Fracture-filled Synthetic Emerald, with Quartz Inclusions

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Recently, the Gem Testing Laboratory, Jaipur, India, received a 1.15 ct, green, oval mixed cut, measuring 8.02 x 5.86 x 4.06 mm (Figure 1). Initial observation with the unaided eye suggested it was emerald. RI values were 1.580–1.587 (birefringence = 0.007), the hydrostatic SG was 2.70 and it displayed typical Cr-absorption in the desk-model spectroscope. All of these features are consistent with emerald. Viewed with the microscope, strong wavy 'chevron' growth features were seen throughout the stone (Figure 2); in addition, some reflective liquid 'fingerprints' also were present, mostly in one direction. These features are indicative of a hydrothermal synthetic origin. The gem also contained surface-breaking fractures that displayed blue, green and 'golden' yellow colour flashes (Figure 3)—suggestive of fissures that have been filled with resin—along with a few reflective patches that resulted from incomplete fracture filling. This is the first time our laboratory has encountered a fracture-filled synthetic emerald.

Figure 1: This 1.15 ct hydrothermal synthetic emerald proved to be fracture filled, and also was unusual for its quartz inclusions.

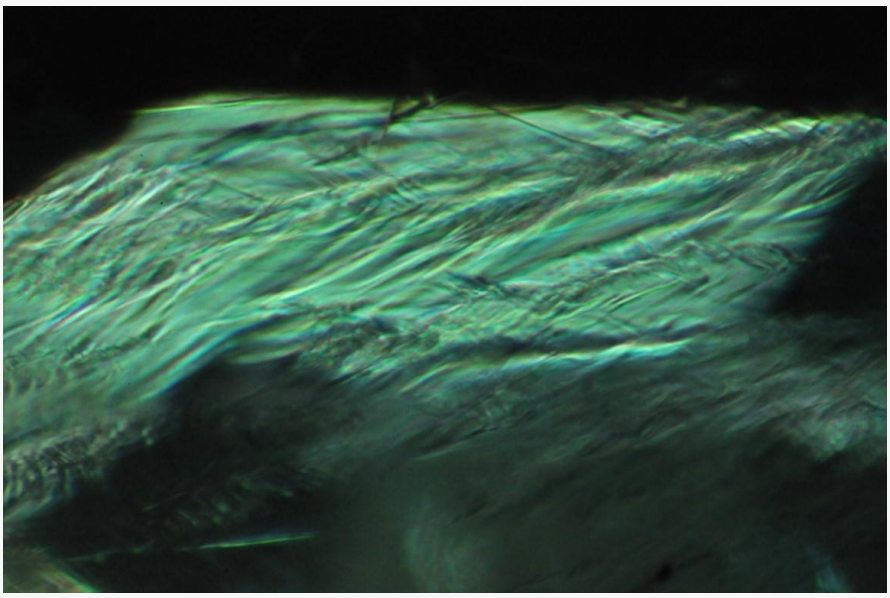

Figure 2: The emerald in Figure 1 displayed a strong wavy 'chevron' growth pattern, indicating a synthetic origin by a hydrothermal process. Image width 4.6 mm.

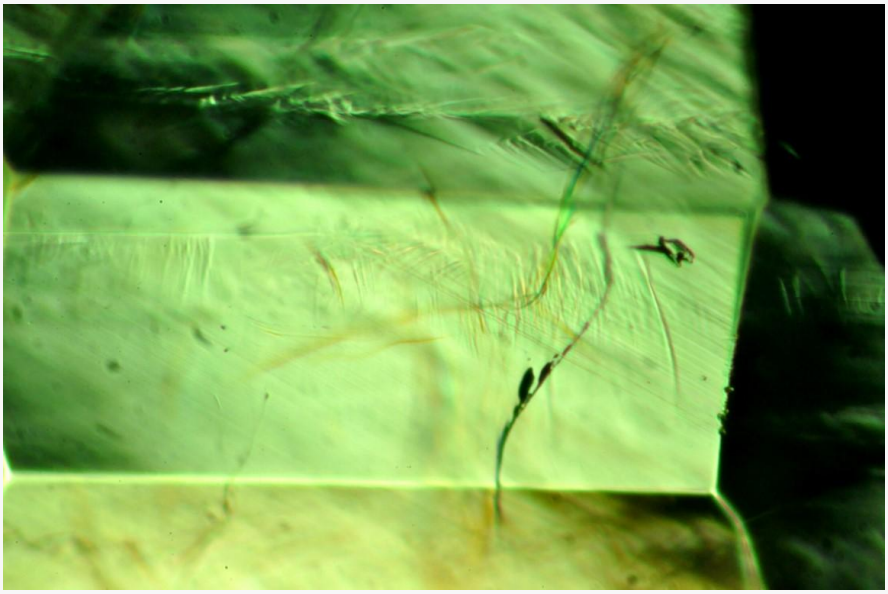

Figure 3: Surface-reaching fissures in the synthetic emerald displayed flash-effect colours suggestive of fracture filling by a resin, along with some reflective patches of uneven filling. The presence of resin was confirmed by FTIR spectroscopy. Also note the nail-head spicule (center-right of view), consistent with the synthetic origin. Image width 4.6 mm.

Microscopic examination also revealed a few colourless crystals in the synthetic emerald. On careful examination, some of these crystals were found to be associated with nail-head spicules (again, see Figure 3), while others formed isolated clusters of elongated inclusions. Closer observation of one of the spicules showed a hemispherical 'head' that appeared to be composed of tiny grains, some of which were granular and frosty (Figure 4, left). The isolated clusters (i.e. without a spicule) consisted of euhedral prismatic bipyramidal crystals (Figure 4, right). The morphology of these crystals, particularly the larger ones, resembled that commonly seen in quartz.

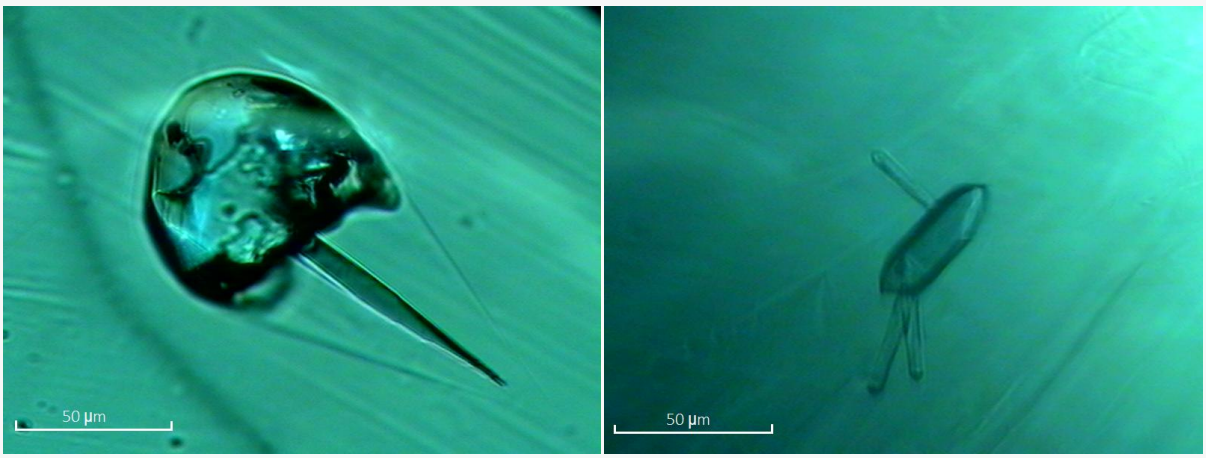

Figure 4: On the left, this spicule in the synthetic emerald consisted of a hemispherical 'head' composed of tiny grains, some of which were granular and frosty. Raman analysis of the 'head' showed the presence of quartz. The photo on the right shows a cluster of well-formed crystals that also were identified as quartz by Raman spectroscopy.

Raman analysis of the crystals, present as the 'head' of the spicules as well as isolated clusters, using a 532 nm laser, confirmed them as quartz. The spectra showed major characteristic peaks in the 2000–200 cm^{-1} region at ~1157, 1080, 807, 464, 353, 263, and 206 cm^{-1}. FTIR spectroscopy was further used to confirm this emerald as synthetic. The spectra displayed a sharp line at ~5280 cm^{-1} (type II water) with side bands for type I water at around 5500–5380 and 5150–5040 cm^{-1}, an absorption band ranging from 4000 to 3400 cm^{-1} and general absorption below 2100 cm^{-1}. The synthetic origin was proven by the 2400–2200 cm^{-1} region, with bands at ~2358, 2340 and 2328 cm^{-1}. The CO_2 band at ~2358 cm^{-1} is usually present in association with a feature at 2291 cm^{-1} in natural emerald (not present in this sample); further, bands at ~2340 and 2328 cm^{-1} are typical of synthetic emerald (Giard et al, 1998). In addition, the FTIR spectra also displayed features at ~3060, 3032, 2923 and 2871 cm^{-1} that are associated with resin, consistent with the flash effects mentioned above.

The 'head' of the spicules in synthetic emeralds is usually composed of grains of phenakite, beryl, chrysoberyl, gold, or other mineralisers (Choudhary and Golecha, 2007). The presence of quartz inclusions in synthetic emerald—either as the 'head' of spicules or forming isolated crystals—has not been reported previously, to this author's knowledge. In addition, the fracture filling of this synthetic emerald is quite unexpected, and could have occurred when the gem was accidentally mixed into a parcel of natural stones.

References

Choudhary G. and Golecha C., 2007. A study of nail-head spicule inclusions in natural gemstones. *Gems & Gemology*, 43(3), 228–235, http://dx.doi.org/10.5741/gems.43.3.228.

Giard D., Giuliani G., Cheilletz A., Fritsch E. and Gonthier E., 1998. *L'émeraude - Connaissances Actuelles et Prospectives*. Association Française de Gemmologie, Paris, France, 81–95.

All photographs by Gagan Choudhary

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