

Editors • Mary L. Johnson and John I. Koivula

Contributing Editors

Dino DeGhionno and Shane F. McClure,  
GIA GTL, Carlsbad, California

Emmanuel Fritsch, University of Nantes, France

Henry A. Hänni, SSEF, Basel, Switzerland

Karl Schmetzer, Petershausen, Germany

## DIAMONDS

**Conference on diamond technology.** More than 400 scientists—mostly from Europe, the United States, and Japan—attended the DIAMOND 1996 conference in Tours, France, September 8–13, 1996; the attendees specialized in all fields of diamond research, but many were involved with synthetic diamond thin films. The conference was a joint meeting of the 7th European Conference on Diamond, Diamond-Like and Related Materials and the 5th International Conference on the New Diamond Science and Technology (ICNDST-5). Contributing editor Emmanuel Fritsch attended the conference and provided this report.

The conference began with talks about the commercial viability of synthetic diamond thin films. The first goal in achieving commercial viability was to make these thin films as industrial products. Although the consensus was that this goal has been reached, development took longer than expected, and the market for such products is smaller than had been hoped. One reason for the limited market is that synthetic diamond thin films are still expensive. Also, unfamiliar technologies are needed to use these coatings in most customers' applications, so additional education is required. Nevertheless, some applications of synthetic diamond (and diamond-like carbon) thin film technology have already generated over a million dollars in revenue per application. These include hard optical coatings for scanner windows, sunglasses, prescription lenses, and magnetic media; hard coatings for cutting tools and parts subject to heavy industrial wear; laser diode heat sinks; and deposition equipment (reactors) to make thin films. Many other highly specialized "niche" products (such as radiation detectors) have generated smaller, but growing, revenues.

One major field of development for synthetic diamond thin films is electrochemistry—in particular, the use of electrodes coated with conductive thin films (heavily doped with boron). Professor John Angus of Case Western Reserve University, Cleveland, Ohio, described how such electrodes can be used to remove nitrates and

other pollutants from water, a process with a potentially enormous market. In another talk, Dr. Pravin Mistry of QQC Inc., Dearborn, Michigan, presented a truly new synthesis technique that uses the combined effects of four "multiplex" lasers to deposit thin films of diamond-like carbon; Dr. Mistry believes that diamond films should be obtainable by the same process.

A number of topics were of gemological interest, if not always directly applicable to gemology. Synthetic diamond thin films now have been successfully deposited on an ever-growing array of materials, including the diamond simulants silicon carbide and strontium titanate, as well as on glasses and various oxide materials usable as gems. In general, a layer with an intermediate composition is first deposited on the substrate material. This guarantees good adhesion (which was lacking in earlier experiments) even when significant shrinkage occurs

*Figure 1. The pear-shaped center stone in this ring is a "piggyback" assemblage. The prongs hold a large windowed diamond on top of a smaller pear shape. The assemblage was misrepresented as a 7.78 ct diamond. Photo courtesy of James O'Sullivan.*



between the substrate and the thin film during deposition of the film and subsequent cooling. Dr. W. Kalss from the University of Technology, Vienna, Austria, reported the growth of isolated synthetic diamond microcrystals—but not thin films—on precious metals (platinum, palladium, and gold). However, several other teams reported the growth of synthetic diamond film on single-crystal platinum substrates.

Several presentations and posters covered the creation of large, monocrystalline “thick” (about 0.10 mm) films. If such films could be grown thicker, they could be faceted into small *mêlée*. A method called “tiling” is used to obtain single-crystal films: Adjacent small substrates are crystallographically aligned, like tiles on a wall, and a monocrystalline film is subsequently grown on top of this “multisubstrate.” Progress has been made in devising methods for freeing such a newly grown crystal from its substrate. Polycrystalline films are, of course, easier to produce: Large (up to 50 mm in diameter) transparent films up to 1.5 mm thick are now commercially available.

A few posters and talks dealt with high-pressure/high-temperature synthetic diamond monocrystals. Dr. Hisao Kanda from the National Institute for Research in Inorganic Materials (NIRIM), Tsukuba, Japan, reported on some color centers in these monocrystals that were caused by the cobalt used as a solvent during growth. Most of the synthetic diamonds described were yellow to light yellow, types Ib to IaA. The cobalt-related centers did not significantly affect color, but all of Dr. Kanda’s samples showed a cobalt-related yellow fluorescence. High-pressure synthetic crystals are being grown in a variety of other solvents. For example, another Japanese team reported on the growth of synthetic diamond crys-

tal in phosphorus that are intended for electronic applications.

**A “piggyback” diamond assemblage.** Recently, gemologist James O’Sullivan, of Jaylyn, Boca Raton, Florida, told us that he had seen a “piggyback” diamond: an assemblage where two thin diamonds are superimposed to look like a larger stone (see, e.g., *Gem Trade Lab Notes*, Winter 1985, p. 233.) A customer brought a ring to Mr. O’Sullivan for repair of a loose prong on the center stone, which was supposedly a 7.78 ct pear-shaped diamond of good color (figure 1). On closer examination, the center stone looked shallow and poorly proportioned. With magnification (figure 2), Mr. O’Sullivan saw that it was, in fact, two diamonds—one placed on top of the other. The upper diamond was poorly proportioned and very shallow, with a large window, but the bottom stone was well cut.

Mr. O’Sullivan’s client had purchased the ring recently in Florida, with the central assemblage represented as a single stone. Mr. O’Sullivan said that he discovered the misrepresentation because he routinely examines every piece with a microscope before working on it. As with the assemblage in the 1985 Lab Note, the two diamonds were not glued together; the prongs simply held them in place. The platinum filigree mounting hid the bottom stone from view very effectively.

**Synthetic diamond thin film jewelry.** Jewelry that uses thin films of synthetic diamond (figure 3) was commissioned by Dr. Peter Bachmann of Philips Research Laboratories, Aachen, Germany, a well-known figure in the synthetic diamond thin film research community. Dr. Bachmann told contributing editor Emmanuel Fritsch that he had the *parure* made for his wife on the occasion of their 25th wedding anniversary. The somewhat drusy plaques in the jewelry were laser cut from a 0.25-mm-thick synthetic diamond plate, 40 mm in diameter, that had weighed 5.5 ct. The larger squares in the jewelry measure 15 mm on edge and weigh 1 ct each; the smaller pieces weigh 0.21 ct each. They were mounted in white and yellow gold by Aachen jeweler Wilhelm Horn.

The plate was grown by microwave plasma chemical vapor deposition (CVD), from a mixture of 2.8% methane in hydrogen gas at about 900°C and at a gas pressure of about 180 mbar. The Raman spectrum of synthetic diamond thin films like those in figure 3 exhibits a single narrow peak at about 1333  $\text{cm}^{-1}$ , which indicates that the tiny crystals making up the films are synthetic diamonds of excellent crystallinity (since defects in diamond crystals make this peak wider). The thermal conductivity of the films was measured at slightly over 2200 watts per meter per degree Kelvin, a value comparable to those obtained for natural type II single diamond crystals (see P. K. Bachmann et al., “Thermal Properties of C/H-, C/H/O-, C/H/N-, and C/H/X-Grown Polycrystalline CVD Diamond,” *Diamond and Related Materials*, Vol. 4, May 1995, pp. 820–826). Such synthetic diamond films

Figure 2. The true nature of the “stone” shown in figure 1 can be seen when it is viewed from the side: two diamonds in close proximity. Photo courtesy of James O’Sullivan.



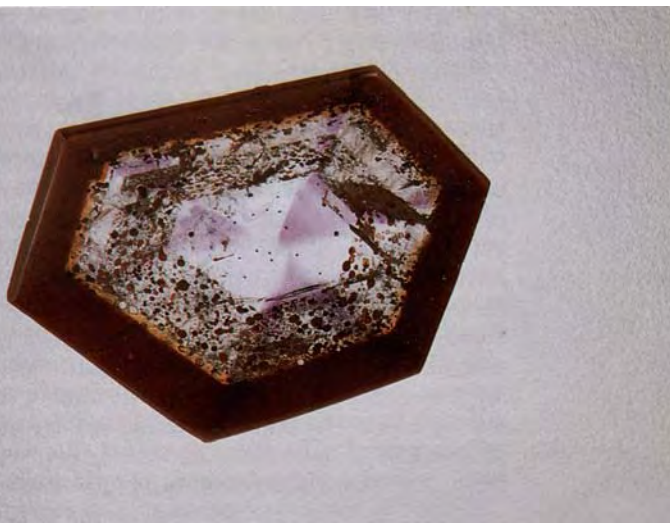


Figure 3. This parure, set by Wilhelm Horn, contains pieces of synthetic diamond thin film, the two largest of which weigh about 1 ct. Jewelry courtesy of P. Bachmann; photo by G. Schumacher, Philips Research Laboratories, Aachen, Germany.

are as transparent as glass of similar thickness when polished; the films in this jewelry appear gray because of light scattering from the tiny diamond crystals.

**COLORED STONES AND ORGANIC MATERIALS** ■  
**Color-zoned amethyst from Thunder Bay, Ontario, Canada.** We occasionally see slices of ametrine, cut perpendicular to the c-axis, that show yellow and purple

Figure 4. The triangular color zones in this 8.40 ct slice of natural amethyst resemble those seen in ametrine slices. Photo by Maha DeMaggio.



color zones patterned like the universal sign for radiation hazards (see, for example, P. M. Vasconcelos et al., "The Anahí Ametrine Mine, Bolivia," Spring 1994 *Gems & Gemology*, pp. 4–23, especially figures 15 and 20). At a recent Tucson show, contributing editor Shane McClure noticed an 8.40 ct amethyst slice with similar zoning at the booth of Bill Heher, Rare Earth Mining Company, Trumbull, Connecticut. The polished slice (figure 4) still showed the red near-surface phantom layers that are typical of material from Thunder Bay, Ontario, Canada. All of the gemological properties were consistent with natural amethyst. With magnification and polarized light, Brazil Law twinning could be seen in the more intense purple layers. Many natural amethysts are color zoned, so we suspect that others could be cut in this fashion.

**Blue- and multicolor-sheen moonstone feldspar from India.** We recently had the opportunity to examine three moonstone cabochons that were sent by importer Lance Davidson of Stockton, California. According to Mr. Davidson, these stones come from a site near the town of Patna, in Bihar State, India. Although the deposit was discovered about nine years ago, material has only entered the market in appreciable quantities over the last three years. Some Indian dealers have been marketing it as the "Rainbow" moonstone from southern India; however, those mines no longer produce much high-quality rough.

Mr. Davidson, who markets the stones as "Blue-Rainbow" moonstones, says that most of the material has a "royal" blue sheen, with about 5% having a multi-



Figure 5. These three plagioclase feldspar moonstones are from Bihar State in India; the largest weighs 15.54 ct. Stones courtesy of Lance Davidson; photo by Maha DeMaggio.

color sheen (see examples in figure 5). Large quantities of included material are available, and clean stones up to 1 ct are fairly common. However, clean stones with good color of 5 ct or more are very rare. Smaller pieces and those that are included are faceted into calibrated goods or made into bead necklaces.

We determined the gemological properties of the three cabochons (again, see figure 5): a 7.38 ct round, an 8.34 ct oval (both with predominantly blue labradorescence), and a 15.54 ct oval with "multicolor" labradorescence. All were semitransparent, with a (spot) refractive index of 1.56, a specific gravity of 2.69, and a moderately chalky, even, moderate-blue fluorescence to long-wave ultraviolet radiation. Fluorescence to short-wave UV was

Figure 6. This 32.8 ct tricolor Oregon sunstone was carved by Charles Kelly. Photo by Maha DeMaggio.

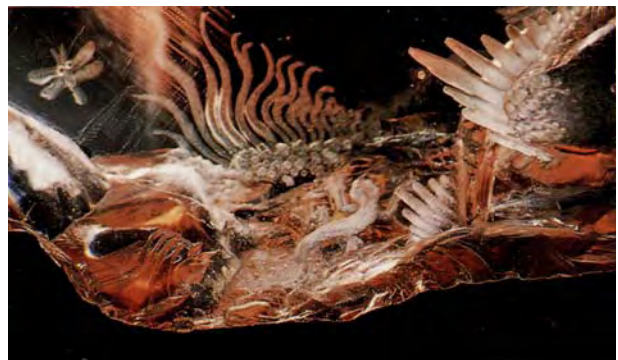


a weakly chalky, evenly distributed, weak pinkish orange. With magnification, all three showed polysynthetic twinning, a feature typical of plagioclase feldspars. Tiny colorless inclusions were visible in the smallest stone. In the Fall 1987 Gem News section (p. 175), Dr. Henry Hänni suggested that "Rainbow" moonstone from India was a labradorite feldspar; the gemological properties of these moonstones are also consistent with labradorite or some other high-calcium plagioclase feldspar (e.g., bytownite). Other moonstone feldspars with blue sheens have been found in Sri Lanka (orthoclase—see P. C. Zwaan, "Sri Lanka: The Gem Island," *Gems & Gemology*, Summer 1982, pp. 62–71), and in New Mexico and other localities (the peristerite variety of albite—see, e.g., Fall 1988 Gem News, pp. 177–178).

**"Watermelon" sunstone feldspar carving.** Sunstone from Oregon occurs in many hues, including colorless, green, and red-orange. Some stones show all three of these colors. A 32.8 ct tricolor sunstone carving (figure 6), fashioned by Charles Kelly of Tucson, Arizona, shows the concentric color zoning sometimes seen in this material. The carving also shows a playful side of the artisan, in its view of nature in desert regions. In addition to the hummingbird and flower motif, tiny intaglio portraits of a lizard (figure 7), a snake, and a tarantula adorn the carving's base. The piece was shown at the 1997 Tucson shows by the Dust Devil Mining Company, Beaver, Oregon.

**Musgravite: A rarity among the rare.** For several years now, we have had one particular gem on our research examination "want list." This wanted gem is the mineral musgravite, a very close relative of the rare gemstone taaffeite. Our long search ended recently, when gemologist C. D. (Dee) Parsons of Santa Paula, California, provided the Gem News editors with a transparent, dark

Figure 7. In darkfield illumination, some finer details of the carving become apparent, including this dragonfly and lizard. Fine parallel arrays of included copper crystals are also visible. Photomicrograph by Shane F. McClure; magnified 6x.



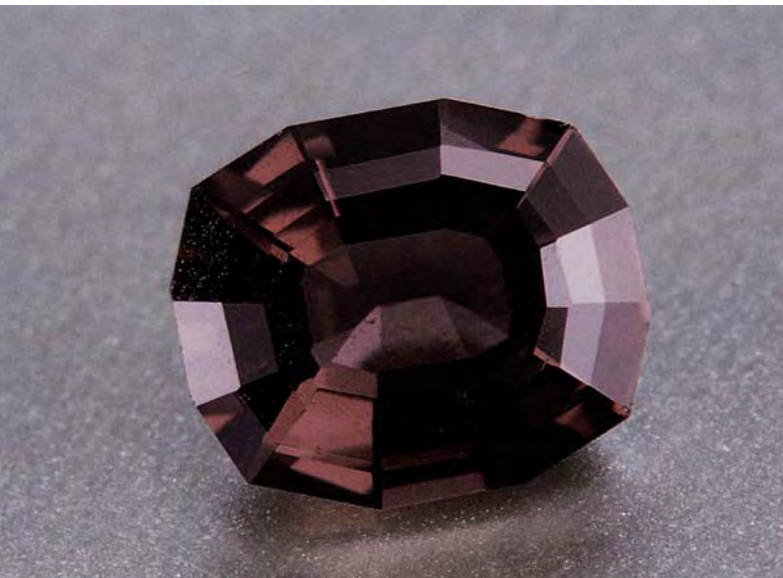


Figure 8. Examination of this 0.60 ct faceted musgravite provided useful identification criteria for this rare gem species. Photo by Maha DeMaggio.

brownish purple, rectangular cushion-shaped step-cut gem that he suspected to be musgravite (figure 8). This stone weighed 0.60 ct and measured approximately  $5.53 \times 4.77 \times 2.86$  mm.

The gemological properties of this stone were higher than would be expected for a faceted taaffeite. The refractive indices were  $n_o = 1.728$  to  $n_e = 1.721$  (uniaxial negative), with a birefringence of 0.007. Specific gravity, obtained in three separate readings by the hydrostatic

Figure 9. The unusual optical effect in these cultured pearls (largest, 14.5 mm) is caused by faceting. Courtesy of Komatsu Diamond Industry; photo by Maha DeMaggio.

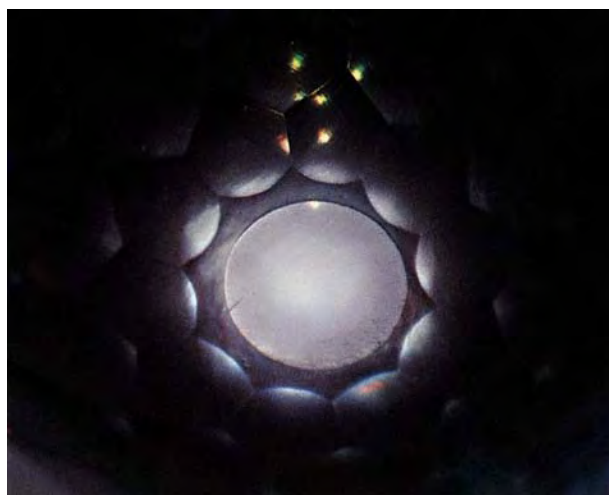


method, averaged 3.69. Only a weak absorption spectrum was seen with the Beck prism spectroscope, with no characteristic features that would be useful in identification. Not surprisingly, because iron was a major component, the stone was inert to UV radiation. No inclusions were observed in this stone with a gemological microscope.

Mr. Parsons gave us permission to characterize this stone further by means of energy dispersive X-ray fluorescence (EDXRF) and X-ray powder diffraction analyses, so that we could positively identify the material and obtain much-needed data for our reference files. The EDXRF qualitative chemical analysis, performed by Sam Muhlmeister of GIA Research, showed the presence of aluminum and magnesium, as would be expected from the formula for musgravite,  $(\text{Mg,Fe}^{+2},\text{Zn})_2\text{Al}_6\text{BeO}_{12}$  (M. Fleischer and J. A. Mandarino, *Glossary of Mineral Species 1991*, Mineralogical Record Inc., Tucson). Also detected were iron and zinc as major elements, with traces of gallium and manganese. (Beryllium and oxygen are not detectable with our EDXRF system.) Although taaffeite's ideal chemical formula ( $\text{Mg}_3\text{Al}_8\text{BeO}_{16}$ ) does not include iron and zinc as major components, these elements might be present as substitutions. Nor is the presence of iron and zinc, as detected by EDXRF, proof that a taaffeite-like gem is actually musgravite. However, detection of these elements in significant amounts should suggest that additional testing is required before identifying a stone as taaffeite.

X-ray diffraction analysis finally proved that this stone was musgravite. Contributing editor Dino DeGhionno obtained a minute amount of powder from the stone's girdle. From that powder, he obtained an X-ray diffraction pattern that was indicative of musgravite—not taaffeite.

Figure 10. Light reflecting off one facet of this "Komatsu Flower Pearl" shows that the facet is flat, not convex as it appears to the unaided eye. Photomicrograph by Shane F. McClure; magnified 23x.



Analysis of this musgravite gave us sufficient reference data to help separate musgravite from taaffeite in the future. Indications of whether a stone is musgravite or taaffeite can be obtained from refractive index and specific gravity determinations, as well as through EDXRF analysis. However, only X-ray diffraction analysis can provide conclusive proof.

**Faceted cultured pearls.** One of the most interesting discoveries we made at Tucson this year was, in our experience, a unique method of fashioning cultured pearls. Komatsu Diamond Industry of Kofu City, Yamanashi, Japan, is *faceting* Tahitian, South Sea, freshwater, and mabe cultured pearls. The finished products are being marketed as “Komatsu Flower Pearls” (figure 9). According to Komatsu literature, the company is using a faceting technique that was developed in 1992 by Kazuo Komatsu, who was trained as a diamond cutter. Since it would be undesirable to cut through to the shell bead, the cultured pearls selected for this technique must have thick nacre layers. Each fashioned pearl has 108–172 facets and should only require the same care as for more typical cultured pearls, according to Komatsu. However, the manufacturer cautions against polishing mounted “Komatsu Flower Pearls” with a buffer.

We examined 10 of these cultured pearls. The faceting produces a very curious optical effect: All of the facets appear to be distinctly convex. However, closer inspection with a microscope and reflected light showed that the facets were indeed flat (figure 10). The curved effect is apparently produced by the flat facets cutting through the numerous individual curved layers of nacre, bringing deep nacre layers closer to the surface in the middle of the facets. In some cases, remnants of the original surface can be seen between facets.

**Inclusions in quartz as design elements.** For some time, inclusions in gems have been used to characterize gem materials, and to determine (for instance) their natural or synthetic origins. Many gemologists also appreciate the beauty of inclusions in the microscope. Today, however, more gem cutters and jewelry designers are recognizing the aesthetic appeal of gems with large, prominent inclusions, and they are fashioning gems to display these inclusions to best effect. Examples that we have seen include: quartz with a three-dimensional jasper(?) scene (Lab Notes, Fall 1987, pp. 166–167) and with a magnified plane of three-phase inclusions (Gem News, Summer 1993, pp. 132–133); morganite beryl with an iridescent fracture plane (Gem News, Summer 1996, pp. 132–133); and a faceted tanzanite with a “wagon-wheel” appearance caused by a centered needle inclusion (Gem News, Summer 1994, p. 128).

Last year, Judith Whitehead, a colored-stone dealer from San Francisco, California, showed us a few samples of fashioned rock-crystal quartz that had bold patterns of included rutile and what appeared to be carbonate crys-



Figure 11. An aesthetically pleasing pattern of rutile and carbonate(?) inclusions adds a special design element to this 33.38 ct rock-crystal quartz cabochon. Courtesy of Judith Whitehead; photo by Maha DeMaggio.

tals. One such stone, a 33.38 ct pear-shaped double cabochon, is shown in figure 11. According to Ms. Whitehead, this is one of several pieces from a piece of rough that Roger Trontz, of Jupiter, Florida, found and had cut. The identification of the rutile was obvious. However, the sparse but prominent rhombohedral crystals, with slightly curved light brown surfaces, might have been calcite, magnesite, dolomite, ankerite, siderite, or some other mineral (though probably a rhombohedral carbonate).

Another example is a pendant that was recently sent to the Gem News editors for examination. Created by Kevin Lane Smith of Tucson, Arizona, the pendant was a free-form design that weighed 121.50 ct and measured 54.58 × 40.09 × 7.80 mm (figure 12). It was fashioned from Brazilian rock-crystal quartz. What makes this creation unique is that an intricate system of large fluid inclusions dictated the overall shape of the finished piece.

With magnification, it was evident that portions of the overall fluid inclusion pattern had been drained of fluid, because they were decorated with an epigenetic iron-containing compound in various shades of yellow to brownish yellow. Other portions of the fluid inclusion system remained intact; some even contained minute mobile gas bubbles. The overall effect produced by the presence of the inclusions in this pendant suggests ancient writing in clay or stone.



Figure 12. Fluid inclusions provide the design element in this 121.50 ct rock-crystal quartz pendant. With magnification (inset), it is evident that some areas have been drained of fluid and stained with iron-colored epigenetic matter. Photo by Maha DeMaggio. Inset photomicrograph by John I. Koivula; magnified 5 $\times$ .

## TREATMENTS

**A new emerald filler.** Arthur Groom-Gematrat, of New York and other cities, has reportedly developed a new filling material for emeralds, which was introduced to the trade at the Las Vegas JC-K show in June. Before the show, the Gem News editors spoke with Fernando Garzón of Arthur Groom-Gematrat, who loaned us an emerald for examination both before and after treatment, together with some samples of this and other emerald filler materials.

The 15.22 ct emerald was first cleaned by a special technique the company developed to remove any evidence of previous filling material (figure 13, left). Then it was refilled using the new, proprietary method (figure 13, right). According to Mr. Garzón, the filler consists of a resin and a catalyst (that is, a hardening agent). It can be removed with warm acetone and isopropyl alcohol; how-

ever, it is durable enough that the emerald can be recut with the filler in place.

Mr. Garzón also showed us glass test tubes of the new filler (resin plus catalyst) and Opticon (resin plus catalyst), which were poured in pairs at six-month intervals, beginning about three years before our examination. These samples were intended to demonstrate that, in comparison with Opticon, the new filler is not yellow when first poured, nor does it turn yellow over time. We hope to present more information about this filler at a later date. Emeralds filled with this new material are being studied by GIA Research and the GIA GTL Identification Department as part of a comprehensive study of emerald treatments.

## SYNTHETICS AND SIMULANTS

### Update on vanadium-bearing synthetic chrysoberyl.

Green vanadium-bearing chrysoberyl (with no change of color) was described in the Fall 1996 Gem News section (pp. 215–216). Natural stones were stated to originate from one of the new deposits in southern Tanzania, and synthetic material of similar appearance was being grown in Russia. As reported in that entry, electron microprobe analysis and EDXRF spectroscopy of one natural and two synthetic samples revealed differences in the amounts of trace elements they contained.

Contributing editor Karl Schmetzer subsequently examined one 1.75 ct “rough” sample of this synthetic material and the two faceted samples (1.00 and 1.12 ct) illustrated in the Fall 1966 entry, all of which were made available to him by the SSEF in Basel, Switzerland. The gemological properties of these synthetic chrysoberyls were within the range of values reported for their natural counterparts. These include: refractive indices of  $n_{\alpha} = 1.742\text{--}1.743$ ,  $n_{\gamma} = 1.751\text{--}1.752$ ; a birefringence of 0.008–0.009; a specific gravity of 3.76; and no reaction (inert) to both long- and short-wave UV radiation. With careful microscopic examination, all three samples revealed a distinct pattern of curved growth striations, which was clearly visible using methylene iodide as the immersion liquid (figures 14 and 15). In addition, the unfashioned sample contained small, slightly elongated bubbles in the outer growth zones of the crystal.

The microscopic properties of the three samples indicated a growth from the melt. In general, however, the growth pattern of these synthetic chrysoberyls differed from the more regular curved growth striations seen previously in Czochralski-pulled synthetic alexandrites. The distributor had mentioned the floating-zone method, but the growth pattern of this material is completely different from previously examined synthetic alexandrites grown by Seiko using the floating-zone technique. However, a brief item in a Fall 1994 Gem News entry about new Russian production of synthetic gems (p. 200) did mention the synthesis of nonphenomenal green chrysoberyl in Novosibirsk by means of the hori-



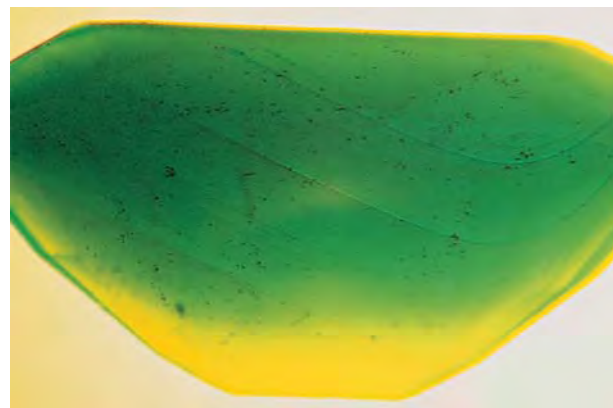
Figure 13. These photos show the appearance of a 15.22 ct emerald before (left) and after (right) it was filled by a new, proprietary method being marketed by Arthur Groom–Gemratrat. Photos by Maha DeMaggio.

zontal-growth method. In this modified floating-zone technique, a flat container with nutrient is moved horizontally through a high-temperature melting zone in a specially designed furnace. If this technique is the growth method for the samples described above, then the irregular growth pattern becomes understandable.

**“Cat’s-eye” synthetic emerald.** Usually, a 6 ct rectangular block of transparent synthetic emerald would be fashioned in a way to minimize weight loss. However, we obtained a block that had been sliced on five sides; one large side retained its rough crystal surface with an array of many subparallel growth steps. (The block was grown in Russia by the hydrothermal process.) No inclusions were visible through the rough faces of this highly transparent piece.

We recently examined, photographed, and described

Figure 14. When immersed in methylene iodide, this Russian synthetic nonphenomenal green chrysoberyl shows strong bands of curved zoning. Photomicrograph by Karl Schmetzer; magnified 30×.



some fashioned natural gem materials with decorative crystal faces incorporated into their design (Gem News, Winter 1996, p. 283). With this in mind, we tried to think of a way to incorporate the rough face with the growth steps into the finished stone, instead of grinding it off to produce a traditional flat facet.

The first idea was to keep the rough surface as a table facet on a rectangular emerald cut. However, because the growth steps appeared to be highly reflective, we decided to create an oval cabochon, with the growth steps remaining on the base of the finished piece, in the hope that some interesting reflections might be projected and magnified through the dome.

The rough block was turned over for cutting to Phil Owens, a gemologist and lapidary in the GIA GTL Gem Identification Department. The result was somewhat surprising: The finished cabochon actually showed a

Figure 15. At higher magnification, the irregular nature of these growth bands becomes evident. Photomicrograph by Karl Schmetzer; magnified 60×.

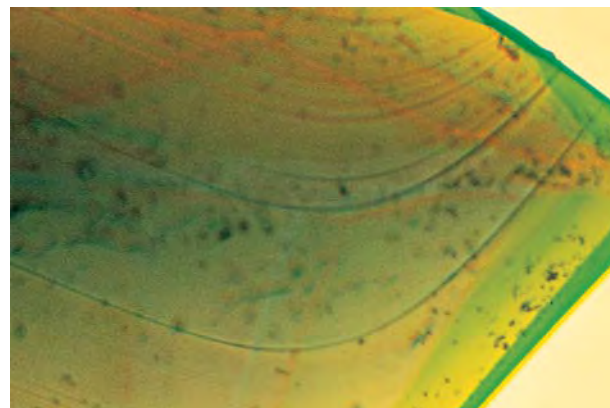






Figure 16. A weak cat's-eye effect can be seen in this 4.77 ct cabochon of Russian hydrothermal synthetic emerald, which retained on its base the original rough surface. Photo by Maha DeMaggio.



Figure 17. The base of the synthetic emerald cabochon in figure 16 is decorated with an array of subparallel growth steps, which cause the cat's-eye effect. Photo by Maha DeMaggio.

weak cat's-eye effect in reflected light (figure 16). This could be attributed to the fact that the growth steps on the base of the cabochon were subparallel and aligned perpendicular to the length of the finished piece (figure 17). Light entering the cabochon is reflected by the growth steps and is concentrated, on its return, across the length of the cabochon's dome.

**Emerald rough—buyer beware!** Apparently, imitations of Zambian emerald crystals are as common now as they were back in the late 1980s and early '90s.

The Spring 1989 Gem News section (pp. 50–51) contained two reports on quartz imitations of emerald crystals that had been purchased by emerald buyers in southern Africa. In these reports, the emerald "crystals" were actually composed of fragments of quartz crystals that

had been glued together with a green epoxy resin. The evidence of assembly was hidden by a glue coating on the surface that was covered by small mica flakes and other bits of fake matrix, which also gave the specimens a more realistic appearance. An almost identical imitation was reported by another contributor in the Summer 1990 section (pp. 167–168). In Spring 1990 (pp. 108–109), we reported on a five-sided (!) glass imitation of an emerald crystal, which had been obtained in Zambia by a group of Zambian emerald dealers. The rough surfaces were enhanced with an orangy brown clay-like "matrix" and flakes of mica.

The most recent imitation brought to our attention, by gemologist John Fuhrbach, has some features not seen in previous imitations. When Mr. Fuhrbach, of Amarillo, Texas, visited Zambia with his wife in the summer of

Figure 18. This "matrix"-decorated, green-coated smoky quartz crystal imitation of emerald was obtained during a visit to Zambia. As shown here, it weighed 473 ct. Photo by Maha DeMaggio.



Figure 19. After removal of the "matrix" and coating from the imitation Zambian emerald, the underlying smoky quartz crystal weighed 407 ct. Photo by Maha DeMaggio.



1996, they were offered several fake emerald crystal specimens by local "gem dealers." Some of these rough "emeralds" were large and gemmy looking, and a real bargain at only US\$450 per gram. To a typical tourist with no knowledge of emeralds, these might prove too tempting to resist. However, a trained gemologist could easily detect these fakes, even with a simple 10× loupe. Mr. Fuhrbach eventually obtained one such specimen (figure 18) to examine gemologically, for substantially less than the original asking price.

Unlike previous imitations that we have examined, this specimen was manufactured with a transparent, singly terminated quartz crystal. The crystal was not fractured and glued back together, as we have seen in the past; instead, it was coated with a transparent bluish green, plastic-like material. This colored coating also served as a glue to attach epoxy-laden "matrix" material to the crystal, hiding the quartz termination. With magnification, the "matrix" appeared to be composed of crushed rock, possibly granite, and a micaceous-looking substance. In the coating itself, dust and many small fibers were visible, another obvious piece of evidence. The coating was so thick that junctions between adjacent crystal faces—which should have been sharp—were appreciably rounded.

Mr. Fuhrbach decided to strip off the coating and matrix to see what the original starting material actually looked like. After experimenting with various organic solvents, he found acetone to be the most successful. [Note that acetone is highly flammable and can cause significant health problems if used improperly.] Before treatment, the specimen weighed 473 ct (94.6 g); after ultrasonic dissolution in acetone for 24 hours, the remaining light-brown smoky quartz crystal (figure 19) weighed 407 ct.

A bonus to this story is that the smoky quartz crystal was itself host to two tourmaline crystals and a large mica crystal. The largest tourmaline, 12 mm long, was a transparent, singly terminated pink-and-green bicolor. The mica inclusion appeared to be colorless, and it measured about 10 mm on its longest dimension. At least two, and possibly three, large faceted stones—each containing a beautiful inclusion—could be cut from this one quartz crystal.

**An especially misleading quench-crackled synthetic ruby.** Contributing editor Henry Hänni encountered a tricky identification challenge at the SSEF. A 6.47 ct red octagonal step cut (figure 20) was received from a client who wanted the origin of this "probably Burmese ruby" determined. Staff members at the lab quickly noticed extended fractures in the sample, which showed evidence of a foreign material that contained large, flat bubbles. They assumed that the filling was a glassy substance. Two possibilities were a natural ruby that had been heat treated to an extreme degree, or a synthetic ruby that had been quench-crackled, with the glassy fill-

ing added to mask its synthetic nature.

In the course of further study of the inclusions, the staff members found a series of narrow twin lamellae, meeting at an 86° angle at one corner (figure 21, left). These structural features were best seen when the stone was immersed in methylene iodide and viewed between crossed polarizers. Such twinning is common in natural rubies from various localities (see, e.g., H. A. Hänni and K. Schmetzer, "New Rubies from the Morogoro Area, Tanzania," Fall 1991 *Gems & Gemology*, pp. 156–167), but it is also occasionally seen in synthetic corundums (see, e.g., Winter 1991 Lab Notes, pp. 252–253). The most surprising feature of this synthetic was the very fine Verneuil banding (figure 21, right), well hidden by the treatment features, which provided the conclusive identification of this piece as a quench-crackled synthetic ruby. No individual or swarms of gas bubbles were seen in the body of this synthetic (as opposed to in the fractures), but the extensive fracture system made it hard to detect such small features. This identification experience led Dr. Hänni to wonder whether similar treated synthetics had been reported in the past; he found this to be the case (see, e.g., J. M. Duroc-Danner, "Radioactive Glass Imitation and an Unusual Verneuil Synthetic Ruby," *Journal of Gemmology*, Vol. 23, No. 2, 1992, pp. 80–83).

#### **New information on flux-grown red spinel from Russia.**

Since the late 1980s, Russian-produced transparent flux-grown red and blue synthetic spinels have become increasingly available in the trade, both as crystals and as fashioned stones. A detailed report on this synthetic

Figure 20. This 6.47 ct Verneuil synthetic ruby (12.23 × 8.28 × 5.54 mm) had been heat treated to induce cracks that were then filled with a glassy material. Photo by H. A. Hänni.



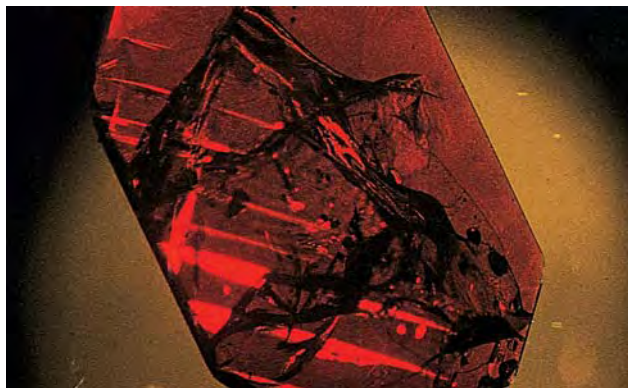


Figure 21. When the sample shown in figure 20 was immersed and viewed between crossed polarizers, two sets of rhombohedral twinning lamellae became visible (seen here on the left side of the photo to the left). Further examination revealed fine Verneuil color banding (seen here in the upper right corner of the photo to the right), which proved that the ruby is synthetic. Photomicrographs by H. A. Hänni.

material (S. Muhlmeister et al., Summer 1993 *Gems & Gemology*, pp. 81–98) noted that one particular type of inclusion was only observed in the blue material. This unusual “dendritic” inclusion forms as distinctly shaped, extremely thin, delicate fans (figure 22).

At the time of the initial report, this type of inclusion was also considered to be diagnostic and quite valuable for separating these synthetic blue spinels from their natural counterparts, particularly from Sri Lankan blue spinels that derive their color from trace amounts of cobalt. It could not be determined why these inclusions were only found in the blue material, and why they were not also seen in the red flux-grown synthetic spinels.

During recent examination of 16 Russian flux-grown synthetic red spinels at the West Coast GIA Gem Trade Laboratory, this inconsistency was put to rest: Three of the stones contained dendritic inclusions iden-

tical to those observed in the blue synthetics. These inclusions appear opaque in darkfield illumination. In transmitted light, they may show slight translucency, with a dark reddish brown color (figure 23), but reflected light reveals an obvious metallic luster. Because at this time destructive testing would be needed to determine the nature of the material in these dendritic inclusions, and because of the limited number of included specimens that were available, we have not yet identified these inclusions.

#### Erratum

*The tourmaline specimen on the cover of the Spring 1997 issue of Gems & Gemology is from the Queen mine in the Pala District of California. The incorrect district was listed in that issue.*

Figure 22. Dendritic inclusions such as this one were first thought to be limited to Russian flux-grown blue synthetic spinels. Photomicrograph by John I. Koivula; magnified 20×.



Figure 23. Extremely thin and translucent dendritic inclusions have now been observed in Russian flux-grown red synthetic spinels. Photomicrograph by John I. Koivula; magnified 20×.

