Clarity Treatments for Diamonds

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本文介紹鑽石處理中之激光鑽孔、KM、裂隙充填等處理方法之鑑證及鑑別技巧。

Introduction

The word "treatment" is a standard term used in gemmology to describe any type of process, other than cutting and polishing, that modifies the appearance of a gem material.

There are two main categories of treatments that are applied to gemstones and diamonds. The first improves an originally unattractive colour of a stone, and the second enhances the clarity and the transparency of an included or fractured stone.

There are many techniques which will enhance the colour of diamonds such as surface coating with a thin film layer, irradiation with an electron beam, annealing at "low" temperature (around 1000°C), and high-pressure high-temperature (HPHT) treatment, as well as combinations of these treatments. Except in the case of coating, the results of such treatments and combinations of treatments are mainly related to the impurities and other structural defects that are present in the diamond. For example, nitrogen rich type I diamonds of low colour grades may be transformed into bright fancy yellow, orange, green, pink or red colour-treated diamonds; and brown type IIa (nitrogen free) diamonds can be made colourless.

This article will examine the techniques used to enhance the clarity of diamonds; laser drilling and fracture filling.

Laser drilling techniques

In the case of laser drilling, lasers are used to connect, from the surface, with an inclusion, black fracture or any other black spots that are sealed inside the diamond.

The first laser drilling technique to be applied commercially has been in use since the 1970s and consists, simply, of drilling a hole into a diamond from its surface down to the dark internal features. The second technique, called "KM" (the initials stand for Kiduah Meyuhad, which means *special drill* in Hebrew), has been in use for about ten years. It involves the creation or extension of a series of small feathers starting from the inclusion and continuing until they reach the surface. Whichever laser drilling technique has been used, the resulting straight channel or the surface reaching fractures will provide an opening allowing acids to enter the diamond and to bleach or to dissolve the undesirable internal features. Depending on the aspect of the treated feature the clarity grade may not always be improved. However, when an inclusion loses its black colouration it will often become less visible, and may therefore be considered more acceptable than the original dark inclusion.

It is usually easy to detect the use of the oldest laser drilling method. A diamond that has been treated in this way shows a tiny circular hole at the surface, when the stone is examined with a gemmological microscope (Fig. 1). By moving the stone, in a direction more or less perpendicular to the axis of the hole, the complete drilled channel that is connected to the bleached internal characteristic (inclusion or fracture) or to the cavity left after dissolution of the original dark feature is revealed (Fig. 2).

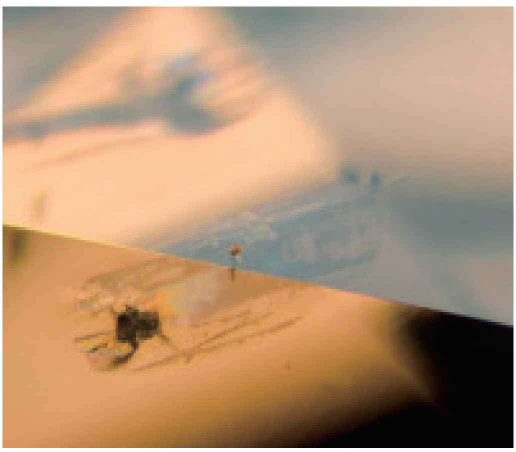

Fig. 1 Drill hole left by the laser at the surface of the diamond after treatment. Following the path of the drill hole inside the stone allows the viewer to see the internal fracture that has been bleached. The original contents of the internal fracture have been bleached with acids introduced through the straight channel created by the laser. (Photo: Eric Erel)

The identification of the "KM" treatment may be more difficult because, in most cases, the diamonds do not show a drill hole that reaches the surface. However, an inclusion surrounded by an unusual network of tiny fractures that expand in only one orientation in the direction of the diamond surface must be considered suspicious. When such a series

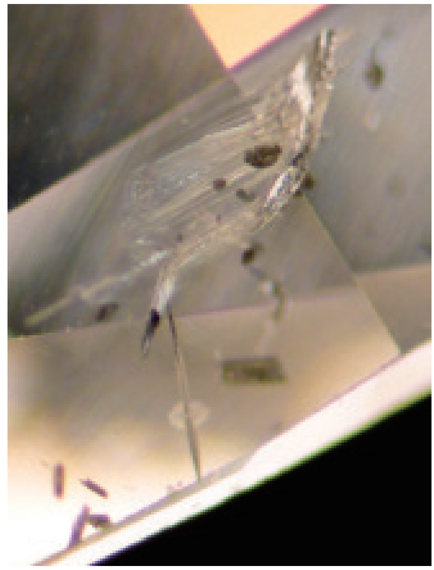

Fig. 2 By changing the viewing angle (compared to Fig. 1) the straight channel left by the laser can be seen much more easily. The laser drill hole extends from the surface of the diamond down to the internal fracture that has been bleached. (Photo: Eric Erel)

Fig. 3 Dark wormhole-like laser channels seen in fractures extending from the diamond's surface to the point where an inclusion has been dissolved. This pattern is characteristic of the "KM" treatment. (Photo: Eric Erel)

of tiny feathers are observed in a direction perpendicular to the plane of the fractures, they display irregular dark channels that look like wormholes and are characteristic of the "KM" treatment (Fig. 3).

Beside dark internal features, diamonds can also contain many fractures and cleavages that reach the surface and can be easily visible, especially when they display mirror-like reflections. In order to improve the transparency of such fractured diamonds a method of filling may be applied to enhance their clarity.

Fracture filling

Filling cracks within diamonds with a high refractive index glass has been in common practice for more than two decades and consists of introducing a glass with almost the same refractive index as diamond into the fractures.

As is the case for the identification of diamonds treated with lasers, glass filling of the fractures can also be detected through magnification using a binocular microscope, and sometimes even with a loupe. The most obvious visual characteristic shown by a glass filled diamond is the "flash effect" where blue, violet, red or orange flashes of colour can be seen in the filled fractures when the stone is moved back and forth.

Sometimes, unfilled surface-reaching fractures may show multicoloured interference colours that can be confused with colours resulting from the flash effect. Careful observation at specific angles, however, allows the viewer to differentiate between the effects that are emitted by filled and unfilled fractures. Usually unfilled fractures show all the colours of the rainbow at once and these interference colours are observed perpendicular to the plane of the fracture whereas the flash effect from glass filled fractures shows only a few different colors and is detected when the fracture is observed in a direction that is almost parallel to the plane of the fracture (Fig. 4). Furthermore, slight differences in the viewing angle around the position where the flash effect is detected will result in a change of the colour of the flashes (Fig. 5).

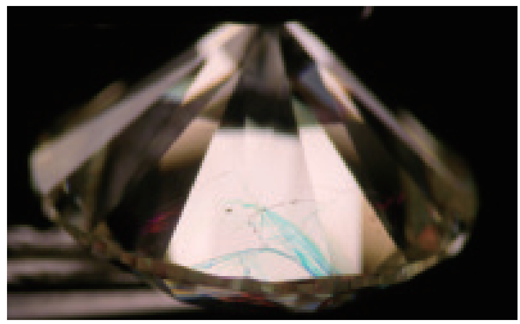

Fig. 4 Blue colour flashes observed in diamond fractures that have been filled with a high refractive index glass. This flash effect is observed when the diamond is viewed in a direction that is almost parallel to the plane of the fractures. (Photo: Eric Erel)

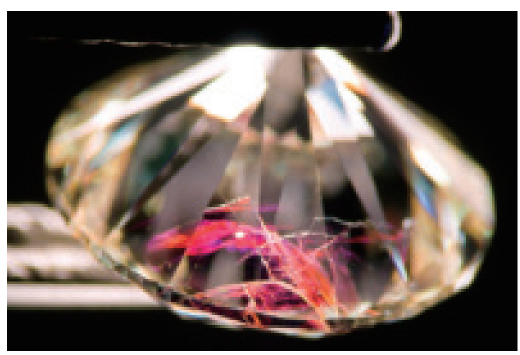

Fig. 5 Slight differences in the viewing angle around the position where the flashes are seen will display a change in the colour of the flashes. In this case the flashes change from blue (see Fig. 4) to purple and orange. (Photo: Eric Erel)

Incomplete filling can be an additional clue leading to the identification of fractured filled diamonds (Fig. 6). Trapped gas bubbles can be present in many of the filled fractures. These voids in the glass may be very small in size, occurring as pinpoints, or may be large and flat. When these voids occur in groups, they can adopt a fingerprint pattern. In addition a very shallow area of the treated fracture, that is located near the surface, may also be incompletely filled. These areas look like a shallow white line following the outline of the fracture at the surface of the diamond, and may be caused by a slight dissolution of the glass following the cleaning of the diamond after treatment.

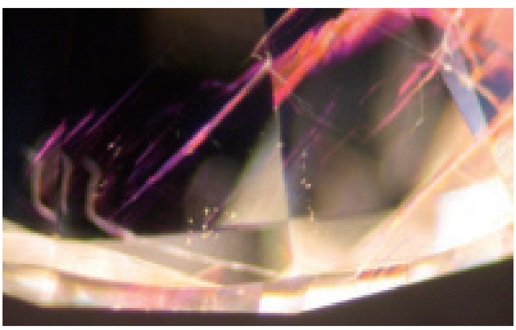

Fig. 6 Diamond showing fractures filled with a high refractive index glass. The colours displayed by the flash effect and the unfilled areas in the filled fractures (that appear reflective when the diamond is observed with a fibre optic), are characteristic of this treatment. (Photo: Eric Erel)

Conclusion

Treatments which affect the clarity of diamonds are often easier to identify than treatments that enhance their colour because their detection does not require the use of advanced analytical techniques such as spectrophotometry or infrared spectroscopy. In most cases, fracture filled and laser drilled diamonds are easily identified simply by means of magnification. However the detection of the use of such enhancement techniques can be challenging and requires special care when the treated features are small and located near the surface. An example might be, for instance, in the case of small and shallow filled fractures that only show very weak flash effects, or extremely short drilled channels.

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