Diamond testing with the IndiGo: a modular handheld spectrometer connected with a smartphone

Introduction

Whether it is to test the authenticity of a gemstone, or to look at the characteristics of the crystalline structure, like the presence of impurities or metal ions, gemology experts rely on an array of analytical techniques to assist them in their daily routines.

In particular, diamond experts know that it is becoming increasingly difficult to distinguish real diamonds from fake ones. Many materials can be mistaken for real diamond, like cubic zirconia, moissanite, corundum, YAG, or even glass, which of course have much lower value. Moreover, with synthetic diamonds becoming more mainstream, the ability to measure photoluminescence is becoming crucial to solve the challenges of understanding different types of synthetic stones.

Different techniques exist but none are as powerful as Raman spectroscopy. Raman spectroscopy is an optical technique that probes the molecular structure of materials. It is non-destructive, non-contact and very selective.

Diamond authentication with Raman spectroscopy

A Raman spectrum usually consists of sharp peaks, whose position in wavelength (usually expressed in cm^{-1}) corresponds to specific vibrations between atoms. It is fingerprint for a given material, which can be used for chemical identification when compared to reference databases. For instance, in the case of diamond, the Raman spectrum consists of a single sharp peak at 1331 cm^{-1}. When this peak is found in the spectrum, the sample can unmistakably be identified as diamond.

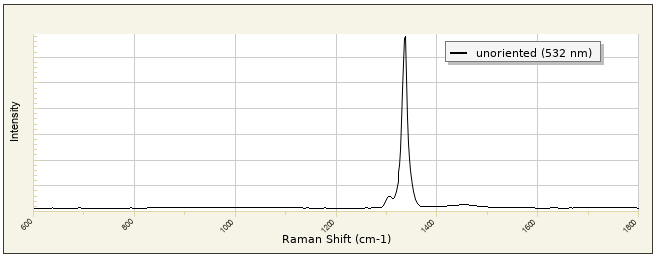

Figure 1 – Typical Raman spectrum from a diamond (laser wavelength: 532 nm, laser power: 150 mW). Source: https://rruff.info/Diamond/R150106

Until recently, Raman spectrometers were costly equipment, only used by advanced laboratories. Today, the IndiGo makes it possible to measure Raman spectra on diamonds. Whether synthetic or natural, big or small, cut or rough, diamond's spectra can be measured with a compact, easy-to-use, smartphone-based device, at a fraction of the cost of a standard Raman spectrometer. The device consists of the main IndiGo unit the the Raman add-on which connects easily to the spectrometer unit to provide laser excitation and Raman signal collection through a microscope objective. It is therefore possible to test even the smallest gems.

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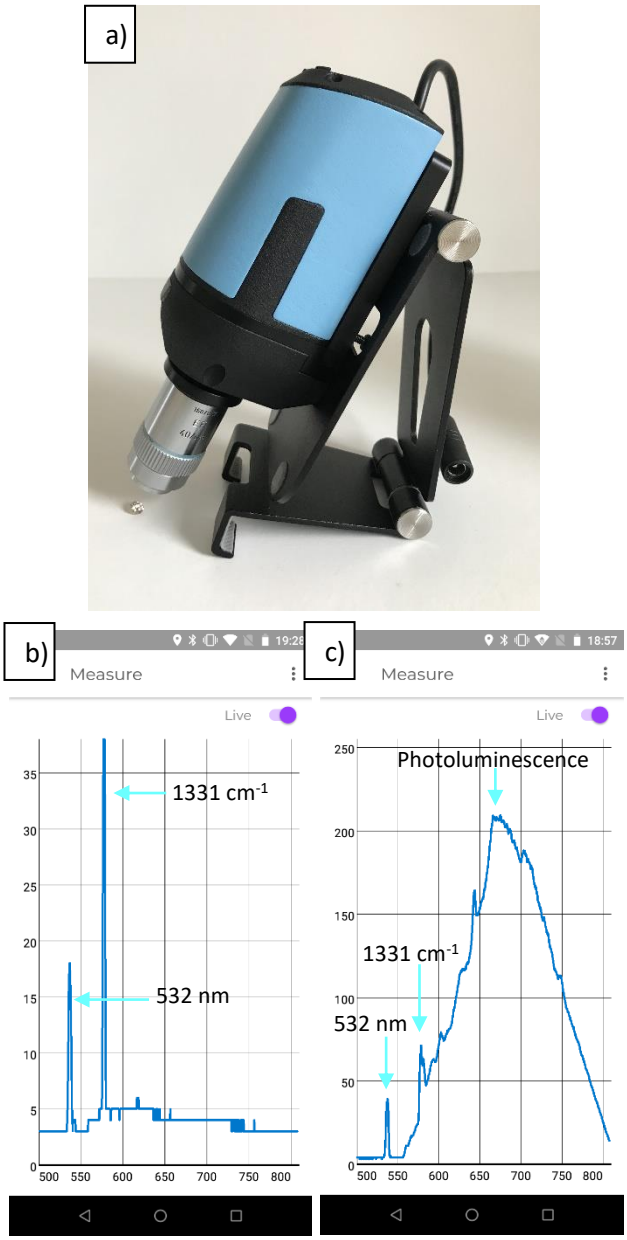

Figure 2 – IndiGo spectrometer with the Raman add-on (Picture a). Raman spectra measured with an IndiGo spectrometer with a 532 nm laser. The left spectrum (picture b) was obtained on a cut natural diamond exhibiting no photoluminescence. The right spectrum (picture c) was measured on a synthetic cut diamond exhibiting strong photoluminescence.

Photoluminescence in diamonds

Photoluminescence is another optical spectroscopy method that can provide important information, giving gemologists clues on possible heat treatments or the synthetic origin of a gem[1]. As a Raman spectrometer is also able to pick up PL signal (which are usually more intense than the Raman emission), it is possible to use the IndiGo together with the Raman add-on to characterize photoluminescence emission from various gems, in particular diamonds. Various impurities, like nitrogen or boron, can thus be detected. Such atomic-level defects are helpful in identifying a diamond's origin and subsequent treatment.

Conclusion

The IndiGo is a compact and affordable device for performing Raman or photoluminescence analysis on diamonds and other gems. Laser excitation can be tailored to target specific needs. The GoyaLab mobile app enables analysis with a simple smartphone. Contact us for more information

[1] https://www.gia.edu/gems-gemology/spring-2016-photoluminescence-spectroscopy-diamond-applications-gemology