

Editors

Thomas M. Moses | Shane F. McClure



DIAMOND

Buff-Top Round

The modern round brilliant diamond is getting a “new old” look with the use of Japanese laser technology. Diamond’s high refractive index and adamantine luster make it ideal for faceting to produce dramatic scintillation, brilliance, and fire. One of the oldest and simplest cuts is the cabochon, with its smooth convex dome. A popular cut among colored stones, the cabochon is rarely if ever used in diamonds due to the gem’s extreme hardness and the difficulty in polishing it into a smooth, rounded surface. The New York lab recently examined several diamonds with an interesting variation on the cabochon.

About 30 buff-top round diamonds ranging from 0.25 to 1.50 ct, originally submitted to GIA’s Japanese lab, were received for grading. The buff-top cut has a low cabochon dome with a faceted pavilion (figure 1). These diamonds were cut with four short main pavilion facets (figure 2). This rare cut posed a challenge for the grading staff, as the smooth dome and faceted pavilion combined to produce internal reflections that made it very difficult to see clearly into the stone. Although diamonds can be cut with lasers, the polishing process with the use of diamond abrasives into a smooth



Figure 1. A profile view of this buff-top round diamond shows its low polished dome.

rounded surface is both laborious and time consuming. The unfaceted dome was likely created using the same technology that produced the first synthetic nano-polycrystalline diamond sphere in Japan in 2011. One Japanese study (T. Okuchi et al., “Micromachining and surface processing of the super-hard nano-polycrystalline diamond by three types of pulsed lasers,” *Applied Physics A: Materials Science & Processing*, Vol. 96, No. 4, 2009, pp. 833–842) found that pulsed lasers most efficiently produce a smooth, undamaged surface for fine finishing diamonds. A combination of three lasers was used: a near-infrared laser for the rough shaping, and ultraviolet and femtosecond lasers for fine finishing (E. Skalwold, “Nano-polycrystalline diamond sphere: A gemologist’s perspective,” Summer 2012 *G&G*, pp. 128–131).

This advancement in diamond finishing offers new possibilities for a variety of interesting shapes and

forms that could not be achieved with previous methods of polishing and faceting alone. Diamond cabochons, completely smooth spherical beads, and sugarloaf cuts could emerge next.

Siau Fung Yeung

Large HPHT-Treated Fancy Pink

These days, high-pressure, high-temperature (HPHT) treatment is very commonly applied to change diamond color. Most of the HPHT-treated pink diamonds submitted to GIA range from 1 to 2 ct, and sizes over 10 ct are extremely rare. We previously reported on a 21.73 ct HPHT-annealed Light pink diamond (see Fall 2011 Lab Notes, p. 227). We have encountered another large HPHT-treated diamond that showed stronger pink coloration.

Figure 2. Viewed face-up, the buff-top diamond shows an arrangement of four main pavilion facets.



Editors’ note: All items were written by staff members of GIA laboratories.

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Figure 3. This 20.32 ct pear-shaped diamond was color graded as Fancy pink. Advanced testing suggested that its strong pink color was enhanced by HPHT treatment.

The 20.32 ct pear-shaped brilliant submitted to the New York laboratory (figure 3) was color graded as Fancy pink. We applied FTIR, UV-visible, and PL spectroscopy to examine the color origin for this diamond. The mid-infrared spectrum confirmed it was a type IIa diamond. The UV-visible spectrum showed a broad band at approximately 550 nm, a typical cause of pink coloration in diamond. But the PL spectra suggested that the pink color was improved by HPHT treatment. Most HPHT-treated pink diamonds have a secondary color component in addition to “pure” pink, either brownish or purplish. Interestingly, this sample had no secondary color component. Such HPHT-treated pure pink is extremely rare. Some HPHT-treated diamonds may contain graphitized inclusions and/or pitted surfaces on the girdle, but this one was microscopically “clean,” both internally and on the surface. It also showed the typical tatami strain of a type II diamond when viewed in cross-polarized light, along with the high interference colors often associated with HPHT treatment (figure 4).

This sample demonstrated the improvement of HPHT treatment techniques in achieving more intense pink coloration in large diamonds. This was one of the largest HPHT-treated pink

diamonds tested in GIA's New York laboratory. It is very difficult to detect such treated pink color using traditional gemological instrumentation, especially with stones that are free of inclusions, and advanced gemological testing is critical for this purpose.

Kyaw Soe Moe

Orange, with Unusual Color Origin

Orange bodycolor in diamond is usually caused by an absorption band centered at approximately 480 nm or by a high concentration of isolated nitrogen. Meanwhile, it is well known that the 550 nm absorption band often introduces pink to red colors. Physical models of these two optical centers have not been resolved yet. The New York laboratory recently examined an orange diamond whose color was attributed mainly to the 550 nm absorption band.

This 1.53 ct heart-shaped diamond (6.84 × 7.76 × 3.88 mm) was color graded as Fancy Intense pinkish orange (figure 5). Color was distributed evenly throughout the stone, which was very clean and showed no internal features under the microscope. The absorption spectrum in the infrared region revealed that it was a regular type IIa diamond, with no nitrogen- or hydrogen-related absorptions. The UV-Vis region showed a



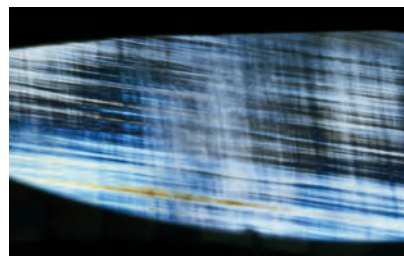
Figure 5. This 1.53 ct diamond was color graded as Fancy Intense pinkish orange. Spectroscopic analysis revealed it was type IIa and dominated by an approximately 550 nm band absorption, which usually introduces a pink-red color in natural diamonds rather than orange.

broad absorption band centered at ~550 nm and its corresponding band at ~390 nm, absorption features typical of natural type IIa pink diamonds. From the optical centers detected, we would not expect this diamond to show a dominant orange bodycolor.

The reason for this discrepancy is not fully understood. Our finding from this stone demonstrates the complexity of diamond color origin.

Wuyi Wang and Ren Lu

Figure 4. The typical tatami strain of type II diamond was observed by viewing the sample under crossed polarizers. It also showed high interference colors, which are often observed in HPHT-treated diamonds. Magnified 30×.



Pseudo-Synthetic Growth Structure Observed in Natural Diamond

Synthetic diamonds created using the traditional HPHT (high-pressure, high-temperature) process ordinarily grow as cuboctahedra. Temperature dictates the crystal form, as cubic growth is predominant at the relatively low temperatures of synthesis. At the higher temperatures of natural formation environments, diamonds typically grow as octahedrons. While small cuboctahedral diamonds are found in nature, these are very rare.

Recently submitted to the GIA laboratory in Israel was a near-colorless 0.70 ct round brilliant (figure 6).



Figure 6. This 0.70 ct, D-color natural round brilliant displayed the cuboctahedral growth structure of an HPHT-grown synthetic diamond.

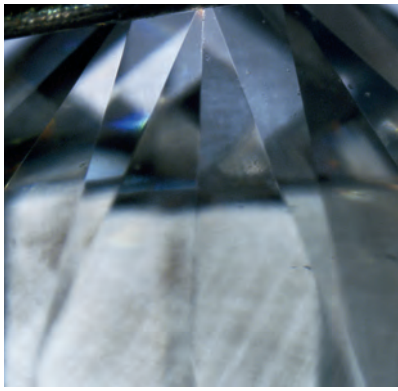


Figure 8. A tatami strain pattern, observed under crossed-polarized light, indicated natural growth. Magnified 40x.

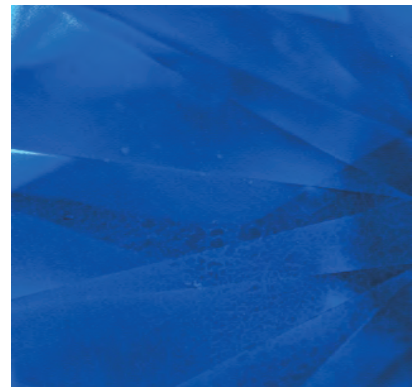


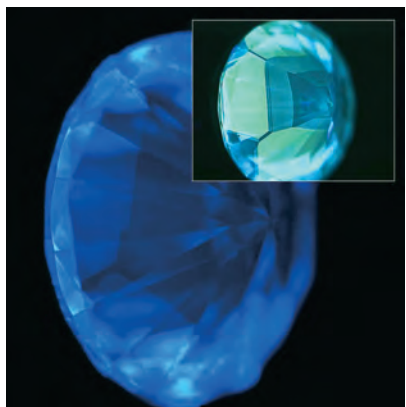
Figure 9. DiamondView imaging showed a micro-dislocation network on pavilion facets, conclusive proof of natural crystal growth.

Found to be a type IIa diamond with no detectable nitrogen impurity, it was examined further for possible treatments and to verify the origin of color.

In the short-wave UV radiation of the DiamondView, a subtle cuboctahedral growth structure (figure 7) was observed on the pavilion facets. This type of structure usually indicates an HPHT-grown synthetic diamond.

The diamond possessed D color and high clarity, with no internal inclusions to help indicate whether it was in fact natural. Shallow surface-reaching fractures were observed, and a few extra facets close to the pavilion contained these natural-looking fractures.

Figure 7. DiamondView imaging of the pavilion facets revealed a subtle growth structure. The inset shows the growth structure of a type IIb synthetic diamond.



Microscopic observation with cross-polarized light showed relatively strong tatami strain pattern (figure 8), a feature indicative of natural growth. Further examination at higher magnification revealed small polygonal dislocation networks on the pavilion. These provided conclusive evidence that the stone was a natural diamond crystal (figure 9).

This stone was a good example of a very rare natural diamond exhibiting synthetic growth characteristics. It exemplifies the challenges posed to gemological laboratories in separating natural from undisclosed gem-quality synthetic diamonds in today's jewelry market. We concluded that the diamond had a natural color origin.

Paul Johnson

Green, Treated with Radioactive Salt

Recently submitted to the East Coast Laboratory was a 3.17 ct round brilliant cut diamond, color graded as Fancy Deep green (figure 10). Natural diamonds of this color are very rare and desirable.

Examination with a gemological microscope revealed a very unusual surface coloration. The surface had a mottled pattern created by very shallow green staining, likely from exposure to radiation (figure 11). This unusual feature is rarely observed on natural diamond surfaces or facets.

Natural radiation staining on the surface of a diamond crystal would be mostly removed during faceting.

The stone owes all of its green color to these shallow radiation stains. Today, most artificially irradiated diamonds are treated with a low-energy electron beam. This often results in shallow color zoning that penetrates into the stone and aligns with the facet shape. In this case, the shallow staining was created using the older method of exposing the diamond to radioactive salts for an extended period of time. Mainly used on polished stones, this method leaves surface contamination.

Stones irradiated in this fashion can have residual radiation, so we

Figure 10. This 3.17 ct round brilliant cut diamond owed its Fancy Deep green color to irradiation with radioactive salts.



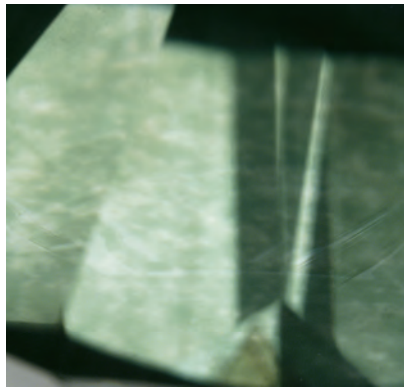


Figure 11. Observed at 35× magnification, the diamond shows a mottled effect created by shallow green radiation stains.

tested this stone using a Geiger counter. Only background radiation was detected, indicating that the treatment likely occurred decades earlier. Thus, this diamond posed no radiation hazards. Sir William Crookes first discovered radiation's effects on diamond color by conducting a series of experiments using radium salts in 1904. Although rarely encountered today, these types of treated diamonds still show up in the trade. A careful inspection of the surface in diffused lighting is the most effective means of revealing the diagnostic surface coloration.

Marzena Nazz and Paul Johnson

With Extremely Strong 578.9 nm Emission Center

Photoluminescence analysis at liquid-nitrogen temperatures and varying laser excitations has become increasingly important in diamond color origin testing. The 578.9 nm emission normally occurs with many other emission lines, and it is usually weak in natural type IIa and IIb diamonds. Meanwhile, the physical model of this optical center is unclear. The New York laboratory tested a very rare diamond that showed extremely strong 578.9 nm emission.

This 4.72 ct rectangular diamond (9.75 × 8.90 × 5.92 mm) had a color grade of Light blue and an even color distribution (figure 12). Infrared absorp-

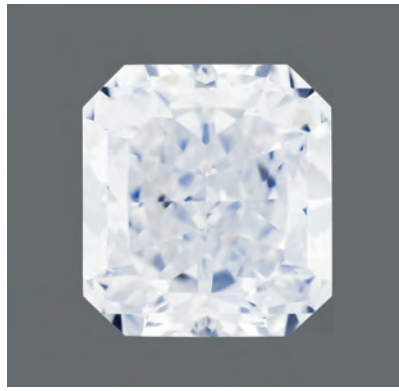
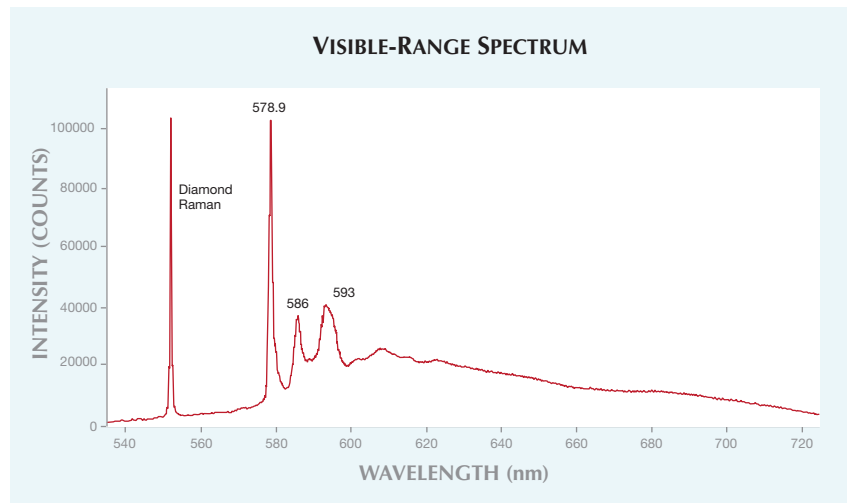


Figure 12. This 4.72 ct Light blue type IIb diamond displayed some of the strongest dislocations ever observed in natural diamonds by GIA. This resulted in a hazy impression and a lower transparency than other type IIb diamonds.

tion spectroscopy analysis identified it as a type IIb diamond with a boron concentration of about 16 ppb. This stone showed very strong dislocations, resulting in a hazy impression and a lower degree of transparency than most type IIb diamonds. Microscopic observation revealed very strong linear graining and related high interference colors. The intensity of the dislocations was among the strongest ever ob-

Figure 13. The diamond showed extremely strong emission at 578.9 nm and its possible side bands at 586 and 593 nm. The exclusive occurrence of the 578.9 nm emission and the very strong lattice dislocations in this diamond suggested that the emission was a dislocation-related optical center.



served in natural diamonds at a GIA laboratory.

The outstanding feature of this diamond was the extremely strong emission at 578.9 nm, with possible side bands at 586 and 593 nm (figure 13). No other emission line was detected in the visible light region, which is very unusual for a natural type IIa or IIb diamond. This feature was confirmed with 457 and 488 nm laser excitations. The exclusive occurrence of the 578.9 nm emission and the very strong lattice dislocations suggested that this emission was a dislocation-related optical center.

Wuyi Wang

SYNTHETIC DIAMOND

CVD-Grown, with Aggregated Nitrogen Impurities

Synthetic diamonds grown by the chemical vapor deposition (CVD) method have become a key topic in the jewelry industry over the past few years. These products, which can be grown at low pressures and moderately high temperatures (approximately 800–900°C), are seeing more widespread use in jewelry. CVD synthetics

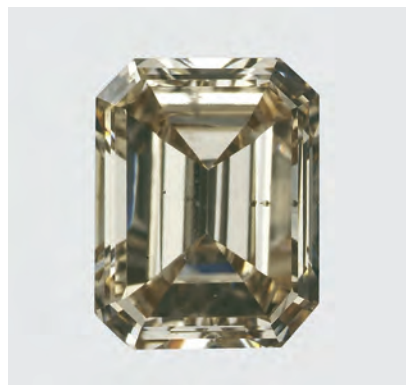


Figure 14. Unusual 0.94 ct yellow-brown CVD synthetic diamond.

are almost always brown or colorless type IIa specimens with little to no FTIR-measurable nitrogen or boron impurities. A few of these synthetics have been doped with nitrogen or boron to produce rare type Ib or IIb colored samples.

Recently, an unusual 0.94 ct Fancy yellow-brown emerald cut (figure 14) was submitted to GIA for a synthetic diamond grading report. It contained a cloud of black needle-like inclusions occurring along a plane (figure 15, left

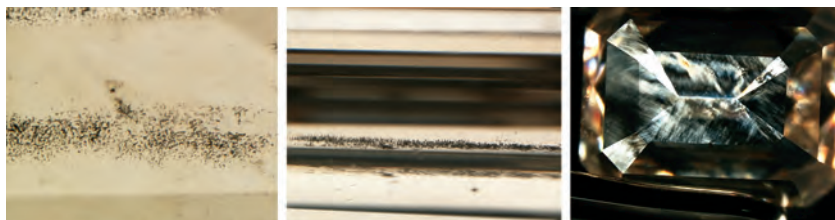


Figure 15. A cloud of needle-like inclusions was observed in the synthetic diamond (left, magnified 50 \times). The side view clearly showed that the cloud was confined to a plane (center, magnified 45 \times). With cross-polarized light, the mottled and crosshatched strain pattern was visible (right, magnified 15 \times).

and center) and showed weak green transmission with fiber-optic illumination. Under cross-polarized light, the synthetic diamond displayed a black and white mottled strain pattern, somewhat similar in appearance to the crosshatched “tatami” pattern usually seen in natural type IIa diamonds (figure 15, right). FTIR spectroscopy revealed that it was type IaA, with approximately 10 ppm of aggregated nitrogen atom pairs in the lattice (figure 16). DiamondView imaging showed red fluorescence and planar growth patterns that are common in CVD synthetic diamonds (figure 17).

Photoluminescence spectroscopy detected silicon-vacancy defects introduced during the CVD growth process (not shown), and further examination of the FTIR spectrum revealed a very weak peak at 3123 cm^{-1} (again, see figure 16), confirming this was an as-grown CVD synthetic diamond (P.M. Martineau et al., “Identification of synthetic diamond grown using chemical vapor deposition [CVD],” Spring 2004 *G&G*, pp. 2–25).

This marked GIA’s first examination of a CVD synthetic diamond with aggregated nitrogen impurities. During HPHT treatment, nitrogen atoms typically start to aggregate as pairs at temperatures above 2000 $^{\circ}\text{C}$. Although some CVD synthetics are HPHT-treated to remove brown coloration, spectroscopic evidence indicates that this sample had not undergone such treatment. It is un-

Figure 16. FTIR spectroscopy revealed that the CVD synthetic diamond was type IaA with aggregated nitrogen atom pairs, the first CVD synthetic diamond GIA has seen with this configuration of nitrogen impurities. The 3123 cm^{-1} peak confirms this is an as-grown CVD diamond.

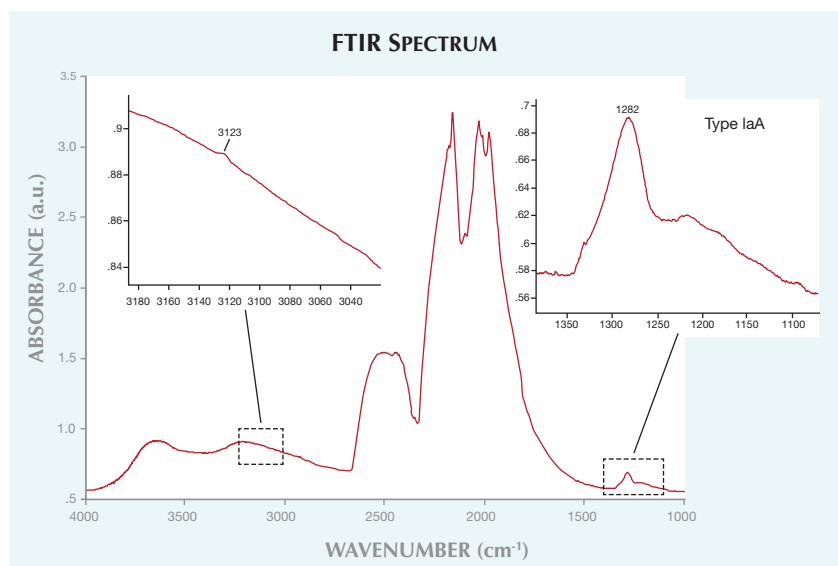


Figure 17. DiamondView imaging showed banded red fluorescence with a striated pattern, typical of CVD synthetic diamonds.



clear how the nitrogen impurities came to be in their aggregated state. It is possible that a type IaA natural diamond was used as a seed crystal for multi-stage CVD growth and remains within the current gemstone, thereby producing the FTIR results. However, no clear evidence of this scenario was uncovered. More research is currently under way to understand this unusual CVD synthetic diamond with aggregated nitrogen impurities.

*Troy Ardon, Tara Allen, and
Christopher M. Breeding*

Three CVD Synthetic Diamonds Submitted to Mumbai Laboratory

CVD-grown synthetic diamonds continue to become more abundant in the gem market, as evidenced by several reports from major diamond-grading laboratories during the past year (e.g., C. Even-Zohar, "Synthetics specifically 'made to defraud,'" *Diamond Intelligence Briefs*, Vol. 27, No. 709, 2012, pp. 7281–7283). In December 2012, three CVD synthetic diamonds were submitted to GIA's Mumbai laboratory. In keeping with the evolving technology of the CVD process, the gemological and spectroscopic characteristics of these type IIa synthetic diamonds suggested that they experienced different growth and/or treatment histories.

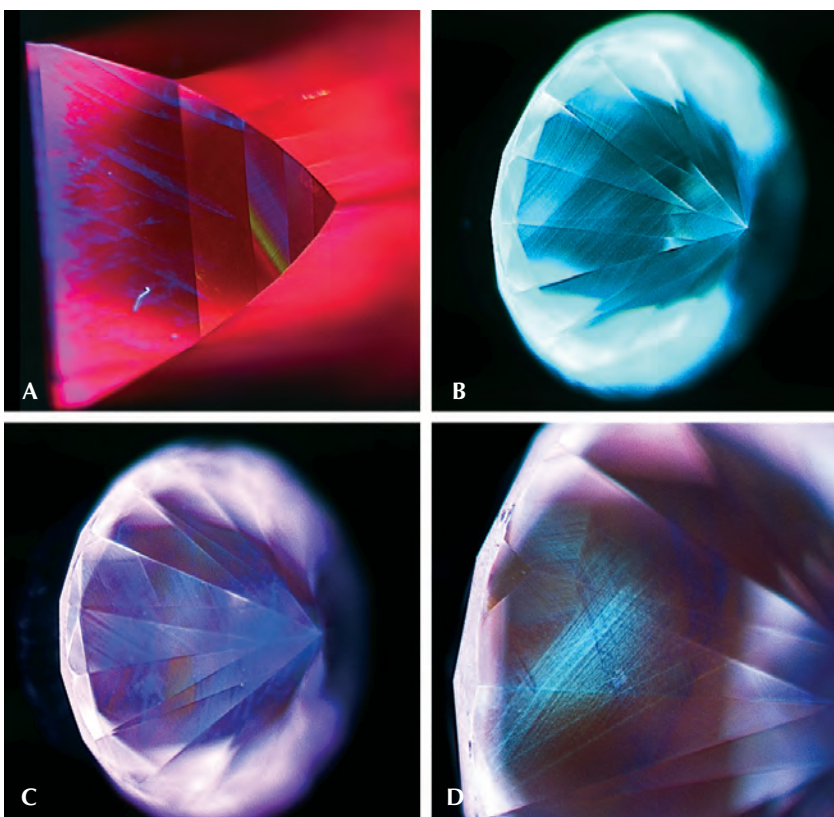
One sample was a 0.93 ct very light brown (O to P range) rectangular step cut with a VVS₂ clarity grade due to the presence of pinpoint inclusions and graining. Viewed under crossed-polarizers it showed heavy strain, with high-order birefringence colors. The photoluminescence (PL) spectra acquired at liquid-nitrogen temperatures using various laser excitations were dominated by the emission of [N-V]⁰ and [N-V]⁻ centers (with zero-phonon lines at 575 and 637 nm, respectively). These ZPLs are widened by high levels of strain and have been previously studied in CVD synthetic diamonds (W. Wang et al., "CVD synthetic diamonds from Gemesis Corp.," Summer 2012 *G&G*, pp. 80–97). The [N-V]^{0/-} peaks for this sample

had full-widths at half-maximum (FWHM) of 0.43 nm and 0.35 nm, respectively. These are relatively broad compared to colorless diamonds, but consistent with the high strain observed under crossed polarizers. The 596.5/597.2 nm doublet commonly observed in "as-grown" CVD synthetic diamonds was weak, as was the 736.5/736.9 nm doublet attributed to [Si-V]⁻. Notably, the [Si-V]⁻ emission was too weak to detect with the 514.5 nm laser excitation. Infrared laser excitation at 830 nm resulted in many emission peaks in the 850–880 nm region, dominated by a sharp peak at 878.5 nm whose origin has not been conclusively identified. The Dia-

mondView fluorescence was primarily red due to the strong [N-V] centers. Although CVD-characteristic violet-blue dislocation patterns were observed, growth striations could not be discerned (figure 18A). The sample did not phosphoresce. The PL features observed, the [N-V]^{0/-} widths, and the DiamondView behavior were similar to those reported for near-colorless CVD synthetics produced by Apollo, Inc. (e.g., W. Wang et al., "Latest-generation CVD-grown synthetic diamonds from Apollo Diamond Inc.," Winter 2007 *G&G*, pp. 294–312).

The other two samples were round brilliants weighing 0.52 and 0.57 ct. Both received G color and VS₁ clarity

Figure 18. DiamondView fluorescence images show distinct colors and patterns that helped identify these as CVD synthetic diamonds. Red fluorescence with purple mottling appears in the putative "as-grown" O-P color rectangular step cut (A). The greenish blue striations in the 0.52 ct sample are more typical patterns (B). The 0.57 ct CVD synthetic demonstrates a unique combination of fluorescence features—dominant [N-V] center-related fluorescence, with minor areas showing some violet-blue dislocations and greenish blue striations (C–D).



grades. The clarity grades were affected by pinpoint inclusions and small fractures. Both round brilliants were weakly strained, revealing low-order (gray and brown) interference colors. They shared several PL spectroscopic traits, including emissions from $[N-V]^{0-}$, $[Si-V]$, H3 (503.2 nm), and weak N3 (415.2 nm) centers. The 596.5/597.2 nm doublet was not observed in either specimen. The absence of this feature, combined with the presence of multi-nitrogen defects such as H3 and N3, suggests that they had undergone post-growth high-temperature annealing to remove the as-grown brown coloration (again, see W. Wang et al., 2012). The FWHMs for the $[N-V]^0$ and $[N-V]^-$ centers were 0.21 nm and 0.16 nm, respectively, for the 0.52 ct round, and 0.23 nm and 0.22 nm for the 0.57 ct sample. These were comparable to the narrowest widths reported for natural diamonds and newer-generation HPHT-treated CVD synthetics produced by Gemesis Corp., and consistent with the low levels of strain detected.

The round brilliants exhibited distinct behavior when examined using the DiamondView instrument (see figure 18, B–D). The 0.52 ct sample showed greenish blue fluorescence and clear growth striations, as well as strong green-blue phosphorescence. These observations were akin to those for HPHT-treated CVD synthetic diamonds produced by Gemesis (again, see W. Wang et al., 2012). Although green-blue phosphorescence was also observed for the 0.57 ct sample, its DiamondView fluorescence images were primarily purplish pink, with violet-blue dislocation bundles and a patch of greenish blue fluorescence. This fluorescence combination in a CVD synthetic diamond had never been observed at a GIA laboratory. The purplish pink fluorescence color was attributed to $[N-V]$ centers. Comparison of the Raman-normalized PL intensities of the peaks revealed that the $[N-V]^0$ and $[N-V]^-$ peaks were approximately 57% and 68% more intense in the 0.57 ct round than in the 0.52 ct sample. This may explain the difference in the Di-

amondView fluorescence responses of these synthetic diamonds. It is possible that the 0.57 ct round was HPHT-annealed at a lower temperature.

The gemological and spectroscopic observations for these three samples emphasize the variations that might be possible through different growth procedures and subsequent treatment for near-colorless to light brown CVD synthetic diamonds. Nevertheless, the specimens could be readily identified as synthetic by careful analysis of data from a combination of laboratory techniques.

Ulrika D’Haenens-Johansson, Sally Eaton-Magaña, Manisha Bhoir, and Yogesh Shinde

Very Large CVD-Grown

In the last decade, we have witnessed rapid improvement in the quality and size of lab-grown CVD synthetic diamonds. The New York laboratory recently tested a 2.16 ct CVD synthetic from Scio Diamond Technology Corp. (figure 19), the largest specimen GIA has seen so far.

This marquise, which measured $13.42 \times 6.73 \times 3.94$ mm, was more than twice the size of a 1.05 ct pear shape examined in 2010, previously the largest CVD synthetic tested by GIA (see Summer 2010 *G&G* Lab Notes, pp. 143–144). It had J/K color with a brownish tint, and microscopic observation revealed small fractures, pinpoints, and non-diamond-carbon black inclusions, resulting in an SI₂ clarity grade.

The mid-infrared absorption spectrum revealed that the diamond could be classified as type IIa. It was very pure in the infrared region, with no nitrogen- or hydrogen-related absorption features. Photoluminescence analysis at liquid-nitrogen temperature with varying laser excitations displayed typical CVD features: very strong emissions from N-V centers, moderate emission lines at 736.6/736.9 nm from the $[Si-V]$ center, and the CVD-specific 596/597 nm pair (figure 20). Also detected was weak emission from the H3 defect with a



Figure 19. This 2.16 ct marquise ($13.42 \times 6.73 \times 3.94$ mm) is the largest CVD synthetic diamond tested by GIA. It had J/K color, with a brownish tint.

zero-phonon line at 503.1 nm, making for an interesting combination of optical centers. Under the short-wave UV radiation of the DiamondView, the table and crown facets showed pure blue fluorescence while the pavilion displayed banded orange fluorescence with irregular blue fluorescence regions. Very strong internal stress with irregular patterns was confirmed under the microscope using cross-polarized light.

Testing of this large, gem-quality CVD synthetic underscored the rapid improvement of lab-grown diamond technology. It is foreseeable that more of these products will continue to reach the jewelry industry.

Wuyi Wang, Kyaw Soe Moe, Siau Fung Yeung, and Ulrika D’Haenens-Johansson

Yellow SYNTHETIC SAPPHIRE Colored by Trapped-Hole Mechanism

Natural sapphires with pale or lemon yellow color and no orange hue are traditionally associated with the chromophore Fe^{3+} , which substitutes for aluminum in corundum. The New York laboratory recently received a 2.58 ct yellow emerald-cut stone (figure 21, inset), identified as sapphire by its RI and SG. But the desk-model spectroscope showed broadband absorption below ~500 nm without any of the Fe^{3+} -related absorption features associated with yellow coloration

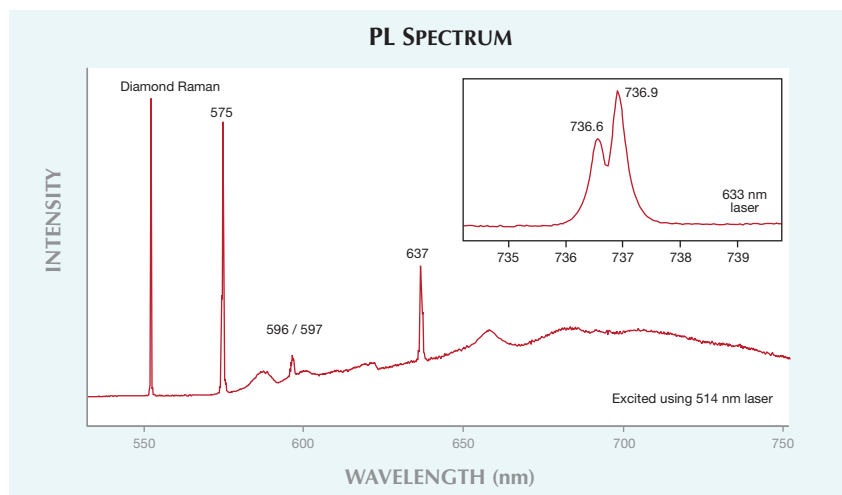


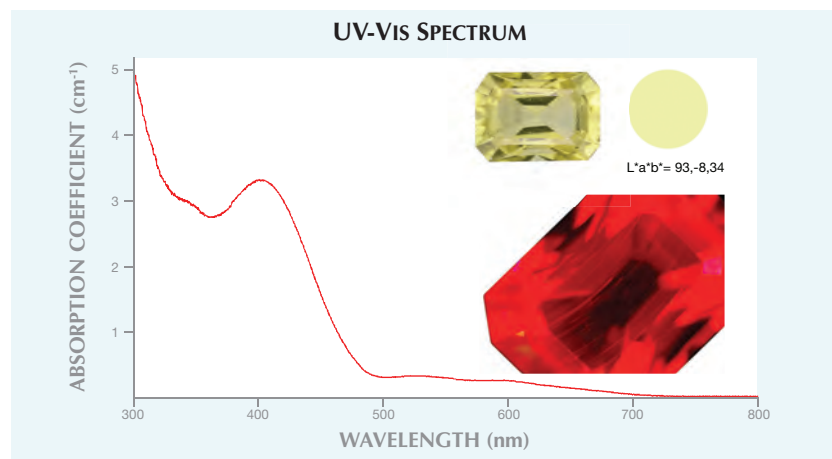
Figure 20. The 2.16 ct synthetic diamond showed typical photoluminescence features of CVD growth, including strong emissions from N-V centers at 575 and 637 nm, moderate CVD-specific emissions at 596/597 nm, and 736.6 and 736.9 nm emissions from the [Si-V] center.

(e.g., at 450 nm). Microscopic observation showed an exceptionally clean interior with only a small cluster of tiny particles that resembled gas bubbles from synthetic materials. The stone fluoresced medium orange to long-wave UV radiation and inert to short-wave UV.

The suspicious inclusion scene and the absence of diagnostic spectral

features warranted additional testing. A standard immersion image failed to show any zoning or features. By contrast, a DiamondView image clearly revealed parallel curved bands characteristic of synthetic origin. Quantitative UV-visible spectra exhibited strong broadband absorptions in the blue and green regions and created a transmission window in the yellow

Figure 21. The UV-visible spectrum of this yellow sapphire shows broadband absorption features below ~500 nm, originating from trapped holes associated with Mg and Cr. The DiamondView image clearly displays curved bands (sub-parallel to the long direction of the stone under the table), indicating a synthetic origin. These curved bands are not seen with standard immersion, demonstrating the DiamondView's effectiveness (the red color is due to the fluorescence of chromium). The stone's CIE $L^*a^*b^*$ color coordinates are reproduced from the measured UV-visible spectrum.



spectral region (figure 21). Detailed chemical analysis via LA-ICP-MS was performed to identify chromophores and color origin. The elements Mg, Cr, and Ni were detected at trace levels (a few ppma). Naturally occurring elements such as Ga were not detected, further indicating synthetic origin. Trace Cr was confirmed both by red fluorescence and by laser photoluminescence spectra with 514 nm excitation, exhibiting a doublet at 692/694 nm and side bands.

A combination of trace-element analysis and UV-visible spectroscopy clearly indicated that the yellow color originated from the much more effective chromophore known as “trapped holes,” associated with the trace amount of Mg and Cr in this stone (J.L. Emmett et al., “Beryllium diffusion of ruby and sapphire, Summer 2003 *G&G*, pp. 84–134). By comparison, a sapphire colored by Fe^{3+} would only display a pale yellow coloration with a concentration above 500 ppma. This synthetic sapphire, however, showed no iron above the detection limit (< 1 ppma). The contribution of trace amounts of Ni is not well known.

Natural and synthetic sapphires colored by a trapped-hole mechanism often possess an orange or reddish orangy hue. This synthetic sapphire exhibited a yellow coloration much like those of samples colored by Fe^{3+} . This example demonstrates that a clear understanding of chromophore contribution and the application of relevant advanced testing can reliably identify the cause of color as well as natural or synthetic origin. In this instance, the prominent curved growth supported the identification, but even without this feature a thorough understanding of the cause of color in sapphire can provide helpful identification clues.

Ren Lu

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