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Composites - A new look!

For many decades 'composite' gem materials have been made to imitate well-known gem materials like emerald and corundum, to improve the overall appearance of a gem or to provide durability for a specific gem like opal. However, there are other instances when composites have been made to create fancy materials with their own eye-catching appeal as described in one of the articles, 'Innovative composites Fusion' (figure 1) published in the Gems & Jewellery (June 2008, volume 17, no. 2) magazine of the Gemmological Association of Great Britain, authored by Gagan Choudhary. The article described various combinations of commonly available gem materials such as citrines, amethysts, lemon quartz and topaz. This changed the concept of composites (see again, figure 1), which are usually made to imitate a well-known gem material or to increase durability. For many years composites have been made using two or three materials joined together along of near the plane of the girdle to enhance the colour or durability, which was not the case in these composites.

Figure 1: Innovative Composites 'Fusion'

2a 2b

Figure 2: These specimens were interesting for their unusual composite patterns

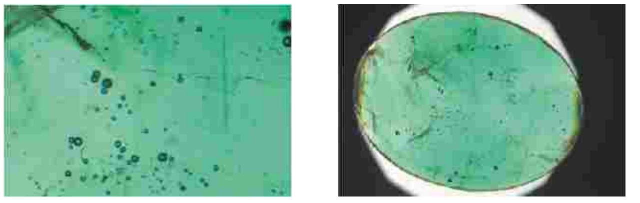
Recently two green stones were submitted to the Gem Testing Laboratory Jaipur for identification within a period of one month, both of which proved to be composites. The two stones (figure 2.a & b) weighing 2.64 and 7.58 ct and measuring 9.93 x 7.62 x 5.50 mm and 13.66 x 10.76 x 7.45 mm respectively, warrant a description due to their interesting and unusual nature.

Preliminary observations indicated that the stones could be emerald on the basis of their colour (see again, figure 2). Both specimens were green of medium to high saturation with fairly good transparency, and a few scattered black inclusions along with 'feathers' and tubes were visible. These features were quite enough to identify the specimens as natural emeralds. But gemmology teaches us not to give a conclusive identification of a stone unless it has been analyzed thoroughly and hence we observed the stones under the microscope. The features we saw were shocking.

Magnification features

Both specimens displayed similar features which were unusual but distinct enough to identify the nature of the stones. When seen through the table facets, the 2.64 ct specimen displayed fine bladelike features (figure 3) oriented perpendicular to the table facet and some liquid-filled 'fingerprints', while the 7.58 ct specimen displayed many long tubes and scattered blackish crystals. All these inclusion features are associated with an emerald of natural origin.

Figure 3: 'Blade-like' features in beryl portion



4a 4b

Figure 4: Scattered gas bubbles with circular features (a) and green of varying saturation following the facets (b)

However on careful examination, focusing deep inside the stone, many scattered gas bubbles (4.a & b) were seen. These gas bubbles appeared to be restricted to some specific areas near the pavilion facets, giving rise to doubt about the true nature of these stones.

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On further examination fine circular features were also observed (figure 4.a), typical of the flattened gas bubbles seen along the junction planes of composite gem materials. In order to confirm their exact nature, we observed the stones immersed in bromoform using transmitted diffused light. This revealed the presence of many layers stuck on the pavilion facets. The central area appeared to be pale green or colourless while the pavilion surface areas were deep green (figure 4.b and 5). These deep green areas consisted of several smaller units which varied in saturation and these variations followed the surface profile of the stone (see again, figure 4.b).

Figure 5: Deep green (glass) area towards the pavilion, while central area is pale green (beryl)

In addition, there were fine yellowish junctions between various layers (Figure 6) which could have been due to glue. The presence of such junction planes proved the stones to be composites. Magnification revealed that they were composed of a central pale coloured faceted material with smaller deeper green pieces glued to the pavilion areas.

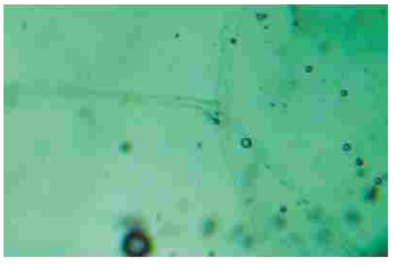

Figure 6: Yellowish junction between the layers due to glue

The central near-colourless region and the pavilion areas displayed different inclusion patterns. Features such as crystals, tubes, blades, liquid 'fingerprints', generally associated with a natural stone, were observed in the central area, while gas bubbles could be seen in the pavilion. The inclusion features indicated the use of a pale coloured beryl in the centre surrounded by glass segments. However, further tests were conducted in order to identify conclusively the nature of materials used.

UV fluorescence

Ultraviolet (UV) light plays an important role in the identification of composite gem materials and so it proved with these stones; an eye-catching reaction was observed when the specimens were exposed to long- and short-wave UV light. A chalky bluish glow was displayed along the junction planes on the pavilion area (figure 7). This fluorescence effect, restricted to just below the pavilion surfaces, appeared to have been caused by glue.

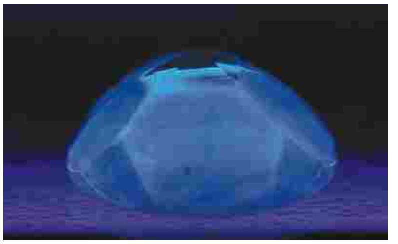

Figure 7: UV Fluorescence

Gemmological properties

The refractive index (RI) measured on the table facet revealed the values of 1.580 to 1.588 with birefringence of 0.008, while pavilion areas gave values of 1.520 with no birefringence. These RI values were consistent with those of beryl and glass respectively. The FTIR spectrum also identified the central material as beryl of natural origin. Specific gravity was not measured as it is of little diagnostic use for composite stones. No absorption features were seen under desk model spectroscope and the stone was inert under the Chelsea colour filter. Therefore the stones were identified as beryl at the centre (table) surrounded by pieces of glass on the pavilion.

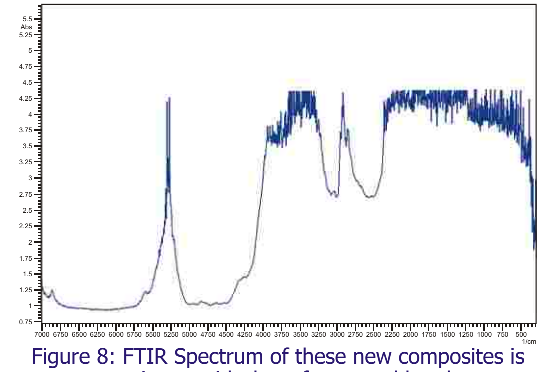

Figure 8: FTIR Spectrum of these new composites is consistent with that of a natural beryl

Conclusions

The identification of these composites was not difficult but careful observations were required. So far we have encountered only two specimens of such composites, but we do not know in what quantities these are being manufactured. If mixed in packet lots, identification and separation of these composites would become a real challenge, especially in routine dealings. These instances reveal that innovative minds who try to develop new materials on a regular basis for deceiving and making good profits are currently active in the trade.

Dyed Pink Alabaster

(This article was first published in Gems & Gemology, winter 2009, pg 309-310)

A massive variety of mineral Gypsum ($CaSO_4.2H_2O$), alabaster is usually colourless, white or gray, with various shades of yellow, orange, brown or even black due to impurities. Gypsum has a Mohs hardness of 2 and is therefore too soft for use as a gem, but it has been fashioned into beads and carvings. However, a cabochon of alabaster (figure 9) was submitted to the Gem Testing Laboratory of Jaipur, India for identification and it has unexpected orangy pink colour.

Figure 9: 'Dyed' Pink Alabaster encountered at the Gem Testing Laboratory, Jaipur

At first glance, the 14.32 ct specimen (17.59 x 12.86 x 8.07 mm) resembled chalcedony or opal because of its translucency. However, the lustre was much too dull and had a distinctive waxy appearance. Fine chips on the dome revealed white powdery white composition (again see, figure 9). The powder was easily removed when wiped with a finger, indicating a very low hardness; this was confirmed by scratching an inconspicuous part of the cabochon with a fingernail. Hence, the specimen could not have been an opal or a chalcedony.

Such low hardness pointed to gypsum, which was confirmed by the spot RI at 1.52 and hydrostatic SG of 2.31. It had a patchy yellow-orange reaction to UV radiation, with a stronger reaction to long wave. Viewed with the desk-model spectroscope, the sample displayed two closely spaced bands in the green region. This absorption pattern is associated with some red dyed quartz, supporting the possibility that the alabaster was dyed. With magnification, the stone clearly exhibited concentrations of red and pink colours in surface reaching fractures (figure 10). Colour variations also were observed in the form of curved bands, with darker zones of concentrated dye in some areas and portions of the original white body colour clearly visible in others (again, see figure 10)

Figure 10: Colour concentrations along surface reaching fractures

The sample's FTIR spectrum (figure 11) displayed complete absorption up to ~5300 cm^{-1}, and bands from 5800 to 5400 cm^{-1} and 6700 to 6300 cm^{-1}. This pattern resembled that of colorless gypsum in our database, and it is commonly associated with other hydroxyl minerals. The complete absorption of wavelengths in the 3200 2700 cm^{-1} region precluded the detection of any absorption features related to organic dyes or other substances such as wax. Qualitative EDXRF analyses revealed the expected S and Ca, and traces of Sr, but no elements related to a coloring agent were detected.

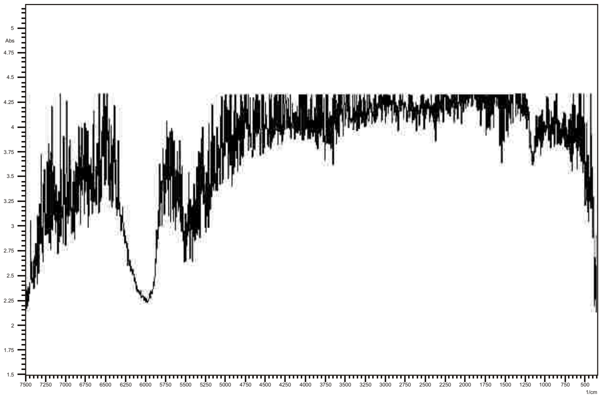

Figure 11: FTIR Spectrum of 'Dyed' Alabaster

Dyed gypsum was mentioned in the summer 1963 issue of Gems & Gemology (R. Crowningshield, "Developments and Highlights at the Gem Trade Lab in New York,"p.44) and in the Fall 1964 Gems & Gemology (R.T. Liddicoat, "Developments and Highlights at the Gem Trade Lab in Los angeles,"p.219); the latter report stated "A group of pieces of inexpensive antique jewelry contained green and pink coloured beads that proved to be dyed-and-heavily-waxed alabaster." Although the lustre of the present cabochon also suggested that the wax had been applied in addition to dye, there was no evidence of wax seen when the sample was scratched, and hot point testing was not performed.

Polymer - filled Tanzanite

Clarity enhancement in gemstones is not new, though most attention has been focused on emerald. However, impregnation of other stones like aquamarine, amethyst, tourmaline, etc. is known for many years. Recently, we had an opportunity to examine two specimens of tanzanites, which were submitted for identification by Mr. Manoj Dhandia, who insisted to test for the signs of impregnation (figure 12). The tests confirmed the presence of polymer-based substances like resin in the fissures and open tubes of the specimens.

Figure 12a

Figure 12b

Tanzanite is mainly known to be heated to produce the rich purplish blue colour from brown or green colours. In the recent past, coatings on light coloured tanzanites to produce a richer blue have been evolved which was also discussed in the Lab Information Circular Vol. 53, January 2009. However, coatings are usually applied to smaller sized stones as compared to heating, which is done on any size.

The two submitted specimens were round drilled beads (see again, figure 12) weighing 9.30 and 7.86 carats respectively had large fissures and surface reaching fractures. Both specimens were readily identified by their gemmological properties, such as spot refractive index of 1.69 (with weak birefringence blink), hydrostatic SG of 3.15 (values were slightly on a lower side, because of the presence of drill holes) and a distinct pleochroism displaying purplish blue and pink colours. Under long wave UV lamp, both specimens displayed a patchy and chalky fluorescence, usually associated with polymer-impregnated stones.

Figure 13: Growth tubes filled with polymer like substance

Upon magnification, large cavities were observed, which were filled with some thick whitish substance; these appeared to be the openings of large tubes present (figure 13) within the stone.

In addition, some surface reaching cracks also displayed similar thick and whitish substance which also appeared wavy and showed some flow patterns. Further, some of the fractures also displayed iridescent colours (figure 14), which are usually associated with oiling.

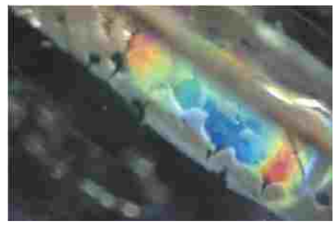

Figure 14: Filled tubes and fractures display whitish wavy pattern and iridescence

These features indicated the presence of some polymer like substance in the fissures; however conclusion can only be drawn by FTIR analysis. The region between 3200 and 2800 cm^{-1} showed features (figure 15) diagnostic for the presence of polymers. It showed the characteristic peaks for polymer e.g. resins at ~ 3043 and / or 3061 cm^{-1} in addition to peaks at 2926 and 2852 cm^{-1} which is associated with oils.

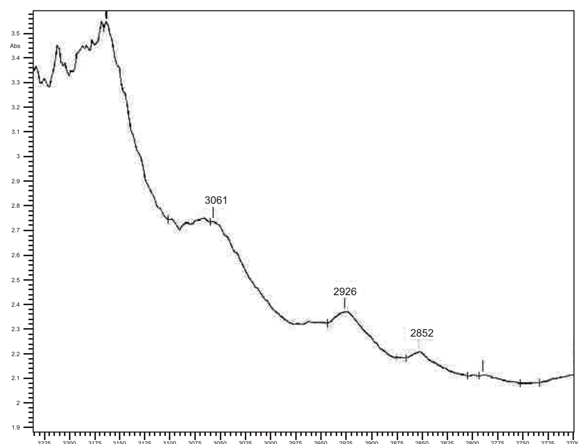

Figure 15: Typical FTIR spectrum of polymer-filled tanzanite

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