NOTES · AND · NEW TECHNIQUES

PINPOINT ILLUMINATION: A CONTROLLABLE SYSTEM OF LIGHTING FOR GEM MICROSCOPY

By John I. Koivula

Pinpoint illumination uses a highly flexible but extremely durable glass fiber-optic bundle that incorporates six easily interchangeable light wands of various shapes and cross-sectional thicknesses down to one millimeter in diameter. The wands are hand held and can be used to illuminate hard-to-reach areas in complex jewelry mountings. With the pinpoint illuminator, a gemstone can be examined from any angle; the light source is placed exactly where it is needed, minimizing glare and unwanted external or internal reflections.

The pinpoint illuminator has its earliest roots in medicine, specifically microsurgery. The author adapted the lighting system first for use in mineral microscopy, to examine the pits, seams, and vugs that occur in certain rocks for interesting mineral crystals. The hand-held illuminator, with its interchangeable light wands, enables the microscopist to probe these rocks as far as 3 cm or more into very small openings and provides the light necessary to examine otherwise hidden crystals. When the author subsequently applied this lighting system to gems, he found that it was extremely useful in revealing inclusions, examining mounted goods, and reviewing damaged stones. The illuminator can also be polarized to provide this special lighting effect in otherwise hard-to-reach areas, and offers greater control over thin films and other reflected light phenomena.

THE APPARATUS

The pinpoint illuminator consists of a highly flexible, rubber-coated glass fiber bundle that is 175-cm (69 in.) long and approximately 2.5 mm in diameter; six separate, easily interchangeable light wands that slip onto one end of the fiber bundle; and an adapter that attaches to the other end for quick conversion of the standard fiber-optic light source shown in figure 1 into the pinpoint illuminator illustrated in figure 2.

The probe wands, the backbone of the pinpoint system, are constructed of glass fibers with protective stainless steel shrouds and high-impact, heat-resistant, white plastic sleeves for easy attachment to the main fiber bundle. Each light wand is approximately 11.5 cm long. The inside diameter of the glass-fiber bundles varies from 3.0 mm for the largest to 0.5 mm for the smallest. The thickest probe is 4.0 mm, and the thinnest is 1.0 mm, in outside diameter.

ABOUT THE AUTHOR

Mr. Koivula is the senior staff gemologist in the Gem Identification Department of the Gem Trade Laboratory, Inc., Santa Monica, CA.

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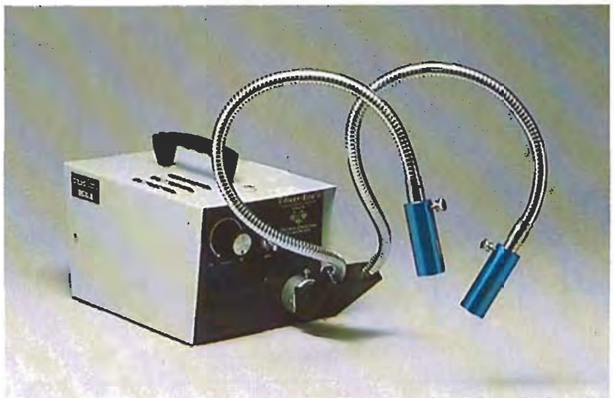

Figure 1. A standard bifurcated quartz-halogen, illuminated, fiber-optic light source.

Figure 2. The quartz-halogen illuminator adapted for pinpoint illumination.

APPLICATIONS

With the pinpoint illuminator, the gem microscopist has at his fingertips a system of highly controllable illumination for practical application in gemology. The hand-held probes make it possible to put the light source exactly where it is most needed for a variety of different tasks (see table 1 and discussion below).

Viewing Inclusions. With this lighting system, groups of gas bubbles such as those in figure 3 (or pinpoint-sized included crystals) are illuminated readily and efficiently. Larger included crystals (as in figure 4) can be examined from every angle, revealing surface-growth details not seen before that are free from the extraneous hot spots and glare produced by the more traditional light sources. Fluid inclusions can be studied quite handily by a point-source-transmitted light, allowing close scrutiny of their gaseous, liquid, or sometimes solid contents.

TABLE 1. Possible applications for the pinpoint illuminator.

Searching for tiny, otherwise invisible, inclusions such as bubbles
Studying the surface details of included crystals to determine habit and possible identity
In the close examination and study of fluid inclusions
To illuminate gems in closed-back or intricate metal mountings
Assessing the nature and extent of damage to gemstones
As a maneuverable source of cool polarized light
As an oblique illuminator to discover and study thin films
As an additional highlighting source for dark-field, transmitted, and polarized light photomicrography
As a source of illumination for detailed jewelry manufacturing
As a watchmaker's light source

Examining Mounted Goods. By placing one of the light wands at the edge of a stone set in a closed-back mounting, the entire interior of the gem is illuminated without any of the harsh reflections that make overhead sources of light virtually useless for this task. Separation planes in assembled stones can be illuminated by simply placing a light probe at the edge of the plane at an angle slightly off parallel to the plane (figure 5).

Reviewing Damaged Stones. Determining the nature and extent of damage to gemstones is yet another area where the controllable pinpoint illuminator excels. Surface fractures, pits, chips, and abrasions can be carefully examined for draglines or percussion marks by placing the light source right on the damaged area at the proper angle for optimum viewing of the subject.

Polarized Light. The illuminator can be polarized as well, and if an analyzer is placed in the usual position over the microscope objectives, then we have a pinpoint source of maneuverable, controllable, polarized light that can be used in the same way a standard polarizing stage is used, but with added flexibility. The results of polarized pinpoint illumination, shown in figure 6, look identical to those achieved by conventional polarizing systems (Koivula, 1981). The difference lies, again, in the greater flexibility of this system and the ability to illuminate areas that would otherwise remain hidden.

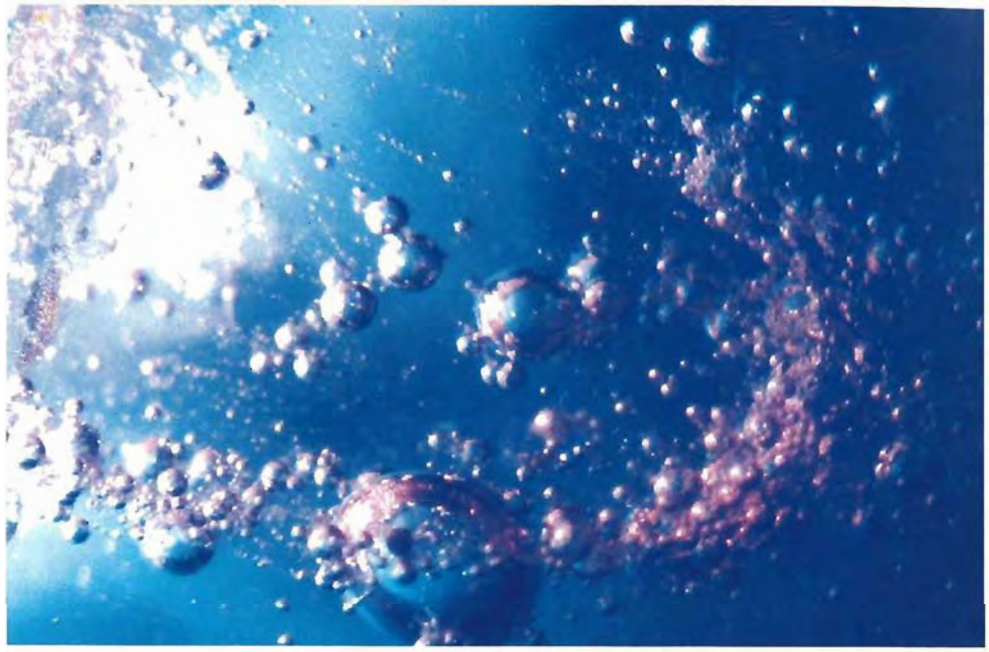

Figure 3. A flowing stream of gas bubbles in a blue synthetic glass illuminated from the side by pinpoint illumination. Magnified 60×.

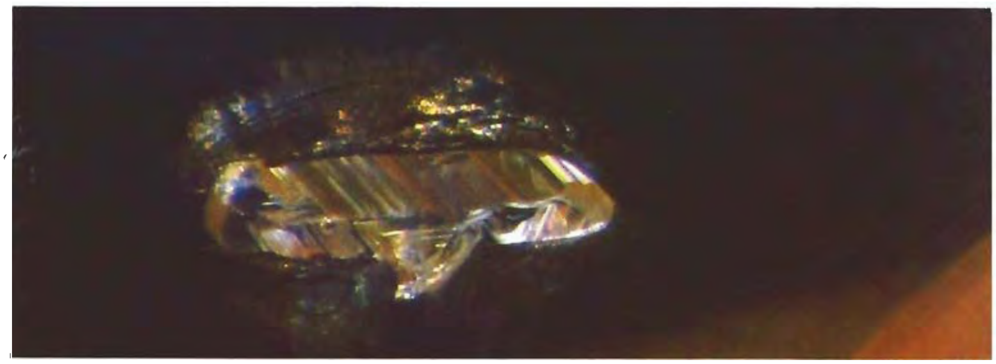

Figure 4. An elongated included crystal of olivine in an orange-brown diamond. Note the lack of glare and extraneous reflections normally encountered in diamond photomicrographs. Pinpoint illumination, magnified 45×.

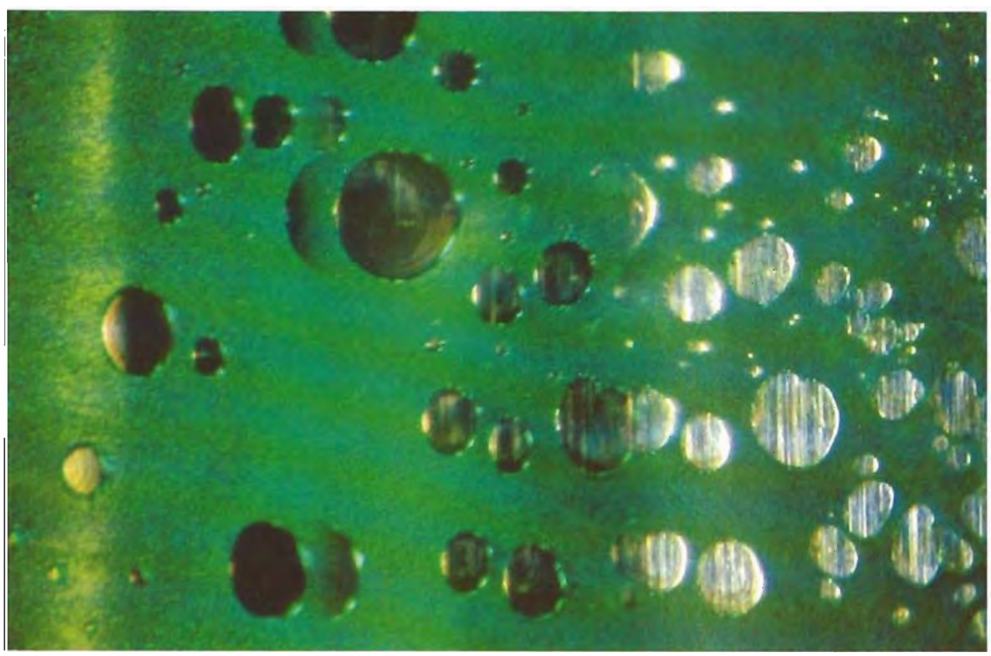

Figure 5. A series of flattened bubbles in the cement plane of an assembled synthetic spinel triplet. The change of viewing angle through different facets is responsible for the change in appearance of the bubbles. Pinpoint illumination, magnified 50×.

Figure 6. An included crystal in a natural Burmese pink spinel is lit by polarized pinpoint illumination. The clarity of this photograph is startling considering the difficult angle of illumination and the degree of magnification, 100×.

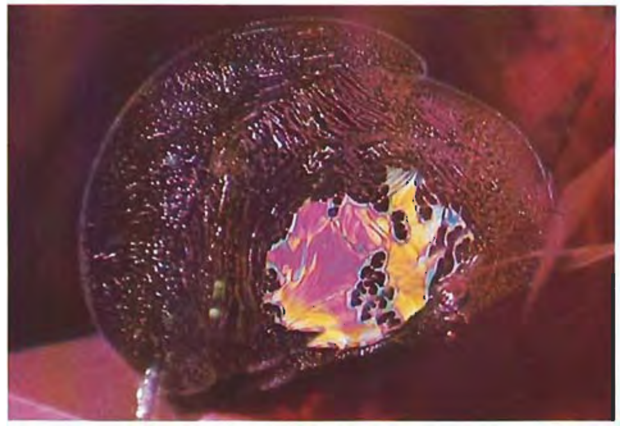

Figure 7. The lace-like pattern of this healing fracture in a Thai ruby under dark-field conditions is given additional life in the form of a brightly colored thin film. The thin-film interference colors resulted from the application of the pinpoint illuminator in an oblique position. Magnified 45×.

Thin-Film Effect. Thin films, like the one shown in figure 7, and other reflected-light phenomena (Koivula, 1980 and 1981) are more easily discovered and studied with the pinpoint illuminator because of its maneuverability. The unit is used for oblique illumination in the same way as the bifurcated fiber optic illuminator shown in figure 1 (Koivula, 1981). However, it is considerably more difficult to place the metal cable of the larger fiber optic illuminator in the precise position necessary to achieve an iridescent thin-film effect in a gemstone.

LIMITATIONS

Since the pinpoint illuminator is designed to be a hand-held instrument, it is not an ideal source of illumination for photomicrography unless one uses a modified bench stand such as a "jeweler's third hand" to hold the illuminator in a stable position during the entire cycle of a photographic exposure. This was in fact done to obtain the photomicrographs shown in figures 3 through 7. The main limitation of the pinpoint illuminator is that it is not completely portable. With a 175-cm reach, it can be used almost anywhere it is needed within the confines of a standard gemological laboratory, but use elsewhere depends on the availability of an electrical power outlet. Also, the instrument is not easily packed for long-distance travel. If the illuminator were freed from its power source and adapted for use in a portable gemological laboratory, this one limitation could be completely overcome.

CONCLUSION

The pinpoint illumination system has applications for the gem microscopist, the skilled manufacturing jeweler, and the master watchmaker. Anywhere a pinpoint source of cool, bright, controllable light is needed, the pinpoint illuminator can be useful. This author sees a broad acceptance of the pinpoint illuminator in the future of gemology.*

REFERENCES

Koivula J.I. (1980) Thin films—elusive beauty in the world of inclusions. *Gems & Gemology*, Vol. 16, No. 9, pp. 326–330.

Koivula J.I. (1981) Photographing inclusions. *Gems & Gemology*, Vol. 17, No. 3, pp. 132–142.

** The pinpoint illuminator is available through GEM Instruments Corp., 1735 Stewart Street, Santa Monica, California 90404.*