And now composite chalcedony!

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From the years 2008 - 2012, we have seen various types of new and innovative composites, many of which have been reported in various gemmological journals. Some of which can be read this website too. On the same lines, this article presents a brief report on few more interesting composites which were made up of pieces of green and orange chalcedonies. The author examined three specimens (figure 1) submitted for identification at the Gem Testing Laboratory, Jaipur which consisted small pieces of chalcedonies held together in a polymer-based matrix. These composites were however very similar to those reported by this author in "A New Type of Composite Turquoise", Gems & Gemology, Vol. Vol. 46, No. 2, pp 106-113.

Figure 1: These three composite specimens, dark green (left), light green (centre) and orange (right) with golden and silvery white matrix were submitted for identification at the Gem Testing Laboratory, Jaipur were turned out to be made up of chalcedony.

Visual Appearance

The three specimens (figure 1) varied in colour from dark green (left) to light green (centre) and orange (right) with golden and silvery white matrix. The visual appearance was enough to identify the specimens as 'composites'. The darker green specimen had a golden matrix while the lighter green and orange specimens had silvery white matrix. All the three specimens were fashioned as cabochons. The lustre of all the three specimens was waxy to dull vitreous which indicated the possibility of chalcedonies, while the matrix portions displayed even duller lustre (figure 2) commonly associated with polymers. The specimens with silvery white matrix also displayed a sheen effect similar to those observed in some shells. Further, transparency of the individual green and orange chips varied from semi-transparent to translucent.

Figure 2: The green and white veined areas distinctly displayed differences in lustre. Note the duller lustre of the polymer filled areas. Magnified 25x

Microscopic examination

Even though the specimens were readily identified as composites by their visual appearance, exact nature of the individual pieces was still to be determined. When magnified, many of the individual pieces displayed a circular to semi-circular banded structure in botryoidal pattern (figure 3) in addition to some cloudy patches. This structure is typically associated with many microcrystalline materials like chalcedony. When concentrated on the white areas, distinctive flow patterns (figure 4) were observed with some depressions due to the softness of the polymer at various places within the vein. At some areas, large gas bubbles (figure 5) were also seen confirming the presence of some polymers; at some places, hemi-spherical cavities were also seen which were formed as a result of explosion of gas bubbles during polishing. In addition, a needle probe in the white areas made indents quite readily. At higher magnifications, this white area displayed the presence of some densely packed tiny white particles / platelets (figure 6) which also appeared iridescent at some angles. The shape of these platelets were irregular, however some of them were triangular (see, again figure 6). These tiny platelets appeared to be responsible for the sheen effect observed in the white veined areas. The brassy yellow veins in one of the samples (figure 1, left) were composed of some flaky substance which was readily observable even at a lower magnification, which was identified as Cu and Zn based substance, example brass, by EDXRF analysis.

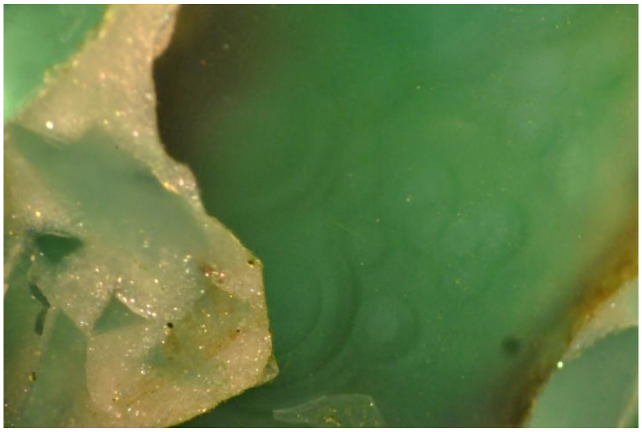

Figure 3: Some of the individual pieces displayed a circular to semi-circular banded structure in botryoidal pattern. This structure is typically associated with many microcrystalline materials like chalcedony. Magnified 45x

Figure 4: The white areas displayed distinctive flow patterns. Also note depressions at various places. Magnified 45x

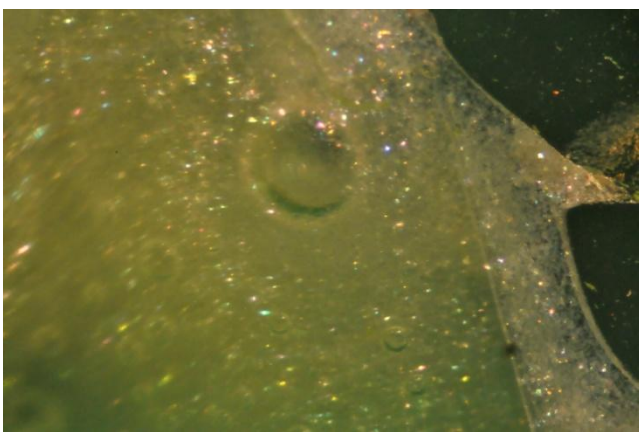

Figure 5: Presence of large gas bubbles also confirmed the existence of polymers. Magnified 45x

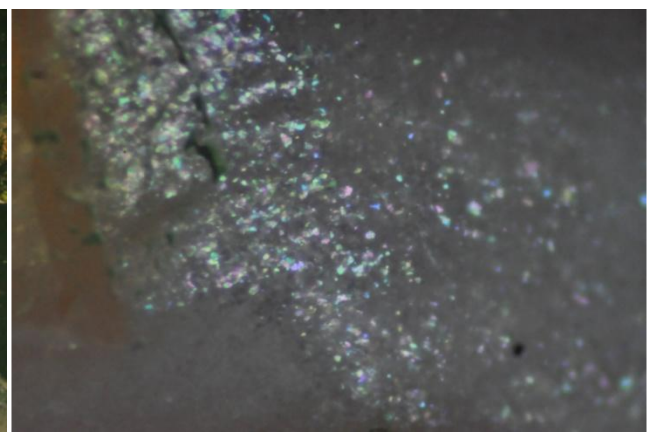

Figure 6: White areas also displayed the presence of some densely packed tiny white particles / platelets which also appeared iridescent at some angles. Also note the shape of some platelets as triangular. Magnified 60x

UV Fluorescence

Another interesting feature of these composites was their reaction under long wave UV. The white veined areas in the centre and right specimens in figure 1 displayed a bright blue reaction, while the brassy yellow veins remained inert (figure 7). This reaction was however expected for white areas because of the presence of the polymers and tiny white platelets.

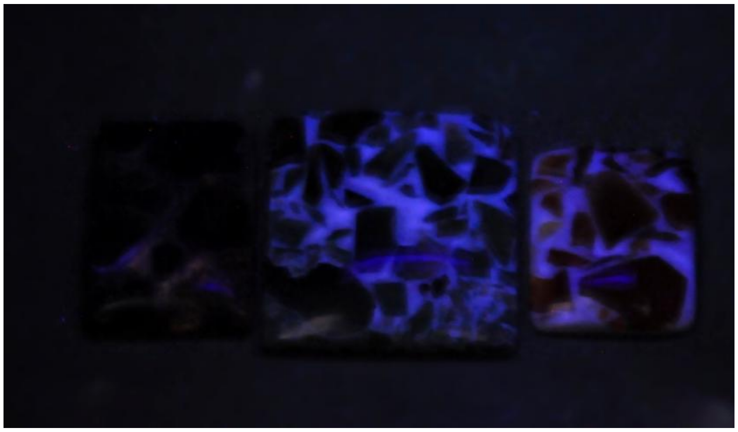

Figure 7: Under long wave UV, white veins displayed a bright blue reaction

Gemmological Examination

Although the specimens were identified as composites, exact nature of the green and orange pieces was still under question. Therefore, standard gemmological testing was performed which identified the pieces used as chalcedony. Key properties are listed in Table 1.

Table 1: Properties of three composite chalcedony specimens reported here

	Samples		
Property	*Dark Green with brassy yellow veins (figure 1, left)*	*Light Green with white veins (figure 1, centre)*	*Orange with white veins (figure 1, right)*
Weight (in cts.)	31.10	57.12	19.30
Dimensions (in mm)	28.00 x 19.82 x 6.01	32.00 x 30.20 x 7.24	24.90 x 19.91 x 5.57
Refractive index	1.54 (spot) – green area	1.54 (spot) – green area	1.54 (spot) – orange area
Specific gravity	2.18*	2.08*	1.82*
Abs. spectrum	Chromium lines in the red region		None
UV fluorescence	Inert	Bright blue along the veins in long wave	
FTIR spectra	Complete absorption of wavelengths up to around 4000 cm^{-1} and two humps at around 4500 and 5250 cm^{-1}		
EDXRF analysis	Si, Cr, Fe, Cu, Zn	Si, Ca, Cr, Fe	Si, Ca, Fe

* Lower SG values due to the presence of polymers

FTIR analysis

In addition to the standard gemmological examination, FTIR spectra were also collected for all the three samples. The spectra displayed complete absorption of wavelengths up to around 4000 cm^{-1} and two humps at around 4500 and 5250 cm^{-1}. This spectral pattern is typically associated with the chalcedonies; hence this provided additional support to the identification as chalcedony. Features related to polymer could not be seen due to the complete absorption of wavelengths in the region associated with polymers.

EDXRF analysis

In order to find out the nature of the brassy yellow and white veins, EDXRF analysis was done on all three samples. The sample with brassy yellow veins displayed the peaks for Cr, Fe, Cu and Zn in addition to Si; Cu and Zn are the brass forming components, hence the possibility of fine flakes of brass along the veins cannot be ruled out. The white veined samples exhibited the presence of Ca in addition to Cr (green sample), Fe (orange and green samples) and Si. Therefore, on the basis of microscopic observations, fluorescence reaction and EDXRF analysis, it is a possibility that these white veins may be composed of crushed shell ($CaCO_3$) mixed in a polymer.

Conclusions

These composites made up of pieces of chalcedony held together in a polymer matrix are similar in nature to the composite turquoise with metallic veins as described by the author in "A new type of composite turquoise, Gems & Gemology, Vol. 46, No. 2, pp 106-113". Although these provide a wider range of materials for the consumers to choose from, care has to be taken regarding its correct and proper disclosure.

All photographs and photomicrographs by Gagan Choudhary