

Diamond Identification with Raman Micro Spectroscopy

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Introduction

Diamond, women's best friend, is the all-time favourite for gem collector. Diamond is a symbol of beauty, perfection, wealth, and people are willing to pay high price for its perfection. Recently, a flawless 100-carat diamond was auctioned off for USD\$22 million dollars. However, current synthetic diamond industry is able to produce gem-grade diamond. Moreover, fake stones (diamond simulant) are also mixed into natural diamond lot in gem industry during trading. Therefore, new rapid and accurate verification tool is required to tell apart the natural and synthesis diamond.

Diamond (natural and synthetic) is composed of three-dimensional sp^3 -hybridized carbon atoms packed into an octahedral crystal structure. Such unique atomic arrangement contributes to distinct Raman signature peaks at 1332 cm^{-1} . The Raman signal from diamond is very strong from its sp^3 carbon bond compared to sp^2 carbon bond in graphene and graphite. Therefore, Raman microscopy is ideal for gem-grade diamond authentication. In this technical note, we demonstrate that our uRaman from Technospex is able to authenticate diamond and its stimulant-diamond in a

Experiment and Equipment



The uRaman-Ci microscope system is equipped with two separate modules, each equipped with separate excitation wavelength via stacking system (Figure 1). Two commonly used excitation wavelengths, i.e. 532 nm and 785 nm are stacked in the current system.

Figure 1. uRaman with dual laser system, i.e. 532nm (top) and 785nm (bottom), equipped with motorised stage and several objective lens.

uRaman™

Results and Discussion

Optical micrograph of samples shows a small diamond on the ring (“diamond 1”) and one relatively large stone (an unknown “diamond 2”). Using 532nm laser excitation, we observe a distinct sharp peak from “diamond 1” at Raman shift around 1332 cm^{-1} , corresponding to the signature diamond wavenumber. However, such sharp peak is not detected in “unknown diamond 2” sample. “Unknown diamond 2” only exhibits a broad peak at 614 cm^{-1} , which is originated from zirconia. Using 785nm excitation, “diamond 1” once again illustrates its diamond Raman peak at 1332 cm^{-1} , whereas multiple peaks ($1259, 1332, 1428, 1530\text{ cm}^{-1}$) are observed for “unknown diamond 2”. These peaks observed in “unknown diamond 2” are typical signature peaks of hybrid-diamond or diamond simulant (aka fake diamond). They are usually cubic zirconia (CZ) crystals grown in amorphous carbon environment. Hence, based on the quick measurement using our uRaman at 532nm and 785nm excitation wavelengths, we confidently conclude that “diamond 1” is an authenticated diamond, whereas “unknown diamond 2” is a stimulated zirconia crystal.

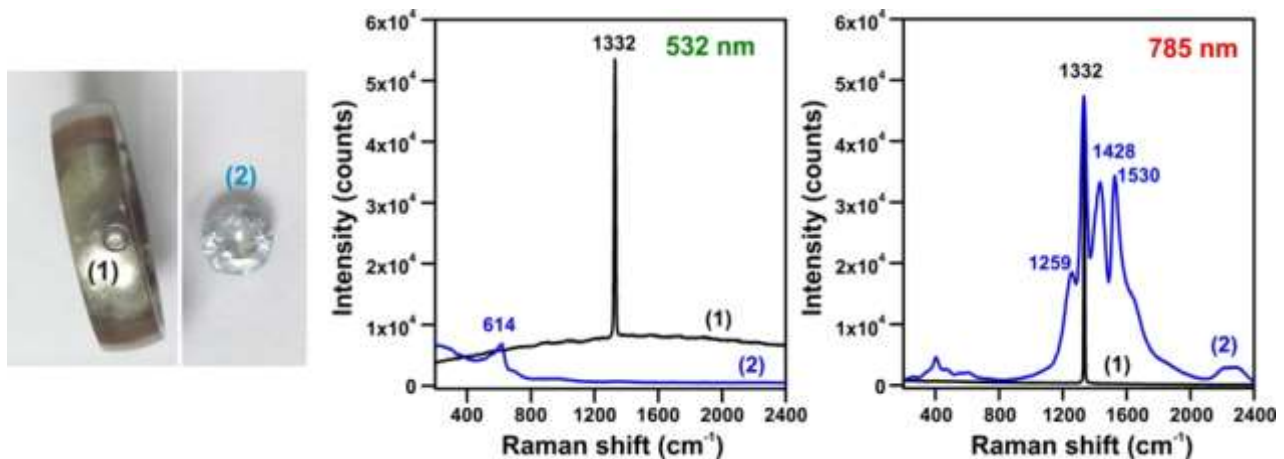


Figure 2. “Diamond 1” and “unknown diamond 2” and their corresponding Raman spectra. The optical micrograph and Raman scattering spectra of sample (1) and (2) measured using 532nm and 785nm laser excitation wavelengths, respectively.

Conclusion

Simulated diamond has physical property, such as the optical clarity, that is similar to authenticated diamond, making it hard to authenticate. Hence, our uRaman provides a fast and rapid spectroscopic platform to non-destructively authenticate and identify diamond. Even without years of experience in gemology, one can instantly differentiate a real diamond worth thousands of dollars from a zirconia crystal of a fraction of cost of natural diamond using a Raman spectroscopy!