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IN THIS ISSUE

The Contact Angle of Water On Gems

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The contact angle of water on inorganic minerals and a variety of diamond substitutes is shown to be a useful gemological test probe. Diamond has a contact angle quite different from that of the various diamond imitations. A complicating factor is the effect of irradiation, which appears to produce a modified surface layer which changes the contact angle. This can be removed by mild abrasion. Contact angles are reported for 27 gem and mineral substances.

Introduction

It is widely known that diamond differs from most other minerals in that it is hydrophobic, i.e., is not wetted by water. This property is used in the "grease-table" separation technique in the South African diamond mines: when crushed rock is washed with water over a table covered with grease (e.g., petroleum jelly), diamonds will adhere to the grease while most other minerals are washed away.[1]

With the proliferation of diamond-look-alike synthetics, a need exists for rapid, positive tests for the identification of high refractive index stones, i.e., those with refractive index beyond the range of refractometers. At present the only tests which can support a loupe or microscope examination for flaws, inclusions, perfection of finish, etc., are a specific gravity measurement, the reflectometer type instruments[2], and checking the hardness, e.g., with a tungsten carbide point[3], which scratches everything except diamond (if one has been assured that it is indeed a diamond!). There are drawbacks to each of these techniques, and an additional test, even if it should not be sufficient in itself, is always useful, particularly if it is simple and non-destructive.

Theory

When a liquid L is in contact with a solid S in the presence of an atmos-

$$T_{SV} - T_{SL} = T_{LV} \cos\theta$$

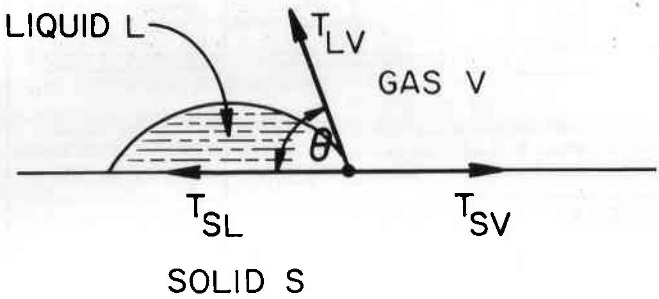


Figure 1. Young's equation for the contact angle θ of a drop of liquid L on a solid S in a gas V with interfacial tensions T.

phere or vapor V, the contact angle is controlled by Young's equation[4] as given in *Figure 1* where T is the tension between any two of the three phases and θ is the contact angle as shown in *Figure 1*. This equation is in fact only a statement that the forces must balance in the horizontal plane at the contact point. It is usually not feasible to measure the individual T values, and θ is therefore measured directly.

Contact angles range from 0 degrees, when complete spreading (wetting) occurs on a clean surface of combinations such as water on glass, quartz, etc. to values close to 180 degrees, when a drop sits on the surface with essentially no contact.

Much work has been done in the contact angle field for polymers and other organic substances and a review has been given by Neuman.[5] There has been some recent questioning of the fundamentals behind Young's equation[6], but a new derivation appears to have placed it on a sound theoretical footing.[7]

The contact angle depends both on the solid as well as on the liquid used. Any liquid could be employed, but in this study we have confined our attention to distilled water. Since the contact angle is characterized by the properties of the surface atomic layer, surface contamination is the main error-producing factor.

Technique

In *Figure 2* a step by step description is given of the technique which was used to measure contact angles on a variety of gem and mineral materials. Additional precautionary notes to this figure are:

(1) If oil, grease, or soap may be present (as in a mounted stone) wash well in water, dry and use an additional preliminary rinse in trichlorethane or a similar grease solvent.

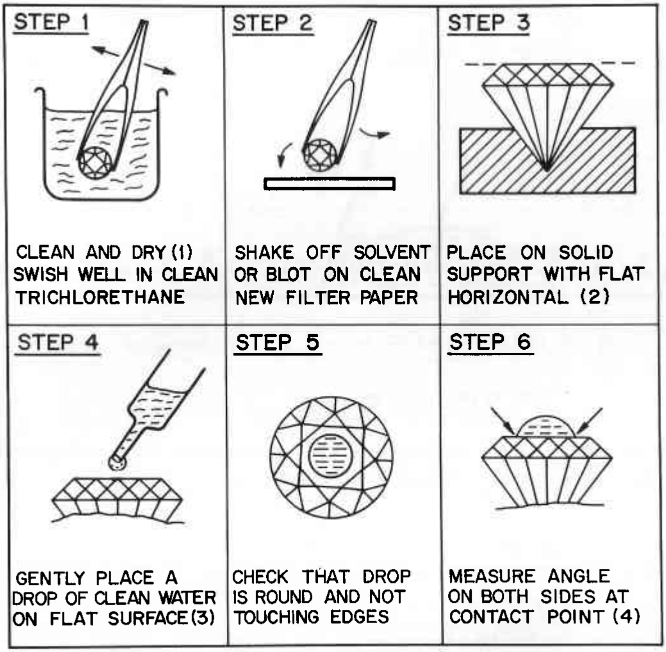


Figure 2. Steps in measuring the contact angle. See text for footnotes.

(2) Do not touch top surface of stone after cleaning. Modelling clay is a good medium to hold stones in place. Measure within a few minutes of cleaning.

(3) Use clean, distilled water, free of soap or grease. Do not drop water from above the surface and do not move drop or suck water back from drop once it is in place. A hypodermic syringe with a fine needle, a glass medicine dropper drawn out to a fine tip, or a micropipette are suitable for adding the liquid.

(4) Measure the angle within a few minutes of forming drop, to avoid excessive evaporation or contamination from atmospheric pollution, and do not shake or otherwise cause drop to move. Make sure angle is being measured right where it is touching the surface. The two measurements should not be significantly different.

Additional cautionary points are the following:

(5) Too high readings may result from any grease present or from some coatings; too low readings will result from some coatings, from soap or detergent, from contaminated water, from waiting too long, or from angles measured away from the contact location. Make sure there is no coating on the surface to be tested and that

the stone is not a combination stone (doublet, triplet, etc.). Irradiation appears to change the contact angle; lowers a high value and raises a very low value (see below).

(6) *It is always best to check one or two known specimens to confirm that good technique is being followed, as with any test.*

The contact angle was measured with a small telescope equipped with two cross-hairs, one being fixed horizontally, the other attached to a rotating scale calibrated in degrees. In this apparatus[8], the sample to be measured is supported on a solid metal table which can be moved horizontally and vertically by rack and pinion drives to obtain an exact position in the cross-hairs.

Results

In *Table 1* and *Figure 3* are accumulated data taken by at least two observers each on a range of gem and mineral type of materials. In many cases a variety of colors was included (e.g., white, blue, brown, and orange topaz; white, pink, ruby, orange, and blue shades of corundum; etc.); both natural and synthetic gems were also tested, and neither color nor origin appeared to introduce any differences except in spinel and cubic zirconia, where the composition of the synthetic is known to be quite variable.

The contact angle is not significantly affected by the quality of the polish, and results were usually reproducible ±3 degrees on a given sample and almost always within ±5 degrees over several samples (except for the variable composition spinel and cubic zirconia).

TABLE 1
CONTACT ANGLES (WATER)

In descending order of the average angle in degrees.

Zincite	94-90
Corundum	94-86
YAG	92-86
Strontium Titanate	90-80
Lanthanum Aluminate	91-85
Alexandrite	90-84
Elbaite	88-80
Grossularite	84-76
Cubic Zirconia	90-70
GGG	84-74
Beryl	89-83
Topaz	80-69
Lithium Niobate	77-71
Spinel	84-64
Wulfenite	73-69
Yttralox	71-65
Rutile	72-62
Zircon	67-60
Spessartite	67-60
Powellite	64-60
Moissanite	66-58
Iolite	62-56
Scheelite	60-50
Diamond	55-47
Oligoclase	41-35
Quartz	0
Glass	0

To check on possible anisotropy effects, an oriented topaz cube was measured on all faces as follows:

a – faces: 70,74; Av. 72.0, SD 2.8
b – faces: 69,74; Av. 71.5, SD 3.5
c – faces: 72,80; Av. 76.0, SD 5.6
Grand average 73.2, SD 3.3

Within the standard deviation (SD) limits the differences found were not significant.

The Effect of Irradiation

Considerable difficulty was experienced in obtaining consistent readings on several of the materials

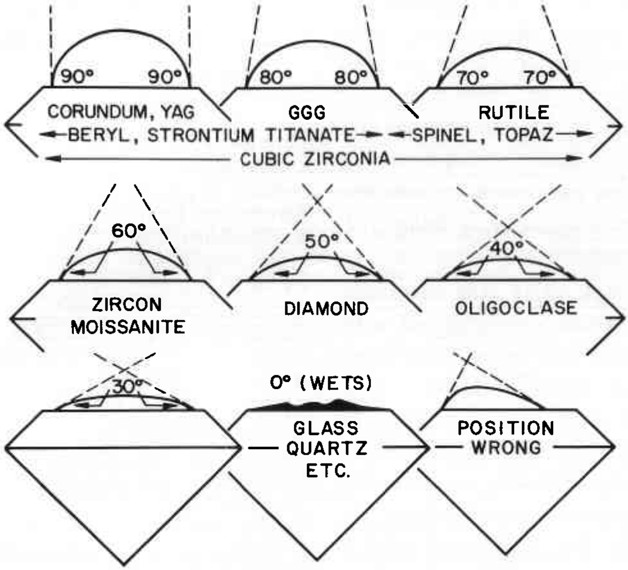


Figure 3. Approximate contact angles of diamond and diamond imitations.

studied, until it was realized that they had one thing in common: they had been known or suspected of having been irradiated. Some irradiation experiments using a cobalt-60 gamma cell on known unirradiated specimens confirmed this effect.

It appears that a thin film of oil, grease, etc. is usually present on all surfaces and when the specimen is irradiated the surface is modified by an adherent layer of possibly polymerized material tightly bonded to the surface. Such a layer is only a few atoms thick and therefore does not affect the refractive index (also a surface property, but which needs a layer at least of the order of a wave-length of light in thickness to have any effect).

Even hot chromic acid/sulphuric acid cleaning solution did not remove this layer, but a light re-polishing always did. In the case of an irradiated blue-green diamond, a light rubbing with Linde A abrasive (much softer than diamond) removed the layer and restored the contact angle reading appropriate for diamond. A check on natural blue and yellow diamonds showed normal results.

Discussion

The most surprising aspect of this study was the finding that so many materials have contact angles even higher than the 50 degrees of diamond. This is particularly true of almost all the more convincing high refractive index diamond imitations

TABLE 2
THE EFFECT OF IRRADIATION ON THE CONTACT ANGLE (WATER)

Material	Re-polished or not irradiated	Irradiated and not re-polished
Corundum	94-86	40-36
Beryl	89-83	74-43
Topaz	80-69	70-48
Diamond	52-47	17-15
Quartz	0	35-22

such as cubic zirconia, GGG, YAG, strontium titanate, rutile, and zircon. Diamonds smaller than one half carat can be readily measured.

In view of the anomalous results produced by irradiation, the contact angle test cannot be recommended as an unambiguous guaranteed-not-to-fail identification test for diamond. Nevertheless it is interesting that, in the absence of irradiation, diamond with a contact angle of about 50 degrees is easily distinguished from the various diamond imitations with contact angles in the 60 to 90 degree range as shown in *Figure 3.*

The range of this study was relatively limited; the values determined need to be checked elsewhere on different specimens and a number of additional studies would be needed for the full applicability of the contact angle as a gemological testing technique. Items that need investigation include the following:

a) Trying different solvents and cleaning techniques to see which produces a clean surface most easily for various possible contaminants (waxes, silicone, grease, soap, etc.).

b) Trying other test liquids. Water is most convenient and gives an excellent separation for diamond, but it becomes contaminated very easily; it is probably still the best for general use.

c) Checking in more detail for small variations of the contact angle with quality of polish, with composition (including impurities, i.e., color) and with orientation. All except major composition changes are expected to be very small effects, if at all detectable.

d) Building up a compilation of accurate contact angles for several specimens each from different localities of many gems and minerals, including any orientation and compositional variation effects.

e) Determining the softest abrasive which will reliably remove the irradiation-produced surface polymer layer.

Acknowledgment

We wish to thank Miss C.A. Wang for independently measuring a set of contact angles for the materials used in this study. We are grateful to Mr. R. Crowningshield of the Gemological Institute of America, and Dr. G. Kaplan of Lazare Kaplan and Sons, both of New York City, for the loan of specimens.

Addendum:

A recent article by W.W. Hanneman (*Lapidary Journal* **31**, 2576, March 1978) and an older one by A.T.H. Tjwan (*Journal of Gemmology* **11**, 205, April 1969; reprinted *Lapidary Journal* **23**, 624, July 1969) report some water drop results. Both authors appear to have used quite inadequate cleaning: Tjwan "wiped with a clean dry cloth" (!) and Hanneman did not specify his technique. As one example, neither the glass nor the quartz of the latter should yield the drops he shows in his figures, since the contact angle of both these materials is zero degrees and complete spreading is known to occur when they are scrupulously clean. Accordingly, the conclusions of both of these reports cannot be accepted as valid.

REFERENCES

1. R. Webster, *Gems,* Butterworths, London, 3rd Edn., 1975, p. 27-28.
2. See e.g., W.W. Hanneman, *Gems & Gemology* **15,** 302 (1977).
3. Available, for example, from H. Rubin, Inc., Booth 36, 42 W. 47th St., New York City.
4. T. Young in *Miscellaneous Works,* G. Peacock, Ed., Vol. 1, J. Murray, London, 1885.
5. A.W. Neuman in *Advances in Colloid and Interface Science* **4,** 105 (1974).
6. G.J. Jameson and M.C.G. del Cerro, *J. Chem. Soc. Faraday Transactions* 1, **72,** 883 (1976).
7. L.R. White, *J. Chem. Soc. Faraday Transactions* 1, **73,** 390 (1977).
8. Model A-100, Ramé-Hart Inc., Mountain Lakes, NJ.

Developments and Highlights at GIA's Lab in New York

By ROBERT CROWNINGSHIELD

More on Cubic Zirconia

Since writing the Fall Column for *Gems & Gemology*, the Laboratory in New York has had the occasion to examine quite a few of this latest diamond simulant. We are proud of all the laboratory staff – from non-gemologist weighers and measurers to diamond graders and colored stone personnel who have recognized stones surreptitiously submitted for examination. In several instances, weighers have noted the weight versus measurement differences while graders have noted the rounded facet junctions, polishing scratches and un-diamond-like girdle treatment. In almost all stones tested, the mere act of taking the stones' measurements chips the culet with a resulting conchoidal fracture which arouses suspicion.

Figure 1.

Recently, a detective for the attorney general's office in a nearby county brought in four rings each set with cubic zirconia *(Figure 1)*. Without question they were the best polished and best quality clear material we have seen (barring the obvious hardness test scratches made before we saw them). The stones ranged in size from an approximate diamond size of 1.00 carat to an emerald cut about the size of a 5-carat diamond. The smallest stone was set in an old platinum engagement ring with two side diamonds, but the prongs had not been repaired to complete the deception. All but one of the stones fluoresced orange under long-wave ultraviolet. The remaining stone was inert but glowed a slight greenish-yellow under short-wave ultraviolet. We were unable to unmount the stones to determine specific gravity but have found it, too, to be inconsistent ranging as it does from approximately 5.40 to 6.00. All showed the effect of great dispersion when examined culet up in the light well of the Gemolite. When tested with a reflectivity meter, the reading for all four stones was 2.15 in good agreement with our standardized cubic zirconia test comparison stones.

Perhaps the most insidious request we have received was for a report on the color origin of a light pink round brilliant. By chance the weighers had just finished a colorless diamond with almost the same measurements and were alerted when the pink stone weight was much greater – but not before the culet had suffered chipping because of the measurement. This was our first cubic zirconia in a near-fancy color.

We feel that well-proportioned and finished cubic zirconia is potentially a great hazard for the jewelry trade, as well as mêlée size stones. We do not know the story behind the four rings submitted by the detective, but he promised to let us know when litigation is completed. Several people are working toward simple tests which non-gemologists can use to detect whether or not a stone being examined is a diamond. Certain properties of diamond not currently being exploited by gemology may have to be used. One can think of thermal conductivity, unwettability, etc. If any reader learns of frauds committed with this material, the writer would like to hear about the incident in order to alert other readers. Meanwhile, with diamond prices still going skyward, there may be a place for this convincing stone.

Evidently, the very diamond-like appearance of cubic zirconia is giving problems to manufacturers and repairmen. Workers forget – or do not know – they are *not* working with diamond, often with disastrous results. *Figure 2* shows what remained of a 2.50-carat round brilliant in a solitaire ring being sized. Manufacturers have told us of higher than average incidence of breakage. At the moment, we do not have enough information about the wearability of the stone since we only recently had one set with the request that the owner wear it regularly.

Currently in the Laboratory, we are working on an interesting project for a client. With the high price of diamonds, he is curious to see if a master color set of cubic zirconia might not be feasible. To our amazement, we have secured an "E," "G," "I," and a rather too brownish "J." We do not know if cubic zirconia will "hold its color" or if it will alter with exposure to ultraviolet or with age. We do know

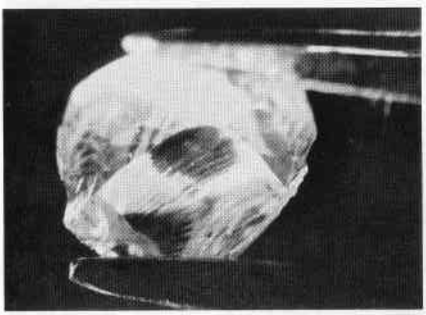


Figure 2.

that the stones do not excite suspicion on the part of the color graders as they "look like diamonds." With the advent of cubic zirconia in colors perhaps we can secure some master fancy colors at a reasonable price to delineate such things as the point at which a pink may be considered fancy or fancy intense pink.

And Now, Diamond

We have reported before that Type IIb conductive diamonds are not all blue. Most recently we mentioned the possibility of brown stones which seem to be laminated with brown and blue. (I am reminded of a flat crystal kindly lent to us for photographing by Lazare Kaplan and Sons in which half was blue and half was brown.) Also, most gray to "transparent" black diamonds are conductive. As an experiment, one friend of the Laboratory showed us a conductive gray diamond with the statement that he planned to bombard it with electrons in order to give it a blue color. This he proceeded to do, but upon retesting for conductivity it was found to be inert. If this is, indeed, the reaction of irradiation on conductive stones, it is a comfort to know since conductivity has always indicated natural color.

One color of diamond which we rarely see and then mostly in mêlée sizes is a light greenish blue resembling un-heat-treated aquamarine. Sometimes the small stones have greenish to brown spots in naturals and some show a cape spectrum suggesting natural irradiation as the source of color. Recently, we examined an exquisite light greenish-blue emerald-cut stone weighing more than 25 carats and which was, incidentally, internally flawless. The stone apparently had some history suggesting that it was in existence as a cut stone long before irradiation was used to alter colors. It was inert to ultraviolet and did not conduct. Moreover, there were no naturals present to search for "skin." We were curious to determine if the stone might not be a Type IIa which is highly transparent to short-wave ultraviolet as Type IIb stones are, but are not conductive. This stone was transparent to short-wave ultraviolet (using the "scheelite test" in a dark room). We are eager to examine more stones of this rare color to see if our findings have any meaning. We are especially interested in a pair of stones cut from the same piece of rough which the cutter said had a "skin" of brown spots. Unfortunately, they were all cut away so that there is no means of determining the color origin. They resemble a light greenish-blue electron-treated stone given to GIA some years ago by the Diamond Research Laboratory in Johannesburg. The two stones have weak 4155 A. U. "Cape" lines which the large emerald cut did not have. Incidentally, both they and the large emerald-cut stone were noticeably more transparent than most "white" diamonds. *Figure 3* depicts this unusual large emerald cut.

A really rare coincidence is shown in *Figure 4.* It is a surface grain or twin line paralleling the girdle and bisecting it so that the stone was suspected of being a doublet.

Those readers who use the spectroscope frequently for determining the

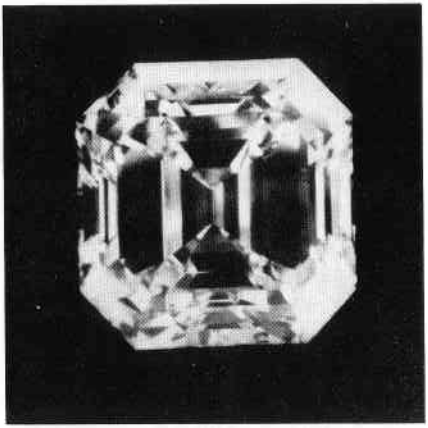


Figure 3.

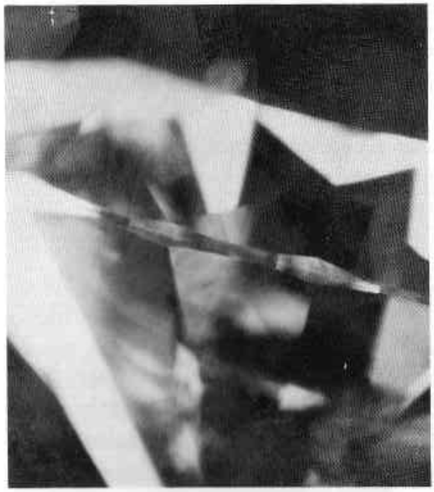


Figure 4.

origin of color of diamonds know how rarely a fluorescent line is seen. The line at approximately 5700 A. U. in treated pinks is the most frequently observed. We were surprised to see such a line at about 5400 A.U. in an intense fancy yellow brown stone of natural color.

In *Figure 5,* we illustrate something that keeps us amused while grading diamonds. For all the world, the inclusions in this diamond resemble worms. It is difficult to imagine what went on crystallographically to produce unusual features.

Another Multi-Star Quartz

Since writing the column for the Summer 1977 *Gems & Gemology,* we have not seen any more of the multi-star quartz until recently when a 204-carat stone in a diamond and platinum cluster ring was presented for identification *(Figure 6).* The stone was light bluish-gray in color and when viewed with the main star along the optic axis, it resembled a star sapphire very well. Unfortunately, the photograph does not show the many other stars which confused jewelers in this country who were asked to evaluate the ring. The ring was purchased in Hong Kong by a tourist.

Imitation Tourmaline

A modest amount of publicity has occurred to promote one of America's

Figure 5.

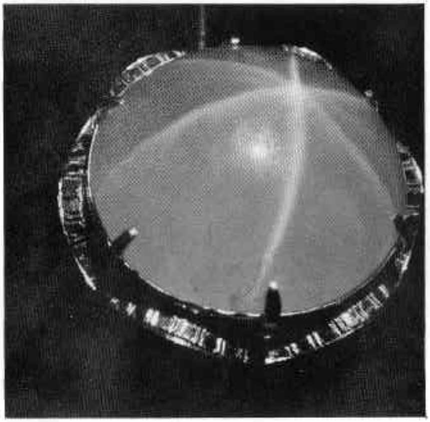


Figure 6.

few gemstones – namely, Maine tourmalines. As we have mentioned before, the colors from the Plumbago Mine tend toward a rhodolite red-purple and a pleasant bluish-green with bi-color stones occurring occasionally. We were surprised to have submitted for identification a pair of quartz triplets which were dead ringers in color for Maine bi-colors *(Figure 7)*.

Black Cultured Pearls, Natural Color

Through the good offices of Assael International, New York, we have had the opportunity to examine the first commercial offerings of Tahiti black cultured pearls assembled in necklaces and paired for earrings *(Figure 8)*. The test for untreated color is use of long-wave ultraviolet in a dark room. Black pearls from some sources will fluoresce an intense red while others take on a "furry" brown appearance. The Tahiti cultured pearls are in the latter category. We find it is helpful to use the contrast goggles to see the brownish

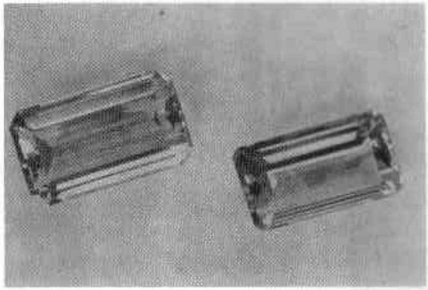


Figure 7.

color otherwise masked by visible ultraviolet reflections. It will be interesting to see how well this new product will be accepted by the trade and public.

Synthetic Amethyst

Although we are quite sure that synthetic amethyst particularly of Russian manufacture has been entering the market for some time, the Laboratories are seldom called upon to make a distinction between it and natural material. Now that the Russians are seeking distribution in the United States we have seen several large lots and have been asked leading questions about marketing it. As we have stated

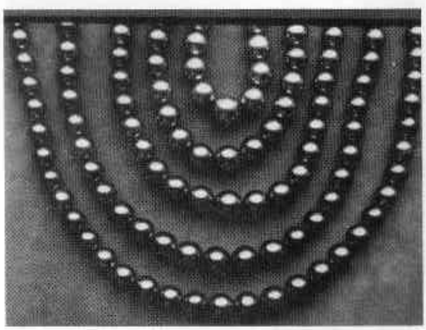


Figure 8.

before, if the stone being examined has no inclusions whatsoever and no color banding it is suspicious – but not identifiable. We were in hopes that a lead offered by Robert Webster who was unacquainted with synthetic amethyst would be helpful. In his monumental book, he suggests that X-ray fluorescence many times distinguishes synthetic rock crystal from natural. Indeed, we found that the paler synthetic amethyst glows a weak greenish compared with the same color natural – sometimes! Darker synthetic stones in our collection are virtually inert while a similar colored natural stone fluoresced weakly. Parcels offered recently at low prices contained as many as 30 calibrated stones not one of which had any inclusions, although some had indistinct color bands. It would appear that the stones were cut from growth areas far removed from the seed plate and carefully examined so that tell-tale bread crumb inclusions would be absent. The lack of flaws, of course, was suspicious. In color, the stones we have seen vary from pale brownish-purple to a deeper purple, but still brownish. In fact, we have seen very few synthetic amethysts with the exciting red-purple of the finest natural stones. Because amethyst is not really one of the most popular stones, it remains to be seen how well a synthetic counterpart resembling less than fine quality will be received. We have had the experience in the recent past of being offered large lots of amethysts by Brazilian dealers eager to sell at any price in order to get the air fare home. The prices asked for stones very similar to the synthetics we have seen must surely be lower than that at which the synthetic ean be sold.

A Puzzling Natural Emerald

The difficulty one encounters in using the loupe alone for identification was pointed up when a natural emerald was identified recently for a jeweler who is familiar with the so-called "Ferrer" emerald appearance under the loupe. This glass imitation of emerald was reportedly made in the 1920's in Barcelona by one Ferrer who managed to make an excellent color and to introduce swirled inclusions of gas bubbles resembling the "garden" in a natural emerald. In *Figure 9* two-phase inclusions are swirled in a "Ferrer-like" pattern.

Figure 9.

Amber From the Dominican Republic

A recent issue of *National Geographic* reminded us that we have been seeing quite a bit of interesting amber from this Caribbean island. One American dealer has been very helpful in providing our collection with samples of the wide range of colors and appearances. In *Figure 10* we attempt to illustrate in black and white a part of the collection. In color they range from very pale yellow resembling white wine to a very dark almost black-brown. A few are highly fluorescent and will appear blue in certain lights. A fairly large percentage of the pieces we have seen have contained insects or botanical specimens such as flowers and needles. We are told that the highly fluorescent amber never contains insects. *Figures 11* through

Figure 10.

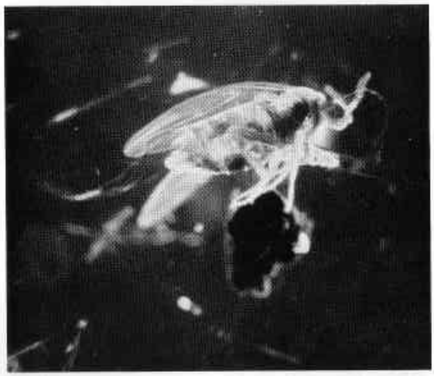


Figure 12.

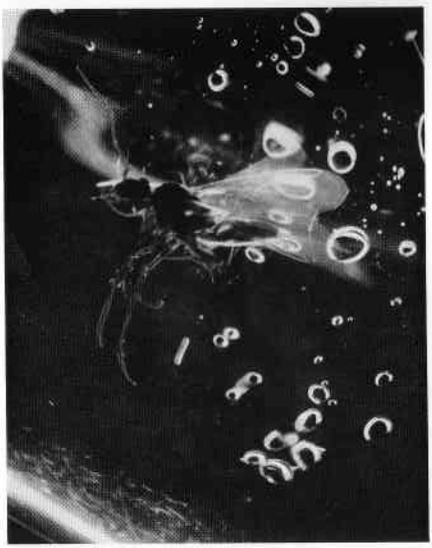
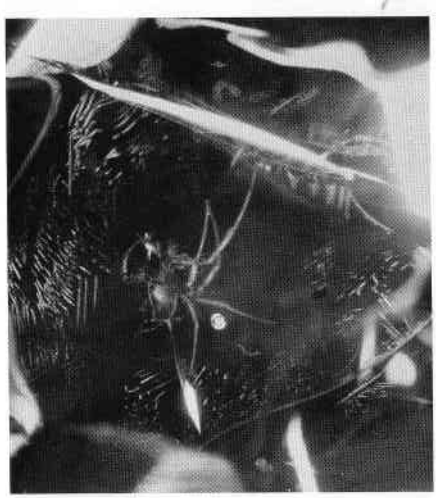


Figure 11.



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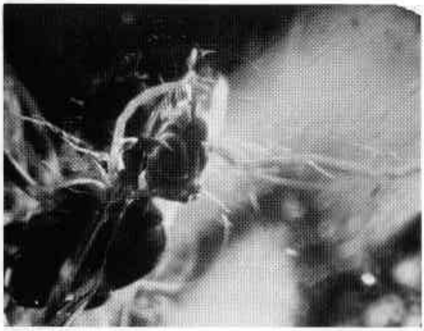


Figure 14.

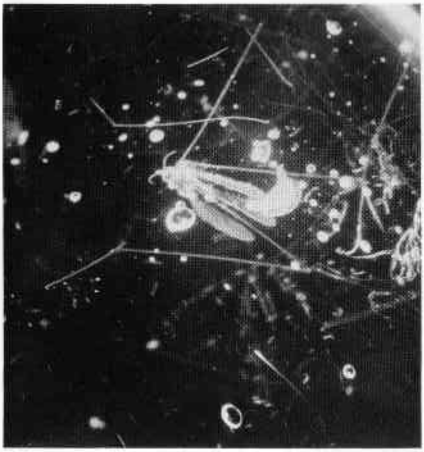


Figure 15.

Figure 16.

16 show them, some beautifully preserved. The compound eyes of some of the flies can be seen clearly under the microscope. In *Figure 17* is seen what appears to be an orchid flower entrapped in the amber. *Figure 18* was taken of a rare true green amber without a hint of normal amber color. It is unfortunately not part of the Institute's collection. We have not seen any of the "sun spangled" or "stress figured" amber such as the Baltic piece shown in *Figure 19.* By coincidence, we received for testing a pendant containing a pale yellow to nearly colorless cabochon which resembled amber. It was identified as rock crystal with a yellow stain in fractures. Whether the stain as seen in *Figure 20* was natural iron oxide or an induced dye we were unable to determine.

Figure 17.

Figure 18.

Figure 19.

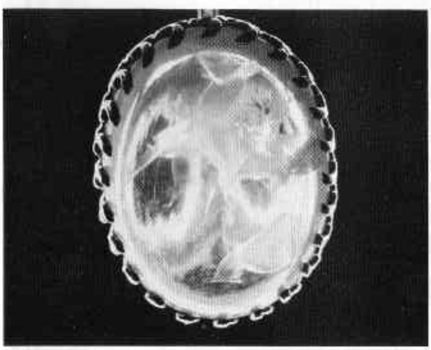


Figure 20.

Some Unusual Items Recently Seen

A flexible block bracelet with alternating diamonds and synthetic sapphires was of interest because the synthetic sapphires seem to have been selected with very natural appearing fractures – perhaps quench induced. One stone is shown in *Figure 21.* A clear Mexican opal with quite definite crystals is illustrated in *Figure 22.* One of the inclusions was polished through as seen in *Figure 23* and it appears to be empty, posing a question as to the formation of negative crystal shapes in an essentially amorphous mineral.

We were amused by the story of a member of a tour visiting Russia. The person had tried on 5 consecutive days, without success, to enter a store in Moscow where it was assumed one could purchase demantoid garnets. We have not heard of any "fresh" demantoids being available in more than 30

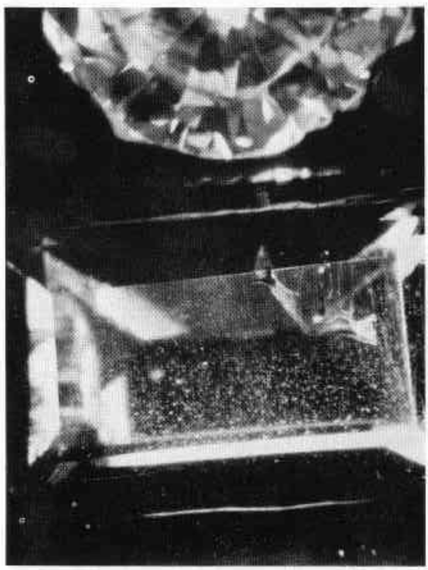


Figure 21.

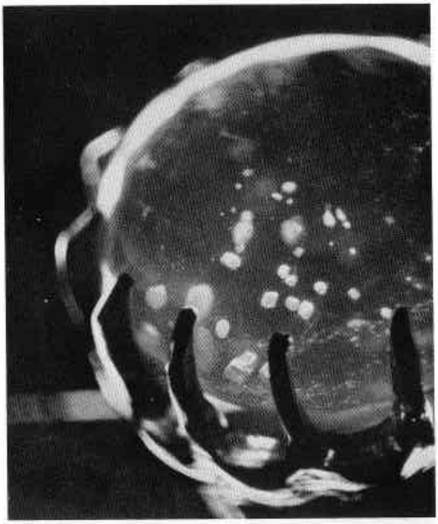


Figure 22.

Figure 23.

years. The best source is to "mine" auctions or antique jewelry shops. The stones (approximately 20 carats) in *Figure 24* were all removed from a Victorian necklace purchased at auction in Europe. Repolished, they were as handsome a selection of these rare green gems as we have ever seen.

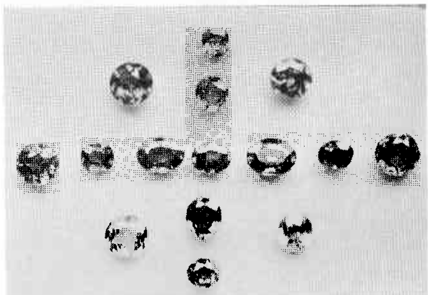


Figure 24.

Acknowledgements

We wish to express our thanks and appreciation for the following gifts:

To *Mr. Lazar Wolf* of Weiss-Wolf, Gem Trade Laboratory member, for a number of diamond saw blades for use in diamond appraisal classes.

To graduate *Howard Rubin,* New York City, who has given us a sample of his carbide tipped pencil for use in identifying diamond substitutes. With practice, Mr. Rubin feels one can make a discreet test without disfiguring the newer imitations *(Figure 25).*

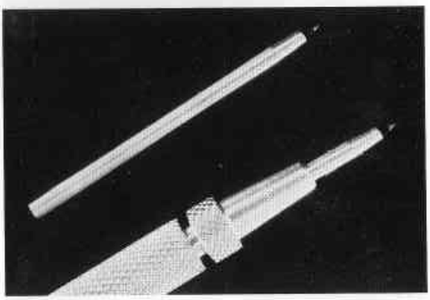


Figure 25.

Gemological Education in Great Britain

By M. J. O'DONOGHUE MA, FGA

This topic was considered some years ago in an article commemorating 60 years of gemology in Great Britain (Journal of Gemmology* vol. 11., No. 3, July 1968). The article did not, however, discuss the part played by organizations and institutions outside the Gemological Association, nor did its terms of reference include the work of the Precious Stone Laboratory of the London Chamber of Commerce. Today the intending student of gemology has a choice of learning methods, whether or not he wishes to become formally qualified.

The only gemological qualification in Great Britain is the Fellowship Diploma of the Gemmological Association and this may only be obtained through success in the Preliminary and Diploma examinations set and marked by the Association. Study for the examinations may be undertaken quite on one's own, by use of the correspondence course, again set and marked by the Association, or by attendance at a live class. Which option is chosen depends to a large extent on the time an individual can devote to study and when he can devote it; geography plays a large part, too, since live classes are only held in the larger towns.

*NOTE: Gemology spelled with two m's is British usage.

The correspondence course is of a high standard and marking is rigorous, with the instructors spending a large part of their time outlining comments on the student's work. Many students find this discipline useful and develop a relationship with the instructor leading to personal friendship – one of the best features of this method of study. Others who are suitably placed to do so, find greater attraction in attending a live class where the same opportunities for friendships are available and where there is the constant challenge of other students. Some students get the best of both worlds by following the correspondence course and attending a live class, often for the practical sessions only.

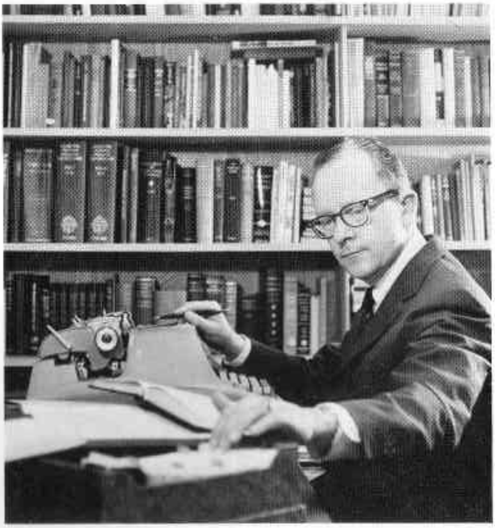
The live classes are conducted at a wide variety of institutions of further education, depending on the town concerned. Instructors are appointed by the local education authority and paid by them, not by the Association, which confines itself to the examinations. The largest classes are, as one might expect, held in London at the City of London Polytechnic and this institution, as far as the gemology classes go, is a descendant of the Chelsea Polytechnic, where the first classes were held after the first world war. In London student numbers approach 200 and are divided amongst Preliminary and Diploma classes (the latter being themselves divided between practical and theoretical groups), a Post-Diploma class, run on the lines of a group of gemological friends meeting once a week; and a Gem Diamond class. Students of this class, which teaches grading as well as some more detailed aspects of the diamond, must be in possession of their Diploma.

The Hatton Garden Laboratory, as it is popularly known, was well described by its first director, Mr. B. W. Anderson, in an article entitled "1925 . . . and all that" (Journal of Gemmology, Vol. 13, No. 7, July 1973, and continued by two further articles in the same journal, Vol. 14, No. 3, and Vol. 14, No. 6, July 1974 and April 1975). The full title should be the Laboratory of the Diamond, Pearl and Precious Stone Section of the London Chamber of Commerce. This body is similar to bodies in the USA with the same title. No teaching has ever been carried out by the Laboratory, since its function is the testing of stones; however, most of its staff have at some time lectured to live classes in London and have conducted the correspondence courses for the Gemmological Association. Messrs. B. W. Anderson, R. Webster, A. Farn and C. J. Payne are well known to all gemologists and all have worked at the Laboratory. Close links are maintained with the Gemmological Association but the London Chamber of Commerce is the parent body.

In the last few years the trade newspaper *Retail Jeweller* has conducted classes of various kinds, ranging from those directed at students with no previous gemological knowledge to an advanced class for those with Diplomas, aimed at giving them an introduction to more sophisticated testing methods and to newer synthetic materials. Mr. Alan Hodgkinson originated these classes and conducts them; he and I share the advanced class. At present these classes are the only residential ones in Great Britain, lasting for two days.

The picture in this country is a varied one but I feel that it is a strength to have such a diversity of approach. Historically, Great Britain did much to introduce gemology as a separate science and today many of those concerned in gemological education are interesting themselves in geology and mineralogy as part of a wider program of study. There are close personal links between the wider earth science organizations such as the Mineralogical Society and the Geological Society and those concerned with gemology. The British Association for Crystal Growth and similar organizations could also come into a close relationship with gemologists. I am myself a member of some of these societies and am by no means the only gemologist interested. Some gemologists take field trips to suitable areas where gem materials (or other minerals) can be found; others lecture to a wide variety of audiences. The interest has never been greater and it is for those concerned with education to see that students get as wide an attractive picture as possible of the gem world and its relatives.

In Memoriam



Lawrence L. Copeland
1921 - 1977

On Thursday, December 29, 1977, Lawrence L. Copeland, long-time Research Librarian for the Gemological Institute of America and Associate Editor of *Gems & Gemology,* passed away. After suffering a stroke in 1961, Larry's health never fully recovered. Following his recuperation from the stroke, he acquired narcolepsy which bothered him during his remaining years at the Institute. He retired from the Gemological Institute of America in 1970 and continued to live in West Los Angeles.

Larry Copeland was born in Chillicothe, Missouri, on June 14, 1921. His interest in gemology started early in life, when as a young boy, his grandfather interested him in lapidary and mineral collecting. His fascination with gems and minerals increased as he grew older and he became an avid mineral collector and faceter. Following graduation from high school, he worked in mining, mineral exploration, and metallurgy in Texas, New Mexico, and "old" Mexico. During this time, he also studied mineralogy at the Colorado School of Mines.

After serving in the U.S. Air Force in World War II, Larry returned to continue his studies of geology at the University of New Mexico. He soon became associated with a retail jewelry store and gained over-the-counter experience, both in Albuquerque and Denver, Colorado. Recognizing a need for gemological knowledge in the trade, Larry enrolled in the GIA Correspondence Courses. In May of 1948, after completion of his studies, he joined the GIA staff in Los Angeles as an instructor, but soon his skill in writing and knowledge were recognized and put to other important use. Until his retirement, he wore many hats and contributed greatly to the Institute and the courses as we know them now. For many years, Larry was charged with the responsibility of keeping the GIA Home-Study Courses up-to-date, as well as working on *Gems & Gemology.* He also compiled many glossaries for GIA, and did much on the early compilation work for the *Diamond Dictionary.* Larry was the author of *Diamonds – Famous, Notable and Unique* which is the standard in the trade for information on famous diamonds, and co-author with others on the *Jewelers' Manual,* the *Diamond Dictionary,* and many of GIA's shorter publications.

Even with his many duties, Larry found time to help the many students who visited him during their studies at the Institute. He was fond of classical music and reading, especially the history of the old American Southwest and philosophy and spent many of his free hours pursuing these interests. Larry will be missed by all who knew him.

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