GL Gem Raman – a powerful tool in gem and mineral identification

Kuehn, J. Wolfgang* and Konorov, Stanislav O.**

*Gemlab Research & Technology, Canadian Institute of Gemmology, P.O. Box 57010, Vancouver, B.C., V5K 5G6, Canada

**Department of Chemistry, The University of British Columbia, 2185 East Mall, Vancouver, BC, V6T 1Z1, Canada

Introduction

Raman spectroscopy is particularly useful in identifying and characterizing gems and minerals.

Recent advances in optical technologies, innovative design of Raman geometry and miniaturization of spectrometers with real-time software allow for lower production cost and practical applications in geoscience related fields.

Due to its non-destructive technique it is very useful for gemmologist appraisers, gem merchants, mineral collectors and others.

After the introduction of a UV-VIS-NIR portable spectrometer (the GL Gem Spectrometer) as a gem and mineral testing tool certain limitations in transmission spectroscopy led to the feasibility study of a compact and portable Raman system.

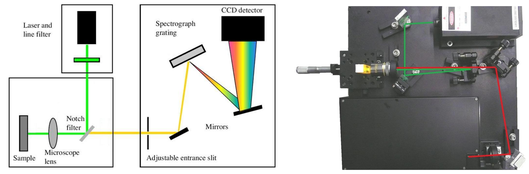
The following aspects were important and could be realized for a reasonable price point (under 5,700 €):

Aim

The GL Gem Raman is built to highest operator safety through fully enclosed and screened optics; see diagram for the optical design of the back-scattering geometry.

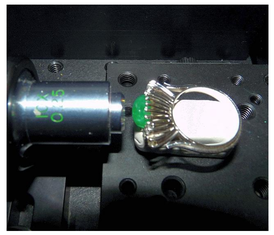
The GL Gem Raman has a sample compartment big enough to accommodate larger specimen of gems and minerals as well as single pieces of jewellery.

Method



System Layout of the GL Gem Raman

- A 300 mW 532nm laser excitation source was chosen as commercial units are now available at economical prices. These devices use diode lasers to "pump" a Nd-YAG laser which operates at 1064 nm.
- The light in this high quality laser is then frequency-doubled to give green 532 nm light output. This wavelength is about optimum for both Raman efficiency and the detector operating range.
- The Raman spectral range is from 200 – 2,500 cm-1 with a resolution of ~3cm-1 ; the spot size is approximately 10 – 15 micron at 10x magnification.
- Laser output under 300 mW is usually sufficient and safe for the sample.
- The Raman uses a high resolution spectrometer with a Toshiba TCD1304AP (CCD 3648 pixel, 8 um x 200 um)



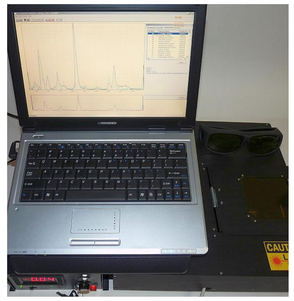
Sampling stage: 90 x 90 x 50 mm covered by observation lid.
Size: 33 x 33 x 7.6 cm (13 x 13 x 3")
Weight: 10 kg (22 lbs)
Operational system: Windows XP/Vista/Windows 7 32/64
Power supply : 110 – 240 Volts (for laser),USB connection to computer

Raman spectroscopy is scattering-based, not a result of transmission/reflection; i.e. no need for extensive sample preparation. Only a small testing area is required.

To achieve highest signal strength no fiber optical connections are being used and maintenance is minimal.

Several on-line Raman reference data-bases are available and linked with the Raman's operating software.

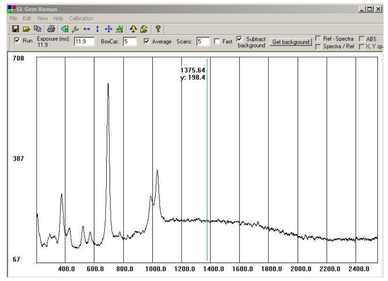
Results



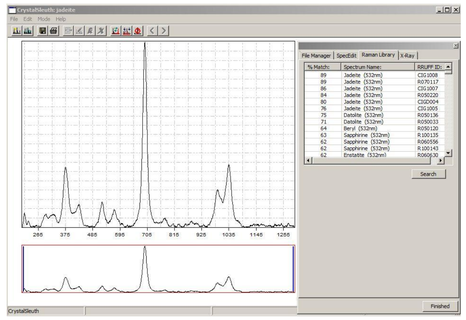
The GL Gem Raman quickly can tell the difference between diamond, cubic zirconia, glass and zircon, distinguish jadeite from nephrite, separate real from faux pearls, tell whether it is ivory or plastic.

There is great potential for detecting treatments and colour enhancements in gemstones; it will help in the determination of the nature of diamonds, gemstones and minerals.

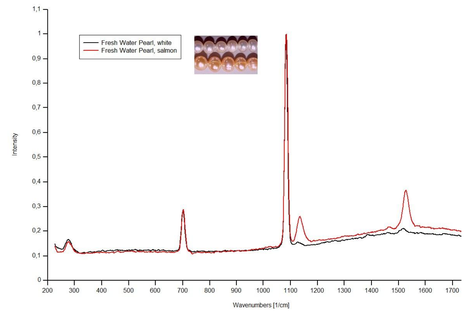
The GL Gem Raman software allows real-time spectral acquisition. The spectra can be saved and imported into a searchable database program with over 2,500 references; the database is linked to the large on-line mineralogical RRUFF database for Raman spectra.



Unoriented raw Raman spectrum of green jadeite cabochon



Matching Raman spectrum with references in RRUFF database



The GL Gem Raman can be used to detect treatment of freshwater cultured pearls: all natural colour pearls show the two mayor Raman resonance features of polyacetylenic pigments assigned to C=C stretching at about 1530 cm-1 and C-C stretching at about 1130 cm-1.

Raman CCD detectors have problems with fluorescence which in some cases "overwhelms" the signal; for those gem materials other testing instruments such as the GL Gem Spectrometer should be used.

Conclusion

The portable GL Gem Raman is an economical solution for advanced gemstone and mineral identification; it can be used on rough and faceted gems even set in jewellery.

For more information on the GL Gem Raman and other advanced testing instruments contact:

Gemlab Research & Technology
Wolf Kuehn, Project Manager

Ph: 1-604-530-8569
Email: wolf@cigem.ca
Web: www.gemlab.ws

References

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Geo-Raman Xth Meeting in Nancy, France from June 11-13, 2012