GIA Confronts Challenge of HPHT-Treated Diamonds

BY THOMAS MOSES, GIA GEM TRADE LABORATORY, NEW YORK, NEW YORK, AND JAMES SHIGLEY, GIA RESEARCH, CARLSBAD, CALIFORNIA

Commercial treatment to change the color of diamonds began in the late 1940s. This involved exposing the diamonds to a radiation source and, in some instances, subsequent heat treatment to further alter their colors. This was the first significant commercial enhancement to diamonds, and it caused great concern in the industry. It also represented one of the Gemological Institute of America's (GIA) first important research efforts, which continues even today with the documentation of colored diamonds for issuance of "origin of color" identification reports by the GIA's Gem Trade Laboratory.

In some ways, the trade encountered a similar situation in early 1999 when General Electric (GE) and Lazare Kaplan International (LKI) introduced High Pressure-High Temperature (HPHT) diamonds to the marketplace, initially sold under the name "GE POL," and more recently as "Bellataire." Again there was confusion and concern, with little information to go on about this new process and the means of identifying these diamonds.

Development of practical identification criteria requires both an understanding of the treatment technology and the gathering of data on known-untreated and known-treated

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diamonds for comparison. Over the past three years, GIA and other researchers have acquired a much better understanding of the HPHT process. Not only have we at GIA established relationships with GE and others with HPHT capabilities, which has resulted in more information about the process, but we at GIA also have benefited from the opportunity to carefully document a large number of HPHT-treated and natural-color diamonds to test new ideas on identification.

Blue (3.42 carat) and pink (1.72 carat) GE HPHT-processed type II diamonds. Photograph by Elizabeth Schrader, copyright GIA.

HPHT PROCESSING

HPHT treatment involves subjecting the diamond, polished or rough, to very high temperatures and pressures in specialized equipment. Depending on their size, only a few diamonds can be treated at one time in such equipment. As a result of this process, which in some instances takes only a very short time, the color of the diamond can be dramatically changed.

Diamonds are classified scientifically into two "types" with subcategories for each. "Type I" diamonds — the most abundant in nature — contain nitrogen. They usually vary from colorless to yellow or brownish yellow. "Type II" diamonds — which are rare in nature — lack all but tiny amounts of nitrogen. They are sometimes colorless, but more often brown; if they contain boron, they can be blue to gray. These two categories of diamonds display differences in some physical properties and in their absorption or luminescence spectra. The brown coloration in diamonds of both types results when they have been subjected to plastic deformation (i.e., "strain") deep in the earth during long periods of geologic time.

As a result of HPHT processing, type II brown diamonds can be transformed to colorless or near-colorless. The same procedure can transform a limited number of brown-pink or brown-to-gray-blue type II diamonds to pink and blue, respectively. In both cases, heating at very high pressures results in a "healing" of the plastic deformation mentioned above, thereby removing the cause of the brown coloration so that the type II treated diamond is colorless, pink or blue.

The transformation of type II brown diamonds to colorless was the first product that GE and LKI introduced, and to date these diamonds represent the overwhelming majority of what they offer for sale. Colorless to near-colorless HPHT-annealed diamonds have proven to be a difficult identification challenge. GIA researchers have now carefully documented over 8,000 such diamonds and have systematically compared their properties to those of type II natural-color diamonds, thereby allowing us to develop robust criteria to separate them.

These three GE Bellataire type IIa diamonds (4.11–5.34 carat) are products of the HPHT process. Photograph by Elizabeth Schrader, copyright GIA.

Since 1999, several organizations in addition to GE have become involved with HPHT treatment of diamonds, and their "recipes" for transforming the colors of diamonds at high temperatures and pressures may be slightly different. Consequently, we are constantly updating our research to ensure that practical identification criteria are established.

Within the past few years, the

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HPHT process has also been used for the treatment of more common type I brown diamonds to transform them to yellow-green, yellow and orange-yellow. This expanded range of diamonds being treated by HPHT continues to make this a difficult identification problem.

The specialized equipment needed for HPHT treatment is not common, existing at only a few high-technology companies and research institutes around the world. Despite having the equipment, not all of these companies and institutes have ready access to the appropriate precursor diamonds for HPHT processing.

RESEARCH ON HPHT DIAMONDS AT GIA

The GIA first learned of the work by GE and LKI on HPHT treatment of type II diamonds in the spring of 1999, although GIA researchers were aware that some activity involving this kind of treatment had been going on elsewhere on an exploratory basis since the early 1990s. Beginning in the mid 1990s, dealers began to submit yellow-green diamonds to the GIA Gem Trade Laboratory for identification reports. We suspected that a number of these diamonds had been HPHT treated, although at the time we did not know the details of the treatment and, in some instances, could not determine conclusively that all of these diamonds had been treated. Late in 1999, both General Electric and the Novatek Company announced plans to market yellow-green HPHT-annealed type I diamonds. At about the same time, we also began to encounter HPHT-processed yellow diamonds that had originated in Russia and China.

Because these HPHT diamonds represented a new kind of treatment and could not be recognized by traditional criteria, we began a major effort to expand our gemological database on specific natural-color and HPHT-treated diamonds. This ongoing effort has allowed us to augment and refine our identification criteria. Currently, this database includes results from our examination of more than 10,000 natural-color and more than 8,000 HPHT-treated type I and type II diamonds, both colorless and colored. To accomplish this expanded data-collection effort quickly and efficiently, and more significantly to screen every diamond submitted for grading, we had to purchase new spectroscopy instruments and hire additional technical staff at our facilities in New York and Carlsbad. We also arranged for selected diamonds to be treated at high pressures and temperatures so we could better understand the changes in gemological and spectroscopic properties that result from HPHT treatment. In addition, we have been

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These four type Ia diamonds (0.30–1.89 carat) were HPHT treated in Russia. Photograph by Elizabeth Schrader, copyright GIA. Stones courtesy By Nature.

The four type Ia diamonds (0.32–0.47 carat) shown here were HPHT processed in China. Photograph by Elizabeth Schrader, copyright GIA.

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working closely with other research organizations to analyze the collected data in order to develop new ideas for testing and identification.

After the introduction of HPHT-processed diamonds by GE, we focused our HPHT research efforts almost exclusively on detecting decolorized type II brown diamonds. We expanded these efforts when a wider range of colors produced by HPHT treatment entered the diamond market. Although recognizing decolorized type II brown diamonds is a challenge, in some ways the identification of HPHT treatment in type I diamonds can be even more challenging because of the wider variation in properties they exhibit. As mentioned earlier, HPHT treatment of type I diamonds produces a range of colors from yellowish green to orange. Because of their varying amounts and configurations of nitrogen, these diamonds respond differently to HPHT processing, and the resulting color changes range from subtle to dramatic.

To date, we have found that some HPHT-treated diamonds may display visible identifying features, such as alterations or small areas of graphite within fractures. Decolorized type II brown diamonds frequently exhibit strong banded strain patterns that are visible in a binocular microscope with darkfield or cross-polarized illumination. We have determined, however, that the best means of identification for processed diamonds of both types are features that can be seen in the infrared and photoluminescence spectra.

CONCLUSION

The lack of many practical distinguishing features means that the identification of HPHT-annealed diamonds currently requires the use of advanced scientific instrumentation. This identification problem is complicated by the growing number of companies around the world that are experimenting with commercial HPHT treatment of diamonds, many of whom do not provide an identification mark on their treated diamonds as GE does. An identification and registry mark is required for all HPHT-processed diamonds that receive a GIA diamond grading report. Because companies consider HPHT treatment technology proprietary information, we are not always fully aware of their activities and are greatly challenged to keep up with this technology.

While we can report that important progress has been made in identifying HPHT-treated diamonds, such diamonds can be detected only at knowledgeable, experienced, fully equipped gemological laboratories. Unfortunately, it is not yet possible to conclusively identify all HPHT-treated diamonds, although we believe that the vast majority are detectable by a well-equipped laboratory with qualified staff and extensive gemological data to reference. ✦

Taken before (left) and after (right) treatment of the same 1.01 carat type IIa diamond, these photos show the decolorization that can be produced by the HPHT process. Photographs by Elizabeth Schrader, copyright GIA.

Dark inclusions of graphite in healed "fingerprint" were seen in this Bellataire diamond examined in 1999. Photomicrograph, magnified 15 times, by John Koivula, copyright GIA.

A graphite inclusion resulting from HPHT treatment in type Ia diamond. Photomicrograph, magnified 20 times, by John Koivula, copyright GIA.