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Gemstone Analysis by FT-IR: Identifying Treated Jades

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Key Words

- Artificial Color Enhancements
- Chemometrics
- Epoxy Resins
- FT-IR
- Jade
- Wax

Introduction

Gemstones have a long and occasionally checkered history. Since prehistoric times, precious gems have been used in barter, for decoration, and in rituals. The primary key to the value of gemstones lies in their beauty (Figure 1). For instance, a superb jade bangle, with an interior diameter of 49.50 mm and 8.36 mm thickness, sold in 1999 for $2,576,600 at Christie's®. The obvious problem is that the character of a gemstone can be enhanced (or even produced ab initio) by non-natural methods. In cases where such enhancement is disclosed, this is not a "problem," although the stone value is not as high as that of a totally natural example. Fraud is, however, a major concern.

There are three classes of jadeite jade now commonly available.[1] "A" grade jade is totally natural (jadeite), and has the highest true market value. The "B" material has been treated as discussed below, and "C" grade material has been artificially color-enhanced. Typically, "C" jade is fairly easy to spot, but the treatments applied to "B" materials are more subtle.

Figure 1: Gemstones

"B" jade starts as raw jadeite with brown or black stains.[1] The jade is soaked in strong mineral acids to remove the stains, which also weakens the stone by leaching out some structural materials (mostly metallics like sodium). The pores generated are filled with a melted wax or polymer resin whose index of refraction closely matches that of jade. A hardener may be applied to the outside of the jade to seal the stone. Besides the issue of potential fraud, the "B" treatment has several long-term issues – some skin burns from residual acid have been reported, and discoloration of the epoxy resin can occur. All of this underscores the need for a rapid and sensitive analysis method.

"B" grade samples are often uniform in color and translucent.[1] Green jade is the main example, but pink and yellow "B" jade has recently appeared. Normal gemstone analyses showed "B" jade was jadeite jade and not color-enhanced "C" jade. Critically, the refractive index was in the correct range for jadeite, and normal (UV) spectroscopic analysis did not indicate the presence of dyes. Microscope examination may not show enough detail to identify the treatment, and even in cases where it can, this requires considerable skill. Essentially, the "B" material passes most of the normal testing done by a jeweler.

Fourier Transform infrared (FT-IR) provides an excellent tool for analyzing "A" and "B" jade. Signals due to the wax or epoxy resin are quite definitive. The analysis takes only a few seconds, and the procedure yields unambiguous results. Similar analyses of diamonds and other gemstones are also underway.

Experimental

A Thermo Scientific Nicolet™ spectrometer, such as shown in Figure 2, was used in the analysis. Samples of "A" and "B" jadeite jade were mounted easily using "blue-tac," although care had to be taken to prevent contamination of the gem stone. A 4X beam condenser was used here, although other work has shown this is not generally necessary to obtain definitive spectra.

The data were collected using the Thermo Scientific OMNIC™ software. A small number of scans was needed (4-16) to see the presence of resin; the spectra shown here were collected over a longer time (64 scans) to improve the s/n ratio. A resolution of 4 cm^{-1} was easily sufficient. The full spectrum was obtained, but the glassy nature of the material obscured all signals below 2300 cm^{-1}; the critical range is between 2600 and 3800 cm^{-1}, so this is no impediment to the analysis.

Figure 2: The Thermo Scientific Nicolet™ iS™10 spectrometer is ideal for gemstone analysis

Results

Spectra from "A" and "B" jade are shown in Figure 3. The "B" jade has a large peak located in the aliphatic hydrocarbon region. The differences between the spectra are immediately obvious.

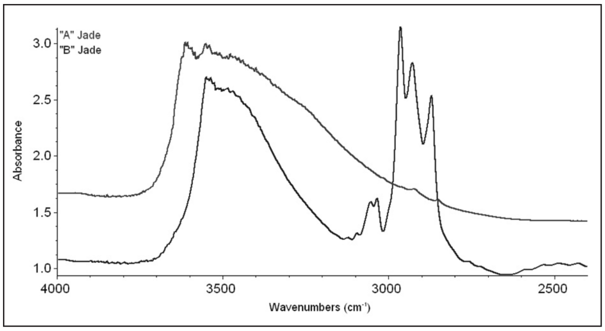

Figure 3: Spectra peaks of "A" and "B" jade differentiate the two stones

Amazingly, the spectral region between 4000 and 2500 cm^{-1} is sufficiently diagnostic to identify the class of material used in the treatment. Searching this region against the whole of our FT-IR libraries yields the results shown in Figure 4. The top hits are all epoxy resins, in excellent agreement with the expected results.

The FT-IR analysis of gemstones is simple and non-destructive. The ability of the OMNIC software to be customized will allow a standardized procedure to be built, and then operated by workers unfamiliar with FT-IR – the spectrometer becomes a black-box. The speed of the analysis would allow incorporation of this method into bulk testing facilities; the inexpensive nature of the unit would allow even small retailers to use the method.

This analysis could easily be extended using Thermo Scientific TQ Analyst™; a chemometric program. A quality check coupled with a simple report would result in a simple "A-B-C" discrimination, and could be used to identify known treatments of the "B" and "C" jades, or other gemstones.

Conclusions

As stated in reference 1, *"B jade is here to stay."* This is not inherently an illegal activity, unless the treatment is hidden from documentation accompanying the gem. Most, if not all, precious stones are susceptible to this type of "enhancement." FT-IR is shown here to be an effective tool in uncovering treated stones, which should assist in enforcing proper disclosure.

Acknowledgement

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References

1. Hughes, R. W.; Galibert, O.; Bosshart, G.; Ward, F.; Oo, T.; Smith, M.; Sun, T.T.; Harlow, G. *Burmese Jade: The Inscrutable Gem Part 2: Jade Trading, Grading & Identification* http://www.ruby-sapphire.com/jade_burma_Part_2.htm

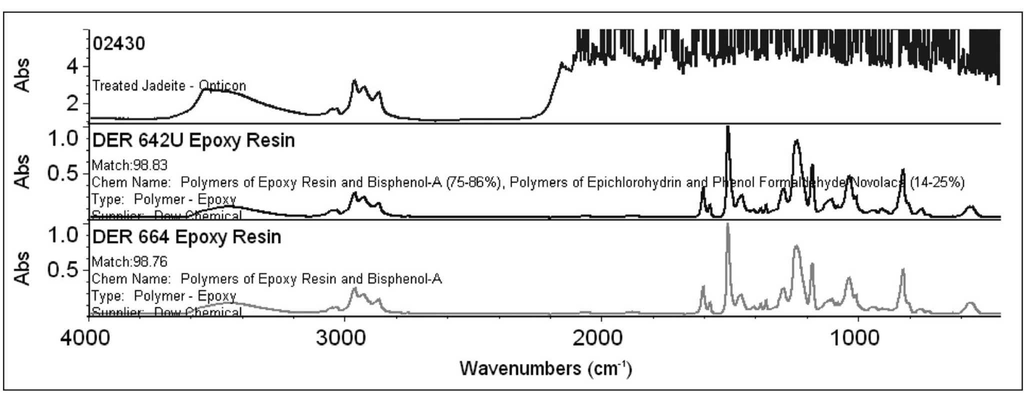

Figure 4: Class of materials identification used in the treatment of gemstones

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