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# GEM TESTING LABORATORY

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# A suite of synthetic sapphires with 'natural-like' sheen

'Sheen' is commonly known as a moving white light or milkyness on the surface caused due to reflection and scattering of light from minute inclusions. Such effect is a common feature in feldspars (especially moonstone), however can be observed in any gem provided such inclusions are present; other common gem material is corundum where 'sheen' is caused as a result of presence of minute inclusions of titanium oxide in the form of fine silk, discs or dust. Presence of such inclusions is usually an indication of a stone being natural. However, since the production of synthetic star sapphires and rubies, rutile inclusions are being produced in synthetic corundum by inducing or diffusing titanium oxide in the lattice. Such inclusions when properly oriented and present in higher concentrations give rise to a star effect (when cut as a cabochon) and if present in lower concentrations produce only milkyness.

Recently, at the Gem Testing Laboratory of Jaipur, we were able to procure few specimens of synthetic sapphires displaying sheen effect for study and reference purpose (figure 1). This study presents the gemmological properties and inclusion features of this suite of synthetic sapphires with 'natural-like' sheen.


Figure 1

**Results & Properties**

***Visual Characteristics:*** The procured samples were yellow, green and greenish blue having a good transparency, ranging in weight from 2.17 to 3.14 carats. All four samples displayed sheen like effect on the table facet (again, figure 1); no other part of the stones displayed this effect. As a result all the samples appeared slight hazy from the table. The greenish blue sample gave an 'electric' look similar to that seen in 'Paraiba' type tourmalines. The green and greenish blue sample also displayed eye- visible blue coloured curved zones of pinpoints which immediately identified the stones as product of flame fusion or vernueil process. The blue zones in one of the samples (figure 1) were quite broad and dense and gave appearance of a 'parti-coloured' stone with blue and green colours; yellow samples were uniformly coloured.

***Polariscope reaction*:** All specimens displayed anisotropic nature with strong interference colours visible at the table facet. Using a conoscope, 'uniaxial' optic figure was readily resolved. This indicated the 'c' axis is oriented perpendicular to the table facet.

*Refractive index*. All specimens displayed a refractive index typically associated with natural or synthetic corundum, i.e. 1.760 to 1.770 with birefringence not more than 0.008.

*Specific gravity*. The values ranged from 3.97 to 3.99, consistent with those for natural or synthetic corundum.

*Ultraviolet fluorescence*. All specimens displayed a chalky blue fluorescence under shortwave ultraviolet while inert under longwave. This chalky fluorescence was restricted only to the table facet (figure 2) as a result of concentration of fine inclusions giving rise to milkyness or sheen effect.

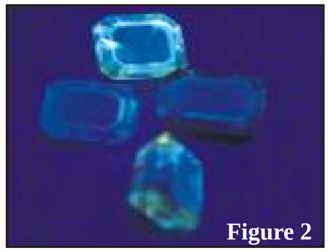
Figure 2

*Chelsea filter reaction.* The greenish blue sample showed a strong red reaction with stronger intensity towards the blue bands, while green sample displayed a weak red only towards the corners and yellows did not exhibit any changes.

*Visible spectroscopy*. The greenish blue variety displayed a typical cobalt spectrum with three bands at around 540, 580 and 630 nm, while green sample displayed only fine lines at the red end. No absorption features were seen in yellow samples.

**Microscopic features**

*Minute inclusions*. In all samples, fine minute inclusions of variable pattern were present restricted to the table facet. These mainly consisted of oriented short needle like (figure 3.a) as well as fine pinpoints similar to dust (figure 3.b); both these types gave rise to the sheen effect. These pinpoint (dust) or needle like inclusions similar in appearance to those observed in star corundum, either synthetic or natural with induced inclusions. Such inclusions are formed as result of exsolution of titanium oxide in the structure of corundum. Therefore, these inclusions were presumed to be of rutile, which was well supported by the EDXRF analyses.


Figure 3 a Figure 3 b

continued to page 2 ....

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*Curved bands*. In green and greenish blue samples, thick and distinct curved bands were visible even with unaided eyes (see again, figure 1). Although, these bands appeared blue but these were quite different from those usually seen in synthetic blue sapphires. These were composed of blue coloured droplets (figure 4) which ranged from very fine to coarse in appearance. EDXRF analyses of these samples revealed a high concentration of cobalt, therefore, the possibility of these blue droplets corresponding to cobalt impurity cannot be ruled out.

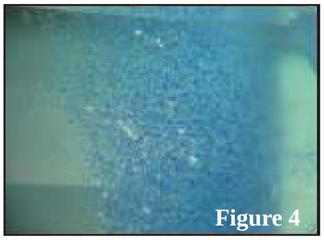
Figure 4

*Pinpoints in curved pattern*. In addition to the pinpoints described above, these synthetic sapphires also exhibited fine whitish pinpoints similar to gas bubbles or unmelted feed powder which was arranged in curved zones or clouds. These zones were mainly oriented along the axis running parallel to the table facets (figure 5). Such curved zones are formed along the length of the boule and represents the growth direction. However, in these samples, the 'optic' axis or the 'c' axis and the growth direction of the boule were at 90° to each other. The optic axis or the 'c' axis was oriented perpendicular to the table as 'uniaxial' optic figure was seen at the table, while the axis with circular zones parallel.

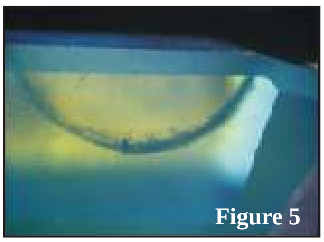
Figure 5

*Gas bubbles*. In addition to the minute gas bubbles presented in zones, some scattered spherical gas bubbles were also encountered.

*Wavy clouds*. In addition to the typical features associated with synthetic corundum, few uncommon inclusions were also observed. These comprised some wavy clouds (figure 6) composed of fine dotted inclusions and appeared white. Such clouds however did not follow any crystallographic orientations and appeared as if some stress cracks have been filled up by these dotted inclusions / pinpoints.


Figure 6

*Fingerprint-like feature*. In the green sample, one surface-reaching, fingerprint-like inclusion was observed (figure 7). It had a whitish appearance, suggesting they contained a foreign substance, as commonly seen in corundum exposed to high-temperature heating. In addition it also appeared iridescent as in case of natural sapphires.

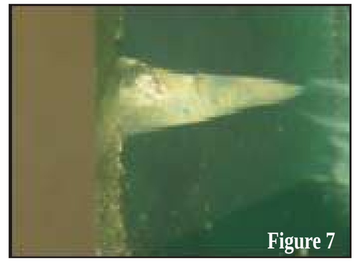
Figure 7

**EDXRF analysis**. Qualitative EDXRF analysis revealed the presence of Ca, Ti, Fe, and Ni in all samples. The presence of Ti indicates that the sheen producing inclusions are most probably rutile; this probability becomes even stronger due to the fact that Ti was detected only when the stones were analysed from the table facets. No Ti was detected when samples were analysed from the pavilion facets (which did not had such inclusions). Further, the greenish blue and green samples also revealed distinct Co peaks along with Cr (weak) and above mentioned elements.

## Conclusions

Although identification of these sapphires is not so challenging, but a care has to taken while dealing in such stones. Two of the stones studied here readily displayed the identifying features like curved zones, but this may not appear so convincingly in lighter coloured samples like in yellows. Further, when presented in the routine trade, these may pose problems for the traders, who in general do not use a lens or any other gem testing equipment.

**Table 1**: Gemmological properties of three different colours of synthetic sapphires displaying natural like 'sheen'

| Property | Description | | |
|---|---|---|---|
| Colour | Green (1) | Greenish blue (1) | Yellow (2) |
| Weight | 2.83 carat | 2.10 | 3.41 2.17 |
| Optic character | Anisotropic; uniaxial optic figure | | |
| Refractive index | 1.760 to 1.770; Birefringence 0.008 | | |
| Specific gravity | 397 | 398 | 397-399 |
| UV fluorescence | Bright chalky fluorescence under SW (restricted to table); inert under LW | | |
| SWUV transparency | Opaque | | |
| Chelsea filter reaction | Weak red at corners | Strong red intense towards blue zones | No reaction |
| Visible spectroscopy | Weak lines in the red end | Bands at 540, 580 and 630 nm | None |
| Inclusions | Minute inclusions (needles and pinpoints) , Curved bands (consisting of blue droplets), Curved zones of pinpoints Gas bubbles, Wavy clouds, Fingerprints | | |
| EDXRF | Presence of Ca, Ti, Cr, Fe, Co, Ni | Presence of Ca, Ti, Cr, Fe, Co, Ni | Presence of Ca, Ti, Fe, Ni |

# *A tourmaline crystal within a crystal*

*This article was first appeared in the Gem News International Section of the Gems & Gemology, fall 2008 issue, page nos. 272 273; authored by Mrs. Shyamala Fernandes and Mr. Gagan Choudhary*

Few months back, we had the opportunity to study an unusual 2.5 g tourmaline crystal (figure 8) that contained an intergrowth of a second, smaller tourmaline crystal. The specimen, reportedly from Nigeria, was loaned by Mr. S. K. Ajmera (Poorva's, Jaipur). The crystal was transparent and displayed characteristic tourmaline morphology, including a prismatic habit, a roughly triangular cross-section with broken terminations, and striations along the length of the prism. The stone appeared bright green when viewed from the sides, but much darker along the c-axis. From its appearance, it was readily identified as tourmaline.


**Figure 8**

Observed with transmitted light, the stone's unusual feature became evident: it contained an elongated crystal that was inclined to the length of main crystal (figure 9). With magnification, the prismatic habit of the included crystal was seen to be remarkably well developed. It displayed a pyramidal termination and a triangular cross-section (again, see figure 9). Weak striations along the length of prism also were visible. A small part of the included crystal extended beyond the host crystal, and it displayed a green color similar to that of the host.


**Figure 9**


**Figure 10**


**Figure 11**

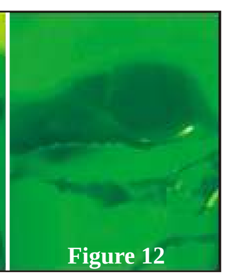
**Figure 12**

At higher magnification, the prism faces displayed fine etch marks (figure 10), which appeared angular (like two sides of a triangle. The pyramidal faces appeared to be coated with a bronzy material, and a complex pattern of triangular etching/growth hillocks was present (figure 11). In addition, this crystal displayed some angular growth zoning just below the pyramidal faces (figure 12). "Trichite" inclusions (hair-like fluid inclusions typically found in tourmalines) were present in both the host and the included crystal.

When observed between crossed polarizers, the specimen clearly showed an anisotropic nature. As we expected based on the orientation of the crystal within its host, the polariscope reaction of the inclusion was distinctly different from that of the host crystal (figure 13), indicating different polarization planes.


**Figure 13**

The surface features of the included crystal indicated variations in its growth conditions. We believe that it is "protogenetic," meaning it formed before the main tourmaline crystal. After the smaller crystal formed, its prism faces were apparently etched by residual fluids, and subsequently it was overgrown by the host tourmaline crystal.

### *Conference Report*

The 2nd International Gem & Jewelry Conference was organized by the Gem & Jewelry Institute of Thailand (Public Organization) on 9th and 10th of March 2009 at the Bangkok Convention Centre, Bangkok. This was followed by post conference excursion to the famous Kanchanaburi sapphire mines on 11th and 12th of March 2009. Various prominent gemologists from all over the world attended the conference and shared their topics of ongoing research and their outcome. Shri Gagan Choudhary, Asst. Director represented Gem Testing Laboratory, Jaipur and presented a poster on "Various Remarkable Stones Tested at Gem Testing Laboratory, Jaipur". The poster received a lot of appreciation and many participants were amazed to observe such varieties and types of stones encountered at the Gem Testing Laboratory, Jaipur. Discussions with various prominent gemologists and scientists from several parts of the world were quite fruitful and will prove to be helpful in routine certification and educational activities. Shri Gagan Choudhary also received much appreciated feed back from various gemologists on several articles / papers appeared in international journals like Gems & Gemology, Gems & Jewellery, Midlands Focus, etc over the years. This was nice to observe that the Gem Testing Laboratory, Jaipur is well-

## *An imitation Amber*

Natural resins like copal or kauri gum are commonly used as imitations for amber in addition to the plastic. However, these resins are also fused or embedded in the plastic matrix to produce more convincing imitations. In addition, materials like insects, flies, lizards or other reptiles are included in these imitations to make these more realistic. Adding on, 'pressed', 'reconstructed', 'reconstituted' or 'synthetic' amber is also commonly presented as amber.

Amber is known for its flora and fauna inclusions, which makes it a collectors' material and presence of some distinct eye visible inclusions is a treat to watch. In the past, lizards, frogs, small snakes, etc have been reported in addition to the flies and insects. However, such creatures may also be added to an artificial product like plastic or fused imitations.

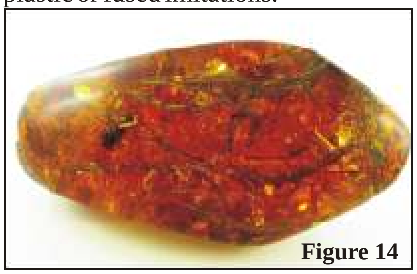

**Figure 14**

Recently, brownish yellow specimen weighing 1102.60 carats (figure 14) expected to be amber was submitted for identification and certification. The visual appearance readily indicated the specimen to be amber or any of its imitations. It was fashioned as a cabochon with highly pitted base having some brown coloured substance. The specimen contained number of large green coloured leaves randomly placed but appeared to follow some planes when viewed from side (figure 15). Presence of such planes suggested junctions of the fused pieces where leaves have been placed.

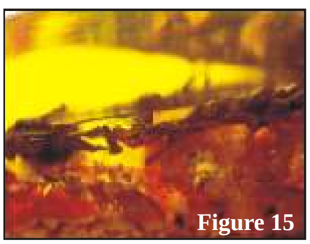

**Figure 15**

Such visual features along with the size were suspicious enough to point towards the nature of the specimen to be an imitation.

However, standard gemmological tests were performed to conclude the true identity. Polariscope reaction displayed a strong ADR effect throughout the specimen and not restricted to the inclusions. Spot refractive index was measured at 1.54; ultraviolet (longwave and shortwave) fluorescence displayed chalky greenish yellow and blue patches at the top surface of the specimen, while the bottom part remained inert. This is probably due to the deeper brownish coloured iron-based substance present at the base. Due to the large size of the specimen hydrostatic SG could not be measured but to determine, the piece was placed in the saturated salt solution (SG~1.13). The specimen was observed to sink at a low speed suggesting the SG of ~ 1.20. Reaction of the sample in the salt water ruled out the possibility of a natural resin, viz. amber, copal resin or kauri gum as all of these will be expected to float due to lower SG's of less than 1.10.

In addition to the standard gemological tests, hot point was also applied at the base of the specimen since it was already highly pitted and no effect of hot point would have been visible. The specimen showed distinct signs of application of hot point as commonly seen is plastics, while in case of amber or other natural resins, hot point did not show such distinct mark.

Besides the leaves, a large fly and numerous gas bubbles (figure 16.a) of various sizes were present. The specimen also contained flow like patterns and sun-spangled stress cracks.

**Figure 16 a**

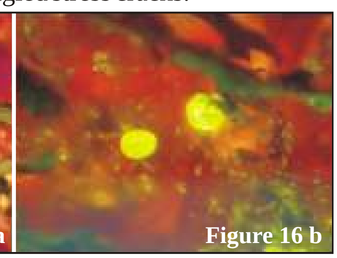

**Figure 16 b**

Other than the pattern of leaves, inclusion features were consistent with the natural resin like amber, copal or kauri gum, although higher specific gravity ruled out the possibility of these resins. However, in the past we have seen few pieces of 'imitation' amber which were made up by fusing amber or other natural resins in a plastic and display the similar properties described here for this sample; tough such fused pieces are simply identified as 'plastic'.

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