Synthetic Tourmaline—Rumors and Reality

Rumors spread like wildfire on the Internet. Knowledgeable gemologists cannot be criticized for believing what appear to be well-researched facts coming from seemingly reliable sources, especially when backed by high tech equipment. Case in point: synthetic tourmaline.

By Bear Williams, CG
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On October 6, 2008, the International School of Gemology (ISG) released an internationally distributed internet newsflash entitled: "A report on synthetic tourmaline in the current market! *An unexpected find during our research on bulk diffused tourmalines!*"

The report goes on to state: "It is our conclusion that the unusual tourmalines in the ISG office are most likely hydrothermally grown synthetic tourmalines as outlined by the Academy of Sciences of Ukraine in their 1993 report, and referred to by Dr. Kurt Nassau in the 1999 Gems and Gemology article. Our Raman shift scans have been repeated on stone after stone and orientation after orientation, and all results have been identical for these stones. We also suspect and will continue to test to confirm that the hydrothermal tourmalines are diffusion treated to impart the color seen in the immersion cell…It is obvious that the hydrothermally grown synthetic tourmaline is very easy to identify with Raman technology. As I stated earlier, we were not looking for this situation when we were studying the heavy metal bulk diffusion of Mozambique tourmaline. But in gemology, you never know when the next revelation is going to appear. This one was a total surprise, but one that is easily identified here in the ISG office."

A natural Nigerian tourmaline weighing 16.72 carats. This tourmaline could be mistaken as synthetic based on Raman readings as described in this article.
Photo: Stone Group Labs.

This newsflash was immediately linked into by several online networks, blogs, forums, and even some reputable gem association websites as a viable source of information. From there, it was disseminated to forums that are more public.

While we know that many gems have been synthesized in the lab at one time or another (some just to prove it is possible), tourmaline, with its long and complicated balance of ingredients, was a recipe for only the most accomplished of chefs. Indeed, a team of Russian researchers had managed to perform synthetic tourmaline overgrowth on natural seed crystals only in the 1990s. The growth was no more than a millimeter, and the extremely high cost and complexity of growing these few, small, low-quality samples made its commercial production unfeasible.

So how did large amounts come to be salted into parcels? How could they afford to sell these valuable and rare synthetics at well under $30 per carat? Why were they producing less desirable colors, when most synthetics imitate the finest and rarest of their type? Most important, how could this be happening on the scale it was reported, without the industry having any inkling?

The stones that the ISG had tested were not made available to Stone Group Labs, so we proceeded to test a broad range of material to see if we could verify the

ISG findings. The conclusions of the ISG research hinged on two things: inclusions and Raman spectroscopy. The first was microscopic observations while under immersion. This method is often employed when looking for indications of known treatments, such as surface color diffusion, or synthetic growth patterns. The ISG posted some interesting photos of zoning in tourmaline, but none of the observations could be attributed to synthetic tourmaline. Natural tourmaline can exhibit any number of unusual inclusions, zoning, or color concentrations. For fascinating views into the bizarre world of tourmaline zoning, look into the *Photoatlas of Inclusions in Gemstones, Vol. 2*, E. Gübelin, J.I. Koivula, or *Der Turmalin*, F. Benesch. These variations in tourmaline might easily be confused for something unnatural, but they are certainly not evidence of synthetic origin.

The second aspect of the ISG's conclusion was an anomalous Raman reading. This was taken as evidence of synthetic origin. Being unfamiliar with this equipment and its limitations, such a conclusion was impossible for most gemologists to refute. Stone Group Lab has a similar Raman unit with a 785nm laser, so we understood that a Raman test is not always conclusive for separating natural from synthetic materials. In a short time, we were able to find tourmalines that gave readings to match the (anomalous) readings of the ISG. Figure1 shows what that particular Raman reading looked like. The tourmaline shown at the opening of this article, when tested, exhibited the anomalous PL reading that could be misinterpreted as synthetic.

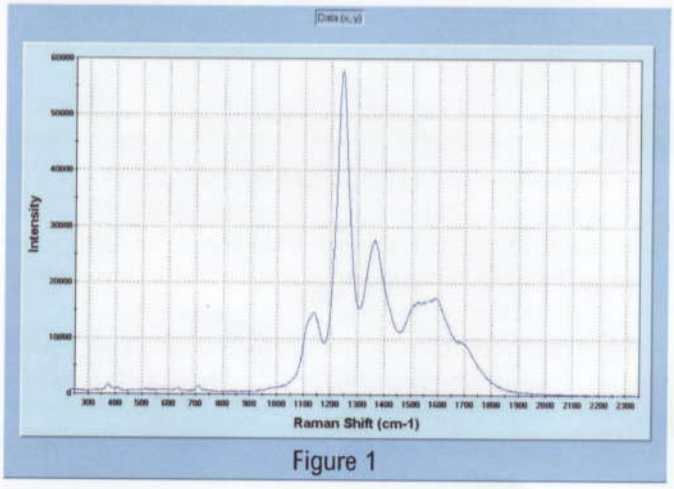

Figure 1

The ISG then ran comparisons through the RRUFF database and did not find any matches to their Raman scan. But their search did find a reference from a 1993 *Physics and Chemistry of Minerals* (Taran, et al., 1993). Regarding these actual studies in synthetic tourmaline this journal states: "An additional intensive absorption band at 12,500 cm^{-1} (σ-polarisation) appears in some specimens but is not yet found in spectra of natural tourmalines."

Taking this spectral information and comparing it to his Raman reading, the ISG then made a jump and concluded in his report: "We should note that the intense peak at the 1,250 (cm^{-1}) on the synthetic tourmaline scan is the same peak referred to in the 1993 Russian report for synthetic tourmaline. That peak does not appear on any of our known natural tourmalines, as also reported by the Russian report."

You may have noticed that the Taran, et al. report stated the band was at 12,500 cm^{-1} and not at the 1,250 cm^{-1} as seen in the ISG Raman reading. The other issue is that a Raman unit uses monochromatic (single wavelength) laser light giving a result known as a Raman shift. It *does not* render its readings based on spectral absorption, as was used in the Taran et al. report. This particular science was somehow missed by the ISG.

Stone Group wanted to confirm the nature of these anomalous readings, and consulted with both Thomas Hainschwang of Gemlab-EU in Liechtenstein, as well as Dr. Lore Kiefert of the AGTA-GTC laboratory. Both confirmed that the anomalous Raman readings were simply a photo-luminescent (PL) reaction due to that particular frequency of laser used, and not a Raman shift reading.

Dr. George Rossman, of the California Institute of Technology happens to currently possess all of the synthetic copper-containing Russian tourmaline samples studied by the Ukrainian group in the afore mentioned report. As a courtesy to us, he ran Raman readings on the synthetics themselves. Using the same laser frequency Raman as ours (and the ISG's), he aimed the laser at both the natural seed crystal and then at the synthetic tourmaline overgrowth. In an oddly humorous turn of events, the synthetic tourmaline gave readings of a normal tourmaline, and the *natural* tourmaline portion (used as the seed crystal) gave the identical Raman photoluminescent reactions that were mistakenly reported as proof of synthetic origin. This concluded any further need to investigate synthetic tourmaline.

Bulk Diffusion

In a separate report by the ISG, there has been talk of copper being "bulk diffused" into tourmaline. Investigations and studies are currently under way and at the time of this writing, there are no revelations. While we do not want to make suppositions, the scientific and laboratory community has voiced their doubts regarding the practical physical possibilities of such a claim. While there may have been attempts to fill open fissures in low-end material with native copper to fool instruments, it is unlikely that any ionic-type cuprian lattice diffusion is possible. In other words, while we can easily see that

copper could artificially be placed in a stone's fissures or even fracture filled within a tourmaline, as yet we have no theory for how copper could be lattice or "bulk" diffused [atomically] within a tourmaline.

Ongoing Efforts

Consumer protection is in everyone's best interest and independent research should be encouraged. New gem materials, new treatments and new synthetics continually enter the market. Education is more important than ever with today's expanding technologies and we applaud the ISG for their efforts in this. We regret that there was not more initial cooperation between the ISG and other industry labs to verify these findings before they were made public. Let's hope this article may lead to a more responsible approach in our industry towards disseminating relevant, and accurate information. ◆

References

Benesch, F. (1990) Der Turmalin. *Stuttgart, Urachhaus, 380 pp.*

Gübelin, E. and Koivula, J.I. (2005) Photoatlas of Inclusions in Gemstones, Vol. 2. *Opinio Publishers, Basel, Switzerland, 830 pp.*

Taran, M.N., Lebedev, A.S. and Platanov, A.N. (1993) Optical absorption spectroscopy of synthetic tourmalines. Physics and Chemistry of Minerals, Vol. 20, *No. 3, pp. 209–220.*

The International School of Gemology Responds to the Synthetic Tourmaline Article

By Robert James, FGA, GG, President of ISG

We have had many contacts over our previous questions regarding that group of tourmalines that gave the anomalous reactions to the Raman, immersion cell, and virtually all other tests. At one point we raised the question as to whether or not a synthetic tourmaline could have been produced and exist on the market. We are pleased to provide this update on that issue.

We have confirmed through several industry sources as well as scientific reports that tourmaline has indeed been synthesized, and for a number of years. This confirms this option to the anomalous reactions to be legitimate and certainly one for consideration.

However, after considerable additional testing we have confirmed that the group of tourmalines sold to us under the name of Mozambique "Paraiba" Tourmaline, is actually a rather rare form of tourmaline from another placement on the isomorphous replacement series known as Liddicoatite, named for the late Richard T. Liddicoat, Jr., renowned past president of the Gemological Institute of America.

The interesting part of this whole issue is that liddicoatite tourmaline is actually more rare and valuable than Mozambique tourmaline, and offers a far greater challenge to identification and testing. However, given the results of our testing of this tourmaline as having been subjected to diffusion, it is expected that the gemological test results would have been skewed, as they were with andesine, which made identification even more difficult. And since the ISG is the first lab to venture into the identification of diffused gemstones on this level we anticipated a certain amount of unknown variables from those stones being tested. This was certainly one of those.

But through LA-ICPMS testing we have confirmed why all of the anomalous reactions have been seen from this material, and why future investigations will have to take these anomalies into account.

We are glad to be able to answer this question for everyone as there were many who have expressed concerns over the possibility of synthetic tourmaline getting to the market. Based on the fact that synthetic tourmaline is in fact a reality, it is only a matter of time until we do see it on the market.

We appreciate all of the responses and input we have received on this issue, and look forward to bringing you all more information on the tourmaline investigation as things develop. ◆