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GEM TESTING LABORATORY

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Beryllium Treated Yellow Sapphires - yet another challenge!

The treatment techniques of rubies and sapphires are developed, modified and improved on a regular basis. This has been witnessed since the beginning of this century, when in the late 2002, beryllium treatment on pink sapphires was commenced to produce the pink-orange "padparadscha" colour. This was followed by the introduction of glass-filling in rubies with high refractive index substances like lead and bismuth in the year 2004. GTL have also described these treatments, their identifying criteria and implications on the gem trade from time to time in the past Lab Information Circulars.

The beryllium treatment which was commenced on the pink sapphires to produce the pink-orange "padparadscha" colour was further modified to produce various fancy colours of sapphires which usually had higher degree of saturation. The most popular of the colors produced by this treatment are vivid and bright brownish yellow to orangy yellow, which are often classified as "Bangkok" sapphires in the trade. Furthermore, the treatment process seems to have become even more complicated than the earlier techniques.

In the country like India, where yellow sapphires are one of the most common 'Navratnas' received a lot of popularity. The

Figure 1: Typical colour shades of beryllium treated sapphires known as 'Bangkok Sapphires' in the trade

reason being, these are available in good colour with high clarity and the most important one – at a cheap price. Availability of these "Bangkok" sapphires in huge quantities raised the prices of untreated yellow sapphires, especially those from Sri Lanka. These Sri-lankan sapphires are characterized by the lemon yellow to orangy yellow in colour which is not as intense as the treated counterparts are. However, some of the untreated sapphires display extremely fine and saturated colours; these colours are also produced by heating and irradiation.

Since the last 7-8 months, we at the Gem Testing Laboratory are receiving for identification many yellow sapphires whose colours are typically associated with those of Sri-Lanka i.e. lemon yellow to orangy yellow. When tested, these turned out to be beryllium treated. Hence, this indicates the arrival of a new type of process of treating yellow sapphires, especially from Sri Lanka. Heating of colourless or pale coloured sapphires from Sri Lanka are quite common in the trade, however, many of them are unaffected by heat and as a result do not turn yellow. Such pale coloured or colourless sapphires when heated with beryllium produce a colour centre and thereby change the colour to yellow. The colour of such treated sapphires is stable against the heated or irradiated counterparts, which usually fades off after few weeks / days of exposure to sunlight.

Figure 2: Colours of natural (a), heated (b) and beryllium treated (c) sapphires from Sri Lanka are identical, hence identification is very difficult.

Identification

Identification of beryllium treated corundum is very difficult or in some cases impossible with classical laboratory techniques. Although, there are few features which when present provides information regarding the treatment. Observations under the microscope with immersion give important clues (see Box A). Some of the features to observe include, melted, damaged or frosted crystals; often these damaged crystals produce a stress around them, known as 'burst halos'. These halos also exhibit the signs of recrystallisation giving a 'fern-like' appearance. Since, the temperature used for performing beryllium treatment is too high, few areas of the corundum melt and as the temperature is lowered, this molten corundum re-crystallises. However, the above mentioned features are associated with high temperature heating but these have been seen in corundum only after the development of beryllium treatment. Therefore, these features can only be considered as conclusive proof of heat treatment and not of beryllium. One of the features, which are typically present

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Box A: Important identifying features observed in beryllium treated sapphires

a. Healed Fingerprints

b. Healed Fingerprints / Burst Halo with a glassy reflection & white edges

c. Cloudy healed fingerprint with associated halos

d. Zones of dotted inclusions / silk

e. Burst halo with a sugary crystal and 'fern-like' pattern formed due to re-crystallisation

f. Presence of colour rim conclusively identifies beryllium treatment

only in beryllium treated sapphires, is 'blue halo' or 'blue spot', which is caused due to the internal diffusion titanium around a crystal inclusion. In addition, one important feature observed in beryllium treated stones is the colourless or light-coloured rim with sharp outlines following the shape of the stone. Although, this rim is not present in all beryllium treated stones, but when present, can be considered as the identifying feature. To see the rim, the suspected stone is immersed in methylene iodide liquid and viewed in transmitted diffused light.

Conclusive identification of the beryllium treatment is carried out on the basis of elemental analyses performed on LA-ICP-MS (Laser Induced-Inductively Coupled Plasma- Mass Spectroscopy) or LIBS (Laser Induced Breakdown Spectroscopy), however availability of these equipment is limited only to few gemmological laboratories across the globe. Also, in some cases, the cost of testing is more than the cost of the stone itself.

In the recent past, FTIR (Fourier Transform Infra Red) spectrometer has become a powerful tool in identifying beryllium treated yellow sapphires from their untreated counterparts. The equipment is available with the Gem Testing Laboratory, Jaipur and is routinely used in the detection of treatments in sapphires. Natural yellow sapphires characteristically display a peak at 3161 cm^{-1}, while beryllium treated shows a hump at around 3050 cm^{-1}; no absorption features are seen in heated samples (especially from Sri Lanka). These results have been drawn after a research conducted at the Gem Testing Laboratory for several months on natural, heated and beryllium treated yellow sapphires originating from Sri Lanka. Such features have also been reported by Atichat et al (2009, The 2nd International Gem & Jewelry Conference, Bangkok, Thailand; proceedings volume).

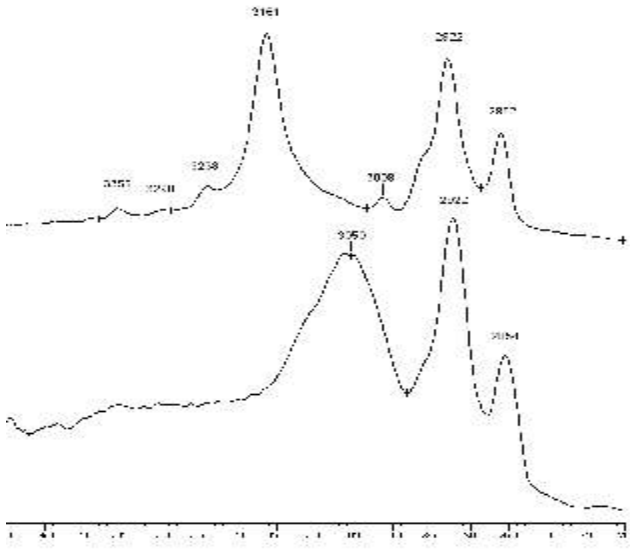

Figure 3: FTIR spectra of natural untreated sapphire (top) is quite different from the beryllium treated (bottom)

Disclosure

The Gem Testing Laboratory follows a clear approach while disclosing the beryllium treatment in its identification reports.

1. When FTIR spectra display hump at 3050 cm^{-1} along with the colourless or light-coloured rim, the stone is identified as:

NATURAL SAPPHIRE (ARTIFICIALLY COLOURED)

Comments: Thermal enhancement and diffusion of chemicals (E.g. Beryllium) from an external source.

2. When any one the features mentioned above in point 1 is present, the stone is identified as:

NATURAL SAPPHIRE

Comments: Thermal enhancement and indications of diffusion of chemicals (E.g. beryllium) from an external source.

GTL Identification Reports.....with a new look!

The Gem Testing Laboratory is serving the Gems & Jewellery trade since its inception on 12th August 1972. On a routine basis, GTL has always insisted on a neutral and simpler disclosure policies while certification considering in mind the international standards, so that the members who are dealing in international trade do not face the problems of disclosing their goods to their potential buyers. On the same lines, GTL has now modified the appearance of its identification reports along with the disclosure policies on treatments. The new look of these reports is much more appealing and of international standards, while the modified disclosure policies are much more trader-friendly without compromising on the technical correctness. Following are few important features of the modified "Identification Reports".

The reports have been kept at a standard size of A4, so that the details given are readily and easily readable and seen. The client needs not to search for the information in fine prints as is the case in small-sized reports. These reports are however, now three-folded which are easier to carry and / or send in a post. In addition to the embossed logo of the Gems & Jewellery Export Promotion Council (GJEPC) on the right hand side top corner of the report, it also carries a 3D- hologram in silver colour, which reads 'GTL' at one angle and the 'logo of GJEPC' at another, with the letters 'GTL' running across in the background.

Further, every report also carries a statement at the bottom, "Log onto www.gtljaipur.info to verify this report". This enables the client to re-verify the report in his hands after logging onto GTL's website. The database is usually updated within 24 hours after the issuance of the reports. This is an additional security system to safeguard the users of GTL identification reports. Since the introduction of this facility 20 months back, many users have been saved by forgeries. The back of the report describes the disclosure policies followed on GTL identification reports. This enables the users to interpret the disclosure of treatments given on the front side of the report.

GTL has also introduced "Pocket size" reports for the convenience of the clients / users. These reports measure 12 x 10 cms and are available on the request of the depositor at the time of depositing the stone. These reports are available only in conjunction with regular A4 sized reports and at an additional payment of Rs. 100. Only "Pocket-sized" reports are not issued at GTL. A sample is given on the right.

A Chatoyant Malachite

The ornamental gem material malachite is known for its striking curved banding in different shades of green. On occasion, however, monochromatic specimens have been seen. The Gem Testing Laboratory in Jaipur, India, recently examined one such specimen, a 9.57 ct cabochon exhibiting chatoyancy (figure 4).

Figure 4

The 13.93 x 10.09 x 5.85 mm oval stone showed a broad chatoyant band when examined with a fiber-optic light source. The band was reminiscent of lower-grade cat's-eye quartz. In some areas, the specimen had a relatively dull luster, indicating low hardness. Careful examination revealed the banded pattern (again, see figure 4) typical of malachite. Spot RI was measured at around 1.75, with a birefringence blink down to 1.66 (the higher value was not visible i.e. beyond the limit of the refractometer. Such a large birefringence blink is typically associated with carbonate minerals, including malachite. Hydrostatic SG was measured at 3.84. No absorption features were observed with the desk-model spectroscope, and the specimen was inert to both long- and short-wave UV radiation. All of these properties are consistent with malachite.

Figure 5

Malachite commonly forms compact masses of radial fibers that produce botryoidal forms and circular color banding (see, e.g., R. Webster, Gems, 5th ed.). Although this cabochon was not distinctly colour banded, magnification revealed a fibrous structure oriented perpendicular to the direction of the subtle banding (figure 5). This structure was responsible for the chatoyancy of the stone.

FTIR spectroscopy revealed several bands in the 5000–3000 cm^{-1} region. Two bands with twin peaks were seen at around 4520–4320 cm^{-1} and 4300–4020 cm^{-1}; a steep plateau was observed at 3430 cm^{-1}, and a band at around 3350 cm^{-1}. These absorption features are characteristic of carbonate minerals (e.g., calcite). No features related to polymer or resin were present. Qualitative EDXRF analysis revealed the presence of Cu, but no other element was detected. These analyses confirmed the identification as malachite.

Figure 6

The base of the cabochon also displayed a distinct milky sheen, which disappeared as the stone was tilted relative to the light source (figure 6). This behavior is typical of cat's-eye and star gems, and is consistent with the malachite showing a true cat's-eye effect and not merely a banding effect.

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GTL courses now shifted to IIGJJ

Various gemmological programs which were conducted at the Gem Testing Laboratory will now be conducted at the premises of the Indian Institute of Gems & Jewellery Jaipur. The centre has already commenced various Jewellery designing and manufacturing programs last year, which were previously the parts of Jewellery Production Development Centre (JPDC). Gemmology courses include Diploma (Regular and Correspondence), Certificate, Masters' Diploma and other Short-term courses will be conducted at the IIGJJ following the same criteria and pattern which was followed at GTL for so many years. Students will now get a thorough knowledge about the Gems & Jewellery industry under the same roof. Further details about various programs at IIGJJ are available at:

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