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GEM TESTING LABORATORY

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'Tairus' Created Gems: "Part II – Corundum"

This is second part of the two-part series of the study of synthetic gems produced by 'Tairus' Co. Ltd. by the hydrothermal process. First part comprised study of the Beryl set covering its gemmological properties and magnification features assisting in their identification. See Lab Information Circular Vol. 51, June 2008.

The corundum set consisted of 13 specimens of various colours/ varieties (figure 1). The set included four 'rubies' (all purple red varying in tone and saturation), two 'padparadscha sapphires (one pinkish orange and another orangish pink), two 'blue' sapphires of variable saturation, two 'yellow' sapphires, one purplish blue/ violet, one green and one colourless (with slight pinkish tint). All specimens were fashioned as 6X6 mm square steps.

Figure 1

Standard gemmological tests and advanced analysis on FTIR and EDXRF were performed on all the samples for our records, even though all samples were readily identifiable as a product of hydrothermal process. All samples displayed strong 'chevron' growth characteristics which were even seen with the unaided eye.

Gemmological Properties

The gemmological properties are described in table 1 and discussed below.

Refractive Index : The lower R.I value (e) varied from 1.764 to 1.775 while the higher value (o) varied from 1.773 to 1.784 with birefringence of 0.008 to 0.010. One of the rubies displayed unusually high values up to 1.784 that corresponded to high saturated colour.

Specific Gravity : The SG values varied from 3.96 for green colour to 4.00 for rubies.

Pleochroism: Dichroism varied weak in 'yellow' colours to strong in darker coloured varieties as in case of 'blue' or rubies.

Absorption Spectrum: The spectrum varied with the colour variety; rubies and 'padparadscha' sapphires displayed a typical chromium spectrum with rubies showing an additional cutoff in violet end. Blue to purplish blue sapphires also displayed chromium lines; one of the blue sapphires and a green sapphire also exhibited an absorption in yellow orange and yellow green regions.

UV Fluorescence: Most of the samples appeared red under long wave UV; weaker reaction in short wave. Few samples were also inert.

Chelsea Filter Reaction: Reactions varied from bright red (for rubies and padparadscha) to dull red (blue and green) and inert (yellow & colourless).

Internal Features: The inclusion study in most of the cases distinguishes a natural stone from its synthetic counterparts. This was so with these stones as well. The range of inclusions observed in this particular set of stones included:

1. ***'Chevron' growth features:*** The features (figure 2.a) typically associated with synthetic hydrothermal stones were visible even with the naked eyes in these stones. The feature was much stronger in darker coloured varieties. In few samples, 'hound's tooth' (figure 2.b) effect was also observed in the direction perpendicular to the chevron growth.
2. ***'Flaky' inclusions:*** Few samples consisted of flaky inclusions which appeared whitish similar to 'bread crumb' and arranged in planes (figure 2.c); the plane gave the impression of a seed plate and associated bread crumb inclusions. In addition, few 'bread crumb' like inclusions were also present scattered (figure 2.d) throughout the stone.
3. ***Liquid fingerprints:*** One of the blue sapphires also displayed fine liquid fingerprints oriented in random directions (figure 2.e).
4. ***Colour zoning:*** Few darker coloured varieties also displayed colour zones following the 'chevron' growth and / or 'Hound's Tooth pattern (figure 2.f)

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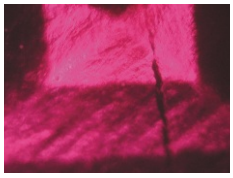
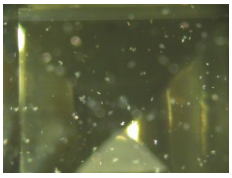
5. ***Milky zones:*** Few samples also displayed fine milky / cloudy patches following the 'chevron' and/ or hound's tooth pattern; the pinkish orange 'padparadscha' displayed strong angular milky zones composed of fine pinpoints (figure 2.g).


2a


2b


2c


2d


2e


2f

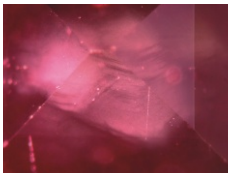
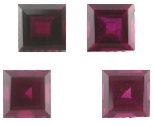
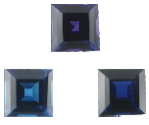

2g

Figure 2: Inclusions in 'Tairus' Synthetic Hydrothermal Corundum

Table 1: Properties of Tairus' created Corundum as studied at the GTL, Jaipur

Property	Ruby (dark to moderate purple red) 	Blue/ purplish blue / violet 	Yellow 	'Padparadscha' 	Green 	Colourless (slightly pink tinted) 
RI	1.764 - 1.773 1.775 - 1.784 (Highly saturated colour)	1.765 - 1.775	1.764 - 1.773	1.768 - 1.777 1.765 - 1.773	1.765 - 1.773	1.764 - 1.773
Birefringence	0.009	0.010	0.009	0.009 / 0.008	0.008	0.009
SG	3.98 - 4.00	3.96 - 3.98	3.97	3.98	3.96	3.97
UV Fluorescence	Strong Red - LW & SW	Weak Red - LW	Weak Yellow - SW	Strong Red-LW Moderate Red- SW	Inert	Pinkish Orange- LW
CF Reaction	Bright Red	Dull Red	Inert	Bright Red	Dull Red	Inert
Pleochroism	Strong; purple red ('ll' optic axis) and orangy red (⊥ optic axis)	Strong; violet or blue ('ll' optic axis) and reddish violet or greenish blue (⊥ optic axis)	Weak; shades of yellow	Strong; purple pink or orangy pink ('ll' optic axis) and orangy yellow (⊥ optic axis)	Moderate; green ('ll' optic axis) and yellowish green (⊥ optic axis)	None
Absorption Spectrum	Typical chromium as seen in natural and synthetic rubies	Chromium lines in the red end along with absorption in orange-yellow and green region similar to rubies	None	Typical chromium as seen in natural and synthetic rubies	Broad absorption in yellow-green region	Fine lines at the red end (as indicated by slight pink tint)
Inclusions	Strong 'chevron' growth, hound's tooth, planes of 'flaky' inclusions, colour zoning	Strong 'chevron' growth, liquid fingerprints	Scattered 'flaky' bread crumb like inclusions, chevron growth	Scattered 'flaky' breadcrumb like inclusions, chevron growth, milky zones composed of fine pinpoints	Chevron growth, colour zoning	Scattered 'flaky' inclusions
Trace Elements (other than Al)	Ca, Cr, Fe, Ga	Ca, Cr, Fe, Ni	Ca, Fe, Ni, Cu, Zn	Ca, Cr, Fe, Ni, Cu	Ca, Fe, Ni	Ca,Cr, Fe, Ni, Cu

EDXRF Analysis : Qualitative elemental analysis performed on all samples revealed the presence of Ca, Cr, Fe, Ni, Cu, Zn, and Ga as trace elements. Ni was present in high concentrations in blue, violet, green and yellow colours while rubies and colourless variety displayed lower concentrations. As per the manufacturer, blue colour is produced by Fe and Ti, but we could not detect the presence of latter one; similarly green colour is produced by adding Co impurity which was also not detected in our analysis. However, presence of Ni in violet, blue, yellow and green sapphires have previously been reported by Schmetzer K and Peretti A (1999), *Some diagnostic Features of Russian Hydrothermal Synthetic Rubies and Sapphires, Gems & Gemology, Vol.35, No.1, pp 17-28.* The presence of Ni in this synthetic corundum set is one of its identifying characteristics since this is not found in natural counterparts.

FTIR Analysis : FTIR spectra of all samples displayed complete absorption of wavelengths till 1600 cm^{-1}. However, two patterns of absorption were observed in the region 1700 to 4000 cm^{-1}. The absorption patterns varied with the body colour of the samples; violet, blue and green colours displayed sharp peaks at 2020, 2132 and 2401 with a broad absorption band ranging from 2600 to 3400 cm^{-1} (figure 3, top). All other coloured varieties displayed a similar pattern with an absorption band ranging from 3000 to 3600 cm^{-1} with number of peaks at 3313 (strong), 3399, 3447 (both moderate) and smaller peaks at 3481, 3526, 3567, 3606 cm^{-1} (figure 3, bottom). In addition, a moderate peak at 1739 cm^{-1} was also present.

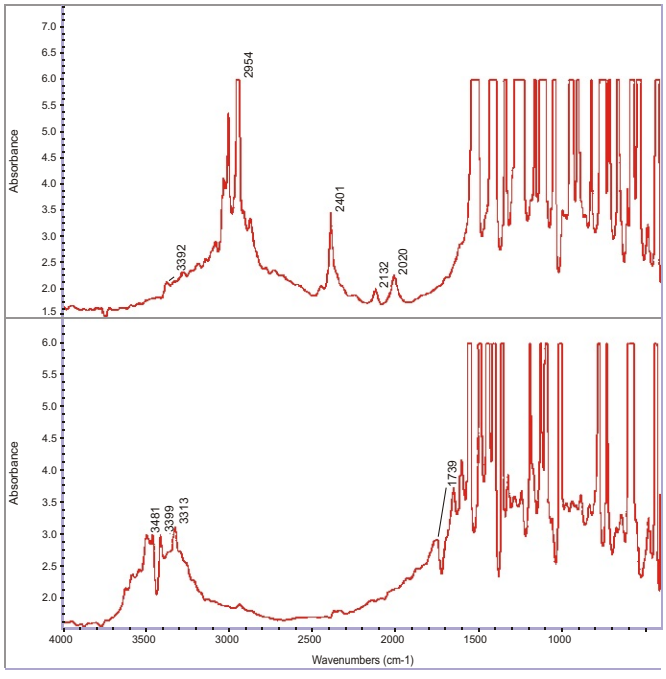


Figure 3:
FTIR Spectra of Tairus synthetic corundum

This two-part series of the study of Tairus created hydrothermal beryl and corundum sets, which were purchased for research and reference purpose, provides an insight in to their identification. Their standard gemmological properties, such RI and SG overlap with those of the natural counterparts. Microscopic features, such as, 'chevron' growth can readily identify this material. Ina addition, EDXRF and FTIR analysis provides a useful information regarding their origin.

GTL launches its own website…

As part of the exciting new initiatives, Gem Testing Laboratory is proud to announce the launch of the new personalized GTL website, which can be browsed by visiting **www.gtljaipur.info**. Till date, GTL had a webpage on The Gem & Jewellery Export Promotion Council's website which leads to an extended navigation. With the launch of GTL's website the users can interact with the laboratory directly and can get updates on gem news and events more frequently. The most exciting feature of the website is the report verification engine which will help the clients to use the gem identification reports more efficiently. This would enable the report holder to verify the report with him online. A user simply had to fill in the report number and the weight of the stone; the search engine will generate the details as appear on the report issued for particular stone. The website will also contain L.I.Cs enabling readers to have access online. Further, you may also register yourself for the LIC in electronic format. The website also has a Recruitment Centre where employers can put up their vacancies; this will help the students to find out details regarding the positions available in the industry.

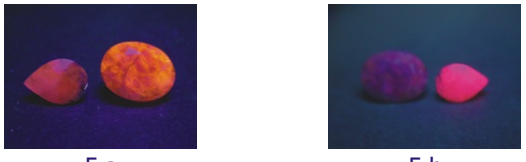
Homepage of GTL website. Your comments are highly valuable for improving the website.

'Tugtupite' from Greenland

Tugtupite is one of the rare and collectors' mineral discovered in Tugtup, Greenland in 1960 from where it derived its name- 'Tugtupite'. Recently, Mr. Jacob Hoyer of Italy donated two pieces (figure 4) of Tugtupite to GTL said to be from Ili maussaq Kvanefjeld of Greenland. One of the samples was purple (5.70 carat, oval mixed) while the other one purple pink (2.40 carat, pear mixed); both were translucent with white cloud patches giving a mottled effect to the stones.

Figure 4

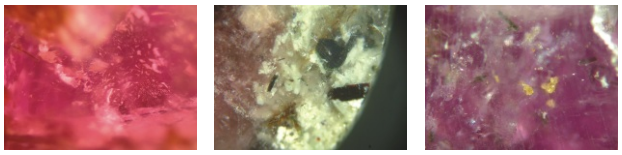
Vague refractive index was measured for both samples; the 5.70 ct sample displayed RI at around 1.485 while the other one at 1.495, with very low birefringence. Specific gravity for the purple tugtupite was measured at 2.29 while the pink sample had value of 2.42. Most striking feature of these samples was the reaction under UV lamp; they displayed a characteristic bright orange fluorescence under long wave (figure 5.a) while under short wave, only one of the samples (2.40 ct, pear mixed) displayed a bright glow of red colour (figure 5.b).



5 a 5 b

Figure 5

Under magnification, white cloudy patches were observed along with reflecting liquid fingerprints (figure 6.a). These liquid fingerprints closely resemble to those observed in tourmalines. In addition to the cloudy patches, some white crystals were also seen having a squarish profile (figure 6.b). Further, many various types of crystal inclusions were seen in these two pieces of tugtupites, which included clusters of some yellow cubic crystals (figure 6.c), brown crystals (again, figure 6.b) with a square profile, clusters of transparent green crystals, etc.



6 a 6 b 6 c

Figure 6

Qualitative EDXRF analysis revealed the presence of K, Ca, Fe, Ni, Cu, Zn, and Ga in addition to Al and Si as major elements; other elements like Be or Li are too light to be detected by EDXRF.

Another interesting part of these specimens is the change of colour after exposure to the UV lamp. When the samples were taken out from the darken cabinet after recording the fluorescence reactions, a notable change of colour was seen in the samples, especially in purple piece. It was amazing to see a darker shade (figure 7) of the samples after exposure to UV light; however the original colour was restored on exposure to strong fibre optic light.

Figure 7

Although this mineral is not commonly used as a gem but the collectors are always interested because of its characteristic reactions under ultra violet light.

A synthetic emerald necklace

Figure 8

Recently, we received for identification an interesting necklace of four strings constructed of emeralds, which weighed approximately 3093 carats. On examining through the Chelsea filter, few of the beads appeared red while few remained inert. The depositor was known to these reactions and was checked by him. Such reaction led him to draw a conclusion regarding the origin of these emeralds as "synthetics mixed with few natural pieces". However, magnification features revealed that all beads were synthetic. Two different sets of inclusions were seen; one set comprised of inclusions which are associated with the 'hydrothermal' growth while the other one with the 'flux-fusion'. Red reaction was displayed by emeralds grown by flux fusion while inert specimens were grown by the hydrothermal process.

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