New fracture filling materials have replaced oil

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For decades, if not centuries, fillings of oils and resins have been used to improve the appearance of gemstones - especially emeralds - by making fractures less visible. Since fractures that reach the surface of a gemstone are filled with air, they reflect light and appear much lighter in color than the rest of the gemstone.

If the fractures are filled with a substance that has a refractive index similar to the gemstone, the fractures will no longer reflect light back, which means that the fractures are much less visible and the appearance of the gemstone is improved.

During the last few years, there have been many developments in the practice of filling gemstone fractures, which seem not to have attracted enough attention. The object of this article is to bring these developments to the attention of the reader. Epoxy resins have replaced the traditional filling materials and now completely dominate the marketplace, appearing with greater frequency than any other type of filling treatment. Fracture filling with epoxy resin is no longer a treatment reserved for commercial quality emerald but is now used to improve the appearance of any gemstone with a fracture that reaches the surface.

Filling substances

Many substances are used to fill fractures in gemstones, including vegetable and mineral oils with volatile components, more durable fillers like fats or resins, and the even more stable synthetic epoxy resins. Another very stable fracture filler material used is molten glass, but corundum is the only gemstone currently treated with glass fracture filling because most gemstones would be damaged by the very high temperatures required for this process.

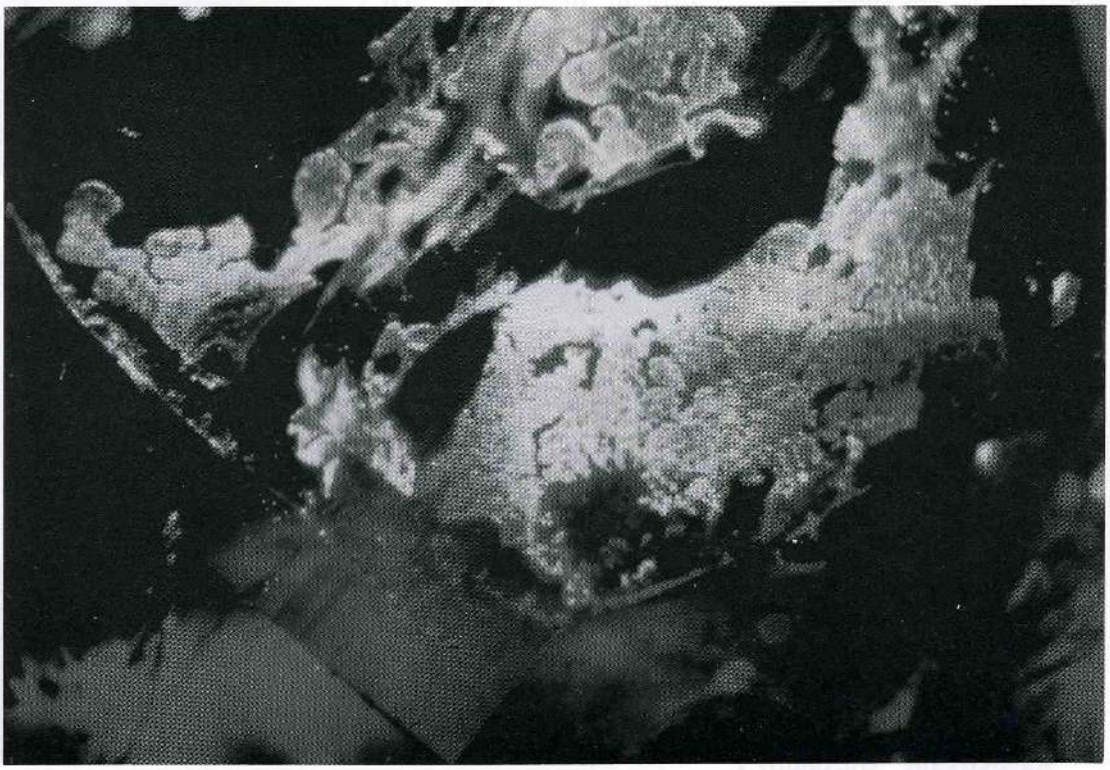
Among the variety of filling substances available, synthetic epoxy resins have the advantage of a more stable adhesion to the stone. This results in a longer lasting improvement in appearance than would be possible with the more volatile compounds traditionally used, like oil and paraffin, which are easily dissolved by soap, detergent, and many solvents.

A group of epoxy resins with similar characteristics commonly used in the trade are generally referred to by the product name of Opticon. Most of the emeralds available on the market today are treated in the rough or cut state with Opticon or a similar epoxy resin, such as Araldite NU 471, Dobeckot 505, Novogen P40, or other such products. The refractive indices of these epoxy resin products range between 1.5 and 1.6.

Epoxy resin can be used either with or without hardener. If the resin is used without hardener, it stays soft and usually completely fills the fractures. In this case, evidence of the filler, such as gas bubbles, viscous fingering and other structures are rare and not easily visible. When the epoxy resin is mixed with hardener it undergoes a solidification called polymerization, which causes shrinking effects like fine fissures and pseudo-dendritic patterns on the filler plane which make it more easily detectable.

Filling substances must have a viscosity low enough to penetrate into fractures: the lower the viscosity, the more completely the substance can fill the fractures. To improve its viscosity, the filler material is often heated. Vacuum is often used to help encourage the filler to completely fill the fractures.

Before fracture filling, a gemstone must be carefully cleaned to remove all dirt, residual filler, and natural deposits, and polishing com-



Emerald with "lakes" of air indicating oil in the fractures which is partially drying out

pound from the fractures, using solvents, acids, ultrasonic, or steam.

Identifying filler treatments

Most of the filler materials seen in fractures contain pockets of air or gas bodies, forming individual bubbles or dendrite-like patterns in a fracture plane. Many of the filler materials also show a bright fluorescence in ultraviolet light which is visible with the unaided eye or with a loupe.

The presence of oil can be detected by a brief immersion of the stone in a solvent such as acetone or hexane, which will dissolve some of the oil. When the stone is examined under a microscope, the solvent can then be seen evaporating in the fractures where it has dissolved the oil. Air dendrites can be seen at the openings of the fractures.

This test distinguishes between oil and all types of resins, since resins are not as easily dissolved. Another indication of resin would be reaction to heat. If a hot needle is slowly introduced into a fracture and observed with a microscope, evidence of the melting and increased liquidity of a resin in the fracture can be seen.

Epoxy resin may also contain individual bubbles and show patterns of dendrite-like viscous fingering - fine patterns of branching, much finer than the coarse, liquid like branch shapes associated with oil. Epoxy resins also are often recognized by iridescent interference colors: orange to violet "flashes" in the fractures.

The identification of filling material in a gemstone's fractures can often present a challenge to the gemologist. The observation that a filling material is present is quite easy, but the determination of the exact character of that material may be a very difficult procedure.

Infrared spectroscopy is very helpful for detecting filling materials and may also in some cases reliably identify that material. However, the numerous varieties of compounds used and the superimposition of the spectra of the filler and the spectra of the gemstone itself may present obstacles to accurate identification. If the gemstone has been filled with different materials at different times without proper cleaning, the resulting spectrum may be difficult to interpret.

Yehuda-style treatments to fill fractures in diamonds and potentially other types of gemstones use a heavy liquid with a high refractive index to fill fractures. This type of filling material can be detected by vivid iridescent rainbow flashes in the fractures and gas bubbles and "lakes" of air in the fractures. The heavy elements can be detected by X-ray spectroscopy, either using a scanning electron microscope or energy dispersive X-ray fluorescence analysis. Yehuda-treated diamonds contain lead and occasionally bismuth.

Glass fillings used to fill fractures in corundum can be recognized by a different luster from the host gemstone. Within the stone, glass fillings can be detected through Raman spectroscopy. Glass that reaches the surface can also be identified through scanning electron microscope which indicates the presence of silica. In many cases voids filled with glass are whitish in color. Radiating fibrous crystals can be seen emerging from trapped gas bubbles.

Trade policy

Although the above mentioned fracture filling treatments are not new, they are not widely recognized or acknowledged by many people in the trade. The use of colorless oiling has been widely accepted as an established trade practice. However, this traditional treatment method has now been increasingly replaced by the use of modern, more stable fracture filling substances. It is very important to note that these new methods are not practiced upon a few single stones but are now the most common methods of filling fractures used on the market today. Unfortunately only a small number of dealers, manufacturers, jewelers, or goldsmiths have the time, knowledge, motivation, skill, or equipment to be able to check whether or not this assertion is accurate. This means that it will take a long time before the general opinion regarding the prevalence of these new filler materials will catch up to the real situation in the market today.

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The exact identification of the numerous more or less viscous oils (vegetable, animal, or synthetic), fats, paraffins, natural and artificial resins used as filler materials is rarely simple and often impossible, even for a well-equipped laboratory. In many cases, after expensive and painstaking analysis, the only conclusion that can be reached is that the gemstone has a foreign substance in its fissures.

Because of the variety of compounds which can and do serve as filler materials, it would be more appropriate not to draw a line between "permitted" colorless filling materials and colorless materials which are not tolerated unless specifically and individually disclosed.

It seems rather advisable to handle all colorless fracture filling treatments the same way, regardless if oil, paraffin, natural or epoxy resins are used.

Due to the widespread application of filling treatment, particularly involving epoxy resin, it is preferable to give a general disclosure statement indicating that fracture treatment with a colorless oil or resin represents common trade practice. Such a regulation would be better than individual disclosure of single stones as treated. However, this would mean a change in the CIBJO rules regarding this point.

In any case, the final consumer should be informed in a general way about commonly accepted trade practices like fracture filling to prevent misunderstandings which could damage the jewelry industry's reputation.

What do you think about fracture filled emeralds?

This *ICA Gazette* has articles by renowned gemologists Henry Hanni of Switzerland and Junko Shida of Japan on the topic of fracture filled emeralds. We would also like to hear what you think. All ICA members are invited to contribute their opinions on how the ICA should approach this subject to be published in the *ICA Gazette*.