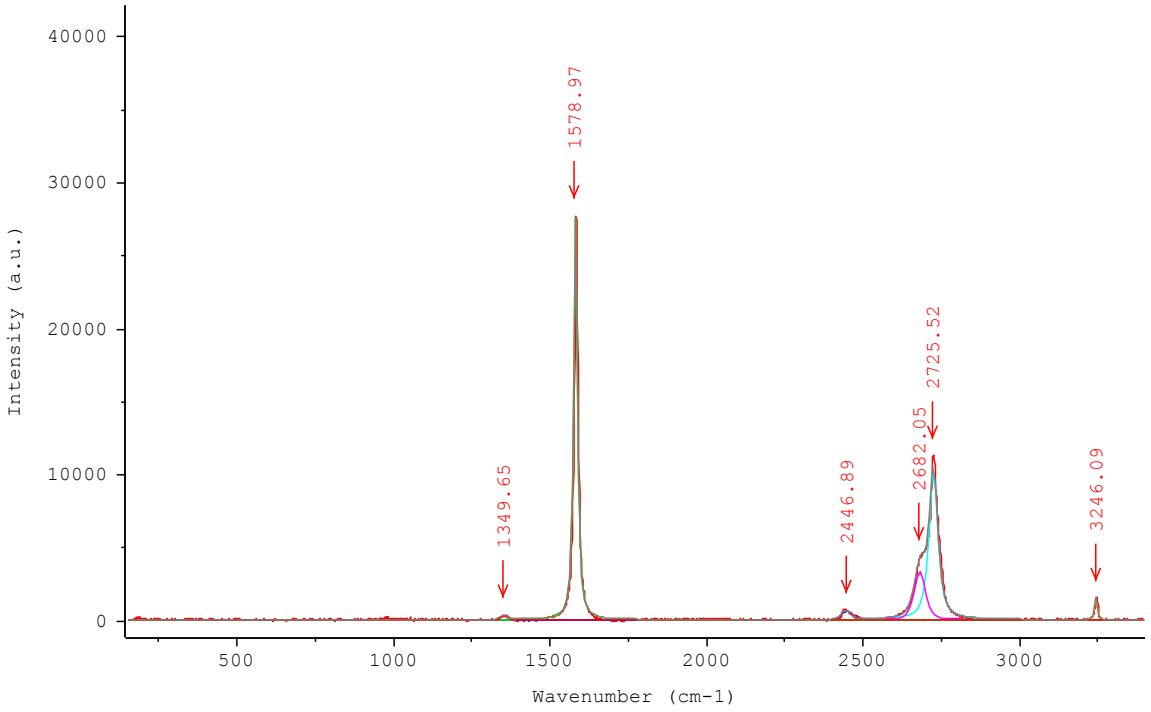
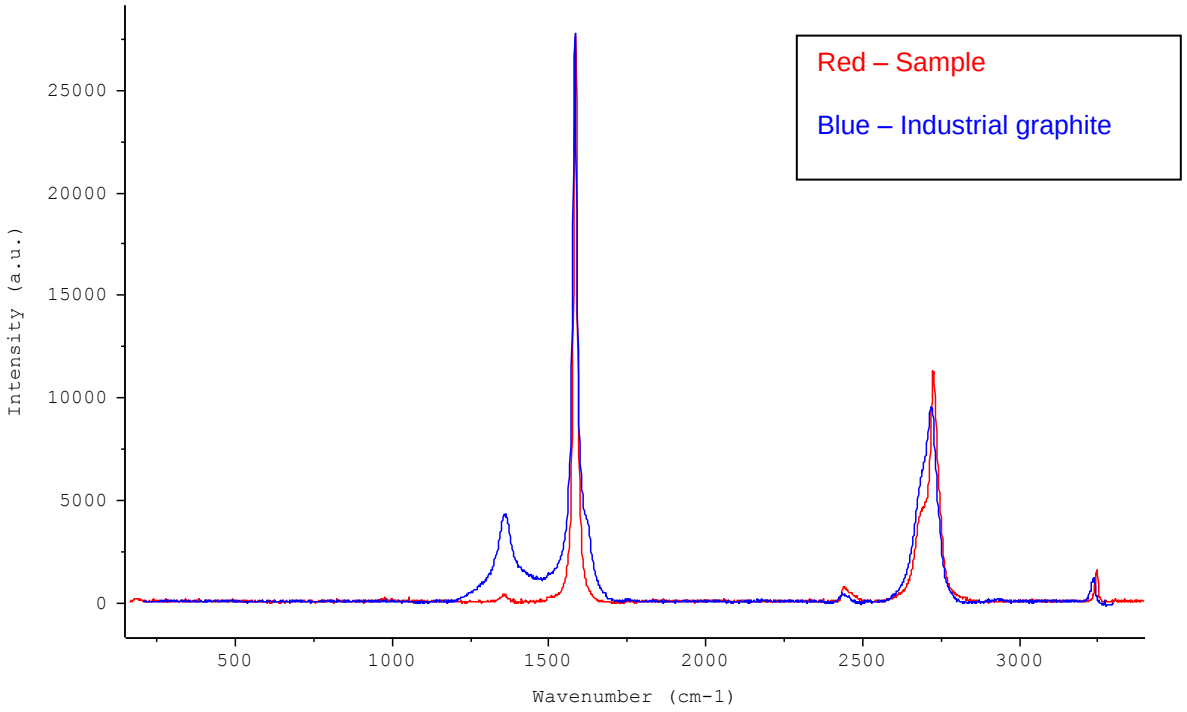


Spectrum 2

Canada Carbon Inc.



Spectrum 3