Identifying yellow sapphires – two important techniques

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Abstract

The author discusses two new techniques for identifying yellow/orange sapphires.

1. Placing a blue filter between the light source and immersion cell provides the contrast necessary to resolve the colour banding (straight or curved) in natural and synthetic yellow/orange sapphires.

2. Heat treatment in Sri Lankan yellow to orange sapphires can be identified by exposing the stones to the heat and light of a strong bulb. Upon heating up slightly, the colour of heat-treated specimens will become darker and more brownish. As it cools back to room temperature the colour returns to normal.

The blue filter as a gemmological tool

In dealing with the corundum gemstones, yellow sapphires are often thought to be among the most difficult to identify. This is largely because yellow sapphires are frequently completely free of inclusions and the colour banding is more difficult to find in this colour than almost any other. The author has developed a new technique which makes it possible to locate the colour banding (straight or curved) in virtually all natural and synthetic yellow sapphires, thus greatly aiding their identification.

Natural yellow sapphires are produced primarily from four sources: Sri Lanka, Thailand, Australia and Tanzania. All of these stones contain straight growth lines (colour bands). Synthetic yellow/orange sapphires are of two types: Chatham has begun producing a flux-grown product, and this contains straight growth lines, but is extremely rare; the vast majority of all synthetic yellow/orange sapphires are produced by the Verneuil process, and, as such, contain curved growth lines. It must be stressed that all yellow/orange sapphires, synthetic or natural, possess these lines. The trick is simply to find them, and to see if they are straight or curved.

Although the presence of other inclusions or an iron absorption spectrum will allow identification, frequently these features are absent. This makes it imperative to locate the growth lines for positive identification. The traditional technique has been to immerse the stone in methylene iodide and examine it in the microscope with light field illumination. Some gemmologists suggest that a piece of tissue paper be placed over the light to provide diffusion. A better method is to use a piece of frosted white plastic or glass, as it won't catch fire. This is readily available from shops making plastic signs for less than $1.00.

The main problem with this technique, however, is that one is looking for yellow lines in a yellow stone immersed in a yellow liquid over a yellowish light (tungsten filament). Is it any wonder that they are hard to find? Some have suggested twisting the overhead fluorescent light under the microscope and placing the immersion cell on top of this. It is a definite improvement, but still not good enough. One day in 1981, while pulling my hair out in frustration at my inability to locate the bands in a yellow sapphire, I stumbled across a solution. Prior to this, on a lark, I had bought thin pieces of plastic of different colours in Bangkok's finest sign shop. On that fateful day, rather than lose more hair, I decided to see what would happen if these were placed under the immersion cell. One by one I tried them: red, green, yellow and then blue. Lo and behold, when the blue filter was placed under the cell (with the white one), the colour bands appeared! I broke it in half and tried a double thickness. Even better! Since that day we at AIGS have taught of and used the blue filter for the testing of all yellow and orange sapphires, and have been able to locate the colour banding in perhaps 98-99% of all stones.

I wish I could tell you that I knew what I was doing from the start, but such was not the case; the discovery was pure accident. However, it is possible to explain the effect. With the white filter only, the bands are difficult to see because they are the same colour as the stone; immersion in a yellow liquid

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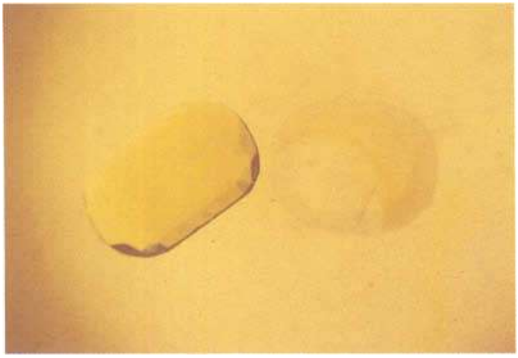

Fig. 1. Two yellow sapphires: a natural (left) and a Verneuil synthetic (right) are shown immersed in methylene iodide with diffuse light-field tungsten illumination. Due to the lack of contrast between the stone and the background, the colour zoning is difficult to see.

Fig. 2. The same two stones from Fig. 1, but now with a blue filter placed below the immersion cell. The blue filter provides contrast between the colour zoning and the background, making it much easier to resolve.

hardly improves the situation very much. The addition of a blue filter (a frosted blue filter allows elimination of the white filter), although cutting down on the available light, provides the contrast necessary to see the lines. Experimentation has shown that deep blue filters work better than light blue ones, up to a point. Experiment to find the best combination. The effect is not subtle; the blue filter provides an improvement of several magnitudes.

Not only does the blue filter work for yellow and orange sapphires, but other colour filters work for other corundums. It has been found that the colour of the filter should match the absorption maxima (wavelength of maximum absorption) of the stone. Thus, for rubies a filter of a yellow-green colour works best.

The effect of the blue filter on a yellow sapphire is shown in Figures 1 and 2. Figure 1 shows two stones over a white filter only; Figure 2 shows the same stones over a frosted blue filter.

Identifying heat treatment in Sri Lankan yellow and orange sapphires

Prior to 1981, to the best of the author's knowledge, heat treatment was not practised on Sri Lankan yellow/orange sapphires. The technique of deepening the colour of yellow/orange Sri Lankan sapphires by the appropriate heat treatment first came to our attention in 1981, when Bangkok gem dealer Robert Stevenson of Gem Resource showed the author a Sri Lankan orange sapphire of unbelievably rich colour. He claimed that it was treated in a new way (later learned to be a new heat treatment) and gave it to us to check the colour stability.

At this point we must pause for a moment to describe the methods used for checking colour stability. For several years prior to 1981, we had been routinely checking the colour stability of all Sri Lankan yellow/orange sapphires brought in for testing. This meant placing the stone on a metal platform and bringing a very hot 150 watt spotlight to within 1 cm of the stone, for up to one hour. (Note: Mr Cap Beesley (1983) of the American Gemological Laboratories has previously described a fade test for stones consisting of exposing the specimen to unfiltered ultraviolet light. If unfiltered short-wave ultraviolet were to be used with Sri Lankan yellow/orange sapphires, this will have exactly the opposite effect, deepening the colour, not lightening it.) The colour in those stones which had been irradiated to deepen the colour would always fade, usually well within one hour. If the stone was naturally coloured there would be no change. (However, reliable sources have reported in Sri Lanka that some yellow/orange stones will fade slightly, or a lot, right after being unearthed. Still, this does not negate the fade test as described above, as a customer wants to know the colour stability, whether irradiated by man or naturally coloured. The AIGS refuses to test Sri Lankan yellow/orange sapphires unless permitted to do this test.) We had tested a number of naturally coloured very deep yellow/orange Sri Lankan sapphires prior to 1981 which showed no change in colour during the fade test. Thus, you can imagine our surprise when, on performing the fade test on Mr Stevenson's stone, we noticed that the colour became much darker and more brownish. As it cooled back down to room temperature, the colour returned to normal. Amazing, but true!

Since that fateful day we have had the opportunity to observe first-hand the treatment process and can testify that it involves only heat (heat to 1800-1900°C in an oxidizing atmosphere). We have

Fig. 3. A heat-treated Sri Lankan yellow/orange sapphire is shown face-down at room temperature.

Fig. 4. The same stone from Fig. 3 is now shown just after it was exposed within 1 cm to the heat and light of a 150 watt spotlight for 15 minutes. The colour has become much darker and more brownish. After it returns to room temperature the colour will return to that in Fig. 3.

performed the fade test on literally thousands of stones and have found the following:

Origin	Reaction during fade test
Natural Sri Lankan yellow/orange sapphires	No change in most. Some may show some fading.
Natural or heat-treated yellow/orange sapphires from Thailand, Australia, Tanzania	No change
Irradiated Sri Lankan yellow/orange sapphires	The colour fades within one hour.
Heat-treated Sri Lankan yellow/orange sapphires	The colour temporarily becomes darker and more brownish. As the stone cools to room temperature, the colour returns to its original state. See Figures 3 and 4 for before and after representations.

In order to detect even slight changes in colour, comparison stones should be used. In other words, select two stones of similar colour. Perform the fade test on one only. While it is still hot (use tweezers!) compare its colour to the other. If it is a heat-treated Sri Lankan yellow/orange sapphire, its colour will have darkened noticeably. As for the reasons that this test works, the author can only speculate. The colour in natural Sri Lankan yellow/orange sapphires appears to be due mainly to colour centres. In the heat-treated Sri Lankan yellow/orange sapphires, however, it appears to be some type of mechanical coloration due to the exsolution of reddish Fe-rich mineral particles (hematite?). Apparently the colour of the particles is temperature dependent; hence the change as the stone is heated during the fade test.

We have found that there is a direct correlation between the original depth of colour before the fade test and the amount of change during the test. In general, the darker and more orangy/brownish the colour is to start with, the more change will be noticed during the test; the lighter the colour is to start with, the less change will be noticed during the test. It is not necessary to use only a 150 watt spotlight. Experiments have shown that almost any source of gentle heat will do, even a microscope bulb. Avoid overheating the specimen, however, for this could damage certain natural stones containing carbon dioxide inclusions.

The author feels that this test is extremely important for it represents the first *simple* test for detecting heat treatment in any type of corundum. It is believed that, in the future, as the gem markets begin to realize the vital importance of detecting *all* treatments in gemstones, tests such as this will come into widespread use.

References

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