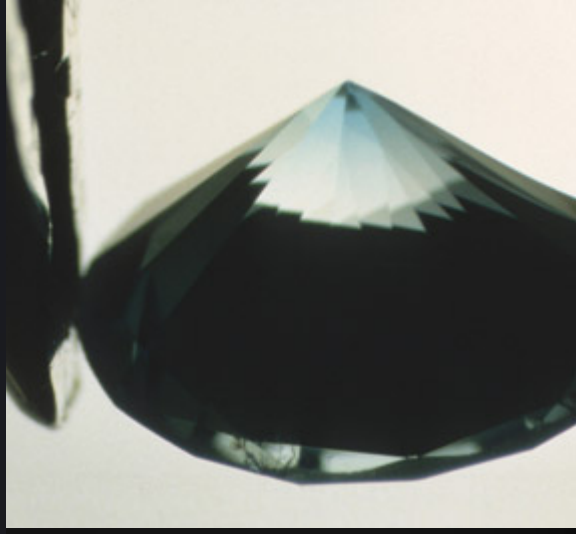
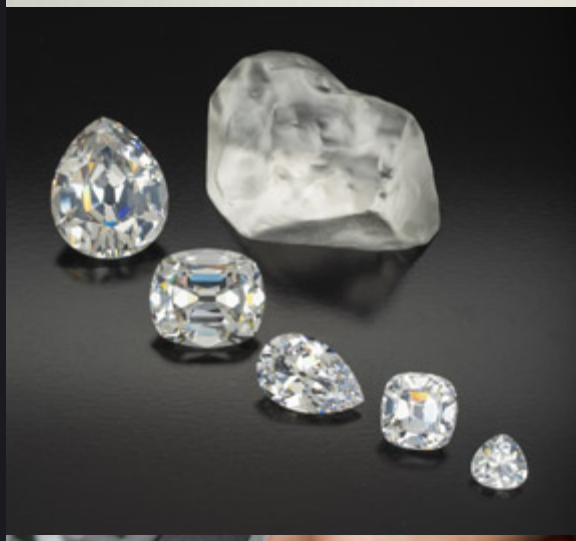
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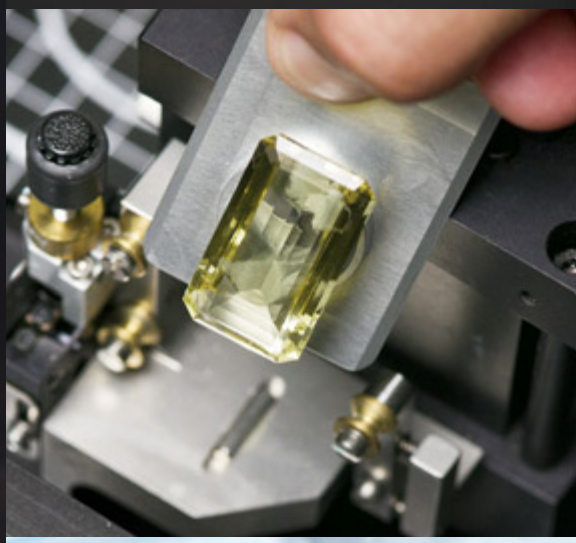
Diamonds & Diamond Grading

BOOK 4

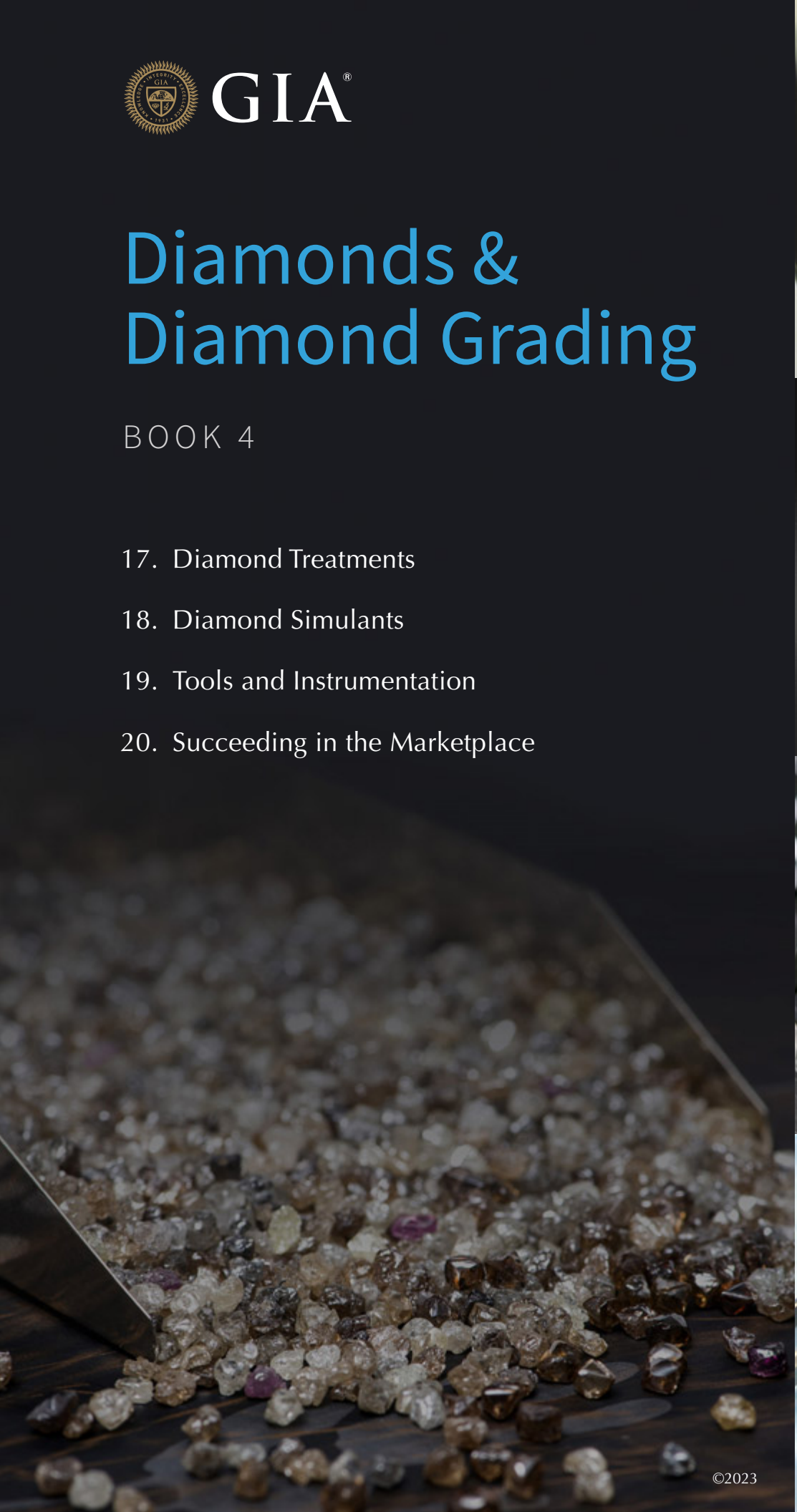
17. Diamond Treatments
18. Diamond Simulants
19. Tools and Instrumentation
20. Succeeding in the Marketplace











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Diamonds & Diamond Grading
Book 4

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Diamond Treatments

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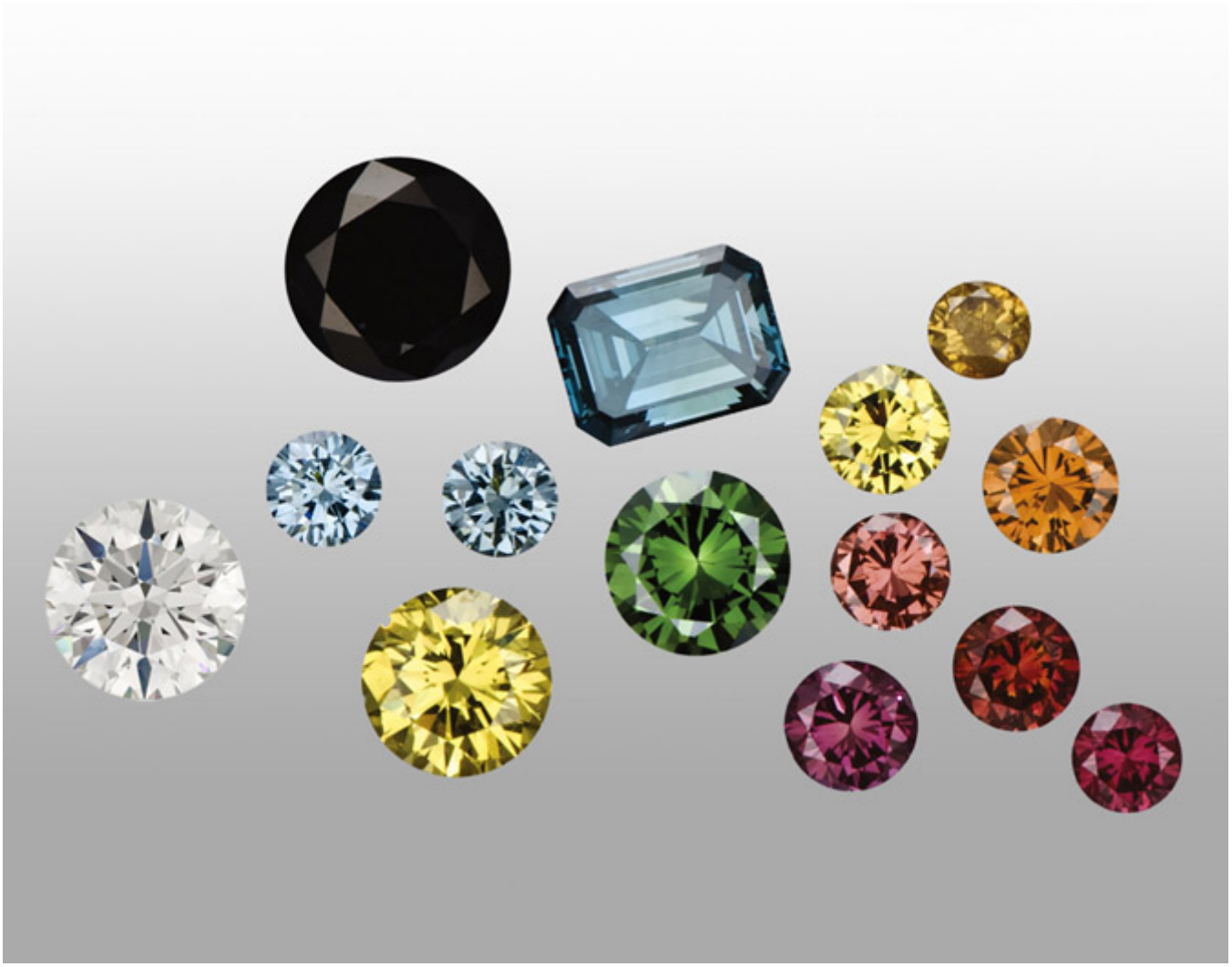
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Welcome to *Diamonds & Diamond Grading* Assignment 17. This assignment contains the knowledge required for you to:

- Identify common diamond clarity and color treatments
- Describe the mechanisms of common diamond treatments
- Recognize visual clues that assist in the identification of treated diamonds
- Describe the current marketplace for treated diamonds



Robert Weldon/GIA

Treatments can improve the marketability of diamonds that would otherwise be hard to sell. As treatment processes improve, detection can become more challenging.

Diamond Treatments

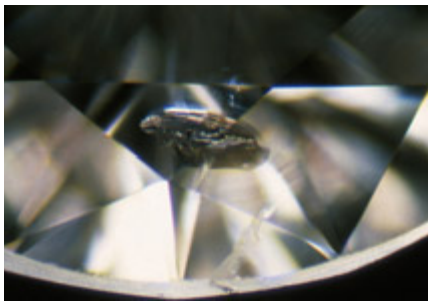
People have admired diamond as a product of nature for thousands of years. The preceding assignments have covered diamond's progress from carbon atoms to rough diamonds to finished gems—and why diamond's rarity makes it exceptionally valuable in the gem world. Is it any wonder that through the ages alchemists and researchers have made countless attempts to enhance diamonds?

Through many efforts, people have discovered ways to "improve" diamond's appearance—to hide its imperfections or alter its color. Diamond treatments are part of the diamond industry, and detecting them is critical. This assignment will cover diamond clarity and color treatments, along with some basic detection methods.

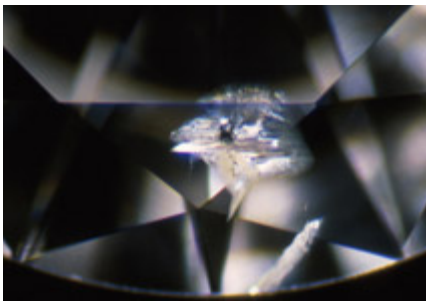


Jian Xin (Jae) Liao/GIA

This treated diamond was graded Fancy red, an extremely rare color grade for untreated natural diamonds.

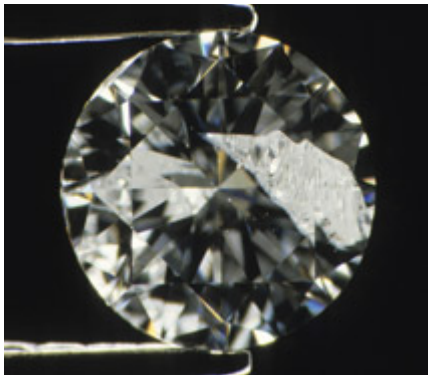


Shane F. McClure/GIA



Shane F. McClure/GIA

Removal of the black coloration from the inclusion with the use of lasers dramatically improved this treated diamond's appearance. Magmified 40x.



Robert Weldon/GIA



Robert Weldon/GIA

Note the drastic change in apparent clarity after treatment (right).

Clarity Treatments

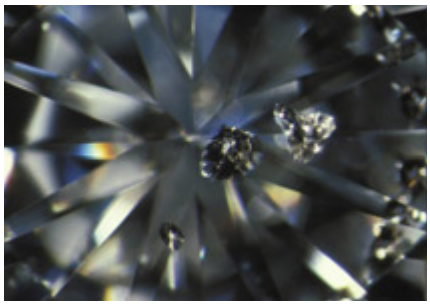
- How can laser drilling improve a diamond's marketability?
- What are some benefits and disadvantages of fracture filling?
- What is the flash effect?

Very few diamonds are perfect when they are found in nature. During the manufacturing process, clarity characteristics can be cut away or positioned so they don't detract from appearance or durability. But some diamonds require more effort to improve apparent clarity. In the late 20th century, improved technologies brought many advances in diamond clarity treatments.

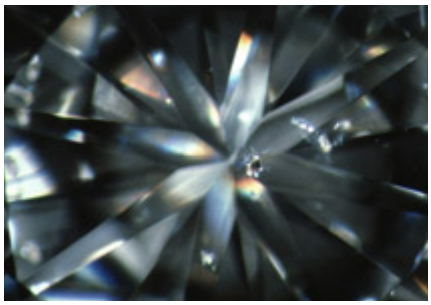
Laser Drilling

Laser drilling—The use of a laser beam to reach a diamond's dark inclusions and disguise or eliminate them.

Since the early 1970s, diamond manufacturers have used *laser drilling* to disguise or eliminate dark inclusions. In this process, a carbon dioxide laser is used to drill a tiny tunnel, thinner than a human hair, by heating an area of the diamond until it evaporates. This produces a tube directed toward an unsightly inclusion. This tube, or laser drill-hole, provides access for acid to bleach or etch out the inclusion, or to vaporize it with the laser.

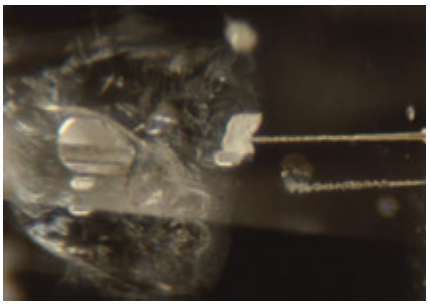


John I. Koivula/GIA



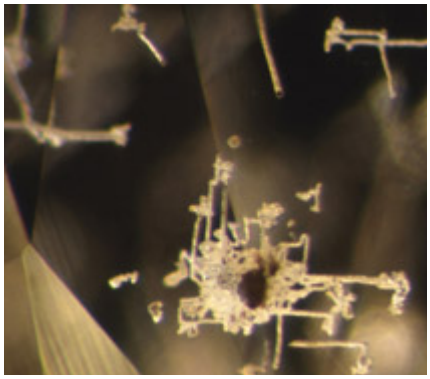
John I. Koivula/GIA

Before laser drilling, dark inclusions stand out against the rest of the diamond (left). After the diamond is laser drilled and the inclusions are bleached and etched with acid, they're much less obvious (right).

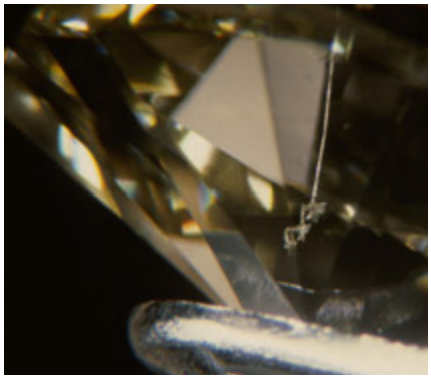


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Laser drill-holes clearly visible in darkfield lighting. The once-dark crystal inclusions are colorless after bleaching. Magnified 40x.

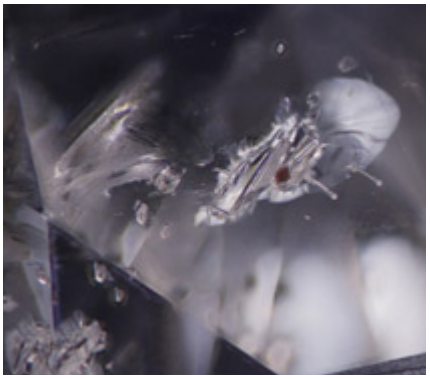


John I. Koivula/GIA



Andrew Quinlan/GIA, courtesy William Goldberg Corporation

A diamond may have more than one laser drill-hole (left) if it originally had more than one large, dark included crystal. If the laser operator is skilled enough, neighboring dark inclusions can be reached with a single drill-hole (right). Magnified 39x.



Nathan Renfro/GIA

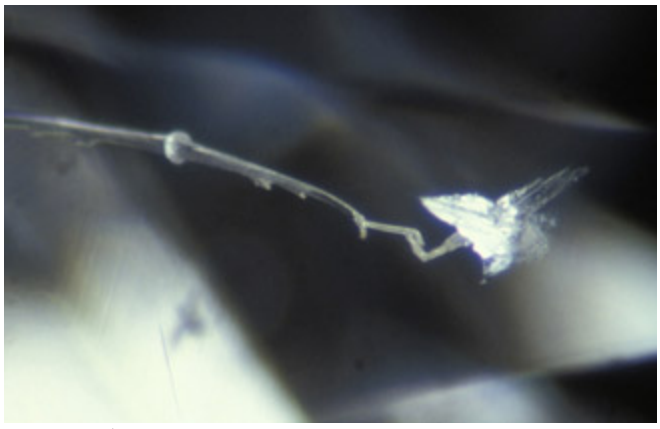
Two laser drill-holes on the table of a diamond. Magnified 20x.

This process lightens a dark inclusion, which can make the diamond more marketable.

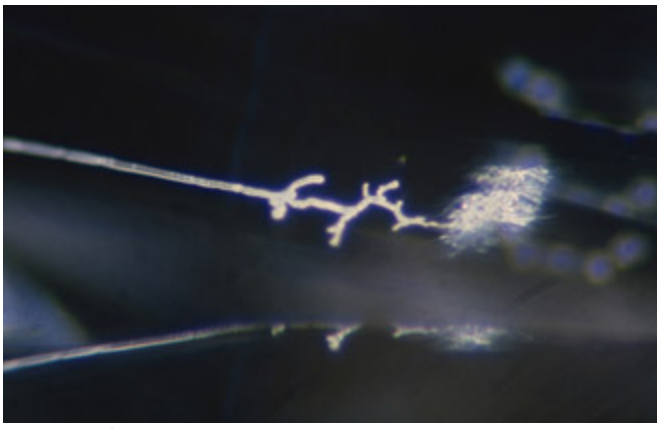
While laser drilling disguises or eliminates an existing inclusion, it often doesn't improve the clarity grade—the drill-hole becomes a clarity characteristic. (Typically a drill-hole is not a durability concern.)

KEY CONCEPTS

Laser drilling can make a diamond more marketable by improving its appearance.

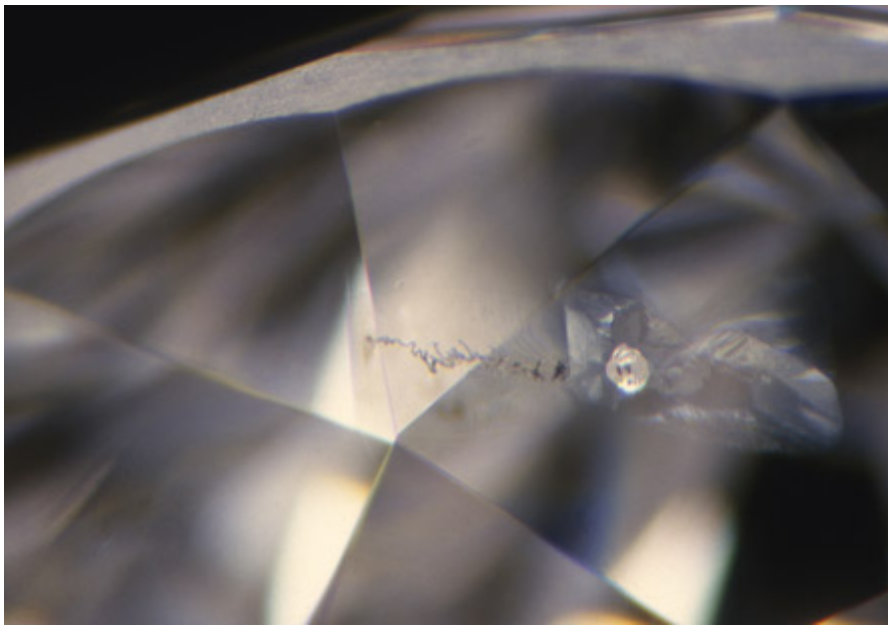


Vincent Cracco/GIA



Vincent Cracco/GIA

Laser drill-holes are typically straight, but they can also be curved (left) or branched (right). Magnified 63x (left) and 47x (right).



Shane F. McClure/GIA

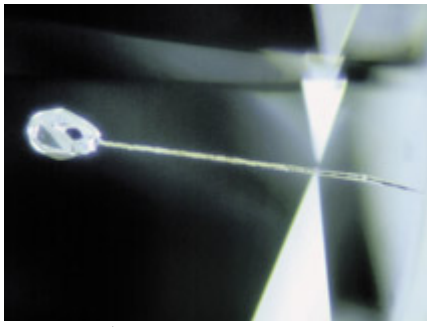
Internal laser drilling often enlarges or generates cleavages around the targeted inclusion and leaves irregular channels within the cleavages.

Internal Laser Drilling

Internal laser drilling—A clarity treatment that uses a laser focused on or near an inclusion to enlarge existing cleavages or create new ones, providing a path for a bleaching solution to dissolve the inclusion.

In the early 2000s, a new laser treatment for diamonds was reported in the trade. It was first called "KM treatment," a reference to *kiduah meyuhad*, which means "special drill" in Hebrew. This treatment is now known as *internal laser drilling*.

Instead of drilling a hole, a laser beam is focused on or near the targeted dark inclusion. The heat from the laser expands the inclusion, which creates enough stress on the diamond that existing cleavages expand and new cleavages may form around the inclusion. Once a cleavage reaches the diamond's surface, it provides a path for acids to bleach or dissolve the dark inclusion. Just as with traditional laser drilling, the result is the lightening of a dark inclusion to make it less visible and enhance apparent clarity. Internal laser drilling works best on dark inclusions near the surface, and often leaves irregular channels within cleavages.



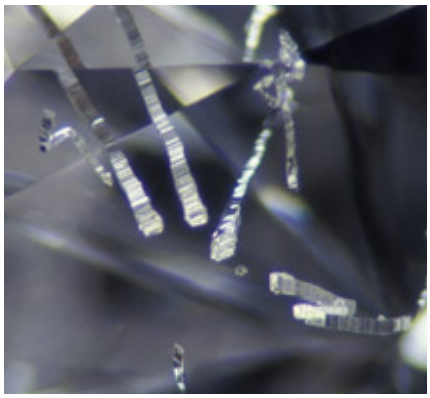
Vincent Cracco/GIA

Close-up of a drill-hole between the surface and an inclusion, which was bleached to be less visible. Magnified 63x.

Detecting Laser Drilling

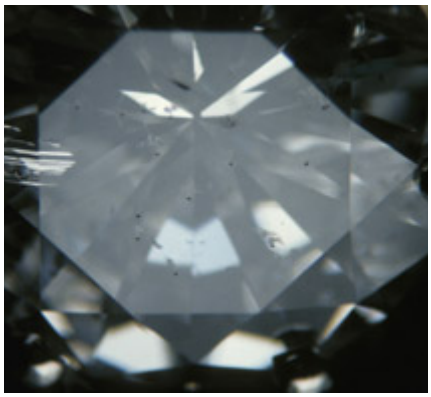
You might be able to detect a laser drill-hole with careful examination under 10x magnification, but higher magnification is often necessary. You can distinguish laser drill-holes from etch channels—natural, hollow, tube-like features in some diamonds—by the fact that laser drill-holes are circular, while etch channels are angular: square, triangular, or hexagonal.

Reflecting light off of a diamond's facets allows one to more easily locate the opening of a laser drill-hole. It's difficult to see a laser drill-hole if it's short or covered by a prong in a setting. A laser drill-hole opening is typically found on a crown facet. When a diamond is drilled from the pavilion facets, the drill-hole almost always appears as a long white inclusion and may be reflected throughout the stone.

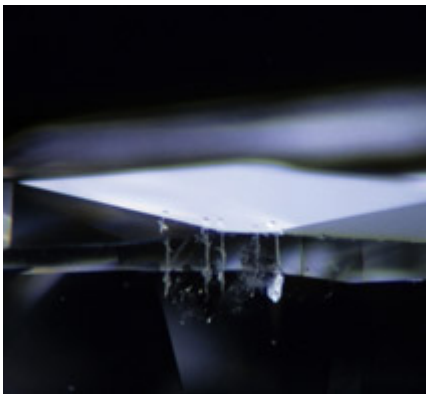


Vincent Cracco/GIA

Some diamonds contain natural features called etch channels, which are angular and can display growth marks. Laser drill-holes are typically rounded and smooth. Magnified 45x.



GIA



GIA

Reflecting light off of a diamond's facets allows one to more easily locate the opening of a laser drill-hole.



GIA

Internal laser drilling resulted in the unnatural, irregular, wormhole-like channel in this diamond.



Vincent Cracco/GIA

Laser drill-holes are typically made on the crown of the diamond rather than the pavilion to avoid creating reflections that would negatively affect the clarity, like those seen here. Magnified 10x.

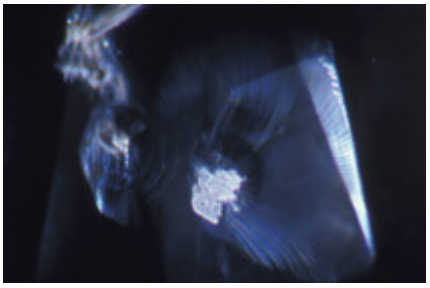


Shane F. McClure/GIA

Internal laser drilling generated these step-like progressions of cleavages. Magnified 40x.

Internal laser drilling creates cleavages that are more natural-looking than a traditional laser drill-hole. The appearance of internal laser drilling varies. Under magnification, a diamond with internal laser drilling may display a step- or worm-like series of tiny feathers or channels, typically black or white, with a sugary or frosted appearance.

Improvement of the technique led to more subtle and less recognizable features of internal laser drilling. Diamonds treated with the improved technique may have small white disk-like features in their cleavages instead of the more obvious irregular channels. These features are more difficult to detect: they are visible when looking perpendicular to the cleavage plane but nearly invisible when looking parallel to the plane. It is important to use high magnification and various lighting techniques to check all surface-reaching fractures.



Shane F. McClure/GIA

Disk-like characteristics left by the improved internal laser drilling process. Subtle irregular channels can be seen in them. This is much more challenging to detect. Magnified 40x.

KEY CONCEPTS

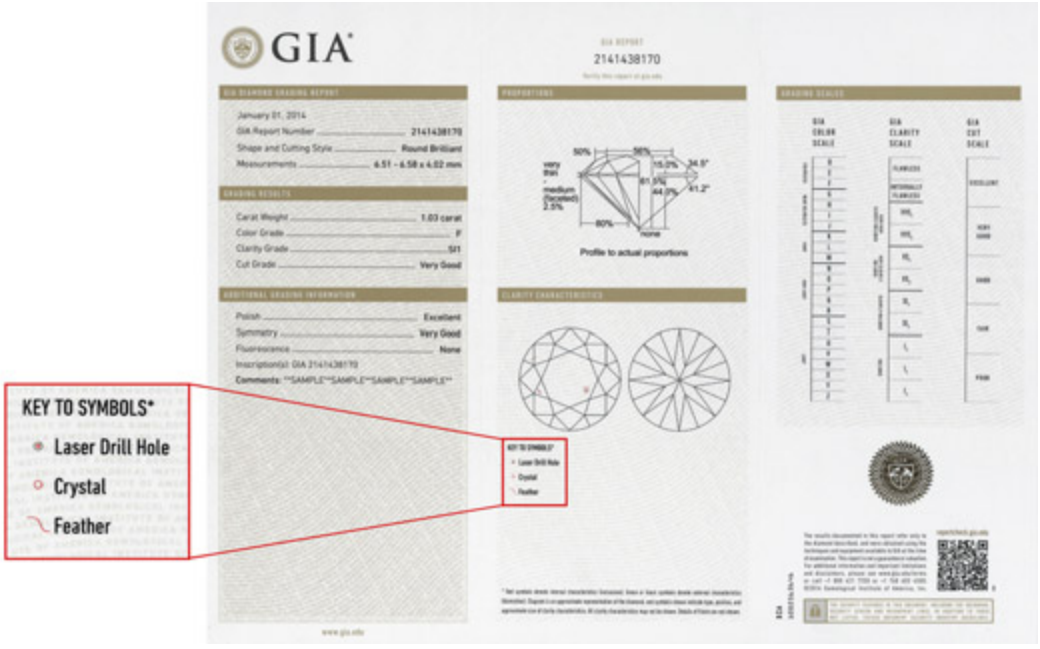
Major gem labs report features left by laser drilling as clarity characteristics because they are permanent.

Some industry professionals once considered laser drilling part of the fashioning process and didn't think it required specific disclosure or description. There was controversy about whether to disclose laser drilling until 2001, when the U.S. Federal Trade Commission updated its guidelines to require disclosure of the treatment. There is now industry-wide agreement that laser-drilled diamonds should be disclosed from wholesaler to consumer. A drill-hole is a permanent characteristic of a diamond, so all major gem labs grade laser-drilled stones and report a drill-hole as a clarity characteristic.



GIA

GIA Diamond Grading Report for an internal laser-drilled diamond. Internal laser drilling is listed in the comment section.



GIA

GIA Diamond Grading Report for a laser-drilled diamond. "Laser Drill Hole" is always listed first on the Key to Symbols and plotted on the diagram.



Shane F. McClure/GIA

Before treatment (left), this 0.20-ct. diamond's fractures are large, reflective, and obvious. After fracture filling (right), the diamond's apparent clarity is improved. The filler refracts light almost as well as the diamond, so the fractures are less apparent.



Vincent Cracco/GIA



Vincent Cracco/GIA

The white feathers in this 1.39-ct. Fancy Intense pink emerald-cut diamond (top) detracted from the stone's color. After fracture filling (bottom), most of the feathers were transparent, and the stone revealed a more highly saturated pink color face-up.

Fracture Filling

Fracture filling diamonds as a way to improve their apparent clarity was developed in the early 1980s. Since then, many manufacturers who produce these clarity-treated diamonds have emerged. The composition of the filler and process varies by manufacturer, but they are all based on the same method: a molten glass substance is infused into a diamond's fractures and cleavages to reduce their visibility. It is assumed this process is done at a moderate temperature (approximately 400°C) in either high pressure or a vacuum.

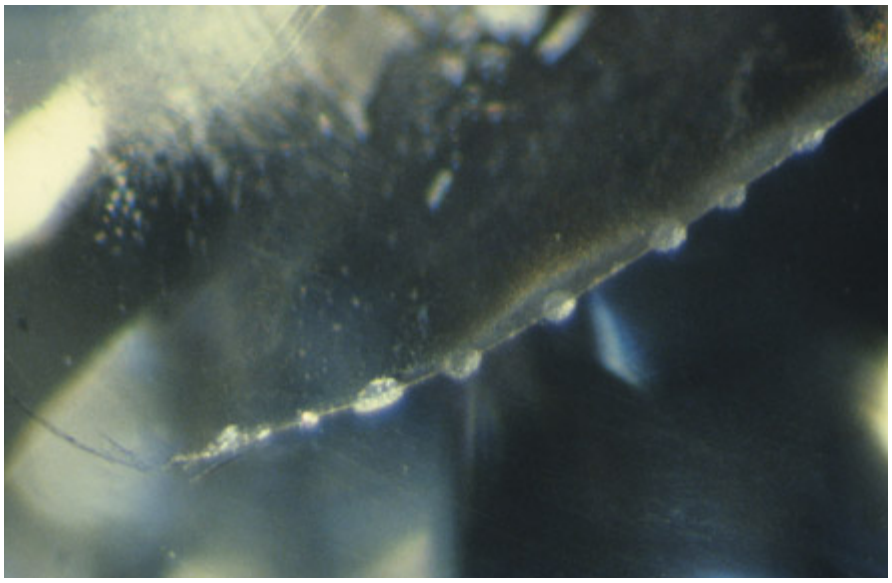
When a diamond has a surface-reaching fracture or cleavage, the air in the fracture has a lower refractive index (RI) than diamond. This lower RI interrupts light's path through the diamond and makes the fracture reflective and easier to see. A filling's RI is closer to diamond's than to that of the air it replaces, so the filled fracture is almost invisible to the casual observer.

Diamonds as small as melee have been filled, but most filled diamonds are over one carat. Colored diamonds can also be enhanced through fracture filling. An improvement in apparent clarity has greater impact on the marketability of larger diamonds and colored diamonds than that of smaller diamonds.

While fracture filling improves a diamond's apparent clarity, it has some disadvantages. Fracture filling can last for years with proper care, but fillers can be damaged by common jewelry repair procedures. Damaging conditions include the high temperatures created during recutting or repolishing and the heat generated during retipping or repair. Over time, repeated cleaning can also harm fillers, especially when the method involves steam, acid, or ultrasonic cleaning. Prolonged exposure to ultraviolet radiation—even sunlight—can discolor a filler and eventually make it look cloudy.

KEY CONCEPTS

Fracture filling makes a diamond's fractures and cleavages less visible by using a high-RI glass filler.



John I. Koivula/GIA

Jewelry repair procedures can damage diamond fillers. During repair of this diamond's setting, heat caused beads of melted filler to leak out of the diamond's fracture. Magnified 50x.

Some damage can be reversed. For example, it's possible to replace filler if it melts and leaks out. But if the filler darkens, there's no way to make it colorless again. The only solution is to remove the darkened filler and replace it with new filler. Many major manufacturers of fracture-filled diamonds offer lifetime guarantees on their treatments for this reason. But that is not enough for everyone. While some jewelry stores carry a selection of filled diamonds, others refuse to accept them from their suppliers.

Diamonds treated by fracture filling show no evidence of weight gain after treatment. The glass filling material is rarely thick enough for its color to be visible, but it can impact diamond color grade. Filler can sometimes slightly lower a diamond's color grade in the D-to-Z range, or enhance a fancy-color diamond's saturation. When filler is thick enough to be visible, it is typically light brown to brownish yellow or orangy yellow.

In some cases, a colorless diamond's fractures and cleavages have been filled with a pink material to change only the face-up color of the diamond. This practice is not common or accepted in the trade.

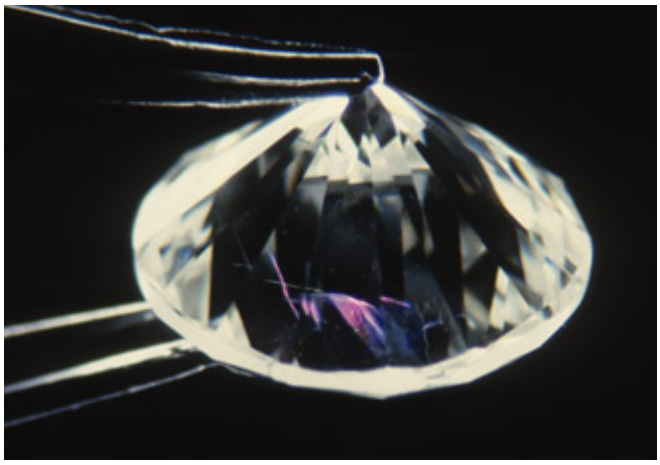
Detecting Fracture Filling

The ability to identify filled diamonds is essential. A standard gemological microscope is sufficient to identify most fracture-filled diamonds. The most obvious evidence of fracture filling is called the flash effect, which is a flash of changing color. The flash effect occurs because glass fillers don't precisely match diamond's RI for all wavelengths of light. It is visible under magnification in both darkfield and brightfield lighting. Fiber-optic illumination makes the flash effect more evident.

In darkfield lighting, the most common colors seen are orange, pink, and purple to violet. In brightfield lighting, the most common colors seen range from bluish green to greenish yellow. To see the flash effect, look parallel to the fracture and rock the diamond back and forth.

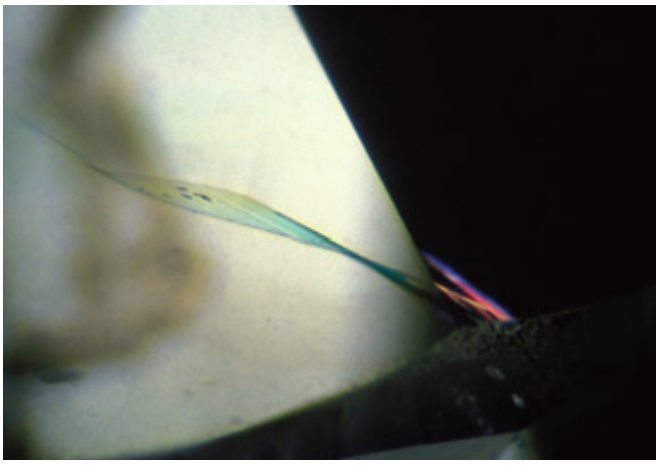
KEY CONCEPTS

Some signs of fracture filling are the flash effect, trapped gas bubbles, flow structure, and a crackled texture.



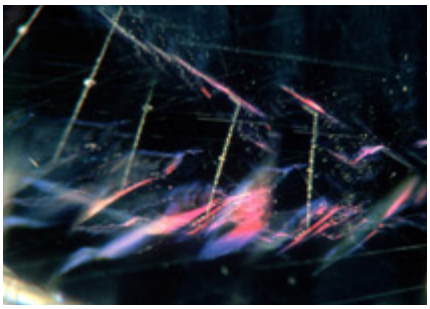
Vincent Cracco/GIA

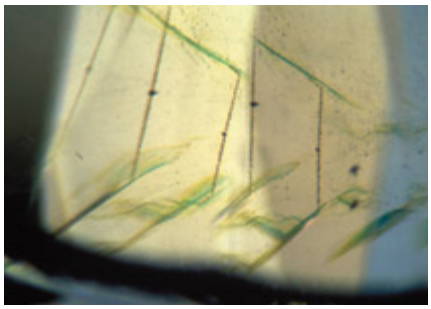
This fracture-filled diamond has a prominent purple flash effect under 10x magnification in darkfield lighting.



Vincent Cracco/GIA

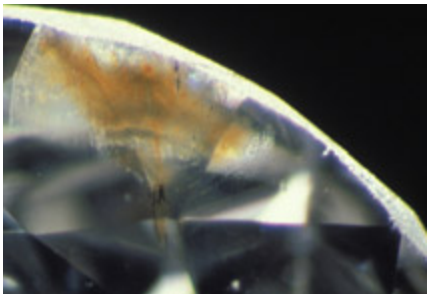
This fracture-filled diamond has a green flash effect against a bright background and purple flash effect against a dark background. Magnified 63x.



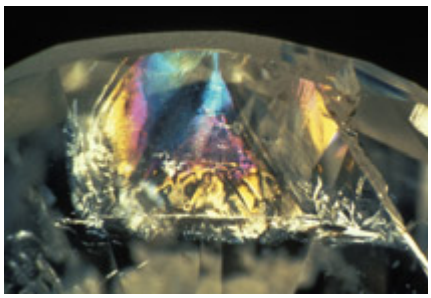


Vincent Cracco/GIA

This diamond's multiple laser drill-holes, pinkish purple flash effect in darkfield lighting (left), and greenish yellow flash effect in brightfield lighting (right) show it is fracture filled. Magnified 37x.



John I. Koivula/GIA

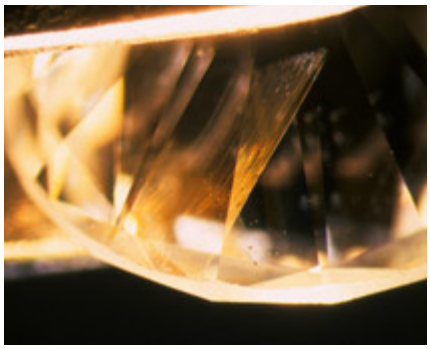


Robert E. Kane/GIA

Orange staining (left) and iridescent colors (right) in the fractures of an untreated diamond.

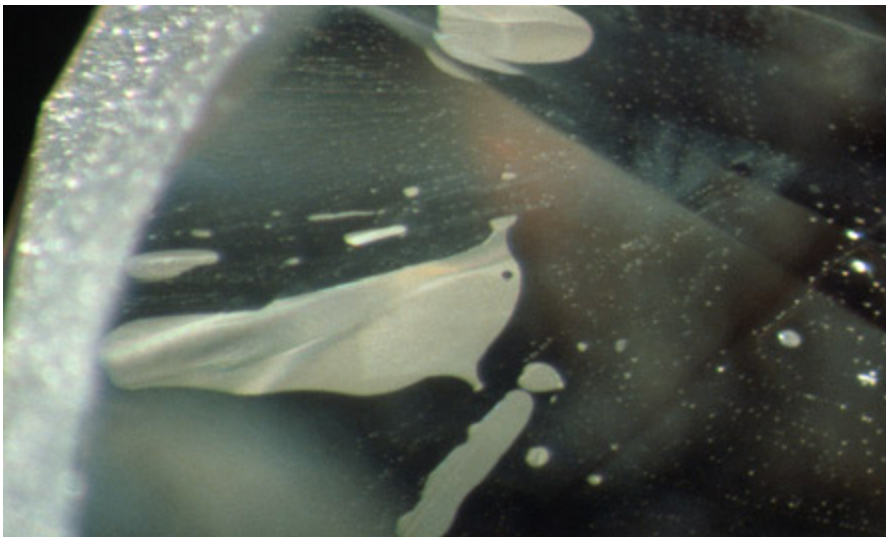
It's important not to confuse the flash effect with the iridescence or orange staining from an iron-containing compound sometimes seen in untreated fractures and cleavages. Unlike the flash effect, these natural features are more readily visible looking perpendicular to the fracture.

Other signs of fracture filling include flattened gas bubbles, flow structure, and a crackled texture in the filled fracture. When you see these features under magnification, it's obvious that they're not part of the diamond's original internal structure.



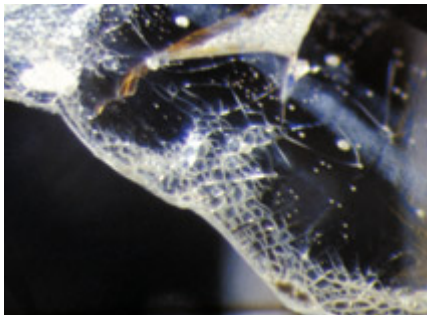
James E. Shigley/GIA

A distinct flow structure can be seen within this diamond's filled cleavage. This is not part of a diamond's original internal structure. Magnified 10x.



John I. Koivula/GIA

This diamond's fracture wasn't completely filled, so it contains large gas bubbles. This is one of the features to look for to identify fracture filling. Magnified 35x.



John I. Koivula/GIA

The filler in some fracture-filled diamonds has a crackled texture. This is obvious when the filler is fairly thick.

Some factors can make detection more difficult. Examining a diamond from many different angles is essential. A small filled fracture is more difficult to see than several fractures and thus requires more careful examination. If a filled fracture is in a less visible part of the diamond, for example behind a prong, detection is even more challenging.

Since the introduction of fracture filling, the industry has debated how to disclose it without alarming the customer. An early solution was the term "clarity enhancement," which sounds more positive than "fracture filling."



GIA

GIA Identification Report for a fracture-filled diamond.

However, the U.S. Federal Trade Commission and others in the industry consider "clarity enhancement" misleading. It was soon replaced by "clarity treatment," which was adopted by many industry professionals as the preferred—and more accurate—term. Diamond professionals and regulatory agencies demand disclosure of fracture filling every time a diamond changes ownership.

Because fracture fillings can be semipermanent, most gemological laboratories (including GIA) do not grade fracture-filled diamonds. They do, however, report the presence of fracture filling through a GIA Identification Report. Your reputation could depend on proper identification and disclosure of this or any other treatment. If you're uncertain about the presence of fracture filling in a diamond, send it to a gemological laboratory for identification.

KEY CONCEPTS

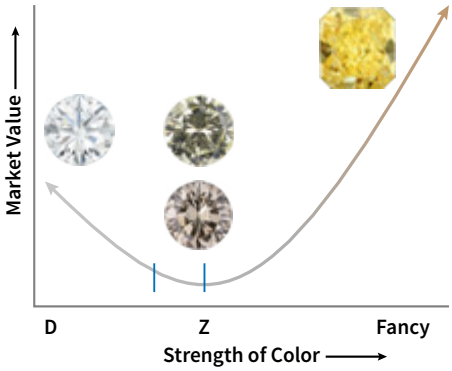
Disclosure of fracture filling is an industry requirement.

Color Treatments

- How can color treatments improve a diamond's marketability?
- What methods are used to alter diamond color?
- How can you detect color treatments in diamonds?

Scientists have experimented with many different methods to alter diamond color. The goal of all diamond color treatments is to create or remove color in lower-value diamonds to mimic natural diamond colors that are more valued.

For D-to-Z-range diamonds, less color means higher value. Diamond value drops as color increases on the D-to-Z scale. For colored diamonds, more color means higher value. When enough color is present for the diamond to be considered a fancy color, value rises. Diamonds chosen for color treatment are typically brown or in the light yellow range of the D-to-Z color scale.



Russel Samson/GIA

Diamonds chosen for color treatment are typically within the blue lines on the graph. These are usually brown or in the light yellow range of the D-to-Z color scale.



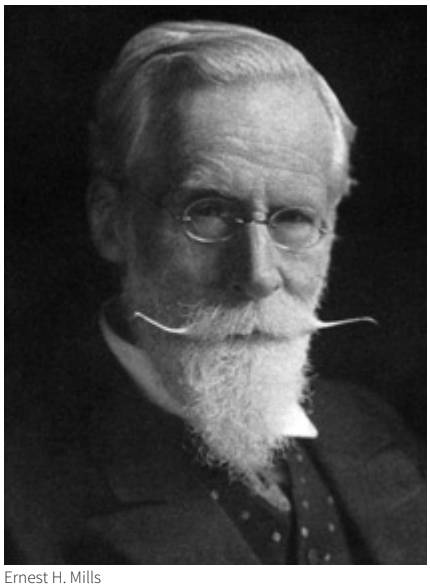
Christopher Bonine/GIA

Diamond colors that were once seen only at auctions are now widely available as a result of a variety of treatments that can change off-color diamonds to attractive bodycolors. Color-treated diamonds can closely resemble their rare natural-color counterparts, such as the famed Oppenheimer Blue and Moussaieff Red.



Maha Tannous/GIA

These diamonds owe their colors to a variety of treatments.



Ernest H. Mills

Sir William Crookes is best known in gemology for his discovery of the effects of radiation on diamonds.

Irradiation—Exposure of a material to radiation.

Colored diamonds are more popular than ever before. Greater interest in colored diamonds has led to new research into the causes of natural colors and how to enhance color in both D-to-Z-range and colored diamonds.

The promotion of pink and brown diamonds from Australia's Argyle mine was one factor in increasing public awareness of colored diamonds. The increasing number of auction records for fancy-color diamonds—such as the Pink Star for $71.2 million in 2017, the Oppenheimer Blue for $58 million in 2016, and the Orange for $35.5 million in 2013—is another factor.

Irradiation

Natural radiation in the ground makes diamonds nearby turn green. In the early 1900s, Sir William Crookes tried to duplicate nature's process and turn diamonds green in the laboratory. Exposure of a material to radiation is known as *irradiation*. Crookes found that he could turn diamonds green by burying them in a radium compound for up to a year. Unfortunately, the treatment also made the diamonds highly radioactive.

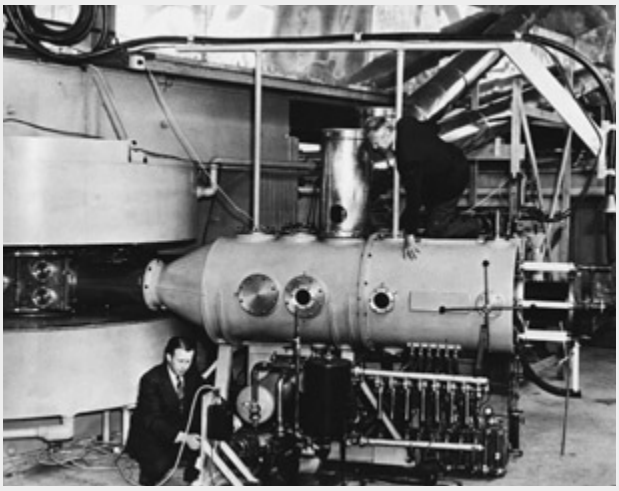
Today the most widely used irradiation technique exposes diamonds to high-energy electrons with a linear accelerator, which accelerates atomic particles along a straight path. This method allows treaters to irradiate hundreds of diamonds in a matter of minutes, without generating radioactivity. A less common technique involves bombardment with neutrons, usually in a nuclear reactor.

Diamond rough can be irradiated, but it is not common due to the shallow penetration of color. Irradiation is typically performed after a diamond is cut and polished. The resulting colors are sensitive to heat. As irradiation generates substantial heat, technicians use running water to cool the sample stage to prevent color changes during the process. The diamond is usually oriented table-down for greater surface contact with the cooled sample stage. After the diamond is set in jewelry, heat from repairs, recutting, or repolishing may change its color.

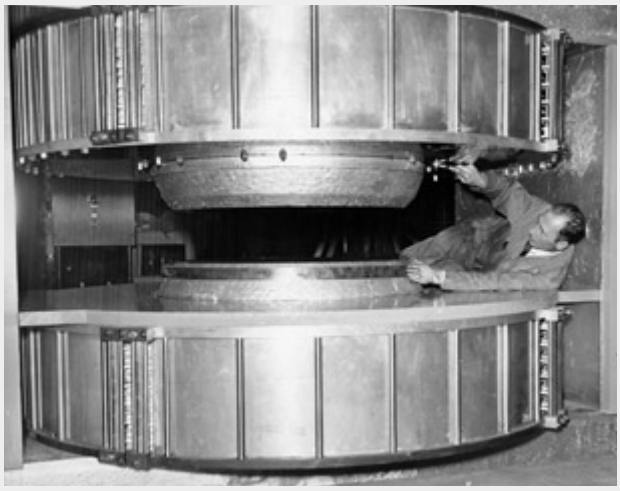
KEY CONCEPTS

Irradiated diamond color can change if the diamond is exposed to heat during repairs, recutting, or repolishing.

The Evolution of Irradiation Treatments



Hulton-Deutsch, courtesy Corbis via Getty Images

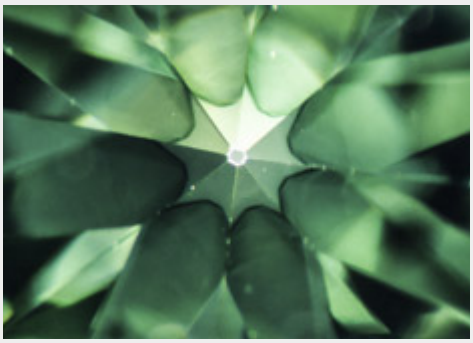


Courtesy Boston Globe via Getty Images

The first commercial quantities of irradiated diamonds were treated in a cyclotron, a large device developed for atomic research.

Since Sir William Crookes's experiments with irradiation in the early 1900s, others have developed ways to irradiate diamonds to change their color. Soon after World War II, atomic scientists invented the cyclotron for nuclear research. The cyclotron was a large machine that accelerated atomic particles around a circular path. Its introduction led to major developments in irradiation, and made laboratory irradiation of diamonds in commercial quantities possible. But this treatment resulted in shallow penetration of the atomic particles into the diamond, causing distinct color zones.

Color zoning parallel to facet junctions is one sign of a cyclotron-irradiated diamond. If a brilliant-cut diamond is irradiated from the pavilion, the color zone is an umbrella-shaped area around the culet. If it is irradiated from the crown, the zone is a dark-colored ring just inside the girdle. If you see either type of color zoning, send the diamond to a gemological laboratory for further testing.



GIA

Cyclotron-treated diamond with color zones around the culet, referred to as the "umbrella effect."

Different atomic particles can be used to irradiate diamonds and generate different results. Sir William Crookes experimented with alpha-particle irradiation, but the process made the diamonds radioactive for at least 50 years. Scientists have also experimented with gamma-ray irradiation, but the process takes several months. Today, penetration of high-energy electrons with a linear accelerator is one of two currently used irradiation techniques. The other involves bombardment with neutrons, usually in a nuclear reactor.

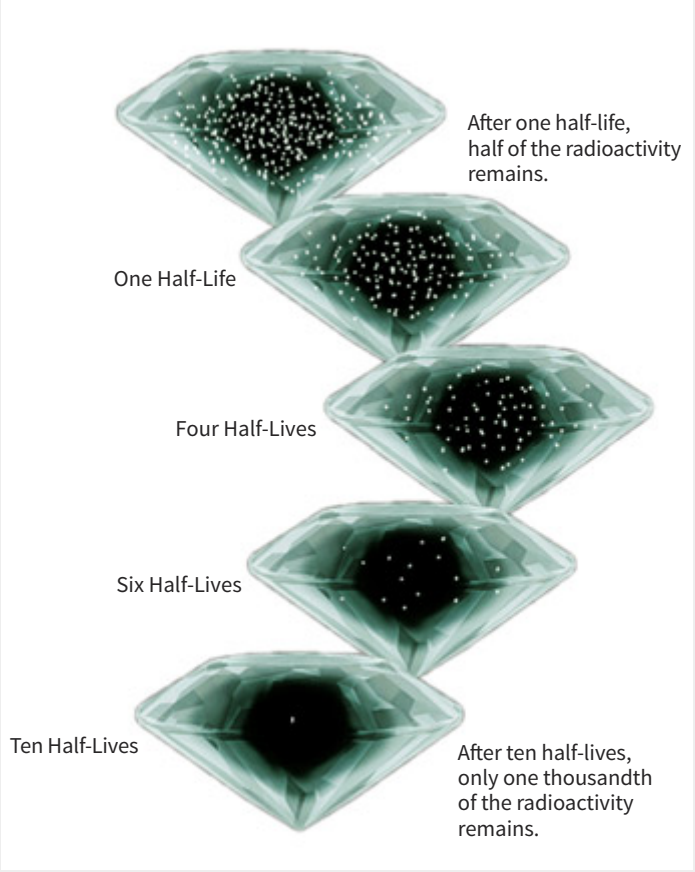
Irradiated Diamonds: Risk and Regulation

The radioactive atoms in diamonds color treated with modern methods usually have short half-lives, so the diamonds lose their radioactivity before they're released into the market.

Scientists use half-life to measure the period of radioactivity in a material. Half-life is the amount of time required for half the radioactive atoms of a substance to become nonradioactive. Once the first half decays in this way, the "clock" resets, and half of what's left begins to decay. This process continues until half of what's left is an undetectable amount. Half-life can vary from less than a second to billions of years.

The Geiger counter is a fairly simple and affordable instrument that can detect and measure moderate to high levels of radioactivity. It converts radioactive waves to electrical pulses that trigger audible clicks. It's a valuable tool to have on hand, especially if you deal in estate jewelry, which is more likely to contain potentially hazardous diamonds treated with radium compounds. Some diamonds irradiated in the early to mid-1900s are still radioactive.

In many countries, government agencies regulate the amount of radioactivity allowed in gemstones. In the United States, the Nuclear Regulatory Commission (NRC) regulates the initial distribution of gemstones irradiated in a nuclear reactor or accelerator. The NRC allows radioactive gemstones to be released to the public only after they're tested by an NRC-licensed organization. The testing organization assigns a release date to a radioactive gem based on when the radioactivity is expected to be at a safe level. Sometimes the release date is far in the future. After the initial release of the gemstone, it can be resold without limit.



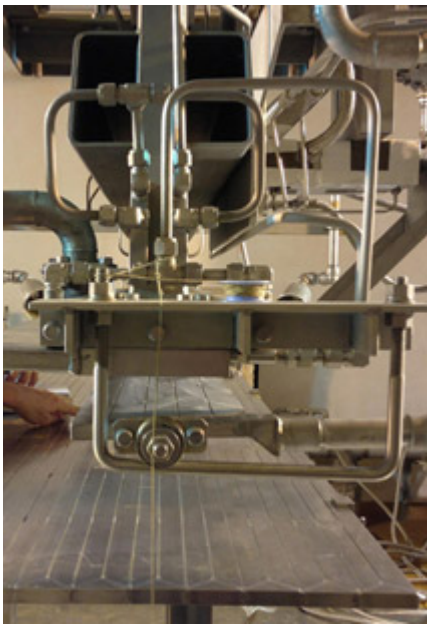
Peter Johnston/GIA

Half-life is a measure of the time it takes for half of the radioactivity in an object to break down. It can be as short as a few seconds or as long as billions of years, depending on the radioactive material involved.

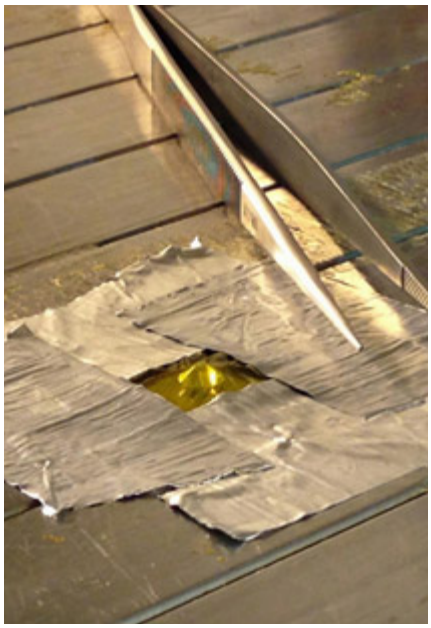


Rade Lukovic/iStockPhoto

The most common and least expensive radiation detector is a Geiger counter.



Wuyi Wang/GIA



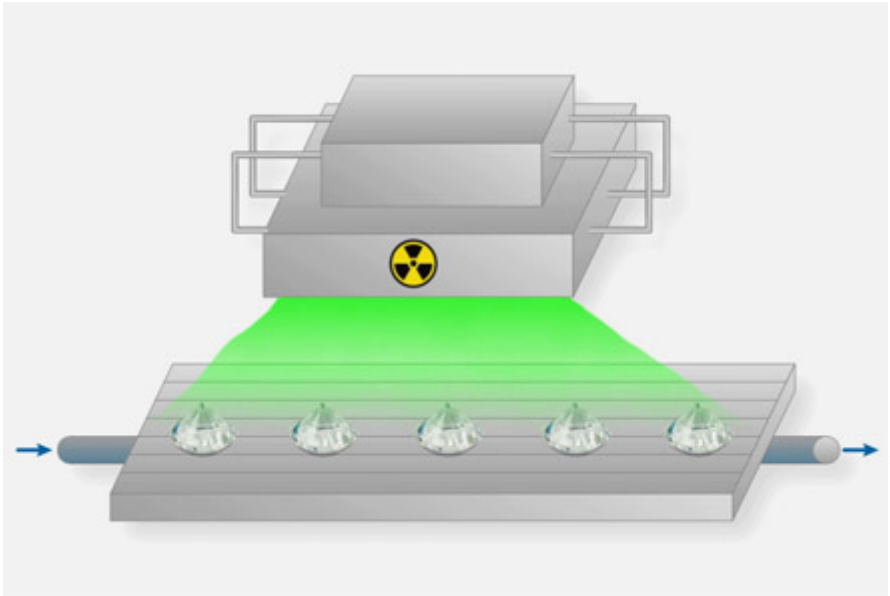
Wuyi Wang/GIA

Penetration with high-energy electrons in a linear accelerator is one of the two most frequently used irradiation techniques. Diamonds are typically faceted and placed table-down on the sample stage where the culet is first exposed to radiation.



Jian Xin (Jae) Liao/GIA

This 0.83-ct. cushion-cut diamond was color graded as Fancy Intense green. Its once naturally light yellow-green color had been changed by irradiation treatment. Green is one of the most popular colors generated by irradiation.



Russel Samson/GIA

Laboratory irradiation with high-energy electrons in a linear accelerator is the most common method used to irradiate diamonds. Because this process results in a great amount of heat, technicians use cool running water during the irradiation process to prevent color changes.



Robert Weldon/GIA

These 0.19-ct. (left) and 0.20-ct. (right) diamonds were irradiated to produce green colors.

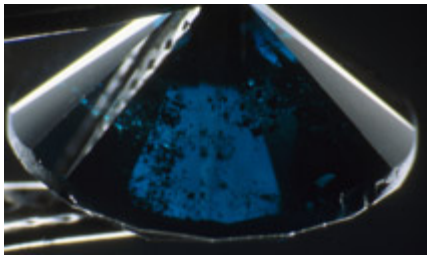
The color resulting from irradiation treatment varies based on starting material. Defects already present within the crystal structure contribute to the final color. Irradiation is considered a permanent treatment for diamonds, meaning the color resulting from the treatment cannot revert to the diamond's original color.

KEY CONCEPTS

The color resulting from irradiation can vary based on the defects already present in the diamond.



Orasa Weldon and GIA



Shane F. McClure/GIA

Some irradiated diamonds have such a dark green or blue bodycolor that they appear black in reflected light (top). Strong transmitted light reveals their color (bottom).

Interstitial positions—Spaces in the regular framework of atoms that are usually uninhabited.

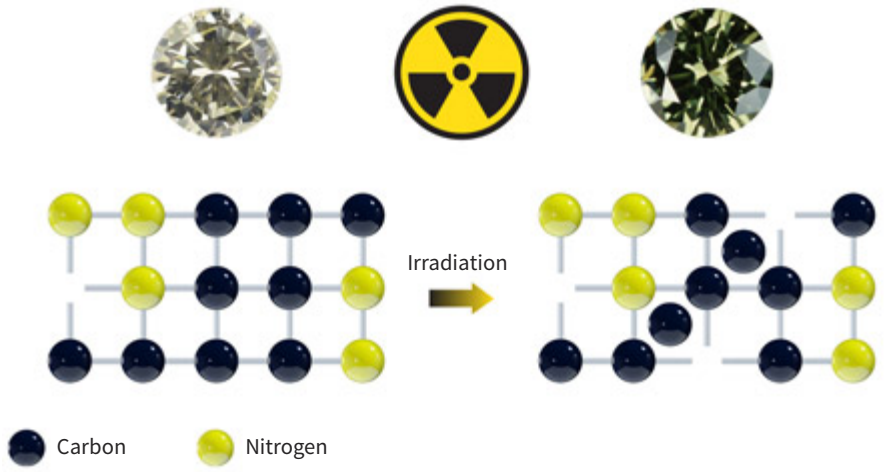
KEY CONCEPTS

Irradiation of a type I diamond creates a blue to green bodycolor depending on the starting material.



Elizabeth Schrader/GIA

Diamond rough can be irradiated, but it is not common due to the shallow penetration of the blue-green color. The strong blue color in this 11.60-ct. partially resorbed diamond octahedron is the result of laboratory irradiation.



Russel Samson/GIA

Irradiation of a cape diamond creates the GR1 defect (vacancy) and results in a green bodycolor due to absorption of light in both the red and blue areas of the spectrum.

Type I Starting Material

When a diamond is irradiated, some carbon atoms are displaced from their normal crystal lattice positions, creating vacancies. This type of vacancy is known as the GR1 defect. These displaced carbon atoms are believed to be pushed into *interstitial positions*—typically uninhabited spaces in the regular framework of atoms. In general, the vacancy absorbs energy in the red area of the visible light spectrum, and transmits energy in the blue to green area of the spectrum. This results in a blue to green bodycolor.

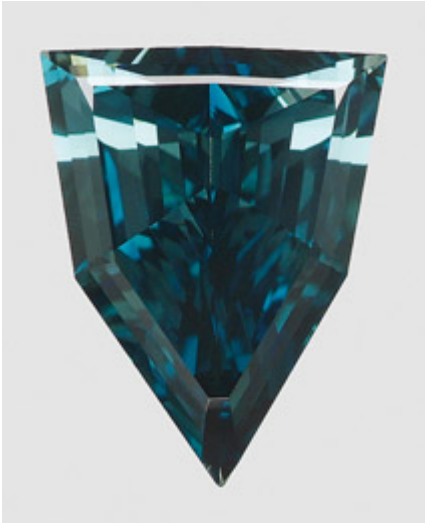
Type I diamonds have nitrogen atoms in place of some of the carbon atoms in the crystal lattice. The arrangement of these nitrogen atoms can cause absorption in the blue area of the visible spectrum, which can cause a yellow bodycolor. Irradiation does not affect nitrogen impurities, so when a type I diamond has a defect that creates yellow bodycolor, it still has that defect after treatment. For example, if the starting material was type I with an N3 color center (known in the trade as a "cape" diamond), after irradiation the combination of defects results in absorption in both the blue and red areas of the spectrum, and transmits energy only in the green area of the spectrum, creating a green bodycolor.



Shane F. McClure/GIA

Irradiation of type I diamonds can result in blue to blue-green to green colors depending on the defects present in the diamond.

Historically, irradiation with neutrons in a nuclear reactor was the only way to create an extremely dark green bodycolor that appeared black face-up. Diamonds treated in this manner can exhibit residual radioactivity. The same apparent black bodycolor can now also be achieved using higher-energy electron irradiation for a few weeks. The diamond's dark green or blue color can be seen under strong transmitted light.

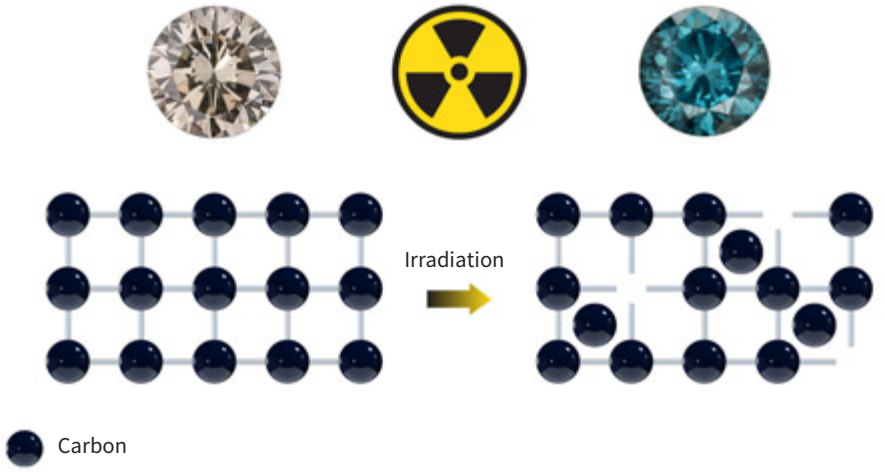


Jian Xin (Jae) Liao/GIA

This 4.13-ct. Fancy Deep green-blue diamond is a rarity: an irradiated type IIb diamond, something that is not often seen.

Type II Starting Material

Type II diamonds have a negligible amount of nitrogen impurities. Of type IIa and type IIb diamonds, irradiation is performed mostly on type IIa, both natural and lab-grown. When type IIa diamonds are irradiated, a GR1 defect is created (the same defect as in type I diamonds). Since there are no nitrogen atom impurities that result in a pre-existing yellow bodycolor, the only color center present is the vacancies—resulting in a pure blue bodycolor.



Russel Samson/GIA

Irradiation of type IIa diamonds creates vacancies (GR1 defects) in the crystal lattice, which generate a blue bodycolor.



Shunsuke Nagai/GIA

This group of green-blue diamonds (1.97 carats total) consists of 299 irradiated natural diamonds and an irradiated CVD lab-grown diamond melee (far right).

KEY CONCEPTS

Annealing a diamond after irradiation results in the reorganization of color centers to further change the bodycolor of the diamond.

Annealing—A controlled heating and cooling process.

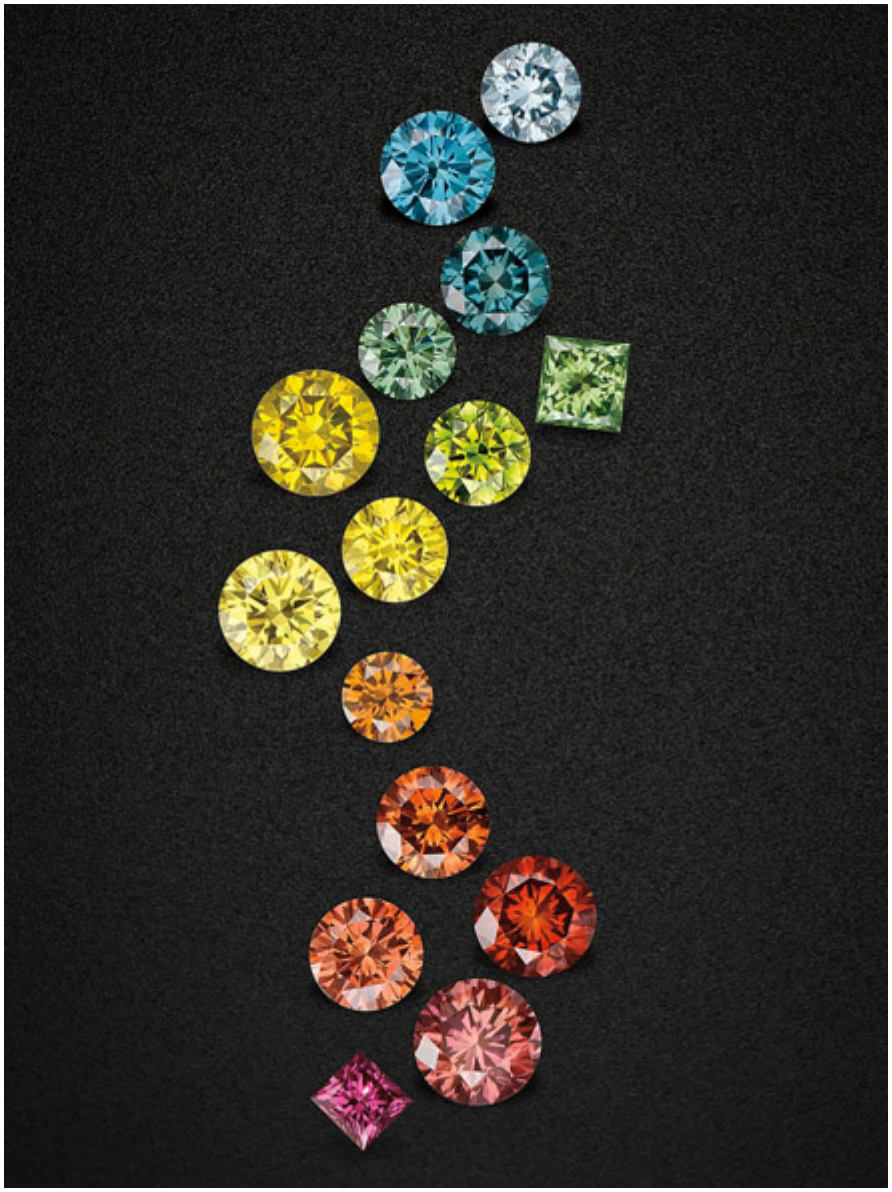
Irradiation and Annealing

Another way to change a diamond's bodycolor is through *annealing*, a process of controlled heating and cooling. After irradiation, annealing further modifies irradiated colors by allowing the vacancies and impurities to diffuse, or move, throughout the diamond crystal lattice and reorganize its color centers. Annealing after irradiation is typically done at ambient pressure, at temperatures ranging from about 600°C to 1000°C depending on the desired bodycolor. Unlike irradiation-only treatments, most colors produced by a combination of irradiation and annealing are considered stable when later exposed to heat, such as from jewelry repairs, but it's always important to exercise caution.



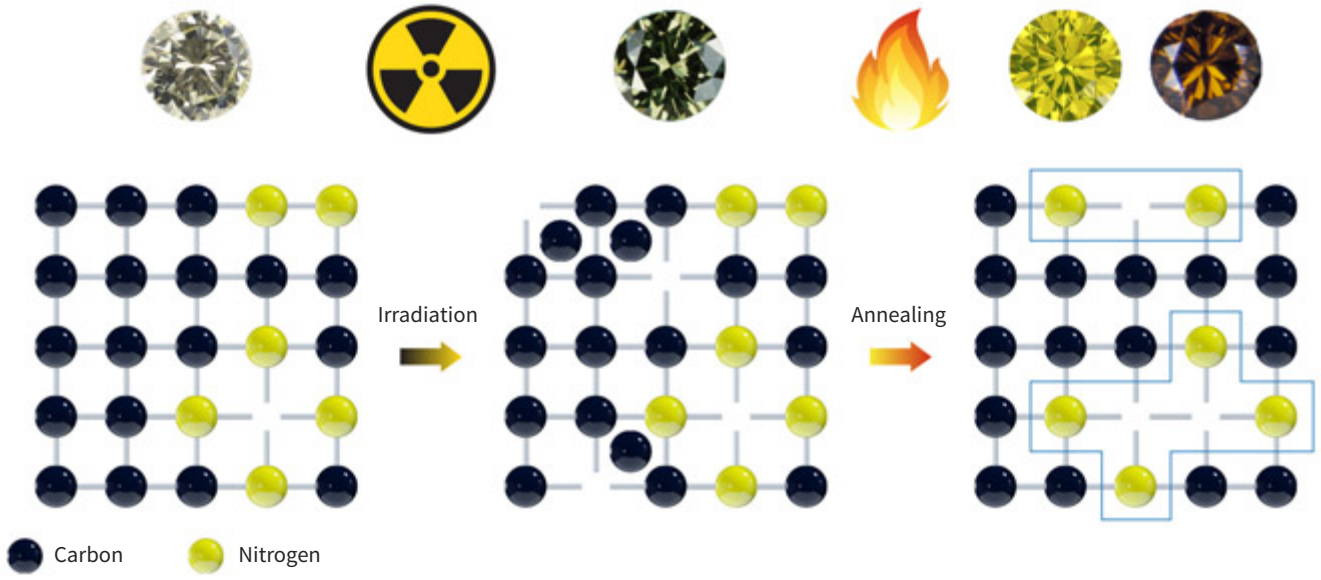
Sood Oil (Judy) Chia/GIA

This 22.27-ct. Fancy Vivid yellow emerald cut diamond was artificially irradiated and annealed. Treated diamonds of this size and color are very rare.



Robert Weldon/GIA and Orasa Weldon

These diamonds (0.30 to 0.74 ct.) illustrate the wide array of colors that can be produced by irradiation and irradiation followed by annealing.



Russel Samson/GIA

Irradiation creates vacancies in the crystal lattice, which produce a blue to green color in type IaAB diamonds. During annealing, the interstitials and vacancies created diffuse throughout the crystal lattice and create the H3 and H4 defects (outlined in blue). The concentration of these color centers can produce a yellow, orangy yellow, yellow-green, or brown color.

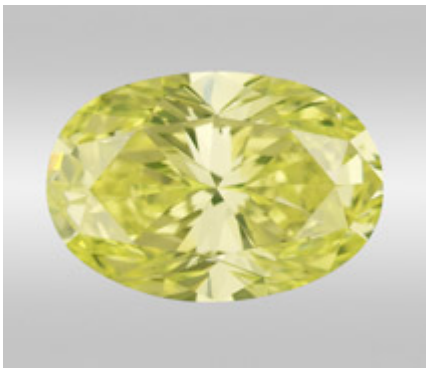
Type Ia Starting Material

The vacancies formed when a diamond is irradiated absorb energy in the red area of the visible light spectrum and transmit energy in the blue to green area of the spectrum, resulting in a blue to green bodycolor. When the diamond is then annealed, the vacancies and nitrogen diffuse, or move, throughout the crystal structure. Annealing after irradiation creates different color centers based on starting material, temperature, and treatment duration.



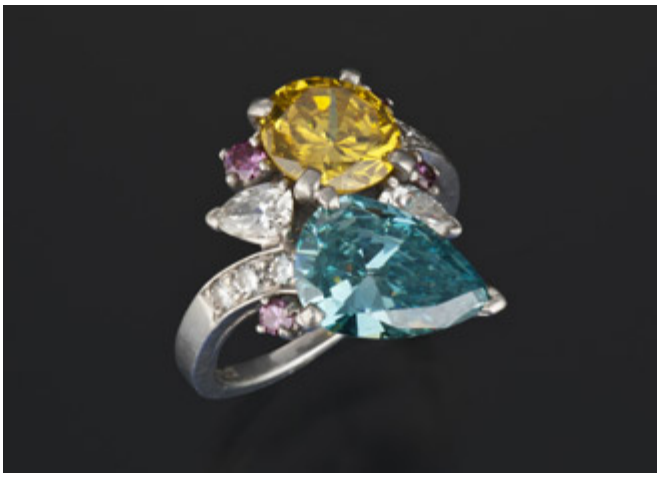
Robert Weldon/GIA

Irradiation and annealing of these type Ia diamonds produced yellow, orangy yellow, and yellow-green colors depending on the starting material, temperature used, and the treatment duration.



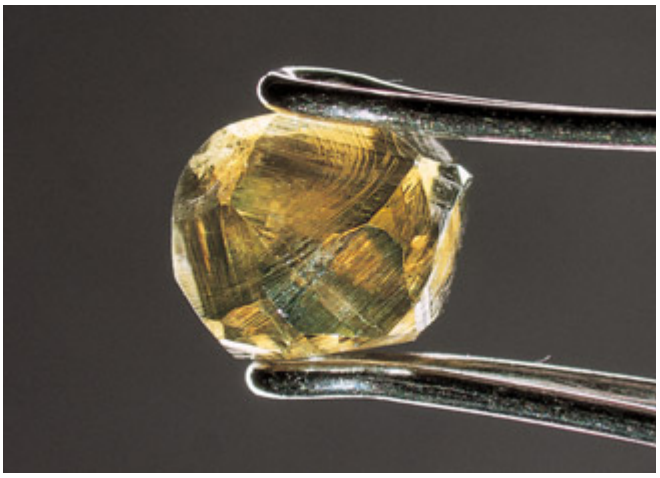
Jian Xin (Jae) Liao/GIA

This 24.16-ct. oval brilliant cut diamond's green-yellow color resulted from a combination of irradiation and annealing. The color is due to the H3 color center.



Orasa Weldon and GIA

The colors of the fancy-color diamonds in this platinum ring are due to treatment. The yellow round brilliant cut diamond's color is due to irradiation followed by annealing.



James E. Shigley/GIA

This 1.06-ct. rough diamond's color is due to irradiation and annealing.

KEY CONCEPTS

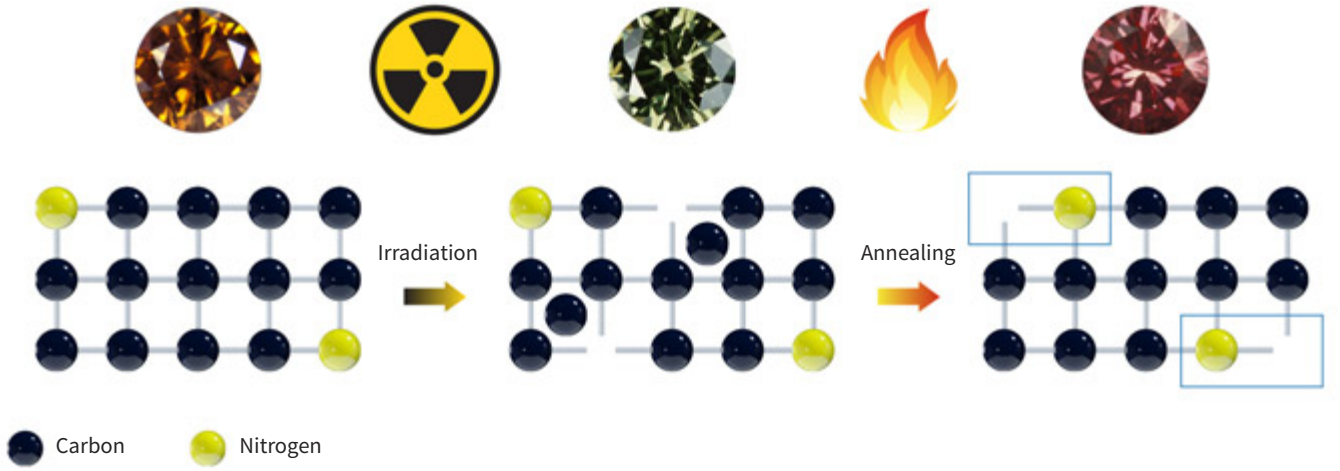
Irradiation and subsequent annealing of a type Ia diamond creates a yellow, orangy yellow, yellow-green, or brown bodycolor.

Type Ia diamonds are usually a mixture of type IaA and type IaB, written as type IaAB. The H3 defect is created when a vacancy combines with an A center. The H4 defect is created when a vacancy combines with a B center. This means that irradiation and annealing of most type Ia diamonds will create a mixture of both the H3 and the H4 defects. This can transform a type Ia irradiated blue-green diamond to either yellow, orangy yellow, yellow-green, or brown.

Type Ib Starting Material

Type Ib diamonds are extremely rare in nature. Only those with a strong brown component are selected for treatment. Natural type Ib diamonds with a strong, vivid yellow color are not treated.

Type Ib diamonds have isolated nitrogen atom impurities, called C centers. In a type Ib diamond, the vacancies created by irradiation diffuse throughout



Russel Samson/GIA

In type Ib diamonds, irradiation creates vacancies in the crystal lattice, which produce a green color. During annealing, the interstitials and vacancies created diffuse throughout the crystal lattice and create a new color center, known as the NV defect. This color center produces a pink bodycolor.



Courtesy Etienne Perret

Laboratory irradiation of diamond melee is common in the trade. The colors of the fancy-color diamond melee in these rings are due to irradiation or a combination of irradiation and annealing.



Nicholas Del Re/GIA

Irradiation and annealing produced the pink color in this natural 0.39-ct. diamond.

the diamond crystal lattice during the annealing process to combine with the isolated nitrogen and form the NV defect. This defect consists of a nitrogen atom adjacent to a vacancy and can produce a pink bodycolor. The saturation of the pink depends on the strength of the bodycolor of the starting material and how long the stone was irradiated.

Laboratory-grown type Ib diamonds are often seen in the trade. Post-growth irradiation and annealing of these vivid yellow lab-grown diamonds to create a pink bodycolor is common.

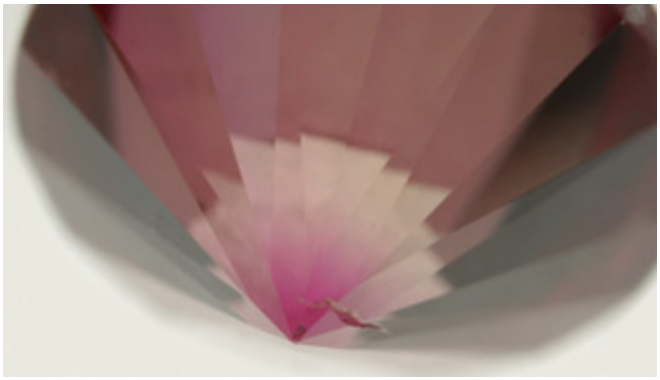
Detecting Irradiation Treatment

Most color treatments are difficult to detect. It's best to send diamonds you suspect of being treated to a gemological laboratory—advanced laboratory equipment provides the most reliable color origin identification. For example, a spectrometer is a complex and expensive instrument that records a gem's interaction with light across the visible, ultraviolet, and infrared ranges. Experienced technicians can interpret that information and usually determine color origin.

KEY CONCEPTS

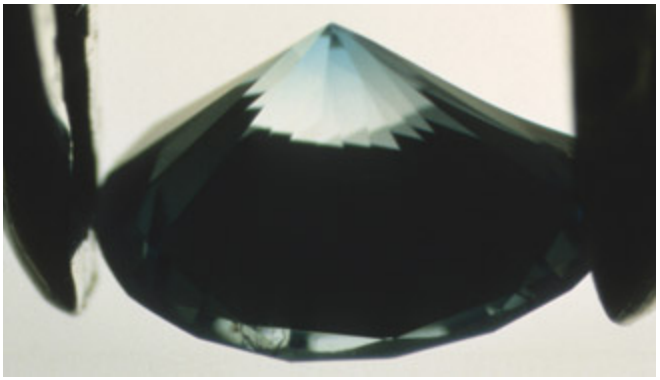
Irradiation and annealing of a type Ib diamond creates a pink bodycolor.

Gemological laboratories have the advanced equipment to determine color origin.



Wuyi Wang/GIA

Strong color concentration around a diamond's culet is evidence of laboratory irradiation.



GIA

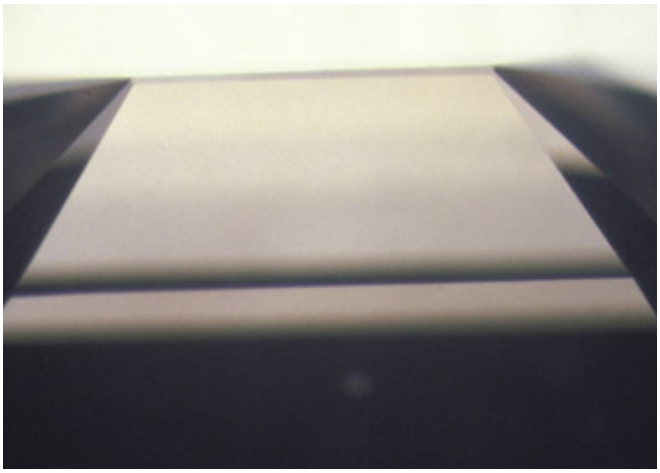
Under a microscope and diffused lighting, this diamond revealed a strong concentration of blue color near the culet—evidence of laboratory irradiation.



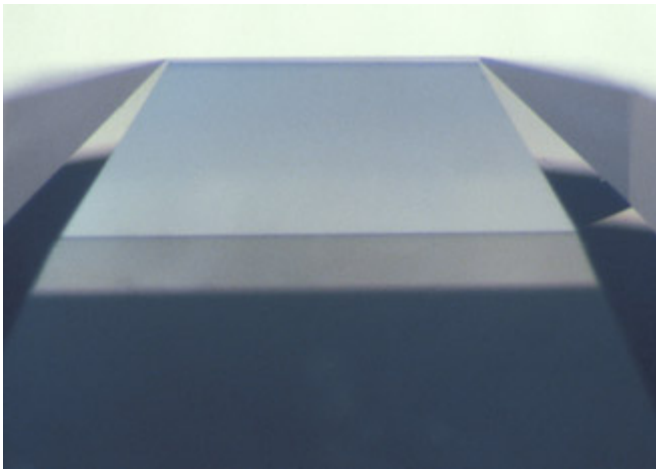
Robert Weldon/GIA



Robert Weldon/GIA



John I. Koivula/GIA



John I. Koivula/GIA

A light brown diamond before irradiation in a linear accelerator (top left). The same diamond after irradiation (top right), now greenish blue. The diamond's culet after irradiation (lower right) has a blue color concentration where there was no color concentration before treatment (lower left).

Some signs of irradiation treatment can be detected with fairly simple equipment. Although modern techniques create more evenly colored samples, you may sometimes see a color concentration around the culet or confined to the surface of a faceted diamond. This is best detected using microscopic examination, diffused lighting, and/or immersion. If you see this type of color zoning, send the diamond to a gemological laboratory for further testing.

Whether the color of green diamonds is natural or artificial is sometimes impossible to determine, even with sophisticated laboratory tests. This is because the majority of green diamonds are irradiated—some naturally in the earth and some by technicians in a lab.

The Deepdene: Treated and Treated Again

The Deepdene

Weight: 104.88 cts./104.52 cts.

Cut: Cushion

Color: Light yellow to deep green to golden yellow (treated)

The Deepdene is probably the most famous color-treated diamond. Gem historians believe that it came from a South African mine in 1890 and was originally cut by the I.J. Asscher Co. in Amsterdam. It appeared on the market as a light yellow 104.88-ct. cushion cut. Its first owner was famed New York diamond dealer Lazare Kaplan.

In the early 1900s, Pennsylvania socialite Helena Bok bought the diamond. She named it Deepdene ("deep valley" in Old English) to honor her family's estate. The Bok family loaned it to the Philadelphia Academy of Sciences, which displayed it publicly in the 1940s. The family sold the diamond to Harry Winston in 1954, and Winston sold it the following year.

Sometime after that, the Deepdene was irradiated in a cyclotron, which turned it a handsome green color. The treaters recut the culet and pavilion slightly to eliminate the umbrella-shaped color zoning left by the treatment, changing its weight to 104.52 cts.



Christie's Images Ltd.

Christie's auction house sold the Deepdene diamond in 1997, set in a cultured pearl and diamond choker.

The diamond was sold again in 1971. By that time, the Deepdene was yellow again. When questions arose about the origin of its color, gemological expert Dr. Edward Gübelin said he had examined the diamond and determined it was annealed. It's said that Dr. Gübelin also sent the diamond to Robert Crowningshield at GIA, who agreed that its yellow color was the result of heat treatment.

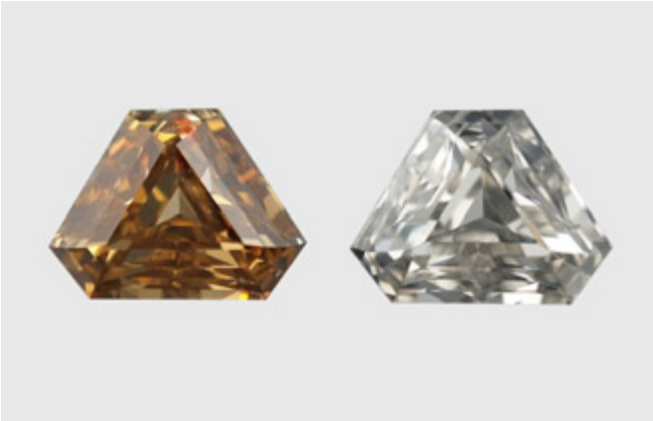
In November 1997, Christie's in Geneva sold the Deepdene at auction. The GIA laboratory had assigned it VS_1 clarity. This time the gem was surrounded by four rows of cultured pearls and diamonds in a magnificent choker necklace. The winning bid was $647,482.

Due to its color and weight changes, there was some controversy over whether this diamond was the original Deepdene. Experts solved the mystery by obtaining a photograph of the original gem from Helena Bok. They compared the photo to the actual diamond under a microscope that magnified them both 12.5 times and displayed the images side by side. The proof was in the form of a natural just above the girdle, identical in both images. This convinced researchers that they held the original Deepdene diamond.



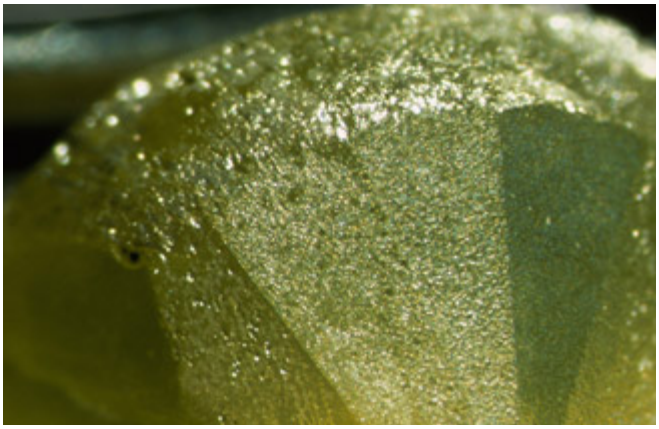
Christie's Images Ltd.

The Deepdene diamond out of its setting. This side view shows its treated yellow color.



Robert Weldon/GIA

A 6.61-ct. diamond before (left) and after (right) HPHT treatment to remove its color. It was color graded as a Fancy yellow-brown before treatment and as "L" or faint yellow after.



Shane Elen/GIA

The high temperatures and pressures of HPHT treatment can create substantial etching and pitting on a diamond's surface. Fashioned stones require repolishing after HPHT treatment.

High-Pressure, High-Temperature (HPHT) Treatment

KEY CONCEPTS

HPHT color treatment of diamonds uses the same equipment as HPHT diamond growth, but at slightly different pressures and temperatures.

The HPHT treatment process works by rearranging defects in a diamond's crystal lattice.

All diamonds need repolishing after HPHT treatment because of the high temperatures and pressures.

HPHT processing of type Ia diamonds can enhance color by rearranging vacancies and nitrogen atoms within the crystal lattice.

The advancement of the high-pressure, high-temperature (HPHT) method to produce lab-grown diamonds in the late 1990s led scientists to experiment with ways to modify diamond color using the same HPHT equipment. The HPHT growth method uses pressures of about 5 to 6 GPa and temperatures of 1300°C to 1600°C to produce diamonds in the laboratory. Scientists found that using HPHT equipment at slightly different temperatures and pressures could be used to color treat diamonds, resulting in HPHT-treated diamonds, also known as HPHT-processed diamonds. HPHT treatment of diamonds occurs at pressures of about 4 to 7 GPa and temperatures of 1800°C to 2500°C, for only a few minutes. High pressures are typically used to prevent the diamond from turning to graphite.

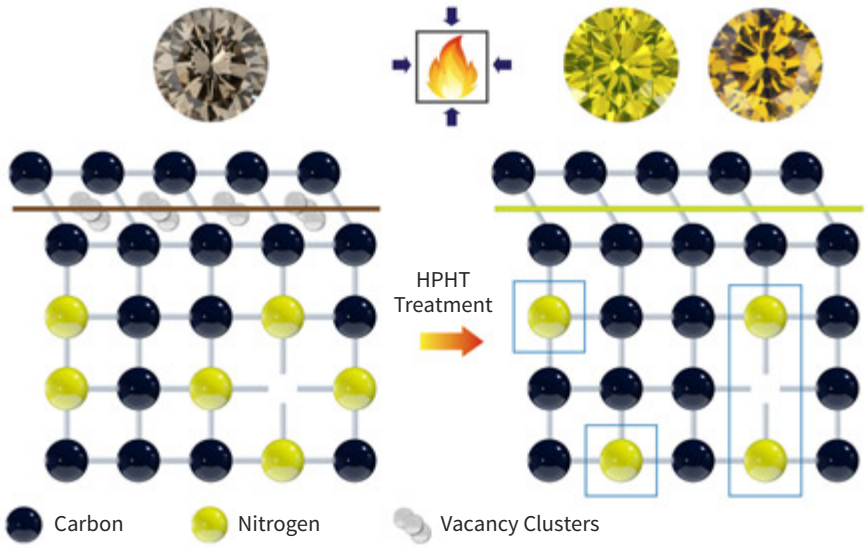
HPHT treatment can move and rearrange defects in a diamond's crystal lattice. Because the high temperatures and pressures create substantial etching and pitting on a diamond's surface, all diamonds need repolishing after treatment.

After the development of HPHT treatment for commercial use, GIA and other gemological labs explored ways to detect its presence.

Type I Starting Material

HPHT treatment of type I diamonds causes existing vacancies and nitrogen atoms to diffuse throughout the diamond's crystal structure, disassembling undesirable color centers and/or creating new color centers. For example, HPHT treatment of type I diamonds can remove existing brown colors and create a yellow, orange, or yellow-green bodycolor.

During HPHT treatment, the defects—vacancy clusters—responsible for a diamond's brown bodycolor can "break up" and diffuse throughout the diamond crystal lattice, causing the brown color to disappear. These "freed" vacancies can increase the rate of nitrogen aggregation during HPHT processing, resulting in the formation of new color centers.



Russel Samson/GIA

HPHT treatment of type Ia diamonds can remove the vacancy clusters that cause a brown bodycolor, as well as allow vacancies to diffuse throughout the crystal lattice and create new color centers, such as H3 and C centers (outlined in blue). Any graining present may change from brown to yellow or yellow-green.

The color produced by HPHT treatment depends on the starting material, the temperature used, and the amount of time the diamond is processed. Based on these variables, the H3 and C centers are two possible color centers that can be produced in different concentrations.



Robert Weldon and Professional Jeweler

The colors produced by HPHT treatment of type Ia diamonds range from yellow to orange to yellow-green.

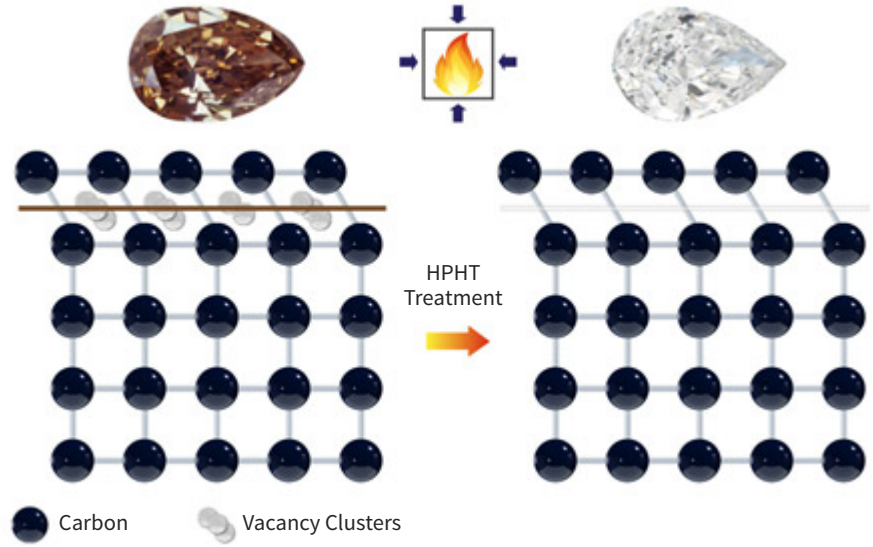


Jian Xin (Jae) Liao/GIA

This 2.47-ct. type IaB rough diamond was HPHT treated to improve its color.

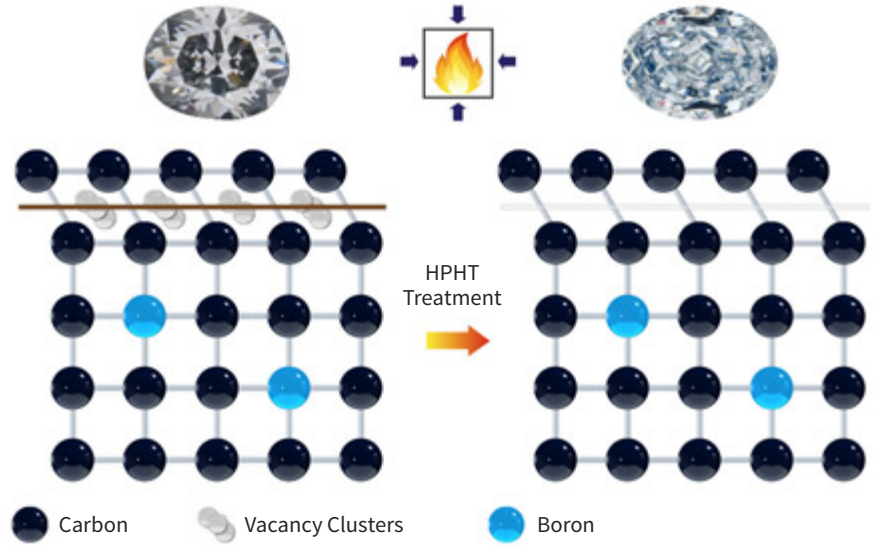
Type II Starting Material

HPHT treatment of type IIa diamonds does not create new bodycolors; it releases the vacancy clusters that cause a brown bodycolor. If the diamond crystal lattice has a color center that generates a pink bodycolor, removal of any brown color makes the pink color more prevalent. If the starting material does not have any pink coloration, the resulting color after HPHT treatment will typically be near-colorless to colorless. HPHT treatment can dramatically improve the color and value of type IIa diamonds. For example, type IIa brown diamonds of N to O-P color, and even Fancy Light brown diamonds, can attain D to H color as a result of HPHT treatment.



Russel Samson/GIA

HPHT treatment of type IIa diamonds removes any brown coloration by eliminating the vacancy clusters that cause the brown bodycolor. Any graining present may change from brown to transparent after HPHT processing.



Russel Samson/GIA

HPHT treatment of type IIb diamonds removes brown and gray coloration by eliminating vacancy clusters. The blue color is more prevalent. Any graining present may change from brown to transparent after HPHT processing.



Jian Xin (Jae) Liao/GIA



Jian Xin (Jae) Liao/GIA



Jian Xin (Jae) Liao/GIA

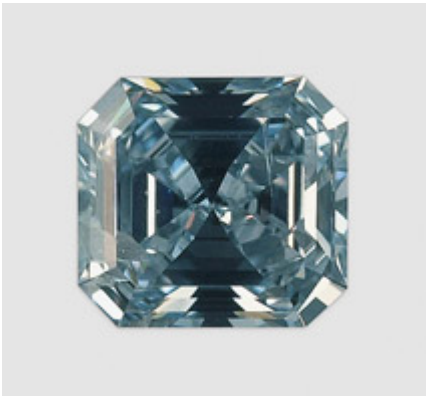


Jian Xin (Jae) Liao/GIA

Type II diamonds with color grades of E-F. HPHT treatment dramatically improved their original color grades of J-M.



Elizabeth Schrader/GIA



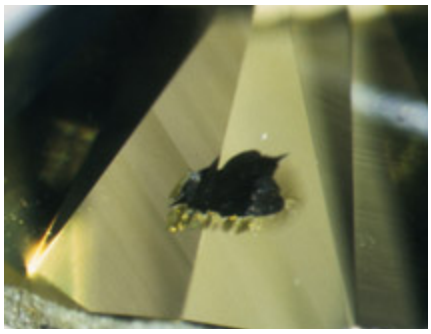
Elizabeth Schrader/GIA

HPHT treatment turned this 0.34-ct. Fancy Light gray-blue diamond to Fancy blue. The boron atoms responsible for the blue color were already present.

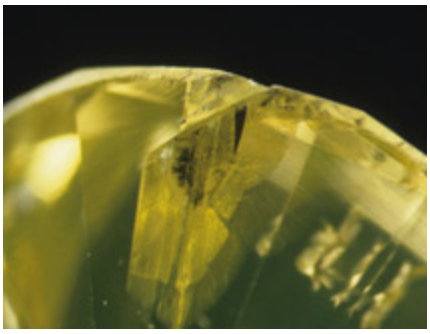
Type IIb diamonds are classified as such based on the presence of boron impurities within the crystal lattice. These boron impurities can cause a blue bodycolor if they are in high enough concentration. Sometimes the blue color can be "masked" by a gray or brown bodycolor. When such diamonds are HPHT treated, the gray or brown coloration can be removed, freeing the boron impurities and resulting in a more prevalent blue bodycolor.

KEY CONCEPTS

HPHT treatment of type II diamonds can enhance color by removing vacancy clusters that cause a brown or gray bodycolor.



James E. Shigley/GIA



Shane Elen/GIA, courtesy Novatek, Provo, Utah

The formation of graphite and a frosted texture within a diamond's feathers and cleavages are signs of possible HPHT treatment. Magnified 10x.

Detecting High-Pressure, High-Temperature Treatment

Identifying HPHT-treated diamonds involves advanced laboratory techniques such as photoluminescence spectroscopy. But some signs of HPHT treatment can be detected with microscopic examination. High temperatures and pressures can be hazardous for some diamonds. They might break from thermal shock, or chip or fracture.

Graphitization—Formation of graphite around a diamond's mineral inclusions and feathers that results from the extreme conditions of HPHT treatment.

One effect that can help you recognize HPHT-treated diamonds is the formation of graphite around a diamond's mineral inclusions and feathers, or *graphitization*. Etched or frosted naturals and fractures are also indicators.

Multistep Treatments

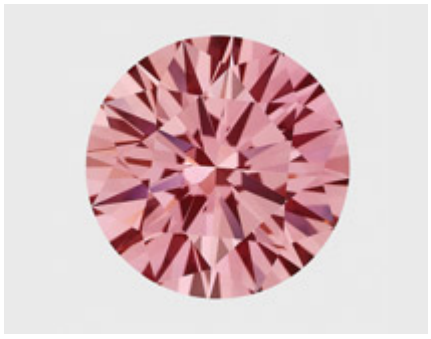
KEY CONCEPTS

Some treaters use a combination of treatments to achieve the desired bodycolor.

Some treaters use a combination of HPHT processing, irradiation, and/or annealing to achieve the desired bodycolor. Two examples are creating a pink color and creating a blue color. Highly saturated pink and blue diamonds are very rare in nature and highly valued. The typical starting material used to create these colors in one process are rare in nature as well, so multistep processes were developed.

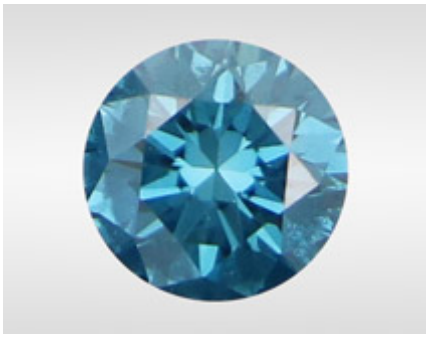
Multistep Treatments: Pink Color

Irradiation and annealing of a type Ib diamond can create a pink bodycolor. Type Ib diamonds are rare in nature, so a multistep treatment process was developed to first produce isolated nitrogen and then irradiate and anneal the diamond to create the bodycolor.



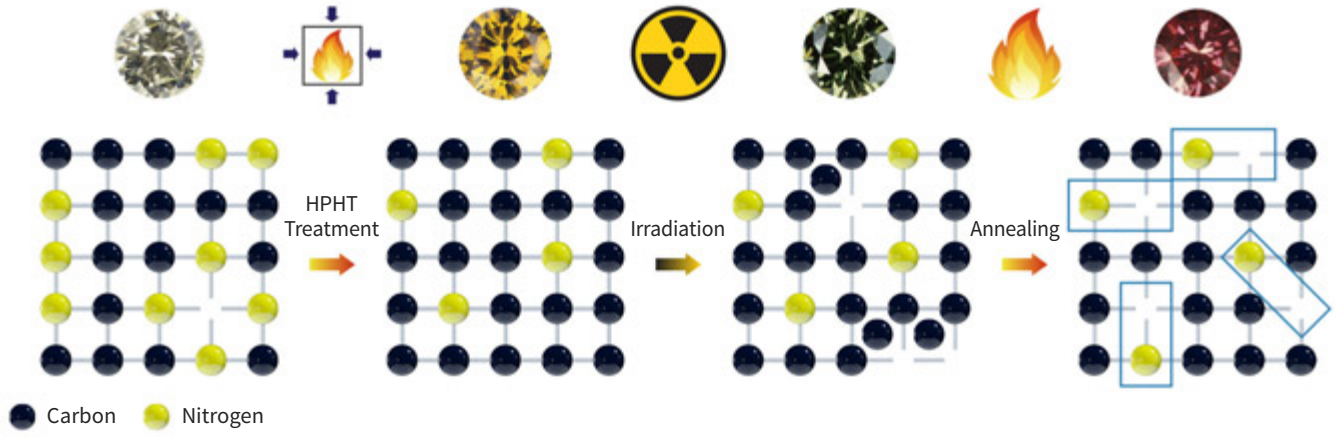
Jian Xin (Jae) Liao/GIA

Multiple treatments produced the Fancy Vivid pink color of this 11.08-ct. diamond.



Wengqing Huang

This 0.36-ct. Fancy Deep green-blue diamond was treated with multiple steps.



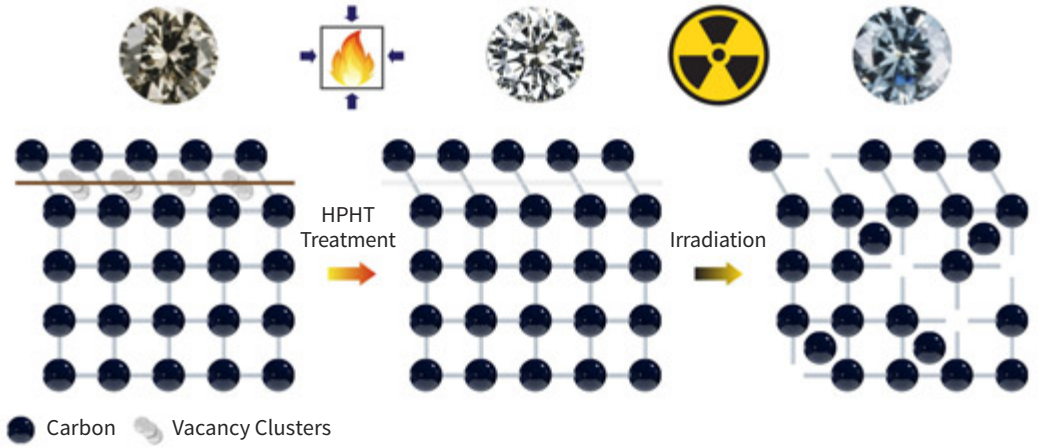
Russel Samson/GIA

HPHT treatment of type Ia diamonds disaggregates the nitrogen impurities, creating a yellow bodycolor. The diamond is then irradiated to create a green bodycolor. Finally, the diamond is annealed so the interstitials and vacancies created during irradiation can diffuse throughout the crystal lattice, pair with the isolated nitrogen atoms, and create NV color centers. These color centers produce a pink bodycolor.

A natural light yellow type Ia diamond is the typical starting material. The diamond is first HPHT treated to disaggregate the A and B centers to create isolated nitrogen and produce a yellow bodycolor. Then the diamond is irradiated. When a diamond is irradiated, GR1 defects—or vacancies—are created. If the diamond has isolated nitrogen, the addition of GR1 defects produce a green bodycolor. Next, the diamond is annealed, causing the interstitials and vacancies created to diffuse and combine with the isolated nitrogen to create NV defects. These defects are responsible for the final pink bodycolor.

Multistep Treatments: Blue Color

The multistep treatment to create a blue bodycolor typically uses a type IIa brown diamond as a starting material. First, the diamond is HPHT processed. This removes the brown color component and leaves the diamond either near-colorless or colorless, depending on the starting material.



Russel Samson/GIA

HPHT treatment of a type IIa brown diamond eliminates the color centers responsible for the brown color, producing a colorless to near-colorless diamond. Subsequent irradiation creates vacancies in the crystal lattice, resulting in a blue bodycolor. No annealing is necessary.

Next, the diamond is irradiated, causing the GR1 defect—or vacancies—to form. These vacancies absorb energy in the red region of the visible light spectrum and transmit energy in the blue region, resulting in the final green-blue bodycolor. No annealing is necessary.

This color treatment is sometimes used on type IIa diamonds grown by the chemical vapor deposition (CVD) process. CVD lab-grown diamonds are typically brown. HPHT processing of these stones followed by irradiation creates a blue color.

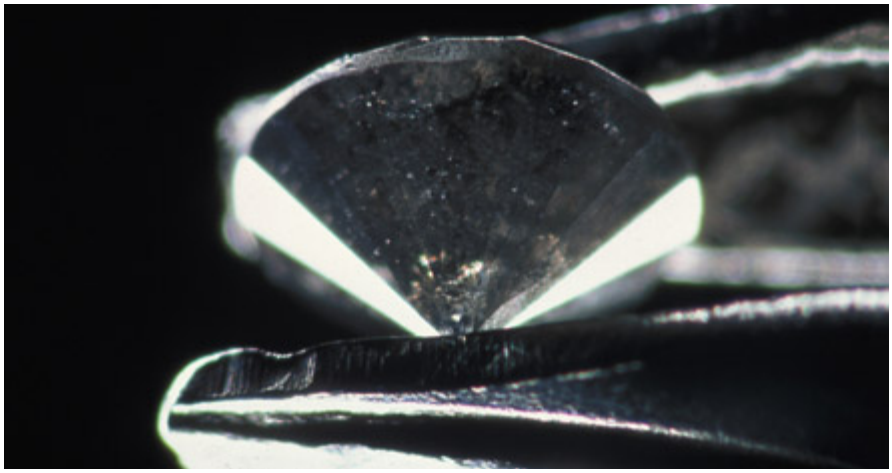
Low-Pressure, High-Temperature (LPHT) Treatment

Low-pressure, high-temperature (LPHT) treatment works similarly to HPHT treatment by rearranging defects in the crystal lattice. While HPHT treatment is done at temperatures from 1800°C to 2500°C and pressures greater than 5 GPa, LPHT treatment uses temperatures from 1400°C to 2200°C and pressures below atmospheric pressure. This low-pressure environment is created in a vacuum. This treatment has produced brownish pink color in CVD lab-grown diamonds; however, it is rare. LPHT treatment works best to create black color in diamonds, by inducing large-scale graphitization within surface-reaching fractures.



Elizabeth Schrader/GIAt

A highly fractured "milky white" diamond underwent high-temperature treatment in a vacuum. After treatment the diamond appeared black because of the graphitization of surface-reaching fractures.



Vincent Cracco/GIA

This LPHT-treated black diamond displays graphitization predominantly along the fracture plane. Magnified 30x.

Coated Diamonds and Detection

Coatings were one of the earliest methods of diamond color modification. One of the oldest accounts of early diamond cutting contains details on how to improve a diamond's appearance by applying several tints. Primitive recipes for coating—such as a mixture of natural resins, oils, and pigments—have evolved along with the science of chemistry.

In the 1950s, modern coatings on diamonds were developed. These coatings are believed to be variations of compounds such as fluorides and later silica. They were originally developed for military purposes during World War II. The process of coating a diamond is carried out in a vacuum chamber. Coatings are typically applied as multiple layers with various trace elements (silver and gold, for example) to cause different colors. Coatings are typically applied only to the pavilion of a cut diamond, but they are sometimes found on the crown.

Blue coatings were originally used on yellow diamonds to make them appear near-colorless. As more fancy-color diamonds entered the market, modern silica coatings evolved. They are now applied to polished colorless or near-colorless diamonds. The process results in a variety of natural-looking fancy colors, including pinks, oranges, yellows, blues, and violets.

KEY CONCEPTS

Coatings were one of the earliest methods of diamond color modification.



C. D. Mengason/GIA, courtesy Serenity Technologies

Coating can make a diamond appear virtually any color, as illustrated by these 0.40-ct. coated diamonds.

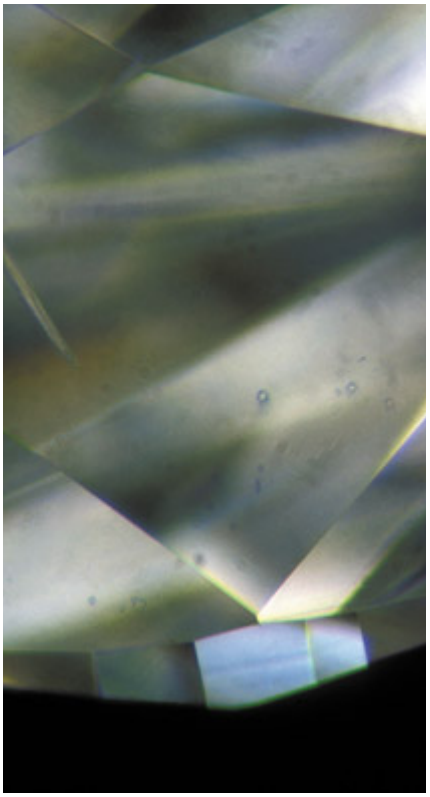


Jian Xin (Jae) Liao/GIA



Jian Xin (Jae) Liao/GIA

This 1.05-ct. diamond owed its apparent Fancy Light brown-pink color (left) to a coating. After the coating was removed by acid cleaning, the diamond received a color grade of J (right).



Vincent Cracco/GIA

The multiple blue spots on the bezel and upper girdle facets of this 3.03-ct. round brilliant diamond are indicative of a coating. Magnified 33x.



Jian Xin (Jae) Liao and Robison McMurtry/GIA

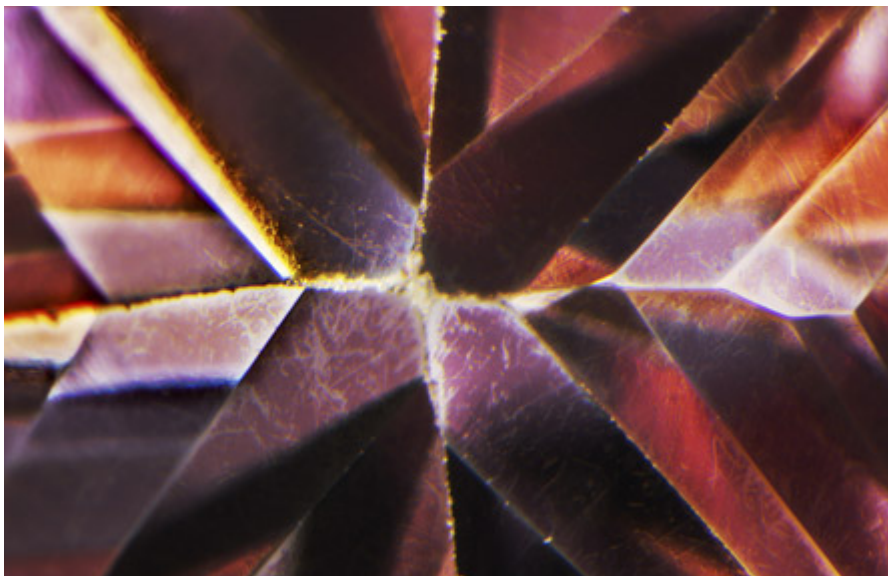


Jian Xin (Jae) Liao and Robison McMurtry/GIA



Jian Xin (Jae) Liao and Robison McMurtry/GIA

Coating is not a permanent treatment and can be affected by routine jewelry repairs. This coated stone went from Fancy gray-blue (left) to Fancy purplish gray (far right) after the mounting (center) was repaired.



GIA

The pavilion of this diamond is covered with an ultra-thin coating that gave the stone its pink color. The coating is heavily abraded along the facet junctions.

KEY CONCEPTS

Modern silica coatings are fairly durable but not permanent.

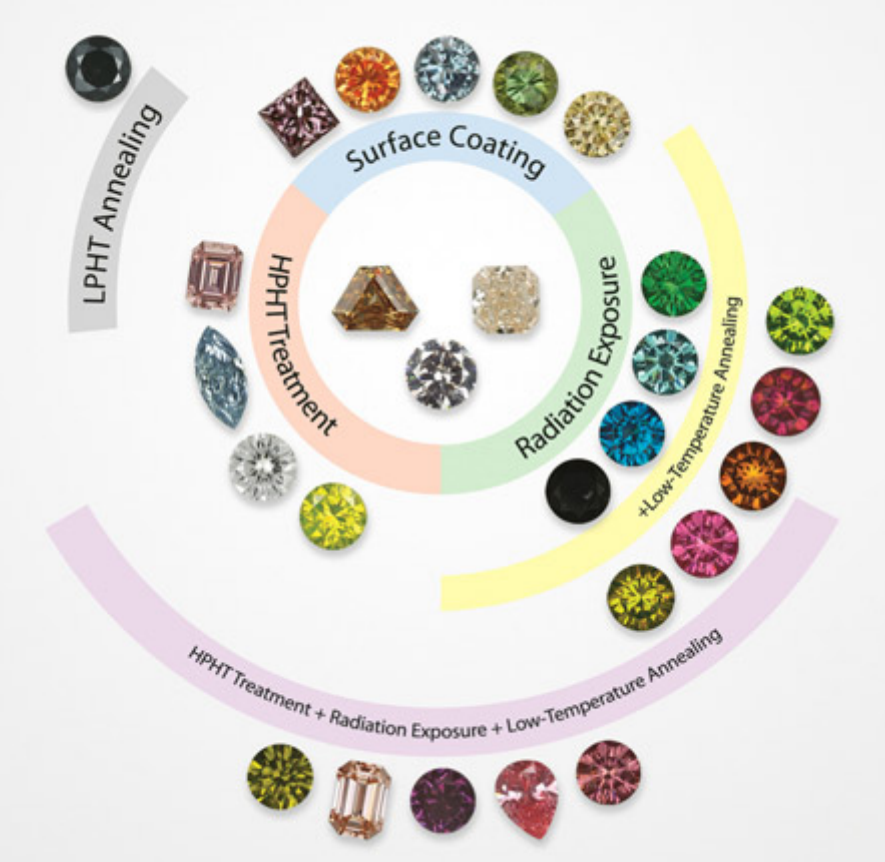
These coatings are fairly durable but not permanent. They can be damaged by the heat and chemicals used during jewelry repairs and polishing. They also scratch fairly easily. Detection and disclosure are vital when handling coated diamonds.

Even with the modern advancement of silica coatings, some primitive coating methods—such as tinting stones with nail polish, markers, and other types of ink—are still seen in the trade.

The signs of color coatings are often visible under simple 10x magnification. You'll often see scratches and other surface features, such as areas with uncoated spots or patches. Looking through the table can make it easier to see these features on the pavilion. Coating irregularities can make a diamond look like it needs cleaning, but they won't wipe off with a gemcloth.

Color-Treated Diamonds and the Marketplace

In the last 10 years, diamond treatments have become an increasingly important issue in the jewelry trade. As modern clarity and color treatment techniques make many diamonds more marketable, the need for definitive, ethical disclosure grows. In an effort to preserve customer trust, most gem professionals have been much more careful about detecting and disclosing treatments of all kinds.

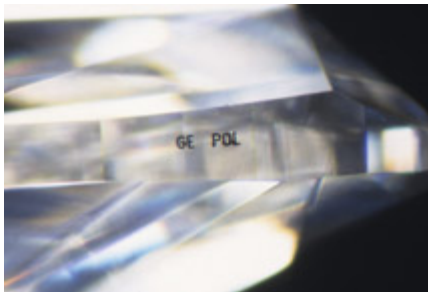


C.M. Breeding/GIA

Examples of the range of treated-color diamonds available on the market. Colors across the spectrum are now possible with the appropriate starting material and combination of treatments.



Jonathan Muyal/GIA



John I. Koivula/GIA

GIA inscribes all irradiated and/or HPHT-treated diamonds with “TREATED COLOR” (left). Some companies inscribe their own diamonds as well. The “GE POL” inscription on this diamond (right) identifies it as one that has undergone HPHT treatment.

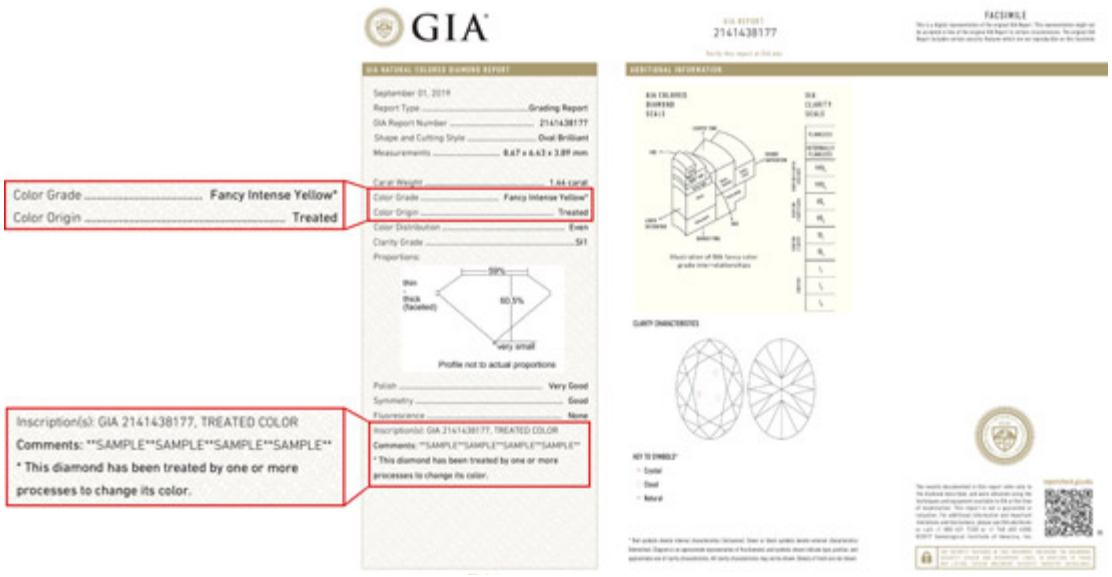


Tino Hammid

Even the most expensive jewelry might be set with treated diamonds. This suite sold at a high-end auction contains both treated-color and natural-color diamonds.

For permanent color treatments, most gemological laboratories—including GIA—do not disclose which treatment was performed. All natural diamonds graded by GIA, whether treated by irradiation and/or HPHT processing, are disclosed and inscribed with "TREATED COLOR." Due to the complications that arise because diamonds are often processed with multiple treatments, the specific treatment is not as important as the fact that the diamond's color has been treated.

For diamond coatings, which are not permanent, most gemological laboratories—including GIA—do not issue a grading report. Coated diamonds receive an identification report stating that the diamond's color is due to coating.



GIA

GIA Colored Diamond Grading Report for a color-treated diamond. Note the asterisk next to the color grade and the comment at the bottom.



GIA

GIA Identification Report for a coated diamond.

Summary

Diamond treatments are part of the diamond industry, and detecting them is critical. It's important to learn as much as you can about them. Stay up to date by attending industry events, reading trade journals, and referring to GIA's *Gems & Gemology* for the latest gemological news and detection techniques. Always remember that disclosure is not only ethical—it's good for business.

KEY CONCEPTS

Laser drilling can make a diamond more marketable by improving its appearance.

Major gem labs report features left by laser drilling as clarity characteristics because they are permanent.

Fracture filling makes a diamond's fractures and cleavages less visible by using a high-RI glass filler.

Some signs of fracture filling are the flash effect, trapped gas bubbles, flow structure, and a crackled texture.

Disclosure of fracture filling is an industry requirement.

Irradiated diamond color can change if the diamond is exposed to heat during repairs, recutting, or repolishing.

The color resulting from irradiation can vary based on the defects already present in the diamond.

Irradiation of a type I diamond creates a blue to green bodycolor depending on the starting material.

Annealing a diamond after irradiation results in the reorganization of color centers to further change the bodycolor of the diamond.

Irradiation and subsequent annealing of a type Ia diamond creates a yellow, orangy yellow, yellow-green, or brown bodycolor.

Irradiation and annealing of a type Ib diamond creates a pink bodycolor.

Gemological laboratories have the advanced equipment to determine color origin.

HPHT color treatment of diamonds uses the same equipment as HPHT diamond growth, but at slightly different pressures and temperatures.

The HPHT treatment process works by rearranging defects in a diamond's crystal lattice.

All diamonds need repolishing after HPHT treatment because of the high temperatures and pressures.

HPHT processing of type Ia diamonds can enhance color by rearranging vacancies and nitrogen atoms within the crystal lattice.

HPHT treatment of type II diamonds can enhance color by removing vacancy clusters that cause a brown or gray bodycolor.

Some treaters use a combination of treatments to achieve the desired bodycolor.

Coatings were one of the earliest methods of diamond color modification.

Modern silica coatings are fairly durable but not permanent.

Key Terms

Annealing—A controlled heating and cooling process.

Graphitization—Formation of graphite around a diamond's mineral inclusions and feathers that results from the extreme conditions of HPHT treatment.

Internal laser drilling—A clarity treatment that uses a laser focused on or near an inclusion to enlarge existing cleavages or create new ones, providing a path for a bleaching solution to dissolve the inclusion.

Interstitial positions—Spaces in the regular framework of atoms that are usually uninhabited.

Irradiation—Exposure of a material to radiation.

Laser drilling—The use of a laser beam to reach a diamond's dark inclusions and disguise or eliminate them.

Questions for Review

- How can laser drilling improve a diamond's marketability?
- What are some benefits and disadvantages of fracture filling?
- What is the flash effect?
- How can color treatments improve a diamond's marketability?
- What methods are used to alter diamond color?
- How can you detect color treatments in diamonds?

Diamond Simulants

18

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Welcome to *Diamonds & Diamond Grading* Assignment 18. This assignment contains the knowledge required for you to:

- Differentiate between natural diamonds and diamond simulants
- Identify some materials used as diamond simulants
- Describe how to identify diamond simulants
- Describe the importance of disclosure in relation to diamond simulants



Courtesy MiaDonna

Diamond simulants like the ones in these rings can make expensive-looking jewelry more affordable and suitable for everyday wear.

Introduction to Diamond Simulants

Diamond is one of the world's most popular gemstones. Its dazzling appearance and universal appeal have inspired a wide variety of less expensive look-alike materials. Some of them come from the ground and some from the lab. Diamond imitations are called simulants. Many of the more convincing simulants are quite attractive. But no simulant comes close to matching the combined effect of a diamond's brilliance, fire, scintillation, and luster.

Knowledge and caution are essential tools for protecting yourself and your reputation. This assignment covers the different materials that have been used as diamond simulants over the years, how to recognize diamond simulants, and how to protect yourself and your clients against misrepresentation and misconceptions about them.



Kevin Schumacher/GIA

Careful and methodical inspection of stones may help you identify diamond simulants.



Lafonn

The simulants in these earrings imitate colorless and yellow diamonds. One reason simulants became a mainstay of the jewelry industry is that they look convincingly like diamonds but cost much less.

Diamond Simulants

- What is the difference between natural diamonds, lab-grown diamonds, and diamond simulants?
- Why are simulants used in the market today and why are they so popular?
- What diamond attributes do simulants try to mimic?

Simulants have been used in jewelry since the natural diamond rush in the late 1800s. Natural gem-quality diamonds are rare and expensive. Lab-grown diamonds are not as rare but still have a relatively high price. Simulants are both readily available and much cheaper.

Simulants make fashionable jewelry available to people who want the look of diamonds without the high price. Jewelry designers and manufacturers know that magnificent diamond jewelry is out of reach for many people. They can reduce the cost of a stylish ring or necklace simply by using simulants instead of diamonds.

Diamonds and Diamond Simulants

Natural diamonds are composed of carbon and formed by natural processes in the earth, anywhere from the upper mantle all the way down to the lower mantle. Lab-grown diamonds have essentially the same chemistry and physical and optical properties as natural diamonds, but they are formed by humans in a laboratory.



GIA & Tino Hammid

Simulants like these can be made of any natural, human-made, or assembled material.

KEY CONCEPTS

Simulants can be natural or human-made.

Simulants can be produced in nearly any size and quantity and cost less than natural or lab-grown diamonds.

Simulants are not lab-grown diamonds, and lab-grown diamonds are not simulants. Simulants don't have any of diamond's physical or chemical properties, and the properties they do have vary widely. Their only connection to diamonds is that they look like them. In fact, any colorless transparent material can be used as a *diamond simulant*. Simulants can be either natural or created by humans.

Diamond simulant—Any material that is not natural diamond or lab-grown diamond, but imitates a diamond's appearance and is used in its place.

KEY CONCEPTS

Convincing diamond simulants mimic diamond's features.

No simulant mimics all of diamond's features.

One reason simulants are important to the jewelry industry is that they can be manufactured in quantity and in nearly any size. This means they're more plentiful, more readily available, and less expensive than diamonds. These features have made them a mainstay of the jewelry industry for the 100-plus years they have been used, from glass in the late 1700s to synthetic moissanite in the 1990s.

Attributes of Diamond Simulants

What qualities must a stone have to imitate diamond? In the simplest form, to imitate a colorless diamond, an imitation must be colorless and transparent. Therefore, any colorless gemstone could be a diamond simulant, like colorless topaz. However, diamond's features go beyond simply being colorless. Gemstones must mimic some of these features to be convincing simulants. These features of diamond are summarized in the table.

Simulants can mimic some of diamond's properties detailed in the table, but no simulant can mimic all of the properties well. For example, many simulants have good brightness but lack fire, or they have fire similar to diamonds but lack brightness.

The properties of simulants are either close to those of diamonds or are distinct in a way that makes them distinguishable from diamonds. This provides the basis for gemologists to detect them.



Pedro Padua/GIA

Due to higher dispersion, synthetic rutile (right) shows extreme fire compared to diamond's moderate fire (left).

Features of Diamond

Optical Properties



Hearts on Fire

Diamond has moderate fire and very high luster.

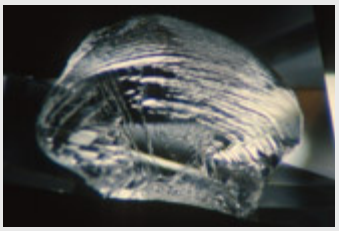
Refractive Index (RI): 2.417

Dispersion: 0.044

Luster: Adamantine

Transparency: Exceptional

Physical Properties



GIA

Diamond has step-like fractures. These features show that diamond has cleavage. Most simulants do not have cleavage.

Specific Gravity (SG): 3.52

Thermal Conductivity: Very high

Hardness: 10 (Mohs scale)

Fracture: Typically step-like, due to cleavage

Finish Details



GIA

This diamond has a bruted girdle and a natural that contains trigons. Both of these features are indicative of natural diamond.

Polish: Superior

Facet edges: Sharp

Girdle: Normally waxy to granular; sometimes faceted or polished; bearding possible

Naturals: Might be present

Other Properties



GIA

Diamonds can show fluorescence. Blue is the most common fluorescence color. This diamond shows strong fluorescence under longwave ultraviolet light.

Fluorescence: If present, usually blue (to longwave ultraviolet light)



GIA

A number of different human-made gemstones have been used to simulate diamonds.

KEY CONCEPTS

Diamond simulants have improved over time, but older simulants may still be seen.

Popular Diamond Simulants

- What materials have been used to mimic diamonds?
- How do the properties of simulants differ from those of diamonds?
- What diamond simulants are the most convincing and common?

Since the first diamond simulants—made from glass—appeared in the 1700s, researchers have discovered a variety of ways to imitate diamond. Every time a new—and better—simulant came along, it tended to replace those that came before it. This created challenges for the industry as well as for the experts, who had to develop a new separation method for each simulant.

Some of the oldest diamond simulants are no longer manufactured for jewelry use, but they still exist. You might find them at estate sales or in jewelry taken in for resale or repair. If you work in these areas, it's important to know how to recognize these less common simulants.

The second half of the 1900s brought many new diamond simulants to the jewelry market, some more successful than others. Each had its own unique properties, and some vanished from the market as quickly as they had appeared.

Whether a diamond simulant is old or new, a gemologist must be able to identify it. Older simulants can still be seen in jewelry today. This section covers the most common simulants in history in chronological order.

Glass and Foilbacks

Glass was an effective diamond imitation beginning in the 1700s, when European glassmakers discovered that adding lead oxide to glass made it more dispersive and brilliant. The process resulted in a convincing diamond simulant, as diamonds began to gain popularity. Today glass is used in less expensive fashion jewelry.



Jane H. Clark

Glass jewels can add dazzle to fashion jewelry without adding to its cost.



Jane H. Clark

Glass is a versatile simulant that can imitate diamonds as well as colored stones.



Emily Lane/GIA



Eric Welch/GIA

Foilbacks are fairly common in estate jewelry. All the diamonds in this Victorian pendant brooch (top) are foilbacked to give them more brilliance. This bracelet (bottom) features glass foilbacks.



Eric Welch/GIA

The jewels in this ring and bracelet are glass, sometimes called paste.

Paste—Glass imitation gemstones and diamonds.

Foilback—A gemstone or simulant with a thin metallic foil or mirroring film applied to its pavilion.

Another name for glass is *"paste,"* from the Italian word pasta. Supposedly early Italian glassworkers thought the molten glass looked like boiling pasta when they stirred it.

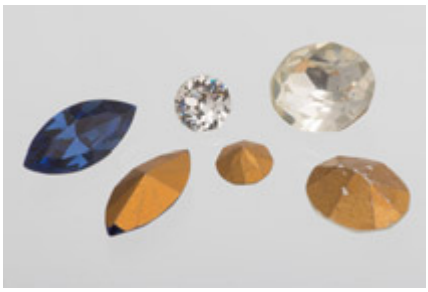
Glass has much lower brilliance, luster, and hardness than diamond, so it's fairly easy to recognize. It also has a lower refractive index (RI) than diamond, so you can see through a faceted glass jewel. This is virtually impossible with a well-proportioned round brilliant cut diamond.

Before the 1700s, almost all transparent gems, including diamonds, were routinely backed with foil to provide color or improve brilliance. Stones backed with metal foil are called *foilbacks*. Not all foilbacks are simulants.

Even today, gemstones and simulants are sometimes foilbacked. A modern method for making foilbacks involves application of a mirroring film rather than metal foil.



Eric Welch/GIA



Eric Welch/GIA



Orasa Weldon and GIA

Foil backing adds brilliance and possibly color to glass imitations (top right). Rhinestones are made of glass. They're commonly used in glamorous, sparkling jewelry that's also affordable (left and bottom right).

Rhinestone is a common trade term for diamond imitations made of glass or plastic, foilbacked or not. The word originally referred to simulants made from a colorless quartz from the Rhine River Valley, but today it usually refers to glass that is foilbacked. Rhinestones are common in costume jewelry.

Rhinestone—A trade term used to describe diamond imitations made of glass or plastic, with or without foilback.

Synthetic Sapphire and Synthetic Spinel

In the late 1800s, French chemist Auguste Verneuil developed a process of synthetic crystal growth for commercial use. The process involved melting powdered materials over a flame and then cooling them until they crystallized. Rubies and sapphires were the first gem materials synthesized with this method.



Valerie Power/GIA

This synthetic colorless spinel is a diamond simulant, but it has lower fire, luster, and brilliance than diamond.



GIA & Tino Hammid

Synthetic spinel, like in this multistone ring, can be an effective and affordable diamond simulant.



GIA & Tino Hammid

In the 1990s, natural and synthetic colorless sapphires were sold as diamond substitutes.

One of Verneuil's students modified the method to produce synthetic spinel. Colorless synthetic sapphires and synthetic spinels sometimes served as diamond simulants. Neither material has as much brilliance or fire as diamond, but both are much harder, and more durable, than other simulants used before the late 1800s. Synthetic and natural colorless sapphire were popular diamond simulants in the 1990s. Synthetic spinel and synthetic sapphire are inexpensive to produce and are occasionally used as diamond imitations today.

KEY CONCEPTS

Synthetic and natural colorless sapphire were popular diamond simulants in the 1990s.

Zircon

Zircon is a natural gem that occurs in a variety of colors. It's more brilliant than glass and has medium fire. Its colorless form was rare until the early 20th century, when heat-treating methods made it more common.

Zircon is doubly refractive, so when you look through the stone from one side to the other, you see double images of the facet junctions on the opposite side. In contrast, diamond is singly refractive, so all its opposing facet junctions look clear, singular, and distinct.

Zircons show wear quickly. Zircons are brittle and chip and scratch easily, so they're less popular today than they were. However, they dominated the simulant market for a while. You might still see them used as diamond simulants as accent stones in less expensive jewelry.

Be aware that many people still use the word "zircon" to mean imitation diamond. Some consumers may also say "zircon" when they actually mean cubic zirconia—this is a different diamond simulant.

KEY CONCEPTS

Zircon and cubic zirconia are two different simulants.



The Field Museum, from *Gems and Gemstones: Timeless Natural Beauty of the Mineral World* by Lance Grande and Allison Augustyn, 2009, University of Chicago Press

The 15.26-ct. zircon in this pendant imitates diamond. The stone is surrounded by natural diamonds. Examine all stones in a piece of jewelry to avoid assuming they are all diamonds or all simulants.



GIA & Tino Hammid

Zircon is brittle. Note the abrasions along this stone's facet junctions, seen as fuzzy white lines. Heat treatment turned this zircon colorless.



Valerie Power/GIA

Synthetic rutile has high dispersion, yellowish bodycolor, and strong double refraction. You can see the double refraction through the table of this stone. These properties help separate it from diamond.

Synthetic Rutile

Scientists searching for a better paint whitener discovered synthetic rutile by accident in 1948. (There is a natural rutile, but it's rarely used as a gemstone.) In spite of its yellowish bodycolor, synthetic rutile was briefly used as a diamond simulant. It's no longer produced, but you might find it in some estate jewelry.

As a simulant, synthetic rutile is quite brilliant, but not as brilliant as diamond. It also has very high dispersion: Even to the untrained eye, its rainbow colors are obvious. They're so obvious that they actually detract from its brilliance and can even make the stone look cloudy. Another serious drawback to its use as a simulant is its low hardness—it quickly shows signs of wear.

Like zircon, synthetic rutile is also highly doubly refractive, so you see double images of its opposite facet junctions when you look through it under magnification.



GIA

Strontium titanate was developed as a simulant in the 1950s. It has a high dispersion and is attractive but not very durable for use in jewelry.

Strontium Titanate

Strontium titanate (a compound of the elements strontium and titanium) first appeared as a simulant in 1953. It had no known natural counterpart until scientists identified the mineral tausonite in the 1980s. Like diamond, strontium titanate is singly refractive. It's closer to colorless and much less dispersive than synthetic rutile, but still noticeably more dispersive than diamond. It also has a low hardness, so it's not very durable.



Pedro Padua/GIA

Simulants like YAG (right) were developed to imitate diamond (left) and act as affordable alternatives.



Robert Weldon/GIA

YAG can be produced in many colors to imitate colored diamonds.

YAG and GGG

In the late 1960s, scientists developed a number of lab-grown crystals with garnet-like (cubic) crystal structure. Although both yttrium aluminum garnet (YAG) and gadolinium gallium garnet (GGG) are lab-grown and have garnet-like structure, neither are synthetic garnets. They don't have the chemistry of any known natural garnet.

YAG was the first to be used as a diamond simulant. Aggressive promotion boosted YAG's commercial success. One of the most famous promotions was its use for Cartier's replica of the 69.42-ct. Taylor-Burton diamond.



GIA & Tino Hammid

As a simulant, YAG has nowhere near the same fire as diamond.



GIA & Tino Hammid

GGG and diamond have almost the same amount of fire, but GGG is much denser than diamond.

Because it has relatively good hardness (about 8.25 on the Mohs scale) and brilliance, YAG was the most popular diamond simulant for many years. But it lacked the distinct fire of diamond, and as newer and better simulants appeared, YAG lost its popularity.

Gadolinium gallium garnet (GGG) was the next garnet-like material to be used as a diamond simulant. GGG is a little more brilliant and dispersive than YAG. Its dispersion is almost the same as diamond's, so it shows similar fire. GGG's major drawback is its lower hardness. It scratches fairly easily.

GGG also has high SG (7.05), so it's much heavier than a diamond of the same size. The heftiness of the stone could deceive a customer into thinking it's a natural diamond. However, gemologists know that diamonds have a moderate specific gravity and are not that weighty for their size. Gemologists test the *heft* of a gemstone by judging how heavy it is in the hand compared to its size.

Heft—How heavy an object feels in relation to its size.

Synthetic Cubic Zirconia

Synthetic cubic zirconia (CZ) is a modern simulant that entered the market in the early 1970s. It has since become the most common diamond simulant. It's called "synthetic" because it has an extremely rare natural counterpart.

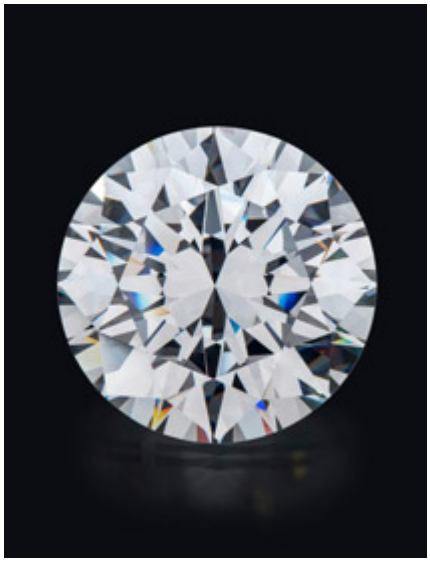
KEY CONCEPTS

CZ is the most popular diamond simulant on the market.



Robert Weldon/GIA

This set of colorless cubic zirconias was fashioned to simulate the five largest diamonds cut from the Cullinan rough: the Cullinan I, II, III, IV, and V.

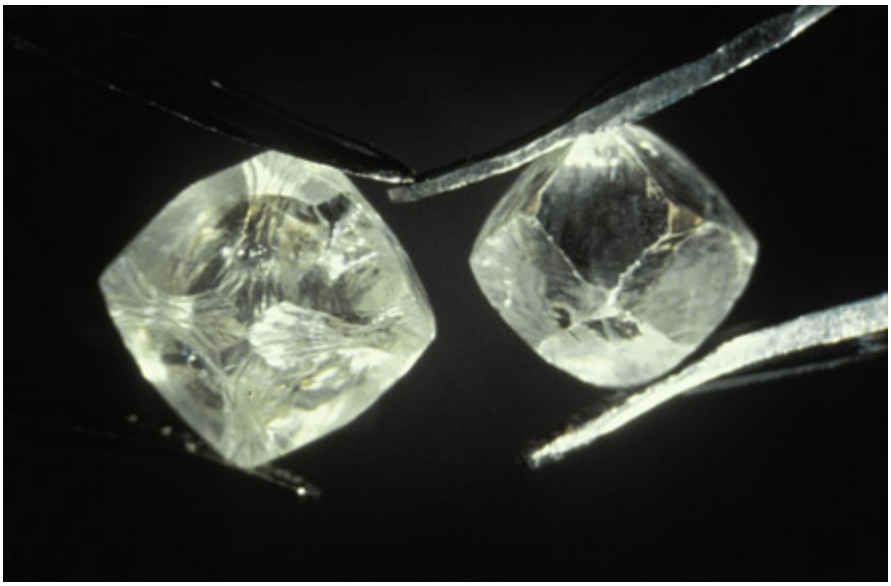


Orasa Weldon and GIA, gift of Dong Keuk Kim



Orasa Weldon and GIA, gift of Dong Keuk Kim

CZ is a modern popular diamond simulant. Its appearance is fairly close to diamond's. It's also durable, low-cost, attractive, and can be cut in any size and shape.



Dave Hargett/GIA

CZ can be fashioned to imitate rough diamond crystals. Diamond growth marks, like these parallel grooves, can be carved into the rough.

CZ is almost as brilliant and lustrous as diamond, and it has slightly higher dispersion. It's also quite durable, with a Mohs hardness of 8.25 to 8.5. However, its SG ranges from 5.80 to 6, so it feels heavier in your hand than a diamond (SG 3.52) with the same dimensions.

Because CZ's appearance is fairly close to diamond's, it is often used as a counterfeit. Dealers have discovered CZ in parcels of rough diamonds. In one case, counterfeiters had shaped a CZ into an octahedron and carved triangular depressions on its surface similar to those on natural diamond rough.



Eric Welch/GIA



GIA & Tino Hammid

The production of colored CZ was inspired by strong public interest in fancy-color diamonds starting in the 1990s. The simulant is now produced in many colors.



Shane F. McClure/GIA



Courtesy Emitations

Colored CZ has the look of fancy-color diamonds at a fraction of the cost.



Emily Lane/GIA

Today CZ is sold as a gem in jewelry such as this tennis bracelet.

CZ comes in a variety of different colors, so it is a convincing colored diamond simulant. However, most of CZ's colors are quite saturated, while natural colored diamonds typically have less saturation.

While CZ is the most popular diamond simulant, it's also a jewel in its own right. It is reasonably priced and attractive in its colorless and colored forms. Jewelry designers and big brands set CZ in fashionable but affordable earrings, bracelets, rings, necklaces, and more, so consumers can get the look of diamond without the high price.

Synthetic Moissanite

Although synthetic moissanite tends to be slightly yellowish or greenish, it is a convincing diamond simulant. It's slightly less brilliant than diamond, but it has more fire than diamond and CZ. This balance between brilliance and fire gives it an attractive appearance. Synthetic moissanite also has high luster. Like CZ, it is marketed as a jewel in its own right, but it is more expensive to produce so is less common in the market than CZ.



Eric Welch/GIA

Synthetic moissanite is convincing as a diamond simulant at first look because it is only slightly less brilliant than diamond, but it shows extreme fire and doubling.



Courtesy Charles & Colvard



Courtesy Charles & Colvard



Joseph Schubach/Schubach Jewelers

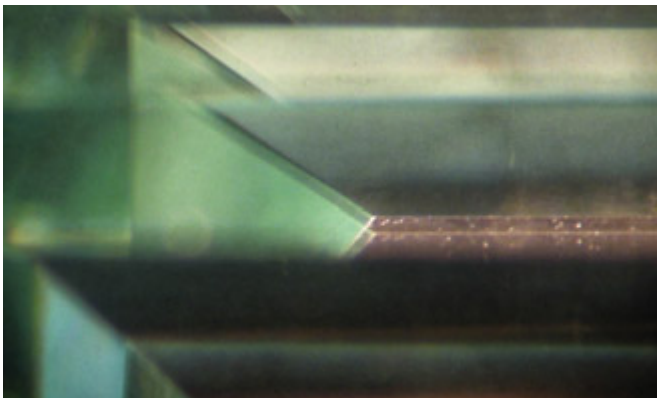


Courtesy Charles & Colvard

Synthetic moissanite shows up in beautiful designer-look pieces that many people are proud to own and wear.

Moissanite gets its name from Dr. Henri Moissan, a Nobel Prize–winning chemist. Dr. Moissan discovered the natural mineral in 1893 while analyzing an ancient meteorite in Arizona. He noted its diamond-like qualities, but there was never enough natural moissanite to make commercial use possible. Natural moissanite occurs as tiny grains in rocks and meteorites and rarely as inclusions in natural diamonds.

Synthetic moissanite is silicon carbide. It was first developed for industrial use. Because of its superior hardness—about 9.25 on the Mohs scale—it was used as an abrasive. Charles & Colvard introduced it as a diamond simulant in the late 1990s.



Yanjun Song

Strong doubling of facet junctions in synthetic moissanite, such as in this emerald cut stone, helps separate it from diamond.



Joseph Schubach/Schubach Jewelers

Synthetic moissanite tends to have a slightly yellowish or greenish tint.

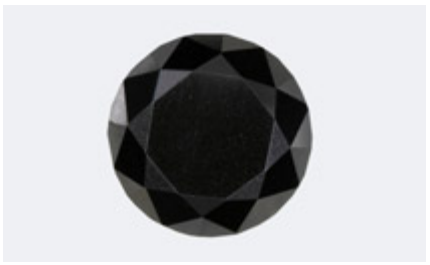
While diamond is singly refractive, synthetic moissanite is doubly refractive, so separating synthetic moissanite from diamond is relatively easy for trained gemologists. They need only look for doubling of the facet junctions.

Unlike most other simulants, synthetic moissanite's SG (3.21) is lower than diamond's. That means it's lighter, rather than heavier, than a diamond of the same size. A loose stone should feel slightly lighter than a diamond of the same dimensions. However, the difference in SG is quite small, so the heft will probably feel the same as diamond's.

Like CZ, synthetic moissanite can be produced in other colors to imitate colored diamonds, but colored synthetic moissanite is not as common as colored CZ. However, synthetic moissanite is routinely found in black to imitate black diamond. Black synthetic moissanite can be tricky to identify due to the lack of visible doubling in its black color along with its high luster and hardness.



Yanjun Song



Jian Xin Liao/GIA



Robert Weldon/GIA

Synthetic moissanite comes in different colors (left). Black (top right) to imitate black diamond tends to be the most popular. The green ring (bottom right) was cut from a single piece of green synthetic moissanite.



Valerie Power/GIA

This garnet-and-glass doublet's green color makes it easy to see the difference in luster between its two layers.

Doublet—Two pieces of material fused or cemented together to form a single assembled stone.

KEY CONCEPTS

To identify assembled simulants, pay special attention to luster differences and the area just above and below the girdle.

Assembled Simulants

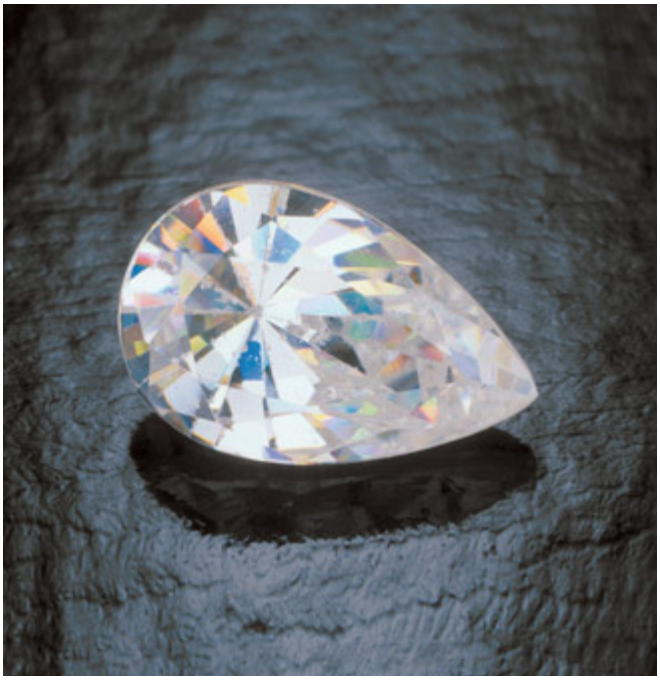
An assembled simulant is made up of two or more components. Assembled diamond simulants are usually *doublets*, consisting of two different materials cemented or fused together.

One of the first types of assembled simulants used were garnet-and-glass doublets in the mid-1840s. These doublets consisted of a reddish garnet top fused to a glass base. The garnet layer's hardness allowed the doublet to be polished to an attractive luster. At the same time, the garnet layer was thin enough to allow the face-up jewel to take on the color—or lack of color—of the glass bottom.

For quick detection of most garnet-and-glass doublets, rock the jewel back and forth under a light. Because of its construction, there is a difference in luster between the garnet top and the glass base. The glass has a much lower luster. These doublets often appear in estate and antique jewelry.

Newer doublets have synthetic spinel or synthetic sapphire crowns and strontium titanate pavilions. The properties of these doublets vary with the components, but most have much more fire than diamond due to the strontium titanate.

Others assembled stones are designed to be more deceptive. They have natural or lab-grown diamond crowns cemented to pavilions of other materials, like CZ or synthetic moissanite. These can be tricky to identify, so pay special attention to the area where it might be assembled, just above and below the girdle.



GIA & Tino Hammid



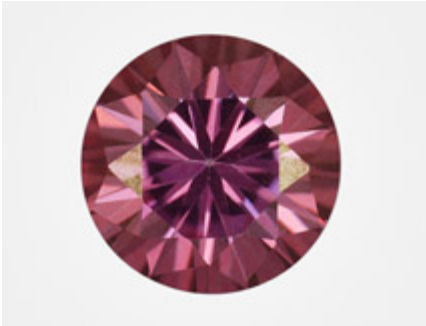
Eric Welch/GIA

Strontium titanate doublets can have convincing luster and brightness, but they show extreme fire (left). On this doublet of synthetic spinel and strontium titanate (right), the line of assembly is visible just below the girdle.



Robison McMurtry/GIA

A 0.31-ct. cubic zirconia reportedly coated with nanocrystalline synthetic diamond.



Aurélien Delaunay

This 0.41-ct. pink stone was found to be a synthetic moissanite coated to imitate pink diamond. The pitting in the coating and odd iridescent colors reflected from the star facets are clues that the stone was coated.

Coated Simulants

Coated simulants are relatively new to the market and have become more common since the early 2000s. These simulants are typically either CZ or synthetic moissanite with a coating that contains some form of synthetic diamond particles. However, the coating is so thin that standard tests cannot detect any diamond. These coatings are also too thin to be seen under standard magnification. The coatings are less resistant to scratching than diamond, so they easily wear away.

Simulants have also been coated to produce color. Synthetic moissanite was originally only produced in a colorless or black form. Coatings of different colors are still used today to produce other colors. Pay special attention to facet junctions, where the coating can easily be scratched or worn away and reveal the color of the stone beneath. Also look for oily or iridescent-looking facets under different lighting.

KEY CONCEPTS

To identify color coatings on simulants, pay attention to facet junctions and oily or iridescent facets under magnification.

Diamantine: A New Type of Simulant?

GIA examined CZ simulants from Serenity Technologies that were coated with a substance containing nanocrystalline synthetic diamond particles. These stones were marketed as Diamantine.

The coating was found to be so thin that no diamond could be detected with standard tests (microscope or diamond tester). These thin coatings could wear away with routine gem cleaning methods or general wear and tear.

Nanocrystalline diamond is a form of diamond made up of many nanometer-size diamond crystals. One nanometer equals one millionth of a millimeter. The coating was said to be around 50 nanometers thick.

The coating supplied no advantage in aesthetics or hardness to the simulant. A much thicker and therefore more resistant nanocrystalline synthetic diamond coating would decrease the stone's transparency due to the difference between the two materials' RIs. A thicker coating would also reduce the simulant's brilliance, scintillation, and fire. This would make the stone look nothing like a diamond.



Robert Weldon/GIA

This 2.00-ct. cubic zirconia, called Diamantine, was coated with a proprietary thin colorless layer said to consist of "nanocrystalline diamond particles" embedded in a matrix.



Ben Martin/The LIFE Images Collection/Getty Images

A successful diamond professional must be able to tell the difference between diamonds and simulants.

Thermal tester—An instrument that measures thermal conductivity to help separate natural and lab-grown diamonds from most simulants.

KEY CONCEPTS

A combination of methods is needed to conclusively identify a stone.

Diamond has a higher thermal conductivity than most simulants.

Synthetic moissanite can cause a standard diamond tester to indicate diamond.

How to Detect a Simulant

- What instruments aid in the detection of simulants?
- What methods are used to detect simulants?
- What is required to identify synthetic moissanite?

Awareness is the best protection against expensive mistakes in the jewelry industry. Some differences between natural diamonds and simulants are easy to spot; others require more advanced knowledge and equipment. The ability to recognize a "diamond" that looks "not quite right" can save you a headache later.

Various methods can help determine whether a stone is a diamond or a simulant. Some require instruments, and others are as simple as observing the diamond under different lighting and magnification. It is important to remember that all of these methods need to be used in combination. Multiple factors, not just one, indicate whether a stone is a diamond or a simulant.

Thermal Conductivity and Testing

A gem's thermal conductivity is the rate at which its surface temperature changes in response to a specific amount of heat. Diamond has higher thermal conductivity than almost any simulant.

The *thermal tester* (also called a diamond tester or diamond probe) provides fast, easy, and reliable thermal conductivity measurements of mounted or loose stones. Many jewelers depend on a thermal tester to help make diamond identification faster and more efficient.

Most thermal testers are operated by holding the tip of the tester's probe against a facet. The tester applies heat to the stone and detects how quickly the stone draws the heat away. Based on this measurement, a dial indicates whether the stone is a diamond or a simulant. If it indicates "diamond," there's still a possibility it could be synthetic moissanite, as it has a high thermal conductivity similar to diamond's.



Eric Welch/GIA

A diamond tester separates diamonds from most simulants by measuring thermal conductivity.



Eric Welch/GIA

Make sure the tester's probe doesn't touch the metal when testing a mounted stone as this could affect the results.



Jian Xin (Jae) Liao/GIA



Maha Tannous/GIA

A diamond tester occasionally gives natural black diamonds (top) a non-diamond result, and black synthetic moissanites (bottom) a diamond result.

Results are easy to interpret in most cases, with a few considerations. If the tip of the probe touches metal, repeat the test. The mounting, the temperature of the room, and the size of the stone may also affect the results.

Another consideration for thermal diamond testers is their use on black diamonds and black simulants. Due to black diamond's high inclusion content, it occasionally has lower thermal conductivity and indicates non-diamond on a thermal tester. A black synthetic moissanite might indicate diamond on a thermal tester due to its high thermal conductivity.

A moissanite tester can be used on black stones. If the instrument gives a positive result it means the stone is synthetic moissanite; if it gives a negative result it could be a diamond or another type of simulant.

Also look at the inclusions inside the stone. Moissanite and diamond have different inclusions, but the dark color of black stones can make this difficult. If you are unsure of a stone's identity, send it to a laboratory for further testing.

KEY CONCEPTS

Moissanite testers use electrical conductivity to separate synthetic moissanite from diamonds and other simulants.

Electrical Conductivity and Testing

A moissanite tester tests for *electrical conductivity*—how well an electrical current passes through a material. Synthetic moissanite can conduct electricity, but the majority of diamonds do not. Very rare type IIb diamonds can conduct electricity due to their boron content, but these diamonds usually have a blue color or slight blue tint that aids in identification.

Electrical conductivity—A measure of how well an electrical current passes through a material.



Sy Kessler Sales, Inc./GemOro Superior Instruments

Multi-testers use both thermal and electrical conductivity to differentiate between simulants and diamonds.

Multi-tester—An instrument that measures both thermal and electrical conductivity to test diamonds and simulants.



GIA

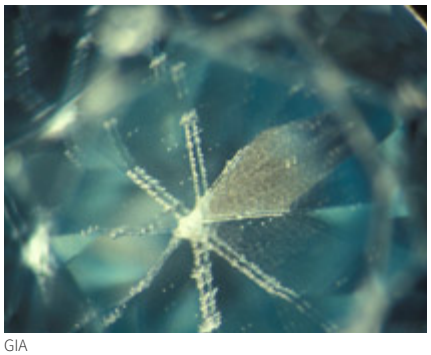
Moissanite testers use electrical conductivity to detect synthetic moissanite.

A moissanite tester passes a small electrical current through the stone, which travels to the metalwork and into your hand holding the mounting. The electrical current then travels through your body and down your other arm to your finger, which rests on a metal plate in the tester that detects the current. It is critical to hold the tester in one hand and place your finger on the metal plate, while holding either the mounting or the loose stone in your other hand.

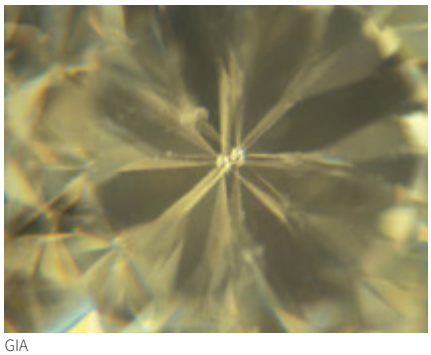
Certain models of diamond/moissanite testers test for both thermal and electrical conductivity at the same time. They are called *multi-testers* and eliminate the need for two testers. These models are more expensive than standard thermal testers or moissanite testers.

Doubling

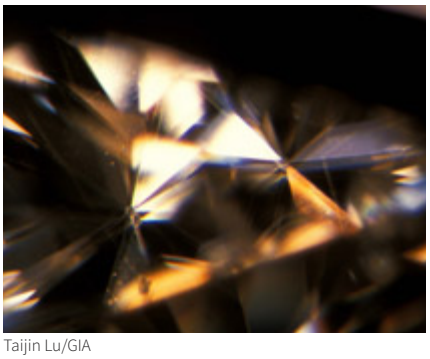
Diamond is singly refractive, meaning that light passes through it unchanged other than to slow down and possibly change direction (refraction). Light enters and exits a diamond as a single beam, meaning that the reflections of facet junctions—the lines where two facets meet—appear only once.



GIA



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Taijin Lu/GIA

Doubling caused by strong double refraction can be seen under magnification in zircon (left), synthetic rutile (center), and synthetic moissanite (right). This proves that the stone is definitely not a diamond.



Christopher Bonine/GIA

The three viewing directions to observe doubling are through the table, diagonally through the stone, and horizontally through the stone.

In some materials that have a less symmetrical crystal system, light splits into two beams. These materials are doubly refractive. Light exits these materials as two beams. This means that you see two reflections of a single facet junction.

You can observe this by viewing a stone in at least three directions under a loupe or microscope. First, look through the table of the stone at the pavilion facet junctions to see if there are one or two reflections. If there are two reflections, the facet junction lines will be quite close together.

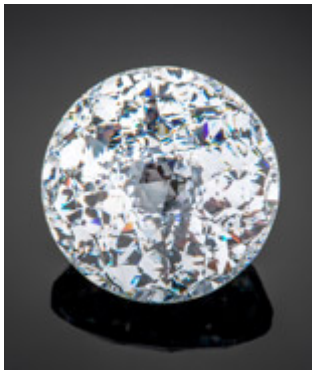
If you do not see doubling in this direction, tilt the stone away from you and look through a crown facet toward the pavilion facet junctions. Most simulants are cut in this orientation because cutters don't want the doubling a simulant might have to be visible through the table. This makes the simulant look singularly refractive and more like a diamond.

Make sure you only look through one facet on the crown. If you look across facets you will see prism images—this is not doubling.

If you still don't see doubling, look horizontally through the stone. (Most of the time doubling is visible in the first two directions.)

KEY CONCEPTS

Make sure to check for doubling in at least three directions.



Robert Weldon/GIA, courtesy Victor Tuzlukov



Eric Welch/GIA



Joseph Schubach Jewelers

CZ has fire similar to diamond (top left), while synthetic rutile and synthetic moissanite (top right and bottom) have extreme fire.



GIA and Harold & Erica Van Pelt

Diamond's moderate fire is enhanced or diminished by the light source.

Dispersion

White light splits into its spectral components as it passes through a material—this is called dispersion. A material's dispersion is a measure of the difference between the refractive index of the red wavelength of light and the refractive index of the violet wavelength. Diamond has dispersion of 0.044 and moderate fire.

Diamond has moderate fire. Simulants can have less, similar, or more fire than diamonds due to differences in dispersion values. For example, synthetic moissanite and synthetic rutile have much greater dispersion values (around 0.100 or more). When these stones are observed under the same lighting conditions as diamond they show extreme fire. Use an LED light with no more than five diodes to judge the fire of diamond and simulants.

Other simulants, like CZ and GGG, have dispersion values similar to diamonds, so their fire looks nearly the same. Dispersion does not conclusively identify these stones as simulants.

Some simulants, like YAG, synthetic sapphire, and synthetic spinel, have less dispersion and so show less fire than diamond. However, a badly cut diamond also has little fire. The lack of fire does not rule out that the stone could be a diamond.



Eric Welch/GIA

Most simulants have a lower refractive index and a larger critical angle than diamond, leading to light leakage through the pavilion. This makes it possible to read text through many round brilliant simulants. Left to right: diamond, synthetic moissanite, cubic zirconia, synthetic rutile, strontium titanate, zircon, GGG, YAG.

Read-Through

The size of the critical angle and the angles of a diamond's facets determine whether light exits through the crown or leaks through the pavilion. Diamond has a small critical angle, and if a cutter chooses the right proportions, light enters through the crown, hits outside the critical angle cone on the pavilion facets, and is reflected back up to the crown. There it hits within the critical angle cone and exits the stone.

Many diamond simulants have lower RIs and thus much larger critical angles than diamond. In these simulants, much of the light that strikes the pavilion falls within the critical angle cone and leaks out. This means that you can see through many simulants and even read through them.

Note that some simulants—synthetic moissanite, synthetic rutile, and strontium titanate—have refractive indexes higher than or similar to that of diamond. Therefore, their critical angles are small, and it's not possible to read through them.

For other simulants, the difference is easy to see. Place a round brilliant diamond table-down on a printed page next to a simulant. You can read print through the simulant but not through the diamond.

This test is reliable only for modern, well-proportioned round brilliant diamonds. It is important to look at the stone's proportions before performing the read-through test. If a round brilliant diamond has a very shallow or steep pavilion you will be able to read through it. This test doesn't work for fancy shapes because of their different proportions and faceting styles. Again, it is important to use more than just one method.

You can read through an emerald cut diamond due to the step-cut facets.



Emily Lane/GIA

You can read through an emerald cut diamond due to the step-cut facets.

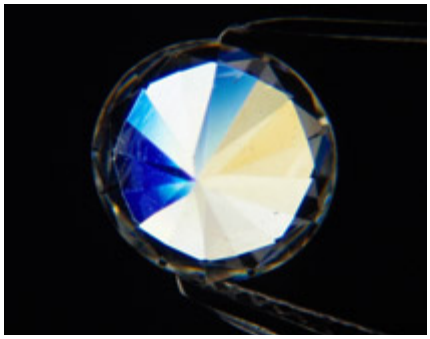
KEY CONCEPTS

The read-through test is only reliable for well-proportioned round brilliant cut stones.

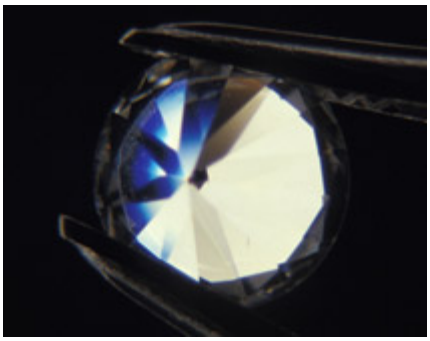


John I. Koivula/GIA

Round brilliant cut CZs show a bright orange flash on their pavilions under darkfield illumination.



Mike Havstad/GIA



Mike Havstad/GIA

GGG (top) can show a blue and orange pavilion flash. YAG (bottom) can show a blue and violet pavilion flash.

Pavilion Flash

Diamond tends to have a spectral flash on its pavilion facets under darkfield lighting. So do synthetic moissanite, synthetic rutile, and strontium titanate. Due to their chemistry other simulants have distinctive color flashes on their pavilion facets under darkfield lighting.

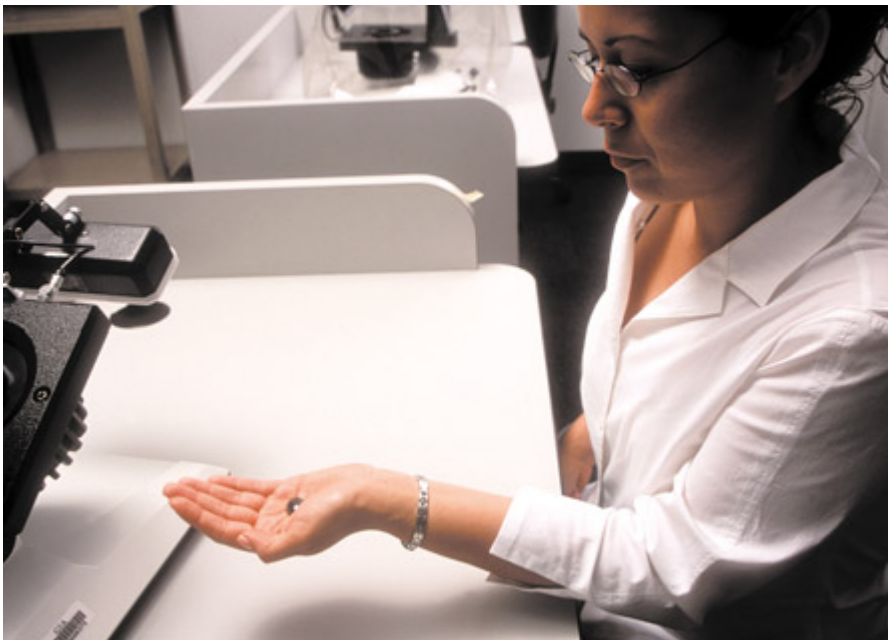
The pavilion color flash test works only for some simulants, but it works particularly well for CZ. Its pavilion facets show a bright orange flash under darkfield lighting as you rock and tilt the stone.

However, like the read-through test, this also has some limitations. The stone must be a well-proportioned round brilliant. If it shows a bright orange flash on at least 50 percent of its pavilion facets, you can be sure it's CZ. The test is not accurate on fancy cuts, poorly proportioned stones, or stones with less than 50 percent orange flash on pavilion facets.

YAG can also show a pavilion flash: a violet and blue one. The same limitations apply as with CZ, but this flash tends to not be as bright or clear as CZ's. It is best to combine the results of this test with another to definitively say whether it is a simulant or a diamond. GGG can show a blue and orange pavilion flash, but it can be similar to diamond's. If this is observed it is best to confirm with further tests.

Specific Gravity and Heft

Specific gravity is the ratio of the density of a substance to the density of an equal volume of water. Diamond's SG is 3.52—it is 3.52 times heavier than an equal volume of water. Most simulants have a much higher SG. The exception is synthetic moissanite, which has an SG slightly lower than diamond's.



Joel Beeson/GIA

Heft gives a rough idea of a gem's density and specific gravity. A large piece of material that feels light for its size is less dense than a small piece that feels heavy for its size.

Excluding synthetic moissanite, if you compare a diamond and a simulant of the same dimensions and cut, the simulant weighs more—it has greater carat weight than the diamond.

Heft compares the size of an object to its weight. A diamond of 6.50 mm average girdle diameter should weigh around 1 ct. If you dropped that 1-ct. diamond into your hand and bounced it up and down to feel the weight, and then did the same with a similar-sized CZ, the CZ would feel heavier. The CZ has higher heft. This is because CZ has an SG of 5.80–6.00. GGG has an SG of 7.00 and would feel extremely heavy for its size.

The heft test takes practice and works only for loose stones. However, if a stone feels quite heavy for its size, this indicates that it might not be a diamond, and further tests are needed.

KEY CONCEPTS

The heft test only works for loose stones.

Diamonds have a lower SG and lower heft than most simulants.

Hardness, Luster, and Polish Quality

Diamond is not only harder than any other natural gem—it's also a lot harder than any natural or manufactured simulant. Diamond's exceptional hardness makes very sharp facet junctions and superior polish possible.

A simulant's comparative softness means that its facet junctions are more rounded than a diamond's. Synthetic moissanite, at 9.25, is closest to diamond's hardness. This means that the facet junctions in synthetic moissanite are much sharper than in other simulants, but still rounded compared to diamond's.

Simulants, with much lower hardness and toughness, might show signs of wear easily, such as abrasions, scratches, or chips. These are usually most apparent near the girdle edge under magnification. Although a diamond can have these, simulants are more likely to. If many of these features are observed, the stone still requires more investigation.

Subadamantine—Surface appearance with slightly less sharp reflections than adamantine.

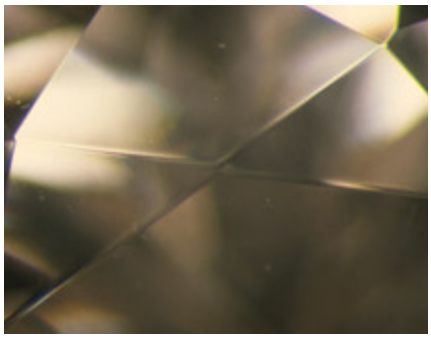
Vitreous—Glass-like surface appearance.

Diamond's capacity for a superior polish gives it much higher luster—adamantine—than a simulant. Even a new, well-polished simulant can't equal the luster of a clean diamond in good condition. *Subadamantine* and *vitreous* are the best lusters simulants can have. Vitreous means "glass-like": the luster looks like that of glass.

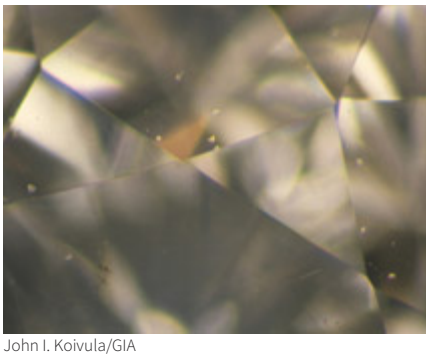
Under magnification, these differences in polish quality, facet junction sharpness, and luster should be apparent. You may also notice them with your unaided eye. If you see these differences in a stone, examine it more closely.

KEY CONCEPTS

Subadamantine and vitreous are the best lusters simulants can show.



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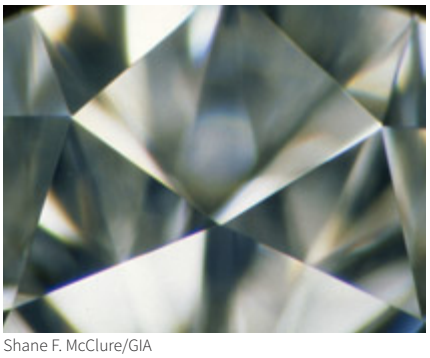


John I. Koivula/GIA

Because CZ has lower hardness than diamond, it has rounded facet junctions (left) compared to diamond's sharp facet junctions (right).



Shane F. McClure/GIA



Shane F. McClure/GIA

Synthetic moissanite (left), with a hardness of 9.25, comes close to mimicking diamond's sharp facet junctions (right), but its facet junctions are still more rounded than diamond's.



Robert Weldon/GIA

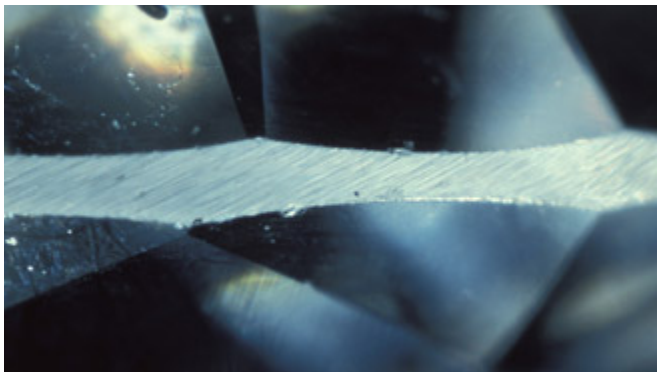


Meenakshi Chauhan, Indian Gemological Institute Gem Testing Laboratory, Delhi, India

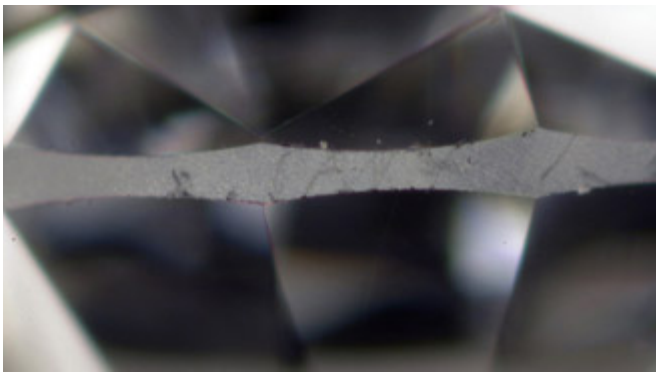


Robert Weldon/GIA

Diamond has adamantine luster (left). Many diamond simulants have subadamantine luster, like this synthetic colorless sapphire (center). Synthetic spinel and glass (right) often show a vitreous luster.



GIA



Mitchell Moore/GIA

The girdle of this CZ (left) shows a pattern of striations. A bruted diamond's girdle (right) has a dull, waxy, smooth, slightly granular gray appearance.

Girdle Appearance

In the 20th century, it was common to see diamonds with bruted girdles. In the 21st century, diamonds with polished or faceted girdles are more common. A polished or faceted girdle can slightly increase a diamond's color grade. It also prevents the buildup of dirt around the girdle, which can create a gray appearance.

Due to the way simulants are cut and polished, and their lower hardness, their girdles cannot be bruted. To imitate bruting, striations are etched into a simulant's girdle. But this looks very different from a diamond's bruted girdle. You might see simulants that have been fashioned this way in estate or secondhand jewelry.

As most diamonds' girdles are polished or faceted today, so are the simulants' girdles. This test doesn't help for modern simulants. The test is only useful for older simulants, such as those in estate jewelry.

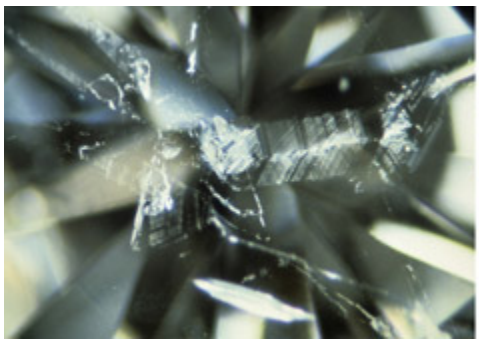
KEY CONCEPTS

Girdles on simulants can't be bruted like those on diamonds.

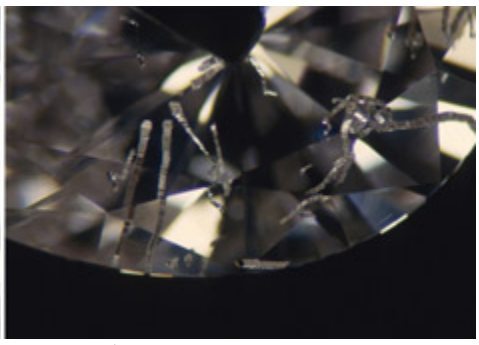
Inclusions and Blemishes

Some inclusions and blemishes occur in natural diamonds but not lab-grown stones, which can help determine whether a stone is a diamond or a simulant.

Twinning wisps, internal graining, and etch channels are inclusions that occur in natural diamonds but not in any synthetic diamond simulants.

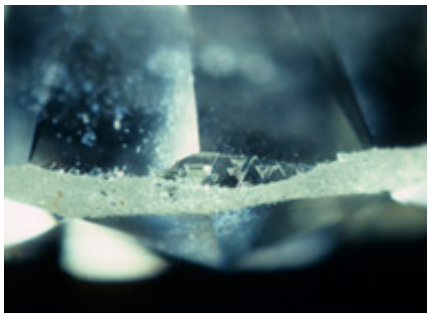


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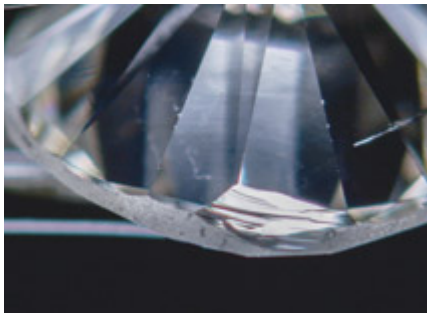


Vincent Cracco/GIA

Some inclusions that can help identify a stone as diamond are twinning wisps (left) and etch channels (right).

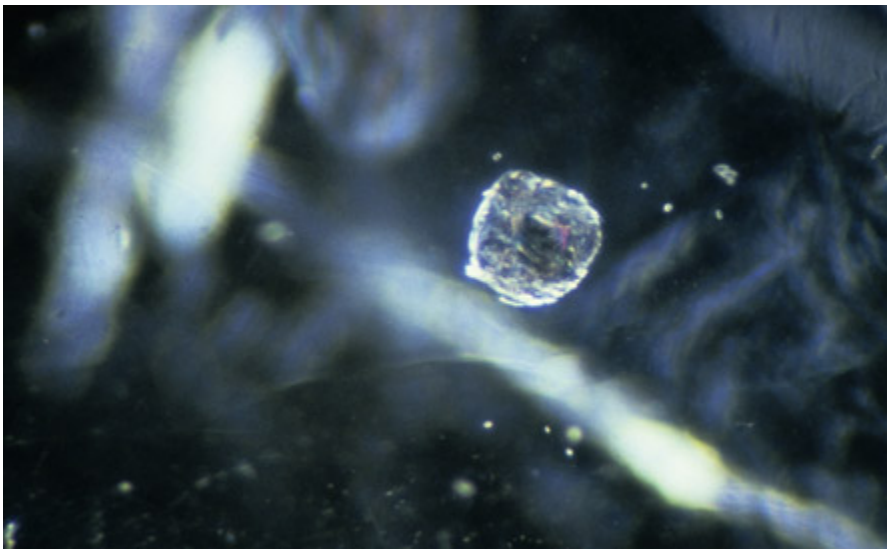


GIA



Mitchell Moore/GIA

Growth marks such as trigons (top) and parallel grooves (bottom) in naturals can help identify diamonds.



GIA

Crystals such as these in a colorless sapphire indicate the stone is of natural origin. This eliminates human-made simulants as possibilities, but others remain: colorless sapphire, topaz, quartz, and any other colorless natural simulant.

Naturals are blemishes helpful in diamond identification. They contain growth marks such as trigons or parallel grooves. Sometimes deceitful people scratch trigons and parallel grooves on simulants. This is more common for simulants imitating diamond rough than polished simulants.

Mineral inclusions can also be helpful because they indicate natural origin. If you see crystals or needles, the stone could be a diamond. However, natural colorless stones such as zircon, sapphire, quartz, and topaz can all contain included crystals and needles.

Gas bubble inclusions can sometimes occur in human-made simulants, such as CZ, YAG, GGG, synthetic sapphire, glass, synthetic spinel, synthetic rutile, and strontium titanate. They look like small high-relief white dots. Synthetic sapphire and synthetic spinel may contain so many gas bubbles that they can look like a cloud. If you can determine an inclusion is a gas bubble, this proves the stone is not a diamond, as large gas bubbles do not occur in diamond.

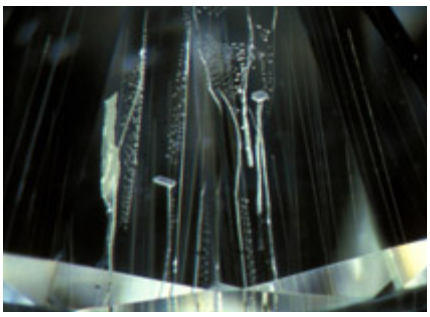
Channel-like inclusions that run from crown to pavilion are common in synthetic moissanite. These are not to be confused with laser drill-holes in diamond, which go from the surface of a stone toward a crystal.

With the exception of synthetic moissanite, most simulants are eye-clean and don't contain many inclusions, if any. As most diamonds contain inclusions, this can aid in their identification. However, with higher-clarity diamonds, or those that only have feathers, cavities, or chips, further tests are needed.

Inclusions, like the other attributes, don't always give a definitive answer as to the identity of a stone. Therefore, it is important to conduct a number of tests before concluding it is a diamond or a simulant. For example, a stone may have moderate fire, high luster, and natural crystal inclusions, which might lead you to say it is a diamond. However, under magnification doubling indicates the stone is doubly refractive and not a diamond.



GIA



Taijin Lu/GIA

Inclusions that can occur in human-made simulants include gas bubbles in YAG (top) and channel-like inclusions that run from crown to pavilion in synthetic moissanite (bottom).



Kurt Nassau

Human-made simulants such as this CZ rough can be made to any specification and cut to any size. There is little concern over wasting rough CZ to get a beautiful and unusual cut stone.

Dealing in Diamond Simulants

- What is the place of simulants in the jewelry industry?
- What are the common trade names for simulants?
- What issues can arise when buying and selling simulants?

You might wonder where simulants fit into the diamond trade. Some jewelers think they have no place in a fine jewelry store. Others carry them without apology, believing that they add to the variety of merchandise available and, in the long run, increase natural diamond sales. These jewelers give simulants their own display area, and when they show them to a client, they handle them as they would valuable gems.

Sometimes simulants attract customers, especially in a retail setting. Many people who appreciate the beauty and rarity of a fine diamond cannot afford one. People with limited budgets are more likely to visit a jewelry store if they know they'll find something beautiful at a price they can afford.

Sometimes a customer's first piece of jewelry is a simulant. Since most simulant material is relatively inexpensive to manufacture, it can be cut for maximum beauty without concern for weight loss.

When used in finished jewelry, the best simulants usually have high-quality settings. Semi-mounts—jewelry mountings preset with small diamonds and a large central area for one or more large stones—can also be set with attractive simulants.

To avoid having diamonds in a case, jewelry sales representatives often use simulants to show off a line of jewelry or a selection of mountings. A semi-mount set with a simulant can help a customer imagine what the piece will look like when it's set with a diamond. The customer might even buy one as is with the intention of later replacing the simulant with a diamond.

At all levels of the industry, the right attitude on a jewelry professional's part will help clients or customers feel good about buying simulants. At the retail level, it's best to avoid praising simulants so highly that they overshadow the desirability of diamonds, or give customers the impression that simulants are anything more than a pretty look-alike. On the other hand, it's preferable to avoid making people feel like they have poor taste if they choose a simulant. A properly handled sale will plant the seeds to bring them back for diamonds when they can afford them.

KEY CONCEPTS

A jewelry professional can help clients or customers feel good about buying simulants.



Robert Weldon/GIA

Semi-mounts have a central opening for one or more large stones. They can be preset with diamond or simulant accent stones.



Dhrumil S. Desai/Freida Rothman

Marketers of simulants such as these CZs often come up with fanciful names for them.

Simulant Names

Diamond simulant manufacturers have given their products a number of trade names over the years. Some of them are as fanciful as "Rainbow Magic Diamond" for synthetic rutile and "Diamontina" for strontium titanate. While many names have fallen out of use along with the simulants they identify, some might still turn up on old documents or in estate jewelry listings. If you see a name you don't recognize, it might be because it's a name invented for a diamond simulant.

Because synthetic cubic zirconia is popular and heavily promoted—especially on home-shopping television networks—it has a few names that you might recognize. Some of those names are Absolute, Diamanti LUXE, Diamonair, Diamonesk, Diamonesque, and Diamonique III.

Another simulant name to be aware of is what retailers call a diamond hybrid or hybrid diamond. This is probably the most confusing of all the names. Many stores promote diamond hybrids, and each retailer has its own patent, but usually the stone consists of a simulant, most likely a CZ, with a coating of diamond particles. "Diamond hybrid" may also be used as a name for certain assembled simulants.



Courtesy MiaDonna

These diamond simulants were said to have a coating of synthetic diamond particles. They were sold as diamond hybrid simulants.



Eric Welch/GIA

These rough quartz crystals were sold as "Herkimer diamonds," but they are actually colorless quartz. Beware of misnomers in the industry.

KEY CONCEPTS

Be aware of trade names and misnomers for common diamond simulants.

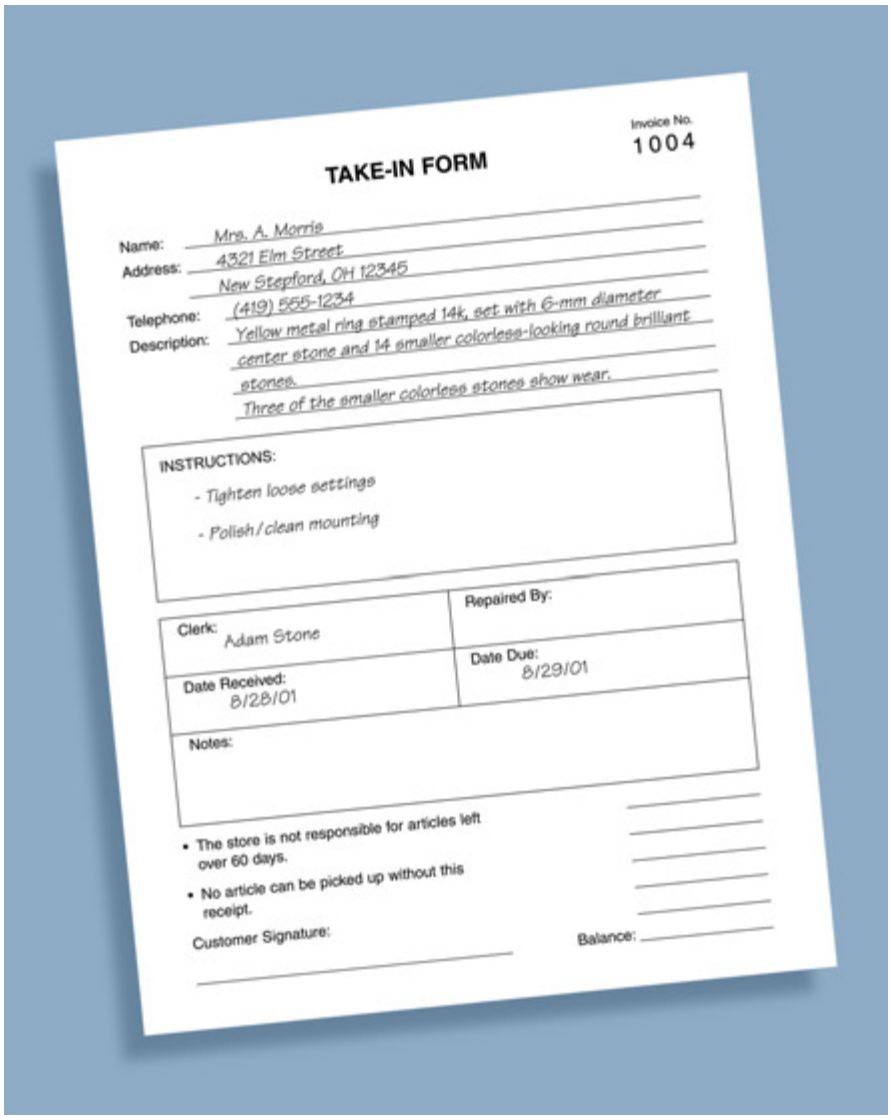
Do not sell a gem unless certain of its identity.

While some names are misleading, some are simply inaccurate. Misnomers used in the past for some diamond simulants include "Matura diamonds" and "Herkimer diamonds." These are actually colorless zircon and a type of colorless quartz.

Mistakes and Deceptions

Problems arise when a simulant is sold or accepted as a natural stone. There are many ways this can happen, and many preventive measures to avoid it. It's important to remember that in the final analysis, there's no substitute for up-to-date knowledge and a watchful eye.

You should never sell a gem—wholesale or retail—without knowing exactly what it is. If you're not 100 percent positive, get help from a qualified gemologist or gemological laboratory to establish its identity.



GIA

If you are uncertain of a stone's identity, use generic terms to describe gemstones on take-in forms.

In a retail setting, simulants can be especially difficult to identify. If you can't positively identify the material in a piece of jewelry when you accept it from a customer for repair or cleaning, use a neutral description. Phrases like "near-colorless emerald cut" are best on a take-in form.

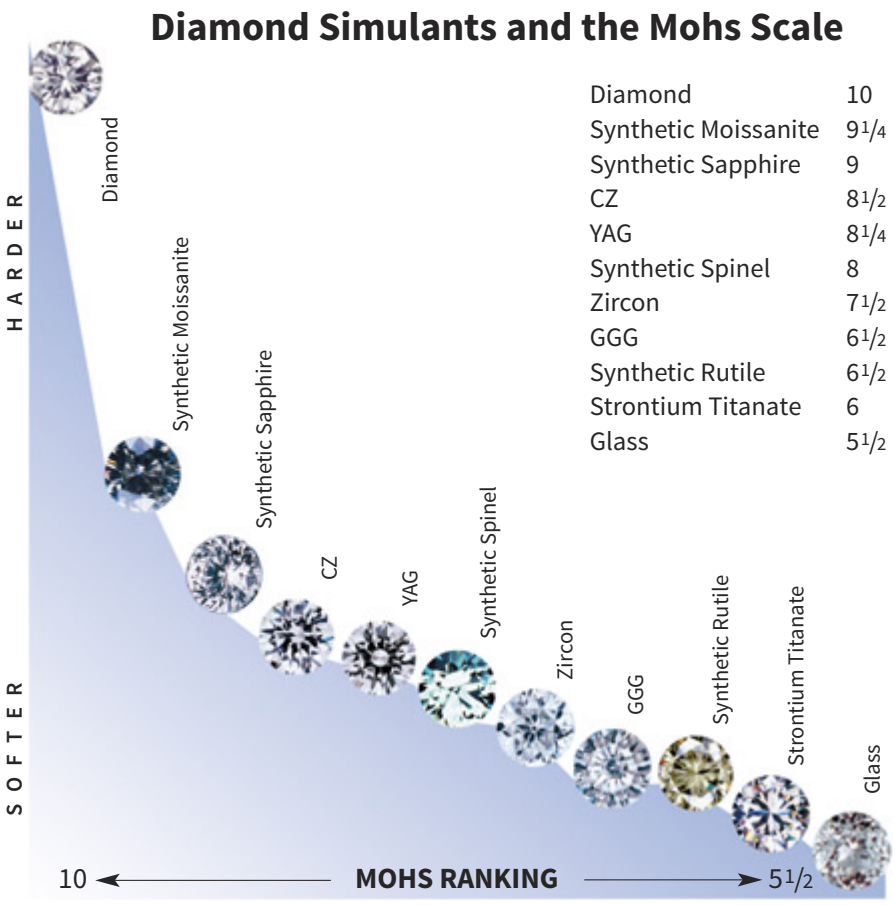
False Advertising

Promotions for diamond simulants are sometimes full of false or exaggerated claims. The best way to avoid becoming part of the problem—and to impress clients or customers with honesty and expertise—is to arm yourself with the facts.

An example of a false claim is one that's sometimes made for CZ: that it's almost as hard as diamond. The claim takes advantage of the common misconception that the Mohs scale represents actual hardness measurements.

KEY CONCEPTS

The best defense against false claims about simulants is thorough knowledge and up-to-date skills.



Peter Johnston/GIA

Gem hardness, as measured by the Mohs scale, is relative. It might seem as if CZ and synthetic moissanite are almost as hard as diamond, but they don't even come close.

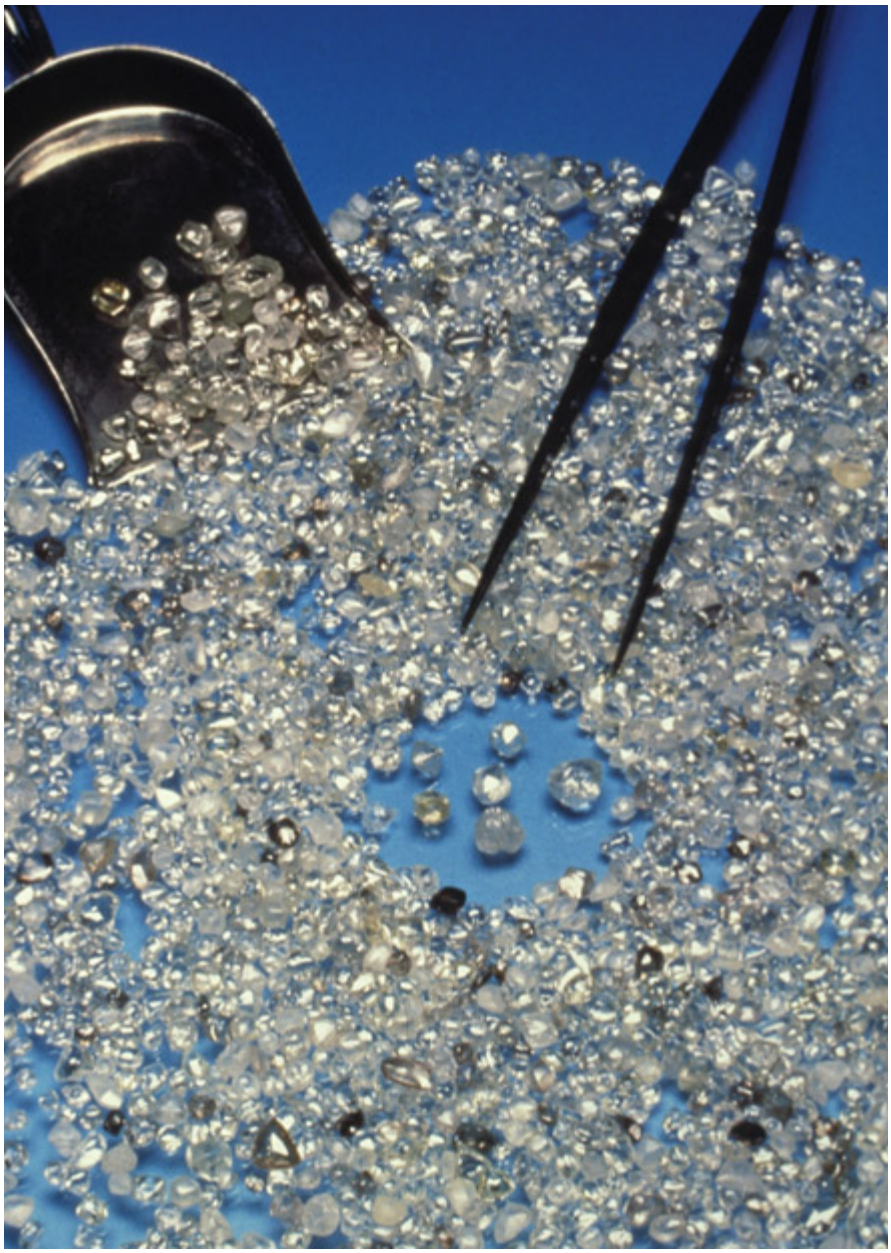
But the scale is comparative. The numbers look close, with CZ between 8.25 and 8.5, and diamond at 10, but the difference in hardness between the two is enormous.

This is just one example of a claim that sounds great but is misleading because it doesn't tell the whole story. As a jewelry professional, you must draw on your own knowledge of gems to dispel the myths that surround diamond simulants. This is not just a matter of ethics: The entire industry benefits from better understanding of fine gems and simulants.

Staying Alert

Be aware that most people who walk into a dealer's office or jewelry store are legitimate, but a few are not. Dishonest people have ways of encouraging you to accept simulants as natural diamonds. Wholesalers must be watchful for simulants hidden in parcels of rough or finished diamonds.

Do not take the identity of a gem or the contents of a parcel for granted. It's important to know what to look for—fire or luster variations, worn or sharp facet junctions, differences in thermal reaction, and more—when trying to differentiate between diamond simulants and diamonds. The more obvious signs are easy to learn and help quickly determine whether a particular stone is a diamond. Checking for double refraction and with a tester can possibly prevent an expensive mistake.



Benguela Concessions/John Gurney

Faced with large assortments of rough, a diamond dealer must be on the lookout for simulants that have been artfully fashioned to look like diamond rough. Detecting them takes knowledge and practice.

A con artist is so called because his or her primary method is to gain the victim's confidence in order to take advantage of them. To do this, one might pose as a customer or a dealer. Note that it may be easier for a con artist to trick a salesperson eager to make a big sale or get a great deal.

The ability to remain objective and rational is tested every time you accept jewelry or diamonds from someone. Even when deliberate fraud is out of the question, it's still dangerous to take anyone's word regarding a stone's identity. A person may believe that a jewel that has been in their family for years is a diamond, and nothing will persuade them it is not.



Joel Beeson/GIA

Do not take the contents of a parcel for granted. Just because a stone is professionally wrapped in diamond papers doesn't mean it's a diamond—these aren't.



Sood Oil (Judy) Chia/GIA

This fancy-color diamond bracelet was submitted to GIA for testing. Two of the melee-sized stones were identified as synthetic moissanite. Even high-priced pieces can have simulants hidden in them.

Before accepting responsibility for any parcel or stone, check it carefully. If possible, do this in the client's or customer's presence. That way, their sincere but mistaken belief in the parcel's contents or the stone's authenticity remains their problem, not yours.

Summary

Diamond simulants can lead to expensive and embarrassing mistakes, but they can also be profitable. Retail stores often find that they boost sales volume and increase customer desire for the real thing. Wholesalers that specialize in them promote them proudly, knowing they have a rightful place in the jewelry industry.

KEY CONCEPTS

Simulants can be natural or human-made.

Simulants can be produced in nearly any size and quantity and cost less than natural or lab-grown diamonds.

Convincing diamond simulants mimic diamond's features.

No simulant mimics all of diamond's features.

Diamond simulants have improved over time, but older simulants may still be seen.

Synthetic and natural colorless sapphire were popular diamond simulants in the 1990s.

Zircon and cubic zirconia are two different simulants.

CZ is the most popular diamond simulant on the market.

To identify assembled simulants, pay special attention to luster differences and the area just above and below the girdle.

To identify color coatings on simulants, pay attention to facet junctions and oily or iridescent facets under magnification.

A combination of methods is needed to conclusively identify a stone.

Diamond has a higher thermal conductivity than most simulants.

Synthetic moissanite can cause a standard diamond tester to indicate diamond.

Moissanite testers use electrical conductivity to separate synthetic moissanite from diamonds and other simulants.

Make sure to check for doubling in at least three directions.

The read-through test is only reliable for well-proportioned round brilliant cut stones.

The heft test only works for loose stones.

Diamonds have a lower SG and lower heft than most simulants.

Subadamantine and vitreous are the best lusters simulants can show.

Girdles on simulants can't be bruted like those on diamonds.

A jewelry professional can help clients or customers feel good about buying simulants.

Be aware of trade names and misnomers for common diamond simulants.

Do not sell a gem unless certain of its identity.

The best defense against false claims about simulants is thorough knowledge and up-to-date skills.

Key Terms

Diamond simulant—Any material that is not natural diamond or lab-grown diamond, but imitates a diamond's appearance and is used in its place.

Doublet—Two pieces of material fused or cemented together to form a single assembled stone.

Electrical conductivity—A measure of how well an electrical current passes through a material.

Foilback—A gemstone or simulant with a thin metallic foil or mirroring film applied to its pavilion.

Heft—How heavy an object feels in relation to its size.

Multi-tester—An instrument that measures both thermal and electrical conductivity to test diamonds and simulants.

Paste—Glass imitation gemstones and diamonds.

Rhinestone—A trade term used to describe diamond imitations made of glass or plastic, with or without foilback.

Subadamantine—Surface appearance with slightly less sharp reflections than adamantine.

Thermal tester—An instrument that measures thermal conductivity to help separate natural and lab-grown diamonds from most simulants.

Vitreous—Glass-like surface appearance.

Questions for Review

- What is the difference between natural diamonds, lab-grown diamonds, and diamond simulants?
- Why are simulants used in the market today and why are they so popular?
- What diamond attributes do simulants try to mimic?
- What materials have been used to mimic diamonds?
- How do the properties of simulants differ from those of diamonds?
- What diamond simulants are the most convincing and common?
- What instruments aid in the detection of simulants?
- What methods are used to detect simulants?
- What is required to identify synthetic moissanite?
- What is the place of simulants in the jewelry industry?
- What are the common trade names for simulants?
- What issues can arise when buying and selling simulants?

Tools and Instrumentation

19

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Welcome to *Diamonds & Diamond Grading* Assignment 19. This assignment contains the knowledge required for you to:

- Identify standard tools used in the diamond trade
- Identify common laboratory testing techniques
- Describe the importance of advanced instrumentation



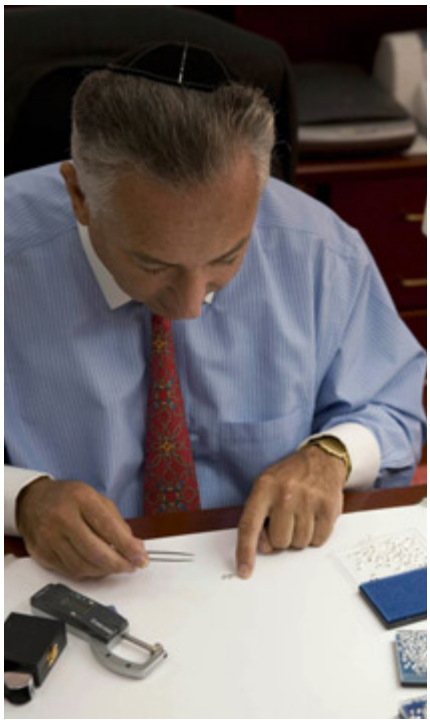
H. Armstrong Roberts/Harstock

Specialized equipment makes handling, sorting, measuring, and grading diamonds simple and accurate.

Tools and Instrumentation

Like most professions, the diamond industry has traditional tools and best practices. A diamond professional uses testing equipment effectively and follows trade practices.

At times you may be unable to conclusively identify a diamond with standard gemological tools and equipment and will need to send it to a reputable gemological laboratory for testing. This assignment covers the tools for handling, sorting, and weighing diamonds, as well as the advanced instruments gemological laboratories use and how they work to identify a diamond.



Eric Welch/GIA

Tweezers are an ideal tool for sorting and handling diamonds.



Kevin Schumacher/GIA

A microscope is an essential tool in the industry as well as in gemological laboratories.

Tools of the Trade

- What tools are used to handle and sort diamonds?
- How are diamonds measured and weighed?
- What are some considerations when matching diamonds?

Diamantaire—A knowledgeable, experienced professional, typically a dealer or manufacturer, in the diamond trade.

A *diamantaire* is a knowledgeable, experienced professional, typically a dealer or manufacturer, in the diamond trade. Many of the industry's foremost diamantaires started out sorting and matching small diamonds. The skills they gained early in their careers are still important. At a glance, they can assess the quality of parcels of diamonds, matched suites of diamond jewelry, or prestigious single diamonds.

A variety of tools and standard gemological equipment are needed to work in the trade. These include—but are not limited to—tweezers, a scoop, a sorting pad, a matching tray, a loupe, a millimeter gauge, sieve sets, hole gauges, and an electronic scale. A true diamond professional has the ability to select the right tool for each task.

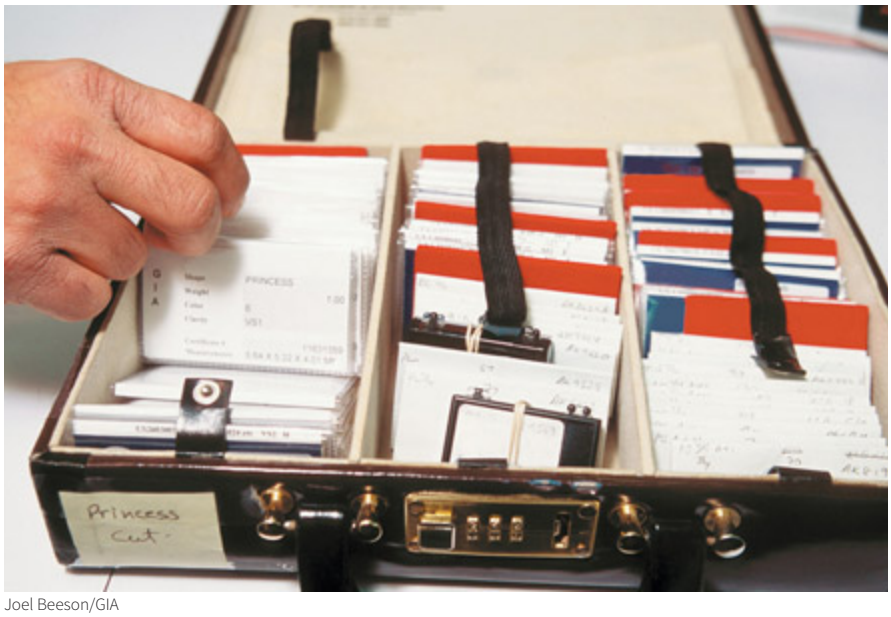
Handling, Sorting, and Measuring Diamonds

There are many tools for handling, sorting, and measuring diamonds. When choosing a tool, it's important to understand their limitations—and which is ideal for a task. For example, fine-pointed tweezers are ideal for handling small stones, but they're less useful for large ones because they don't provide enough contact with their girdles.



De Beers Diamond Promotion Service

Parcels of melee are typically stored in stone papers.



Joel Beeson/GIA

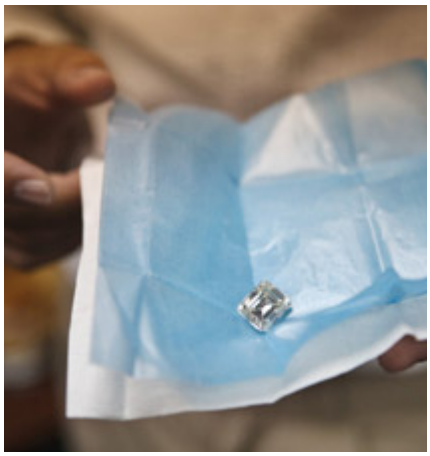


Eric Welch/GIA

Stock boxes are used to organize diamond inventory.

Organization is key when working in the diamond industry. Many use *stone papers*—folded parcel papers that come in standard sizes to fit into stock boxes—to organize their diamond inventory. Detailed information about the diamonds inside—size, weight, cost, and so on—is written on the front of each paper. Stone papers can hold and protect single diamonds, matched suites, and parcels.

Stone paper—A folded paper that comes in standard sizes used to hold and protect diamonds, as well as organize diamond inventory.



Eric Welch/GIA

Handling stone papers properly will enhance your professional image.

Handling Stone Papers

Stone papers come in a variety of sizes and colors. They usually consist of two or three layers of paper folded together. The outside layer is typically white and opaque, while the innermost layer is a thin, translucent liner called a flute.

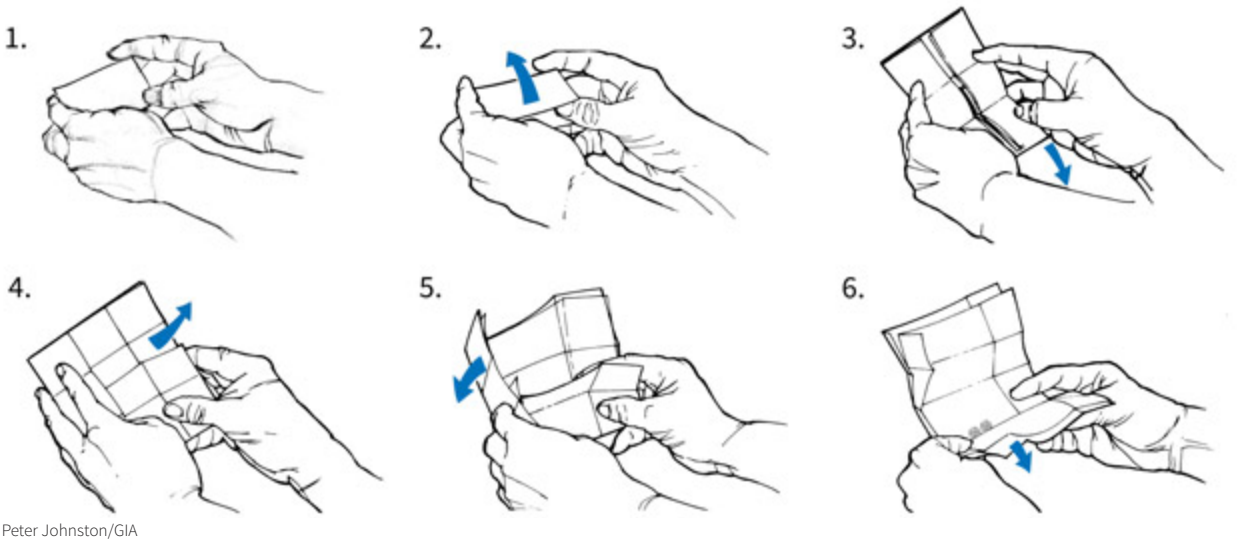
The color of the flute affects the apparent color of the diamonds it holds. Light blue flatters colorless and near-colorless diamonds, but it makes the color of light yellow ones more obvious. Off-white or light yellow flutes make yellowish or brownish diamonds look better.

Handling stone papers skillfully takes a little practice but will enhance your professional image. There are proper sequences for unfolding and folding stone papers.

With repeated folding and refolding, creases can become worn, and the contents might fall out. After a while, papers get worn and dirty. Make sure to replace papers as soon as they show any signs of wear.

Unfolding Stone Papers

1. Hold the paper in both hands.
2. Slip your thumb under the top flap, and lift it up. Feel for the location of the stone or stones. You might want to gently tap one edge of the paper to shift the contents into the center. If the paper contains a large number of small stones, tap one edge to move them to the side opposite the one you're holding.
3. Fold the bottom flap down.
4. Carefully open one of the side flaps. Be careful with parcels of small stones because a few might be caught on the wrong side of the fold.
5. Tilt the paper slightly away from you and sideways, toward the unopened side flap. Slip a finger inside the unfolded flap and slightly open the pocket. Hold the paper more clearly level and open the flap on the other side.
6. Open the bottom fold toward you, exposing the diamonds. Be careful not to flip the stones out.



Peter Johnston/GIA

Folding Stone Papers

1. Place the stone or stones in the middle of the paper, just above the second fold from the bottom.
2. Fold the bottom flap up at the same fold.
3. Fold the sides toward the middle. Be sure not to trap any stones on the wrong side of the fold.
4. Fold the bottom up and the top down.
5. Feel the paper to confirm that the diamonds are still inside.

Tools to Handle, Sort, and Measure

A pair of tweezers and a cleaning cloth are essential. Tweezers with medium points are best for most purposes.

To work with parcels, you need a scoop and a sorting pad. A *scoop* is a small metal shovel that's thin enough to slide easily under tiny stones. A *sorting pad* is a pad of heavy white paper that serves as a background for sorting parcels of gems. Once the top sheet gets dirty, it's torn off to expose a clean one. Most diamond dealers have one sorting pad for themselves and one for their customers.

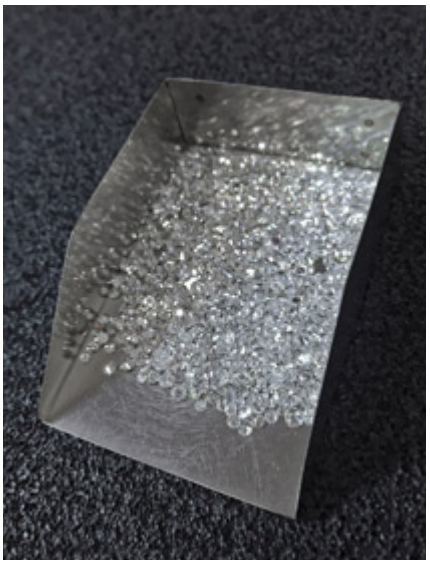
Scoop—A small shovel made of thin metal, used for picking up gems.

Sorting pad—A pad of white paper for sorting and showing gems.



GIA

There are many tweezer styles to choose from. Select a pair that feels comfortable in your hand and has points that fit the diamonds you typically handle.



Ivana Petriska Balov/GIA

A scoop makes handling parcels of diamonds easy.



GIA

Some tweezers feature a small hole to secure the diamond for viewing and examination. This is especially useful for clarity grading.



Joel Beeson/GIA, courtesy K.R. Gems & Diamonds International

A matching tray helps keep diamonds organized during sorting.

Matching tray—A grooved white non-reflective tray used for matching sets of stones.

A *matching tray* is another convenient piece of equipment. It provides a convenient surface for comparing and matching gems to create stone sets. Typically it's a small white plastic tray indented with grooves for various diamond sizes.

Examining and grading diamonds requires a consistent source of light. The most widely accepted and available lighting for color grading diamonds is daylight-equivalent fluorescent light. The best fluorescent light simulates balanced, diffused, full-spectrum daylight.

Professionals need a good-quality 10x triplet loupe that's corrected for color and distortion. They also need a calculator to calculate profit margins, sales prices, and average gem weights, and a memo pad for recording calculations.

The millimeter gauge is used to measure diamond dimensions. When the gauge's jaws close around a diamond's girdle, it registers the diameter to the nearest 0.01 mm. A millimeter gauge can also measure a stone's depth, as long as the stone is unmounted or in a mounting with a hole in the back. The gauge comes with a set of tables to help estimate the weights of some mounted diamonds.



GIA

The millimeter gauge is an essential tool for measuring diamond dimensions.

Because using a millimeter gauge is time-consuming, it doesn't make sense to use one to check large numbers of stones smaller than 3.00 mm—except to check sizes for matching. A sieve set is useful for sorting large quantities of small, round diamonds. A *sieve set* usually consists of a holder and a series of interchangeable plates perforated with holes in specific sizes.

Dealers use sieves to sort small diamonds—especially small single cuts in sizes like 150, 180, and 200 to the carat. It's the most rapid and efficient way to sort such tiny stones. For example, if the holes are 2.00 mm in

Sieve set—Set of circular plates, each punched with precisely sized holes, used for sorting small, round gems by size.

Sieve Sizes

Diamond Weight	Sieve Size	Millimeter Size
180 to the carat	+00–0	~1 mm
150 to the carat	+0–1.5	~1 mm
130 to the carat	+1.5–2	~1 mm
120 to the carat	+1.5–2	~1 mm
0.01 ct.	+2–3	1.30 mm
0.02 ct.	+5.5–6.5	1.70 mm
0.03 ct.	+7–7.5	2.00 mm
0.04 ct.	+8–8.5	2.20 mm
0.05 ct.	+8.5–9.5	2.30 mm
0.06 ct.	+9.5–10	2.50 mm
0.07 ct.	+10–11	2.70 mm
0.08 ct.	+11–11.5	2.80 mm
0.09 ct.	+11.5–12	2.90 mm
0.10 ct.	+12–12.5	3.00 mm



GIA



Joel Beeson/GIA



Andrew Lucas/GIA

Sieve sets are useful for sorting small, round diamonds. The interchangeable plates have holes that allow diamonds of specific sizes to pass through.

diameter, only stones of that size or less will pass through the sieve plate. Stones 2.10 mm or larger can't pass through the sieve, so they stay on top of the plate. Each successive sieve plate has increasingly smaller holes.

Many retailers use hole gauges to measure small gems. These are templates with differently sized holes that represent diamond girdle diameters. Although hole gauges can be useful, they're not precise enough for certain jobs, like measuring small diamonds for a channel setting. Because the setting limits the dimensions of the diamonds that will fit, the measurements must be precise. The best tool for this is a millimeter gauge.



Eric Welch/GIA

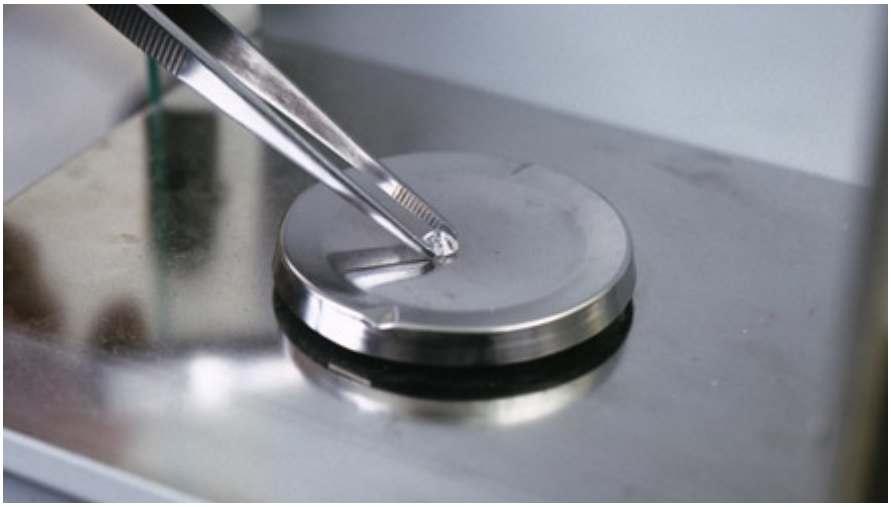
Some hole gauges have round tabs in various sizes. A tab can be matched to the opening in a mounting to determine what size stone will fit.

Weighing Diamonds

Most scales have a leveling mechanism, which typically consists of adjustable feet and a liquid-filled capsule with a gas bubble inside. When you adjust the feet, the bubble moves. The scale is level when the bubble is centered.

Once you've leveled the scale, it must be calibrated. Most scales come with a calibration weight. If the scale is knocked or moved, level and calibrate it again, or it won't weigh gems correctly. It's a good idea to have a scale serviced regularly by an authorized service agent. Once a year is typically enough.

Make sure the scale is set to zero before each use. If a weighing pan is used, make sure it's on the scale before it is set to zero so the pan weight is not included in the diamond weight.



GIA

Weighing a diamond with an electronic scale is simple and precise.



Eric Welch/GIA

Weighing a single stone on the weighing pan's handle is faster than placing it in the pan, but the measurement is slightly less accurate.

KEY CONCEPTS

Electronic scales are extremely accurate, but they must be set up correctly for best results.

Keep the scale on a firm, vibration-free surface, away from foot traffic as well as drafts and heat sources such as windows, heating ducts, and cooling fans. Even direct sunlight can create enough of an air current to affect a scale's accuracy. Most scales have sliding glass doors to protect from drafts.

Always clean a diamond before placing it on the scale. Handle it carefully with tweezers because oils from your skin can affect the diamond's weight. Place the diamond in the center of the pan, close the dust cover doors, and wait for the electronic reading to register.

Many dealers place individual stones on the flat handle of the pan. This increases speed, as it's easier to pick up a gem from there than from inside the pan, but it results in a slightly less accurate measurement.

Matching Diamonds

Checking diamond quality rapidly and accurately is vital in the trade. The ability to measure diamond quality factors—clarity, color, cut, and carat weight—is dependent on the proper tools and their use.

Consistency is important when matching diamonds, especially for good-quality jewelry. Weight, color, clarity, and cut are all considerations in matching. Diamonds must be well matched because the human eye easily detects inconsistencies like slight differences in face-up color, differently sized table facets, or different girdle diameters. For example, when you rock and tilt a pavé-set ring, all the stones should have similar table reflections.



Eric Welch/GIA, courtesy K.R. Gems & Diamonds International

Manufacturers often sort and set aside several sets of matched stones for use in popular jewelry designs.



Andrew Lucas/GIA

Time spent sorting and matching diamonds for jewelry is worthwhile. The quality, appearance, and corresponding value of each finished piece will reflect your efforts.

Color and face-up appearance are the most important characteristics in matching diamonds for jewelry. Color is usually the easiest to match: Just compare the diamonds face-up against a neutral background.

Matching face-up appearance means making sure that table sizes and reflection patterns are the same. Use the flash method to compare table sizes, and check the reflection patterns through each gem's crown. If a set of diamonds is destined for a channel mounting, measure each gem's girdle diameter accurately to within 0.01 mm.



Joel Beeson/GIA

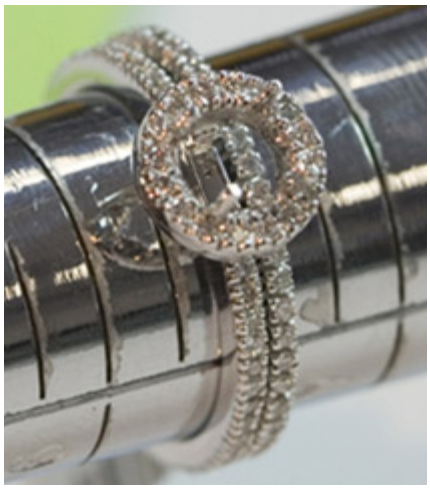


Joel Beeson/GIA



Joel Beeson/GIA

When diamonds are side by side (top), it's easy to detect slight differences in table size. These diamonds' varying brightness and patterns (center) make them unsuitable for use together in jewelry. Their face-down profiles (bottom) can reveal differences in crown and pavilion depth as well as in girdle thickness.



Eric Welch/GIA



Robert Weldon/GIA

Proportion variations are less noticeable in tiny diamonds, so dealers don't spend as much time matching the proportions of small diamonds used in pavé-set pieces.



Eric Welch/GIA

To match a set of accent stones with a large center stone, it's best to choose the center stone first.

Clarity matters when matching large diamonds in the "I" clarity range. This range has much greater variations in appearance among individual diamonds, simply because it has a greater variety of possible clarity characteristics.

The smaller the diamonds, the less matching needed. The function of very small diamonds (0.01 ct. or less) is usually to add sparkle, and they're too small for the unaided eye to judge individually. Just make sure they're all the same size, and flip them onto their tables to compare girdle diameters.

For gems of about 0.025 ct. and larger, look at them face-up on a matching tray and compare table sizes and reflection patterns. Diamonds 0.05 ct. and above require more precise matching. Look at individual stones' color and clarity characteristics.

To match a set of accent stones with a large center stone, it's best to choose the center stone first. That's because there are more diamonds in the parcel of smaller gems, which offers more choices for matching. If you match the accent stones first, it might be difficult to make a match from the smaller number of large stones. Don't separate the pair of accent stones, either. Keep them together at one side of the center stone. It's the best way to make sure they match each other.

Careful matching pays off for both the manufacturer and the retailer. Well-matched stones signal a quality product and attention to detail. It's easy to justify the price of a well-finished piece of jewelry containing precisely matched diamonds.

Advanced Instrumentation

- When should a diamond be submitted for advanced testing?
- What advanced testing techniques are used in gemological laboratories?
- What testing techniques are used to determine color origin?
- What testing techniques are used to distinguish between natural and lab-grown diamonds?

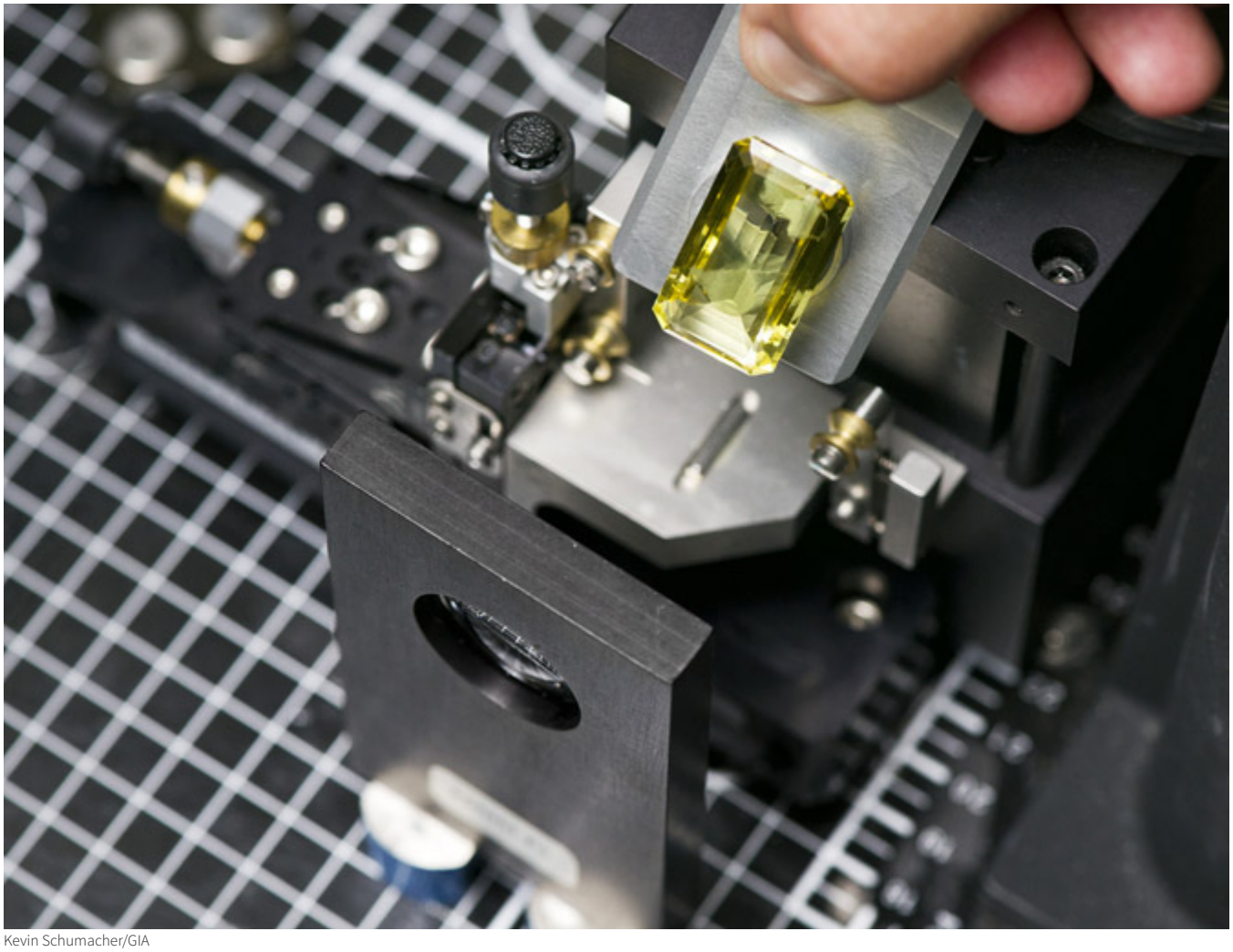
Many of the advanced instruments and techniques used in gemological laboratories were developed for other fields and modified to suit gemological needs. Many of these sophisticated instruments are expensive and found only in a laboratory. Some of the same technology is used in instruments available commercially.

Gemologists operate advanced instruments to collect data on diamonds that can help conclusively identify their nature and color origin, among other things. Further examination and interpretation of the data is required.

KEY CONCEPTS

The information gathered with advanced instrumentation can help conclusively identify a diamond.

Advanced testing results require further interpretation by experienced laboratory gemologists.

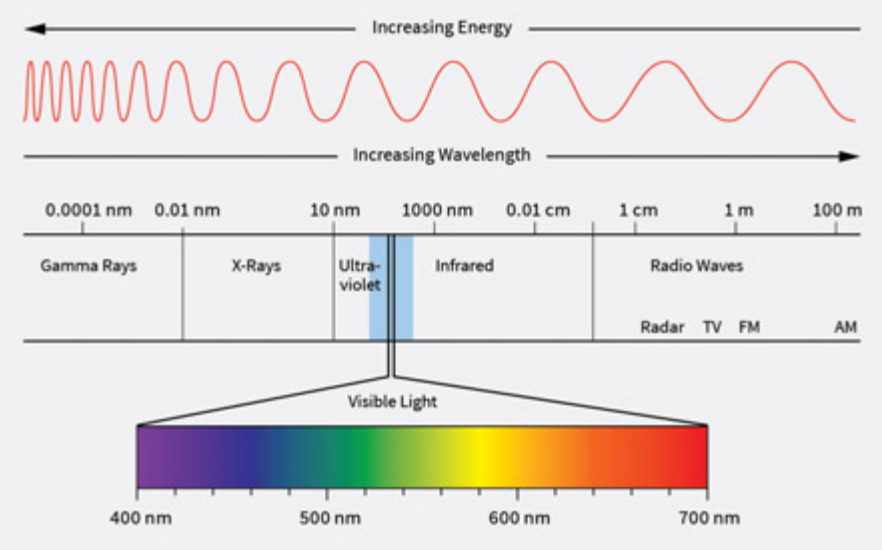


Kevin Schumacher/GIA

Diamonds submitted to a gemological laboratory are analyzed with advanced instrumentation.

KEY CONCEPTS

A UV-Vis-NIR spectrometer measures a diamond's absorption of visible light and portions of the ultraviolet and infrared regions close to the visible range.



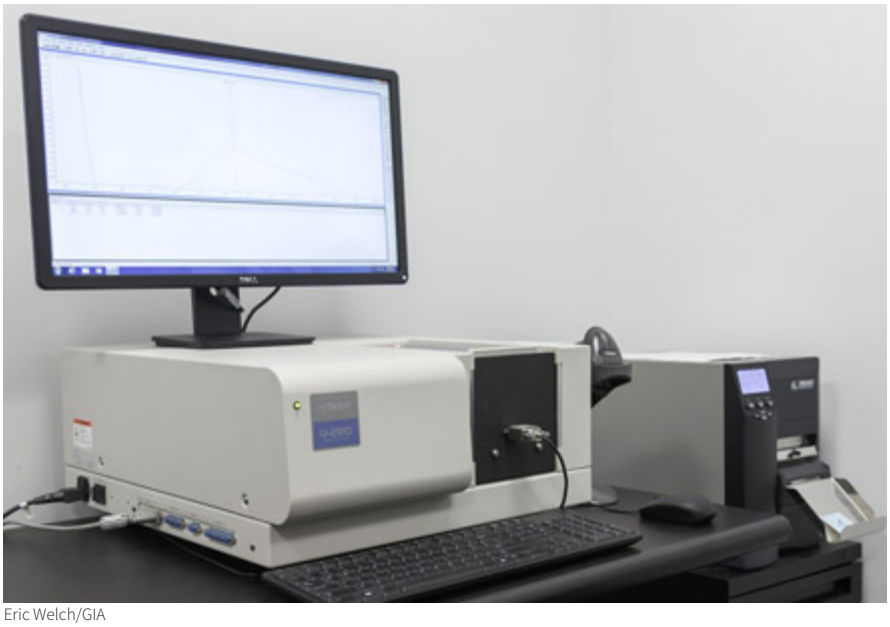
Russel Samson/GIA

A spectrometer uses UV-Vis-NIR absorption spectroscopy to measure a diamond's absorption of visible light, as well as portions of the ultraviolet and infrared regions close to the visible range (blue rectangle).

UV-Vis-NIR Spectroscopy

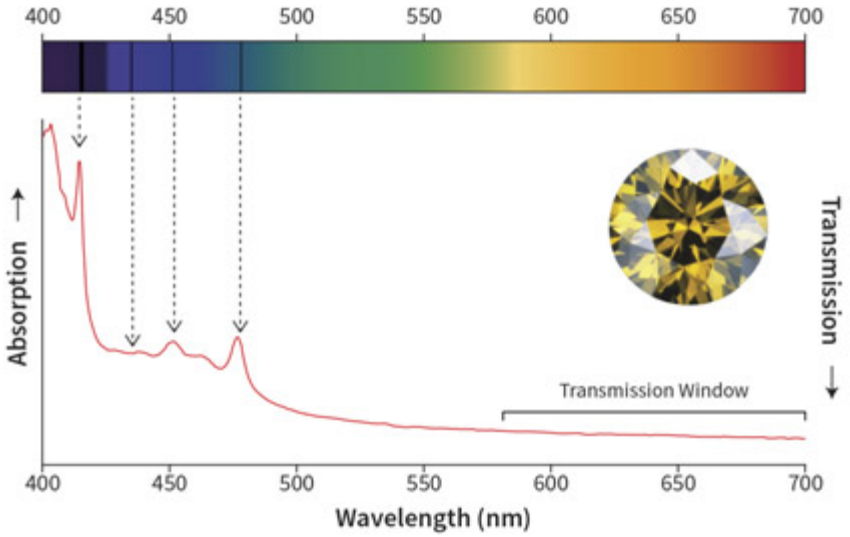
Most advanced testing methods measure a diamond's response to electromagnetic radiation. UV-Vis-NIR (ultraviolet/visible/near-infrared) absorption spectroscopy measures a diamond's absorption of visible light and portions of the ultraviolet and infrared regions close to the visible range. The highly sensitive instrument used to analyze a gem's radiation absorption is called a *spectrometer*. This instrument provides an accurate wavelength position for each peak and records features outside the visible range. Many instruments for UV-Vis-NIR spectroscopy are available on the market.

Spectrometer—A highly sensitive instrument that analyzes a gem's radiation absorption.



Eric Welch/GIA

A UV-Vis-NIR spectrometer used in GIA laboratories.



Russel Samson/GIA

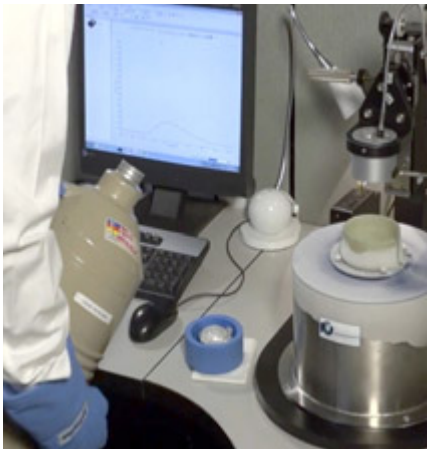
Comparison of output from a spectroscope (top) and a spectrometer (bottom) for a yellow diamond. The arrows point to the absorption peaks and show how they correspond to the absorption lines and bands.

As light is absorbed or transmitted by a diamond, a signal is sent to the spectrometer. The results are displayed on the computer on a linear graph known as an absorption spectrum. This graph shows which wavelengths are absorbed and how much energy is absorbed.

An instrument called a spectroscope can also reveal a diamond's absorption spectrum. Instead of the broad curves and sharp peaks seen in a spectrometer's absorption spectrum, a spectroscope reveals a pattern of broad bands. A spectroscope is much less sensitive than a spectrometer.

Prior to analysis of the diamond by the UV-Vis-NIR spectrometer, liquid nitrogen is used to cool the stone to -196°C. Diamond's physical properties make cooling to this temperature possible; this will damage other stones. Cooling the diamond sharpens the spectral absorption peaks and allows gemologists to identify the optical defects in the diamond. For example, at room temperature a spectrum might show a broad absorption at around 500 nm, but at -196°C, a sharp peak is at 503.2 nm. This level of precision allows gemologists to determine that the diamond contains the H3 defect and better identify it.

The UV-Vis-NIR spectrometer can test only one diamond at a time. First a background scan collects data from the environment. Then the diamond is analyzed, and the computer generates the diamond's absorption spectrum by subtracting the initial background scan data. The test is fairly quick—only a few seconds per diamond.



GIA

Liquid nitrogen is used to cool diamonds for analysis in a UV-Vis-NIR spectrometer.

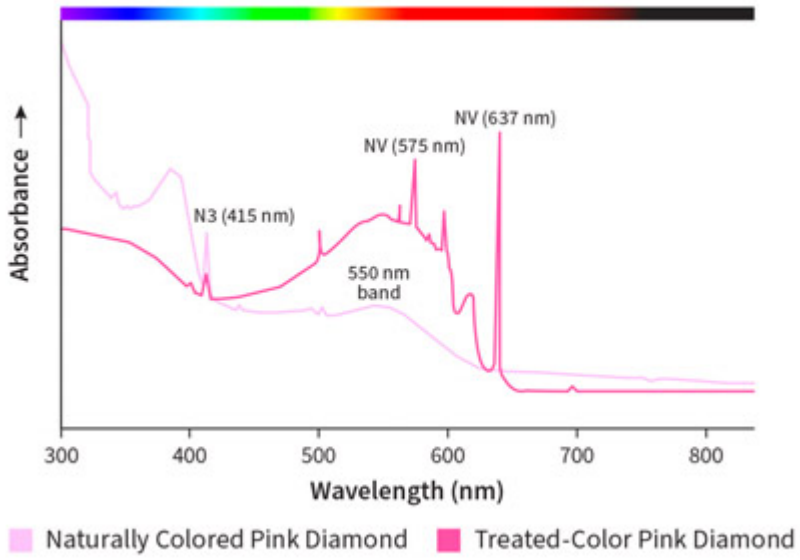
Color Cause Determination

Because natural-color diamonds have high commercial value, distinguishing them from treated diamonds is essential. This can be a significant challenge. Gemologists use UV-Vis-NIR absorption spectroscopy along with other advanced tests and microscopic examination to make the determination.



Robert Weldon/GIA and Orasa Weldon

Gemologists use UV-Vis-NIR absorption spectroscopy along with other advanced tests and microscopic examination to distinguish natural-color diamonds from treated diamonds.



Christopher Bonine/GIA

These UV-Vis-NIR spectra show the difference between treated-color and natural-color pink diamonds. The treated diamond shows various sharp absorption peaks in the 500–650 nm region, while the natural stone shows one broad absorption band in the same region.

KEY CONCEPTS

UV-Vis-NIR absorption spectroscopy is vital for colored diamond identification.

UV-Vis-NIR absorption spectroscopy is vital for colored diamond identification because it assists gemologists in determining the color centers responsible for a diamond's color.

For example, treated pink or purplish pink diamonds typically show some combination of sharp absorption peaks. This is true whether they're irradiated natural diamonds or lab-grown diamonds that were originally yellow or brown. Natural pink diamonds typically show absorption centered at approximately 550 nm. The vast differences between the two absorption spectrums make conclusive identification of the diamond straightforward.

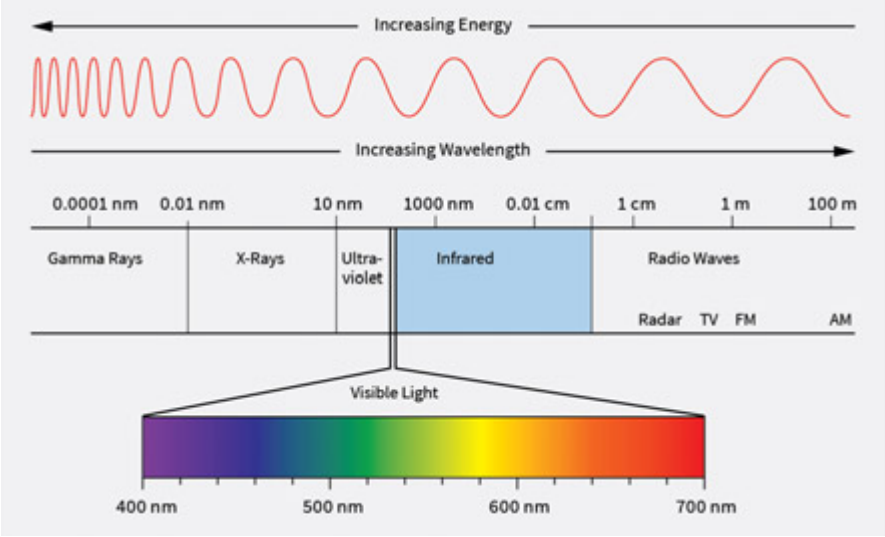
Infrared Spectroscopy

A Fourier-transform infrared (FTIR) spectrometer measures a diamond's absorption of infrared energy and portions of the visible and radio wave regions of the electromagnetic spectrum. One major advantage of an FTIR spectrometer is its speed: It provides results in a fraction of a second. Other IR technology might take 20 minutes or more to record a single spectrum.

An FTIR spectrometer measures and records what portion of energy within the infrared range is absorbed by a diamond. A computer interprets the reading and transforms it into an absorption spectrum. Similar to a UV-Vis-NIR absorption spectrum, an FTIR absorption spectrum indicates which wavelength of energy is absorbed and how much is absorbed. The portions of the infrared region most relevant for gemology occur at wavelengths of 4000–9000 nm.

KEY CONCEPTS

Fourier-transform infrared (FTIR) spectroscopy measures a diamond's absorption of infrared energy.



Russel Samson/GIA

An FTIR spectrometer measures a diamond's absorption of infrared energy and portions of the visible and radio wave regions of the electromagnetic spectrum (blue rectangle).



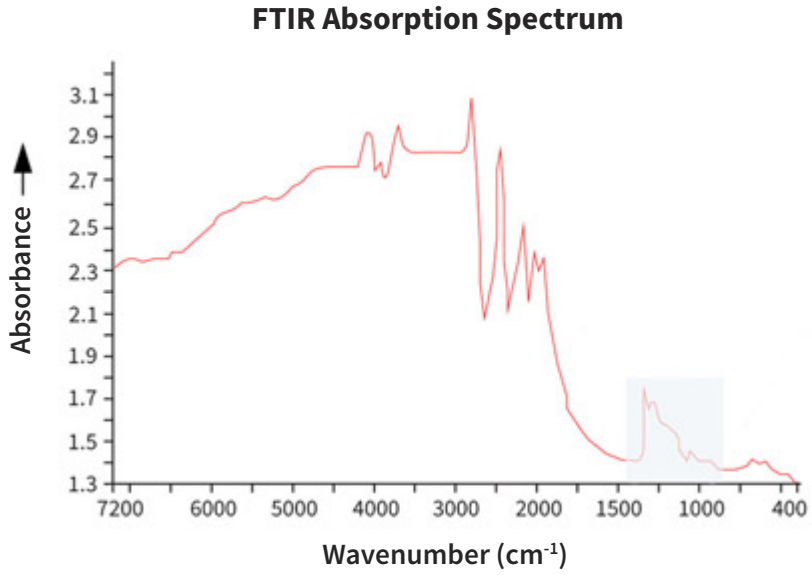
Kevin Schumacher/GIA

An FTIR spectrometer used to test a stone in GIA's Carlsbad lab.



Kevin Schumacher/GIA

A stone is positioned in an FTIR spectrometer for analysis.



GIA

An FTIR absorption spectrum highlighting a portion of the IR range important to gemologists.

Gemologists often convert wavelengths to wavenumbers on the IR absorption spectrum for convenience. A wavenumber describes the number of waves in a unit distance. Like the wavelength, it is also an indicator of energy. The larger the wavenumber, the higher the energy it represents. Some defects in diamond are detectable only in the infrared region. For example, nitrogen aggregates may be present in a diamond in large quantities, but they absorb energy only in the infrared and not in the visible range, so a diamond with those high amounts of nitrogen is still colorless. FTIR spectroscopy can also detect isolated nitrogen, isolated boron, hydrogen-related defects, and more.

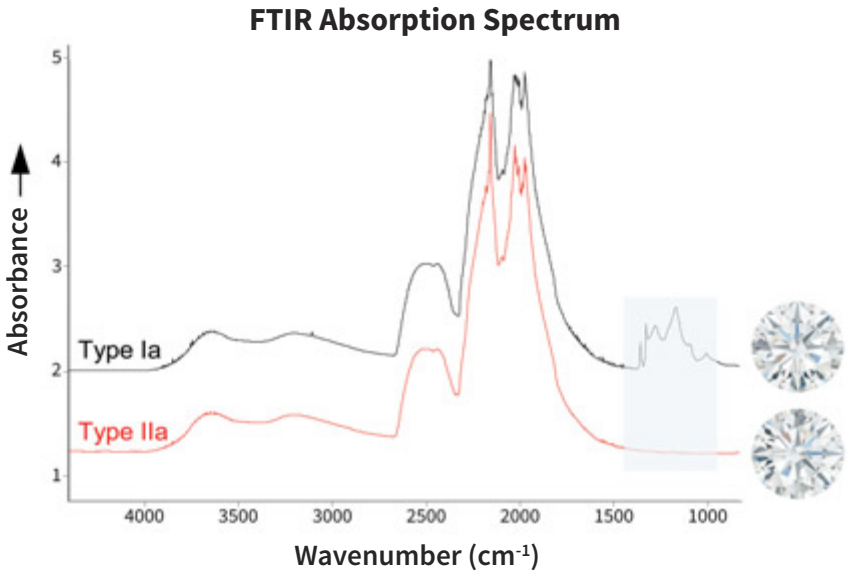
Liquid nitrogen is sometimes used to cool the temperature of the diamond to -196°C, which sharpens the spectral absorption peaks. The FTIR spectrometer can test only one diamond at a time. A background scan is run to collect data from the environment before a diamond is analyzed.

Many FTIR spectrometers are available in the market today. GIA's DiamondCheck instrument is one that is easy to use, conveniently sized, and portable.



GIA's DiamondCheck is an FTIR spectrometer that is easy to use, conveniently sized, and portable.

GIA



GIA

Although these two diamonds look identical based on microscopic and visual examination, the mid-IR regions of their FTIR absorption spectra are quite different.

Diamond Typing

Infrared spectroscopy is the only way to accurately categorize a diamond by type. The presence or absence of absorption caused by boron and/or nitrogen—and whether the nitrogen is isolated or aggregated—in the infrared absorption spectrum of a diamond determines its type. Diamond type can reveal much about a diamond and its possible treatment and growth histories.

An infrared spectrometer can quickly determine diamond type and help separate colorless natural type Ia diamonds from the much smaller population of those that are treated or lab-grown.

The majority of natural D-to-Z diamonds (99 percent) are type IaAB and cannot be decolorized by HPHT processing. Natural type IIa or type IIb diamonds can undergo HPHT processing to reduce their brownish or grayish appearance, and the color origin of such diamonds should be confirmed by a gemological laboratory. Colorless CVD or HPHT lab-grown diamonds are type II.

Photoluminescence Spectroscopy

In gemology, luminescence (such as fluorescence and phosphorescence) is traditionally detected by the eye with a lamp as the light source. Photoluminescence (PL) spectroscopy operates on similar principles: It measures the light emitted by the diamond with more detail and higher detection capability.

All diamonds contain defects. PL spectroscopy allows for extremely precise detection of trace concentrations of these defects. This method is unmatched by other nondestructive characterization techniques. While most other techniques have sensitivity at the parts-per-thousand or parts-per-million level, PL spectroscopy measures defects with parts-per-billion sensitivity. PL spectroscopy can identify defects that might go undiscovered with classic UV-Vis-NIR and FTIR spectroscopy. Therefore, PL analysis has become an essential part of the diamond identification process in gem laboratories.

KEY CONCEPTS

The presence or absence of absorption caused by boron and/or nitrogen within a diamond's infrared spectrum—and whether the nitrogen is isolated or aggregated—determines its diamond type.

Photoluminescence spectroscopy allows for extremely precise detection of trace concentrations of defects, which is unmatched by other nondestructive characterization techniques.



GIA

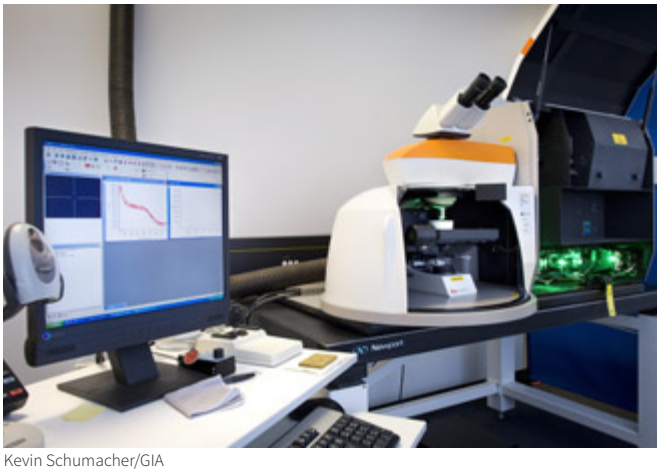
PL spectroscopy is used for diamonds that require more precise testing than others, like these CVD lab-grown diamonds.

KEY CONCEPTS

Photoluminescence spectroscopy examines light emitted by a diamond after exposure to a high-power laser.

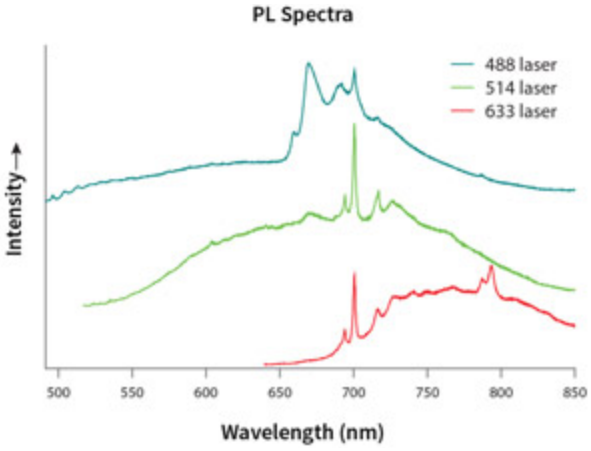
PL spectroscopy uses a high-power laser, a microscope, a high-resolution spectrometer, and a computer. The laser used is based on the defects the gemologist is looking for (shown as peaks on the resulting spectrum). The laser is directed to a diamond through a microscope. The resulting luminescence—light emitted by the diamond—is measured by a high-resolution spectrometer. A computer transforms the reading into a spectrum that indicates what wavelength of energy is emitted and how much. A graph displays the spectrum as wavelength in nanometers (horizontal axis) versus intensity (vertical axis).

PL spectra are typically acquired using lasers across the UV/visible/near-infrared region. The laser will always have a greater energy than the light emitted by the diamond (or a smaller wavelength than the light emitted by the diamond). That is, a 514 nm laser will not activate the N3 center in diamond at 415 nm but can excite the negative nitrogen-vacancy center defect at 637 nm. Also, certain defects are more excited by particular laser wavelengths. For example, most PL peaks in the 900–1000 nm range are more intense when activated by an 830 nm laser than by a 325 nm laser.



Kevin Schumacher/GIA

A photoluminescence spectrometer in GIA's Carlsbad lab.



Christopher Bonine/GIA

Three different lasers were used with a PL spectrometer to test a single diamond. Some peaks on the spectrum are more prominent with different lasers because certain defects are more excited by particular laser wavelengths.



Robert Weldon/GIA

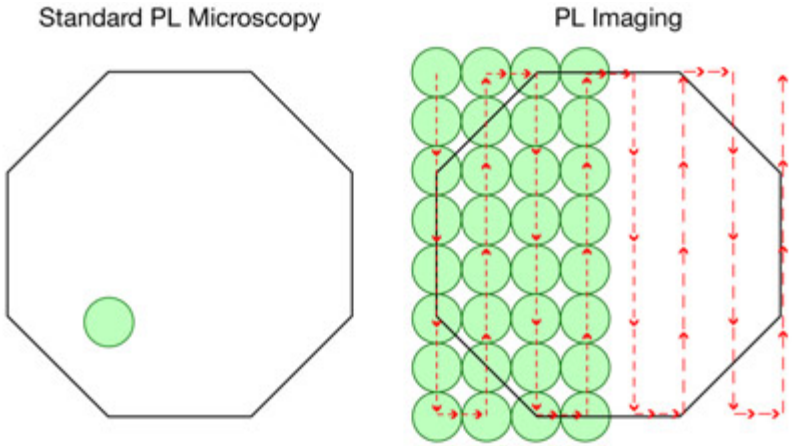
A high-power laser is directed to a liquid nitrogen–cooled diamond through a microscope.

PL spectroscopy, like UV-Vis-NIR spectroscopy, requires the diamond to be cooled with liquid nitrogen for the best results. Only one diamond can be tested at a time, and only one laser can be used at a time. The diamond is typically set in the table-up position, and the scan is run across the entire selected wavelength range. The resulting spectrum allows gemologists to see the wavelengths emitted, which indicate the particular defects in the diamond.

Photoluminescence Mapping

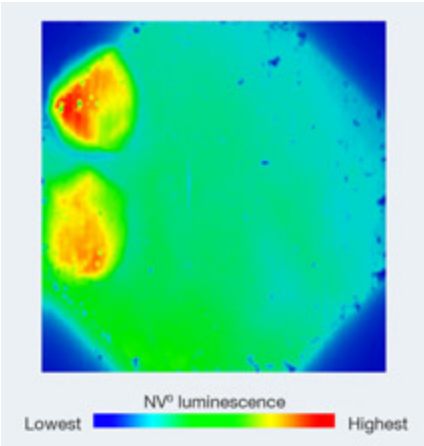
FTIR absorption and UV-Vis-NIR absorption typically sample the entire diamond and provide a result that is an average of the entire stone. PL measurements sample only a small portion of the diamond and only a few microns deep. Because of this difference, gemologists are able to collect and map PL data across the entire surface of a diamond. This technique shows subtle distinctions in defect concentrations and is known as *photoluminescence mapping*.

Photoluminescence mapping—A spectroscopy technique that collects PL data across the entire surface of a diamond, showing subtle distinctions in defect concentrations.



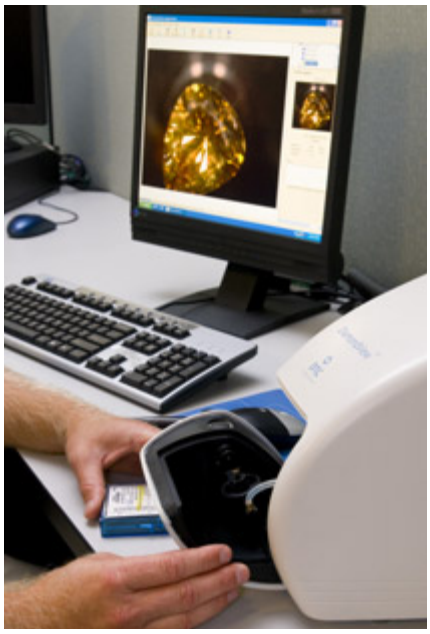
GIA

With standard PL microscopy, a single spot (green circle, left) is analyzed and represents only a small volume of the actual sample. With PL mapping, numerous spots are collected in a raster pattern (dashed red arrows, right), and the data are interpolated and combined to produce a PL map. (Spot size is not to scale.)



GIA

The distribution and high concentration of NV defects on the table of a pink diamond, seen in this PL map, revealed the diamond was irradiated prior to annealing.



Kevin Schumacher/GIA

A yellow diamond is analyzed in a De Beers DiamondView.

KEY CONCEPTS

While most diamonds do not fluoresce to shortwave or longwave UV, all diamonds show fluorescence at the ultra-shortwave UV wavelength.

The DiamondView imaging microscope operates at a lower wavelength and higher energy than the ultraviolet light typically used for fluorescence observations in routine gemological work.

PL mapping takes about four minutes per diamond. It is ideal for rapidly determining the distribution of optical defects resulting from both diamond growth and treatments. There is a definite correlation between optical defects and growth sectors. PL mapping allows gemological labs to identify lab-grown diamonds and color treatments, even with continued advancements in synthesis and treatment technologies.

High-Energy UV Imaging

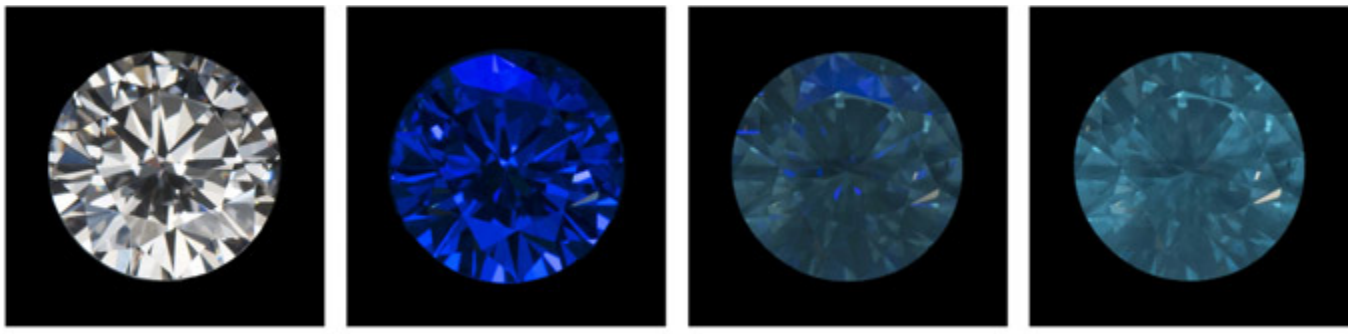
While most diamonds do not fluoresce to shortwave or longwave UV, all diamonds show fluorescence at the ultra-shortwave UV wavelength (about 225 nm—sometimes referred to as deep UV). The DiamondView imaging microscope operates at the level of ultra-shortwave UV radiation. This is a lower wavelength and higher energy than the 254 nm shortwave UV typically used for fluorescence observations in routine gemological work.

De Beers developed the DiamondView to distinguish natural from HPHT lab-grown diamonds in the mid-1990s. It provided a practical means of imaging growth-related fluorescence and has proven useful for CVD lab-grown diamonds as well.

The DiamondView shows fluorescence only from the near-surface region, not the entire diamond. It is ideal for revealing a diamond's growth patterns. The detail and contrast have made the instrument essential in gemological laboratories, as the quality of data cannot be duplicated by shortwave or longwave UV lamps.

The DiamondView incorporates a high-resolution camera, aperture and exposure adjustment, and safety mechanisms to protect the user from exposure to the high-energy radiation. The instrument is connected to a computer so the gemologist can see the images in real time. A vacuum keeps the diamond in place within the chamber.

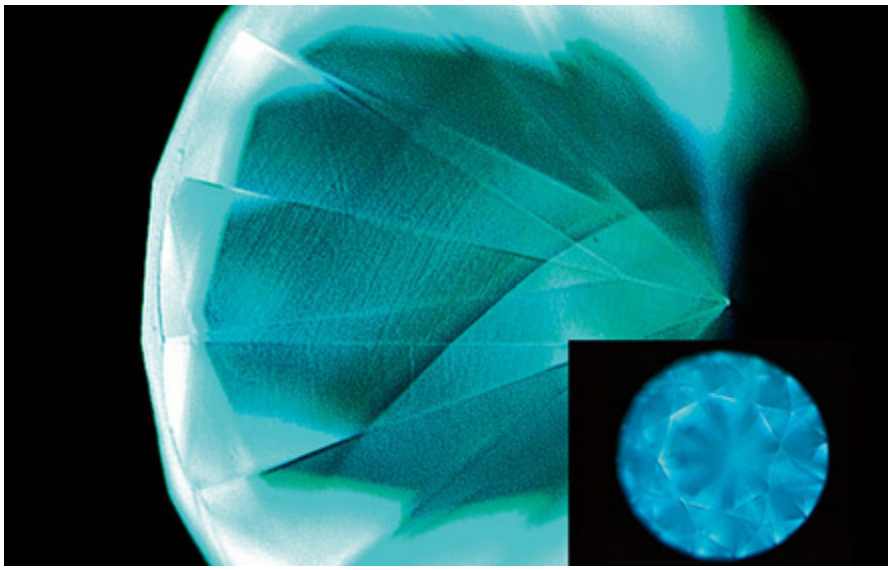
Depending on the orientation of the diamond within the DiamondView, fluorescent growth patterns may be visible. This is why it is important to take multiple images of the diamond in both the table-up and table-down positions.



White Light | LWUV | SWUV | DiamondView

Christopher Bonine/GIA

This near-colorless HPHT lab-grown diamond showed no fluorescence under longwave ultraviolet light and weak fluorescence under shortwave ultraviolet light. In the DiamondView it fluoresced a strong green-blue with a clear cuboctahedral growth pattern.



W. Wang/GIA

The DiamondView software indicates phosphorescence is present in this diamond (inset).

The *aperture*—the opening through which light enters the camera—must be adjusted for an acceptable field of view. If the aperture is very small, then the *exposure*—the amount of time light has to enter the camera—must be much longer, so there is a tradeoff to get the best results. The exposure should be long enough to see sufficient detail of the growth formations but not so long that the image is overexposed.

Aperture—Opening through which light enters a camera.

Exposure—The amount of time light has to enter a camera.

Once an image is collected, the software indicates whether phosphorescence is present. If so, phosphorescence mode, delay time, and exposure time can be selected.

Identifying Lab-Grown Diamonds

Natural diamonds can have a great variety of fluorescence colors and patterns when analyzed in a DiamondView. The vast majority show blue fluorescence, with most natural type Ia diamonds in the D-to-Z color range showing a pattern similar to tree rings. Most natural type II diamonds show a blue spiderweb pattern known as dislocation bundles.



Sally Chan/GIA



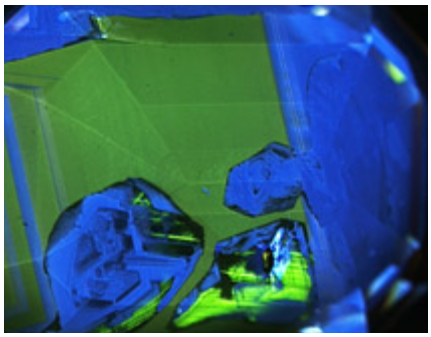
Sally Chan/GIA

The vast majority of natural diamonds show blue fluorescence when analyzed in a DiamondView, with most natural type Ia diamonds in the D-to-Z color range showing a pattern similar to tree rings.

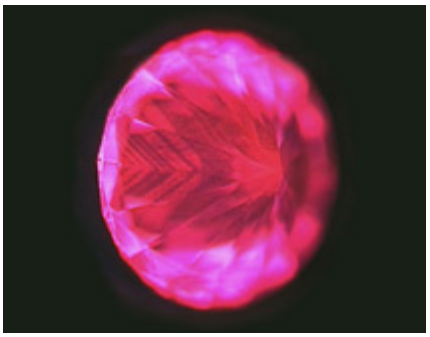


Christopher M. Breeding/GIA

This DiamondView image of a Fancy Deep blue 0.43-ct. HPHT diamond's pavilion clearly shows the cubic and octahedral growth sectors—resembling an hourglass—that indicate the stone was lab-grown.

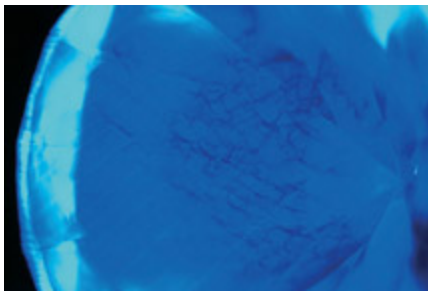


Troy Ardon/GIA

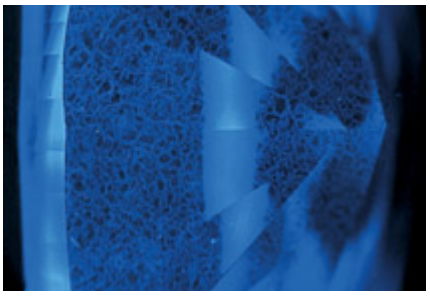


Wuyi Wang/GIA

Colored diamonds show a variety of colors and patterns in the DiamondView based on their color centers.

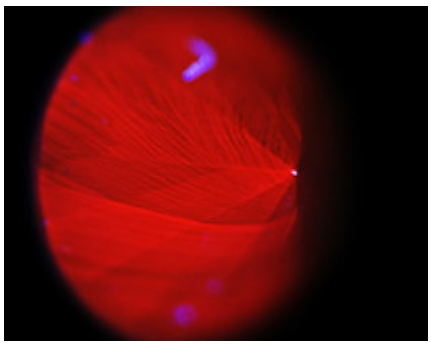


GIA

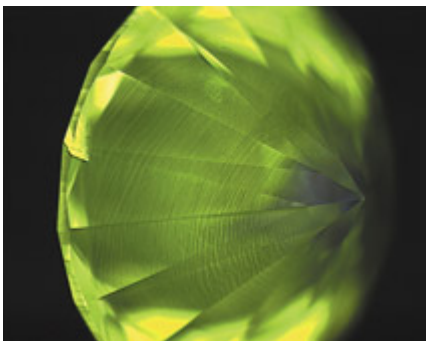


GIA

DiamondView images of natural colorless type IIa diamonds showing dislocation bundles.



Nicole Ahline/GIA



These DiamondView images reveal the characteristic growth striations of a CVD lab-grown diamond.

KEY CONCEPTS

The DiamondView is a reliable tool for identifying HPHT and CVD lab-grown diamonds.

The cuboctahedral growth structure of HPHT lab-grown diamonds is quite distinct from the octahedral structure of natural diamonds. In most cases it is clearly displayed in their fluorescence images. The fluorescence is most often seen as a pattern described as an hourglass.

CVD lab-grown diamonds fluoresce a variety of colors in the DiamondView. No matter the color, however, the most common and distinctive feature that indicates CVD lab-grown diamonds is striations. CVD lab-grown diamonds grow as a thin film, layer by layer, which generates terraces and risers. The striations are the edges of the risers.

A Brilliant Puzzle

While UV-Vis-NIR spectroscopy, FTIR spectroscopy, PL spectroscopy, and high-energy UV imaging are often used in conjunction to identify a single diamond, it is unusual to find that five diamonds may have come from a single piece of rough. It is even more remarkable when that piece of rough may have been an astonishing 2,774 cts.

In November 2015, Lucara Diamond Corp. discovered five large diamonds at its Karowe mine in Botswana. One was the largest gem diamond recovered since the Cullinan in 1905: the 1,109-ct. Lesedi La Rona. The other four included the 812-ct. Constellation and three colorless diamonds of 374, 296, and 183 cts.

Lucara claimed that the 374-ct. diamond was once attached to the Lesedi La Rona. It was believed that all five of these diamonds were one large piece of rough weighing at least 2,774 cts. before volcanic eruptions and/or mining processes split it up.



Jian Xin (Jae) Liao/GIA

The 812-ct. Constellation diamond.

Scientists at GIA had the opportunity to examine all five diamonds, some faceted and some rough. Using FTIR spectroscopy, the Lesedi La Rona rough was found to be a mixed-type diamond, containing both type IIa and pure type IaB regions. The Constellation and the 374-, 296-, and 183-ct. diamonds were determined to be type IaB, with nitrogen concentrations in agreement with the concentration for the type IaB pieces of the Lesedi La Rona.

Photoluminescence spectroscopy further confirmed similar defect content for the five large Karowe diamonds, including H4, H3, NV, and GR1 defects. Even for diamonds of the same type, parallel defect content and characteristics across such a variety of defects is unlikely for unrelated stones.

High-energy UV imaging was used to examine the internal growth structures of the samples. For the Constellation and the 374-, 296-, and 183-ct. diamonds, at least two growth zones with differing blue fluorescence intensities were observed within single pieces.

Due to the similarity in their visible characteristics—including cleavage faces, metallic inclusions, and iron oxide staining—and when the diamonds were mined, these five stones were thought to be related. But this was only speculation before the diamonds were subjected to advanced testing. Using a range of spectroscopic and imaging techniques to gain insight into their defects provided compelling evidence that these five diamonds were all pieces of a truly brilliant puzzle.

Summary

Standard gemological tools and practices are required for working in the diamond trade. When standard tools are not enough to identify a diamond, gemologists rely on the advanced instruments used in the laboratory. Some laboratory technology is also found in instruments that are commercially available, such as the DiamondCheck and DiamondView. Understanding how these instruments work is crucial for working in the trade. Remember that if you are uncertain of a diamond's origin, it's best to submit it to a gemological laboratory. They have the advanced equipment to ensure accurate identification of a diamond.

KEY CONCEPTS

Electronic scales are extremely accurate, but they must be set up correctly for best results.

The information gathered with advanced instrumentation can help conclusively identify a diamond.

Advanced testing results require further interpretation by experienced laboratory gemologists.

A UV-Vis-NIR spectrometer measures a diamond's absorption of visible light and portions of the ultraviolet and infrared regions close to the visible range.

UV-Vis-NIR absorption spectroscopy is vital for colored diamond identification.

Fourier-transform infrared (FTIR) spectroscopy measures a diamond's absorption of infrared energy.

The presence or absence of absorption caused by boron and/or nitrogen within a diamond's infrared spectrum—and whether the nitrogen is isolated or aggregated—determines its diamond type.

Photoluminescence spectroscopy allows for extremely precise detection of trace concentrations of defects, which is unmatched by other nondestructive characterization techniques.

Photoluminescence spectroscopy examines light emitted by a diamond after exposure to a high-power laser.

While most diamonds do not fluoresce to shortwave or longwave UV, all diamonds show fluorescence at the ultra-shortwave UV wavelength.

The DiamondView imaging microscope operates at a lower wavelength and higher energy than the ultraviolet light typically used for fluorescence observations in routine gemological work.

The DiamondView is a reliable tool for identifying HPHT and CVD lab-grown diamonds.

Key Terms

Aperture—Opening through which light enters a camera.

Diamantaire—A knowledgeable, experienced professional, typically a dealer or manufacturer, in the diamond trade.

Exposure—The amount of time light has to enter a camera.

Matching tray—A grooved white non-reflective tray used for matching sets of stones.

Photoluminescence mapping—A spectroscopy technique that collects PL data across the entire surface of a diamond, showing subtle distinctions in defect concentrations.

Scoop—A small shovel made of thin metal, used for picking up gems.

Sieve set—Set of circular plates, each punched with precisely sized holes, used for sorting small, round gems by size.

Sorting pad—A pad of white paper for sorting and showing gems.

Spectrometer—A highly sensitive instrument that analyzes a gem's radiation absorption.

Stone paper—A folded paper that comes in standard sizes used to hold and protect diamonds, as well as organize diamond inventory.

Questions for Review

- What tools are used to handle and sort diamonds?
- How are diamonds measured and weighed?
- What are some considerations when matching diamonds?
- When should a diamond be submitted for advanced testing?
- What advanced testing techniques are used in gemological laboratories?
- What testing techniques are used to determine color origin?
- What testing techniques are used to distinguish between natural and lab-grown diamonds?

Succeeding in the Marketplace

20

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Welcome to *Diamonds & Diamond Grading* Assignment 20. This assignment contains the knowledge required for you to:

- List factors that affect diamond pricing
- Describe the value of market awareness
- Describe sustainability in the diamond industry



wagnerokasaki/E+/Getty Images

A typical jewelry store display often includes finished jewelry and some loose stones.

Succeeding in the Marketplace

Over the last decade, the global diamond jewelry market has hovered at a value between 75 and 80 billion U.S. dollars. It's important to recognize the elements that contribute to success in a market this size. This assignment covers networking and developing market awareness, as well as what it means to promote a sustainable diamond industry. It also introduces tasks like reading price lists and how to best work with suppliers and customers.

Diamond Pricing

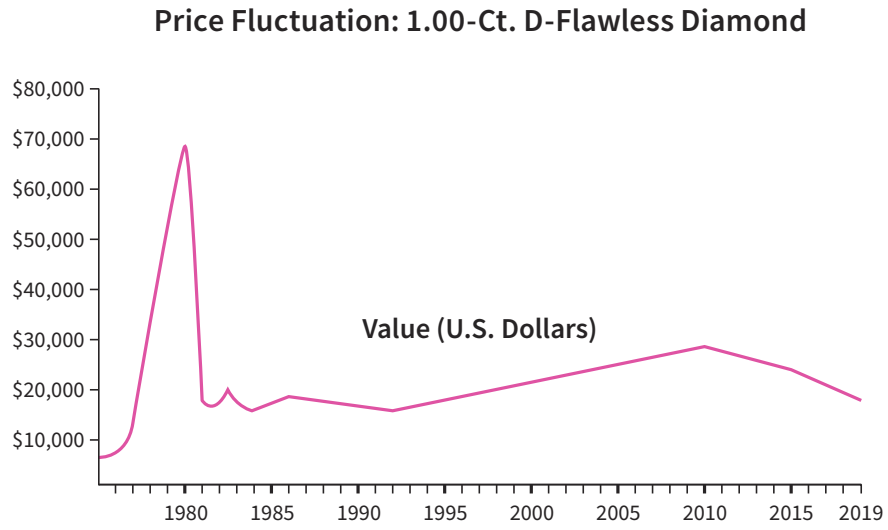
- What factors influence the price of a polished diamond?
- How do payment terms affect price?
- How does lab-grown diamond pricing differ from natural diamond pricing?

The relationship between the 4Cs, rarity, and value affects how diamonds are priced in the marketplace. The diamond industry is constantly changing.



Fuse/Corbis/Getty Images

Success in the marketplace is dependent on relationships with customers and suppliers.



Christopher Bonine/GIA

From 1979 to 1980, a 1.00-ct. D-Flawless diamond rose in price from $10,000 to over $60,000.

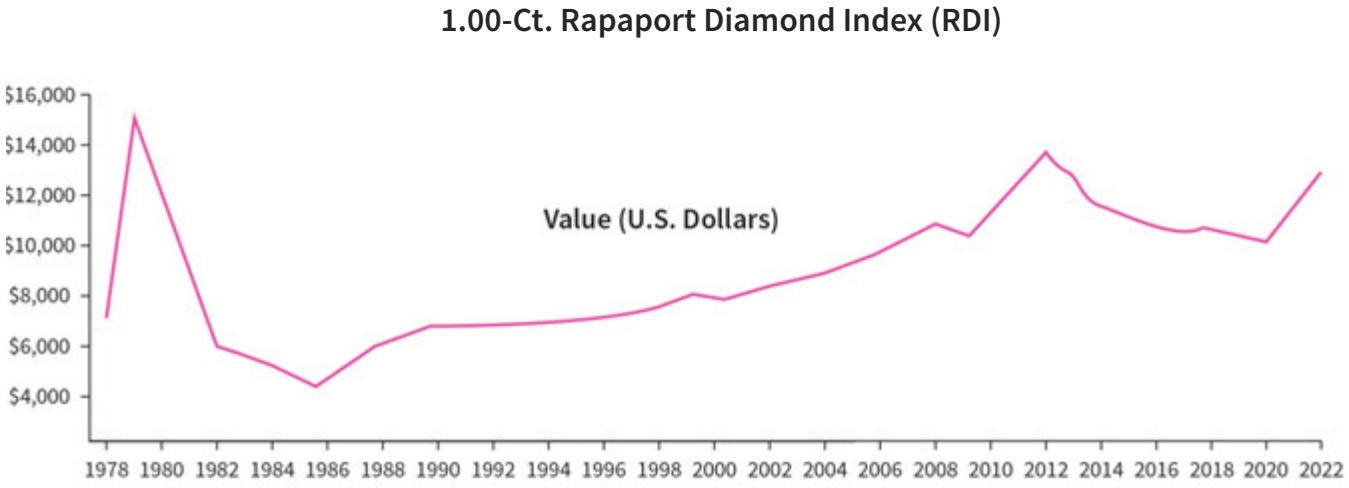
KEY CONCEPTS

Fluctuations in the diamond market often occur as a result of world events.

Mines open and close, cutting centers react to changes in demand, markets shift, and world events cause major fluctuations in the diamond market.

For example, in the late 1970s, speculators began investing in diamonds. The speculation drove the price of a 1.00-ct. D-Flawless diamond from $10,000 to over $60,000 in less than two years. When the investment boom ended, prices fell to a more reasonable level. In the following years, prices stabilized and, aside from dips during global economic recessions, have gradually trended upward. In 2012 prices seemed to peak; since then they have gradually trended downward.

This event and many others illustrate why it's important to understand how the market operates and to stay informed about what's happening in all segments of the industry.



Christopher Bonine/GIA

The Rapaport Diamond Index shows average prices for 1.00-ct. round, D-to-H color, Internally Flawless to VS_2 diamonds.



Express Newspapers/Hulton Archive/Getty Images

Provenance can affect the price of a polished diamond. The Elizabeth Taylor Diamond, a spectacular D-color, 33.19-ct. diamond ring, fetched US$8,818,500 against a presale estimate of $2.5–3.5 million, a record per-carat price for a colorless diamond.



Image courtesy ItsHot.com

The labor, craftsmanship, and design required to create a piece like this may increase its price significantly above the costs of the diamonds and precious metal used to make it.

Polished Diamonds and Diamond Jewelry

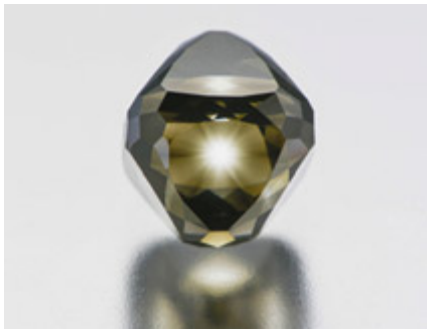
While the Four *C*s largely determine a polished diamond's value, other factors might influence its retail price, such as brand recognition, provenance, design, manufacturing costs, and unique inclusions. In the jewelry industry, *provenance* is the origin and history of ownership of a gemstone or piece of jewelry. Diamond jewelry with a significant or distinguished provenance typically commands a higher price.

A diamond goes through many stages before it reaches the consumer, and its price rises at each stage. From the mine to the final consumer, every organization or individual involved seeks to profit each time the diamond is bought and sold. Profit margins vary widely from segment to segment. The highest profit margins are gained at the upstream and downstream segments, while midstream companies survive on a thin average margin of 1 to 3 percent.

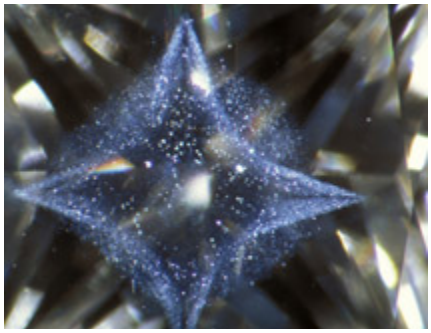
KEY CONCEPTS

Factors other than the 4*C*s can affect the retail price of a polished diamond or diamond jewelry.

Provenance—In the jewelry industry, the origin and history of ownership of a gemstone or piece of jewelry.



Jian Xin (Jae) Liao/GIA



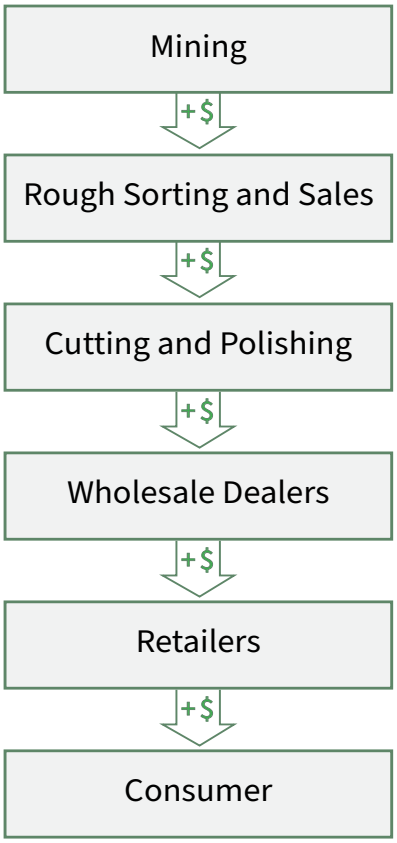
John I. Koivula/GIA

Unique inclusions influence price when a diamond is cut correctly. The Rare Sun diamond (left), a 5.24-ct. Fancy Dark yellowish brown modified octahedron, has an eye-visible inclusion resembling a star and its rays. Under fiber-optic illumination, this stellate cloud (right) is bright and beautiful, with a stunning symmetrical design.



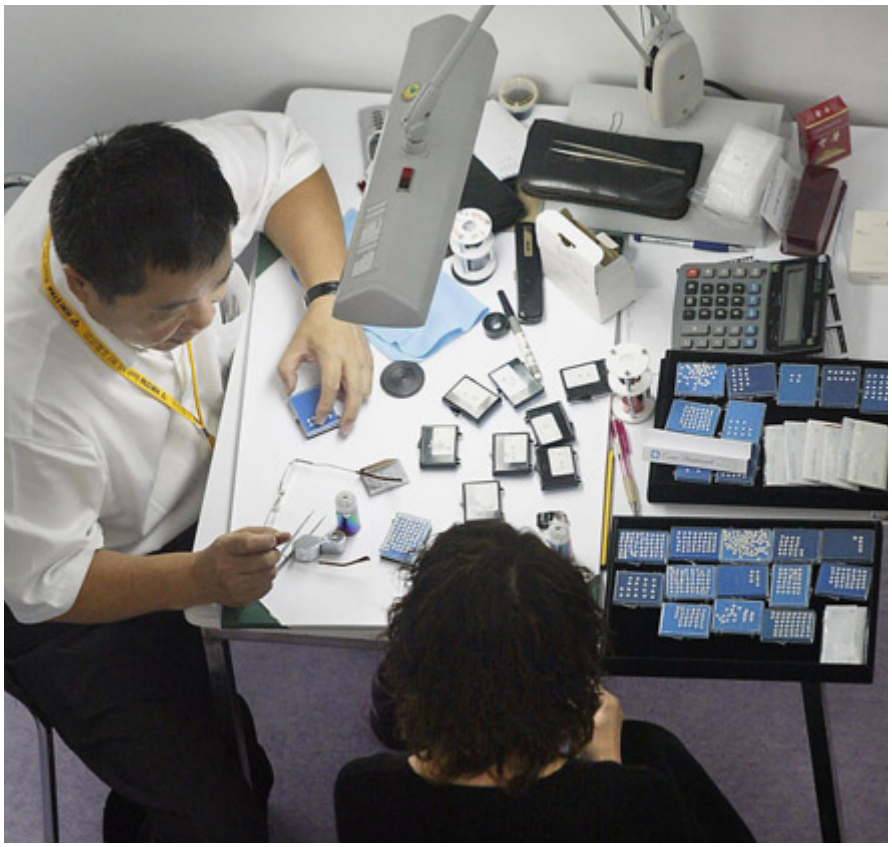
Rahaminov Diamonds

Many factors beyond the diamond's price contributed to the value of this ring.



Christopher Bonine/GIA

Each time a diamond changes hands in the supply chain, its value increases.



Laurent Fievet/AFP/Getty Images

A diamond trader chats with a buyer during a trade show.

For a three-stone diamond ring, for example, there are costs related to mining, refining, and alloying the metal. There are also costs associated with designing, manufacturing, and branding the ring, as well as labor related to buying and setting the stone. Also included are the costs of shipping the jewelry from the manufacturer to the dealer, and from the dealer to the retail store.

The value of the ring rises if it is from a recognized designer. If the center stone is a branded cut, and the two side stones are well cut and carefully matched, the value increases even more.

Wholesale Prices

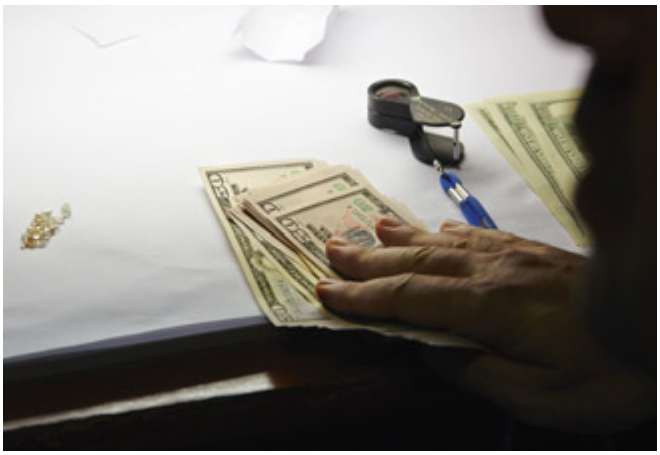
KEY CONCEPTS

Dealers usually offer better prices for immediate payment in full.

Terms of payment—Conditions of a sale agreed upon between buyer and seller stating how and when an invoice is to be paid.

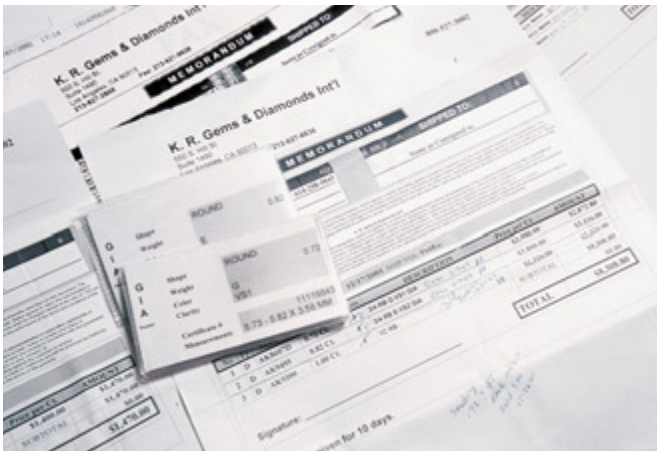
Many factors determine what a wholesaler might charge for a diamond. Several involve the way diamonds are purchased and paid for. Buyers who pay immediately and in full usually receive the best price. The reason is relatively simple. Diamond wholesalers or "dealers" usually borrow money from banks or private lenders in order to finance their own purchases. If a customer takes a longer time to pay, the dealer must pay additional interest to the bank while waiting for the customer to settle the account.

Some dealers may offer the option to make multiple payments over a specific time period. This type of agreement might be referred to as the *terms of payment*, often shortened to "terms." For example, the terms might state that payments be made 30, 60, and 90 days from the initial purchase date and the invoice be paid in full by 90 days ("net 90").



Olivier Polet/Corbis/Getty Images

Buyers who pay immediately and in full receive a better price.



Joel Beeson/GIA, courtesy K.R. Gems & Diamond International

Wholesalers sometimes offer diamonds on memo.

Buying on terms benefits both the buyer and the wholesaler. For buyers, it offers the opportunity to have the goods in their hands and thus the ability to sell them immediately. For the wholesaler, they are able to charge a higher price than if the buyer paid up front, which may result in higher net profits and a steady revenue stream over time. This is not without risk to the wholesaler, so establishing trust between parties is an incredibly important part of buying and selling in the diamond market. The stronger a retailer's relationship is with a wholesaler, the more likely the retailer is to be offered flexible terms.

Wholesalers often charge higher prices if they're selling on terms, memo, or consignment. In these cases a supplier sends goods to a client without requiring immediate payment. *Memo*—short for memorandum—is typically a buying agreement in which the supplier entrusts goods to a potential buyer without requiring immediate payment. In some cases, a memo agreement may be made for the client to inspect the goods without necessarily intending to buy. The agreement is made with the expectation that either the goods or a payment will be returned quickly. The length of time may vary depending on the relationship between the supplier and buyer, but it is often between 7 and 14 days.

Memo—A short-term agreement in which a dealer entrusts goods to a client without requiring immediate payment.



Alexander Ryumin/TASS/Getty Images

Memo arrangements are a way for designers to show their clients stones they don't have in inventory and for wholesalers to offer stones for sale. Trust is essential in the relationship between wholesaler and designer.

KEY CONCEPTS

Establishing trust between parties is an important part of buying and selling in the market.

Consignment—A long-term agreement in which a dealer or manufacturer loans goods to a retailer.

Consignment transactions—when a wholesaler or manufacturer loans a selection of goods to a dealer—are more open-ended. A supplier might offer a dealer a parcel and request a payment or a return of the unsold goods in one or two months.

Some designers and jewelry manufacturers offer finished jewelry on consignment. A small designer might offer one or two custom pieces, or a major manufacturer may offer dozens of mass-produced items.

Few independent jewelers have the financial resources to keep a large inventory of diamonds and jewelry on hand. For this reason, memo and consignment benefit both the retailer and the supplier. The retailer benefits from additional inventory to sell in their store. The supplier is able to put their diamonds or jewelry on display with retailers without requiring the retailers to purchase them. If they sell, the supplier can often collect a higher price than if the diamonds were purchased outright. If they don't sell, they're returned.

Whether working with memo or consignment transactions, it's important that both parties understand and agree to the terms of the agreement. Sending payment and returning goods on time is imperative to maintaining good working relationships.

Wholesale Price Lists

Estimated wholesale diamond price lists are important in the diamond industry. The methods for arriving at these estimated prices vary.

Some price lists are based on recent transactions, while some are based on the price at which almost any dealer would agree to sell, called the high asking price. The first successful price sheet, the Rapaport Diamond Report, lists the "approximate high asking price" in New York. Other price lists use the selling prices from computer trading networks, and some are based on the prices paid in a bourse. The publisher of each list typically states which market the prices are based on and how the figures were derived.



Joel Beeson/GIA, courtesy K.R. Gems & Diamond International

Published wholesale price lists are valuable tools that many dealers use to help determine diamond value.

Cut plays a role in published price lists. Dealers know they pay a premium for high-quality cutting. Most price lists do not show the proportions and finish of a diamond, but they usually suggest a premium for top-quality makes and a discount for below-average ones.

Most price lists quote *per-carat prices*. Some state them as whole numbers, so "3600" means $3,600 per carat, while others list it in hundreds, so "36" means the same thing.

KEY CONCEPTS

Most price lists quote per-carat prices.

Per-carat price—The price of a gem divided by its carat weight.

Sample Price List

Different price lists have various ways of listing the combination of quality factors that determine a diamond's price. The title of this sample price list indicates that these prices are for round diamonds between 1.00 and 1.49 carats. It also states that the prices are in hundreds of U.S. dollars per carat. Within the table, color is listed on the left and clarity across the top.

To find the wholesale price of a 1.32-ct. G-color VS_2 diamond, look down the VS_2 column to find the number in the G row, which is 83. Because the list quotes the prices in hundreds, multiply 83 by 100 to get the per-carat price of $8,300. Then multiply the per-carat price by the stone's weight (8,300 x 1.32) to get a wholesale price of $10,956 for this particular diamond.

Rounds: 1–1.49 cts., Prices in Hundreds of US$ per Carat (January 2020)

	IF	VVS_1	VVS_2	VS_1	VS_2	SI_1	SI_2	I_1	I_2	I_3
D	180	155	136	119	105	86	70	47	27	17
E	145	134	117	108	96	82	67	45	26	16
F	127	120	107	102	90	79	64	44	25	15
G	107	102	95	90	83	74	60	42	24	14
H	90	85	82	80	76	68	57	40	23	14
I	76	72	70	68	66	62	53	36	22	13
J	63	61	60	59	57	53	48	33	20	13
K	53	51	49	47	45	43	39	31	18	12
L	48	46	45	43	41	38	35	29	17	11
M	43	41	39	38	36	34	30	26	16	11

Noting Diamond Size in Quarters

Some price lists use a type of shorthand to express carat weights between 0.25 and 1.50 cts. This shorthand is based on multiples of four.

Shorthand	1/4	2/4	3/4	4/4	5/4	6/4
Approximate Carat Weight	0.25 ct.	0.50 ct.	0.75 ct.	1.00 ct.	1.25 cts.	1.50 cts.

The price listed on a price sheet doesn't mean that all diamonds of the same size and quality will sell for that price. A price sheet is, at best, an educated estimate of wholesale prices in a specified market at a given time. Regional preferences, local market conditions, and payment terms all affect prices. Understanding how your market compares to the prices stated in any given price list comes from experience.

Many dealers quote prices based on a percentage of the published list price. It's common to hear terms like "20 back of Rap" or "10 off Rap." "Rap" is industry shorthand for the Rapaport Diamond Report. When someone says "20 back of Rap," they mean 20 percent off the price listed in that publication. "10 off Rap" means 10 percent off the listed price. You will see these and other terms used in the industry.

Parcel Pricing

Dealers often assemble loose diamonds into parcels and offer the parcels at special per-carat prices. Parcels are carefully assembled and designed to be attractive to buyers. They usually contain a selection of diamonds that vary in color, clarity, and cut.

Lot price—A discounted price for buying an entire parcel or a substantial part of it.

Pick price—A premium price paid for selecting stones from a parcel.

Unlike large mid- to high-quality diamonds, which are usually sold individually, parcels are sold by *lot price*: a discounted price for an entire parcel or a large part of it. The advantage of buying a parcel is typically the price. Retailers or jewelry manufacturers who want to select a portion of the parcel pay a higher *pick price*. The price for an individual stone, whether purchased singly or as part of a parcel, is the unit price.

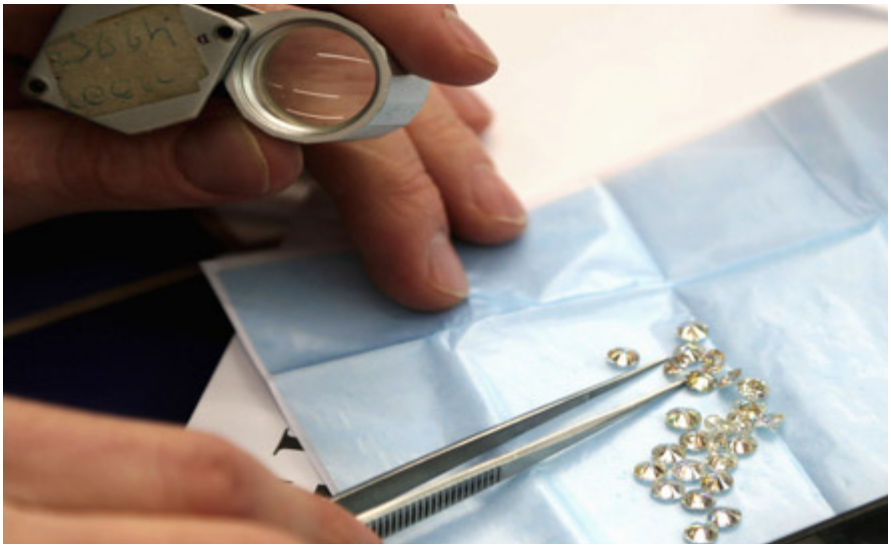
Number of Stones per Carat: Verbal Descriptions	Size Ranges
Ten per carat: "10 pointers"	0.09 to 0.11 ct.
Eight per carat	0.12 to 0.14 ct.
Six per carat	0.15 to 0.17 ct.
Five per carat: "Fifths," "20 pointers"	0.18 to 0.22 ct.
Four per carat: "Quarters," "25 pointers"	0.23 to 0.29 ct.
Three per carat: "Thirds"	0.30 to 0.37 ct.
"40 pointers"	0.38 to 0.45 ct.
Two per carat: "Light halves," "halves," "50 pointers"	0.46 to 0.59 ct. 0.46 to 0.49 ct. 0.50 to 0.59 ct.

The stones in parcels are often within a certain weight range. This chart shows typical ranges, along with verbal descriptions.



Jonathan Torgovnik/Getty Images

Dealers separate diamonds into parcels based on size, quality, color, clarity, and cut.



Xinhua/Chen Wenxian/Getty Images

Buyers can purchase entire parcels at a discount or select stones and pay a premium.

Diamonds in a parcel vary slightly in size, even though the parcel might be labeled with a specific size. For example, a parcel of 50-point stones might contain diamonds that range from 0.46 to 0.59 ct.

Often some of the smaller stones in a parcel have fairly high color grades, which might make the parcel's overall color look better. Larger stones in the parcel are likely to be lower in both color and clarity. If a dealer describes an inexpensive parcel as "white goods with clearly visible inclusions," the gems might represent H to I color and I_2 to I_3 clarity.

To accurately assess a parcel's value, sort the diamonds by size, and assess their color, clarity, and proportions against graded goods of similar size and quality. Then compare the prices of the diamonds in the parcel against a price list.

When you evaluate a parcel, consider how easily you can sell the diamonds in groups or individually. If you can sell them fairly quickly, the parcel might be a good buy. Sorting and grading a large parcel might be time-consuming, which means actual costs, including time and labor, might be a little higher. Consider this when calculating a price for the stones.

KEY CONCEPTS

Price lists estimate wholesale diamond prices in a specific market, so it's important to understand how those estimates relate to your market.

When you calculate the price of stones in a parcel, consider the time and effort involved in evaluating the parcel.

Parcel Pricing Example

Suppose a parcel of 100 rounds has a lot price of $650 per carat. The parcel weighs 25.53 carats, so the lot price is $16,595. Separated by size, the diamonds fall into three different weight ranges:

34 stones around 0.20 ct. each, totaling 6.47 carats

34 stones around 0.25 ct. each, totaling 8.70 carats

32 stones around 0.33 ct. each, totaling 10.36 carats

The next step is to grade these groups for clarity and color, and price each group by referring to a wholesale price list (below).

Approx. Wt.	Clarity	Color	Number	Total Weight (cts.)	List Price per Carat
0.20 ct.	VS	G–H	17	3.03	$1,130
0.20 ct.	SI	G–H	17	3.44	$950
0.25 ct.	SI	I–J	17	4.04	$970
0.25 ct.	I_1	I–J	17	4.66	$770
0.33 ct.	I_1	K–L	32	10.36	$800

Wholesale price list used in example calculations.

Multiply the per-carat list price by the carat weight for each group.

3.03 carats x $1,130 per carat = $3,423.90
3.44 carats x $950 per carat = $3,268.00
4.04 carats x $970 per carat = $3,918.80
4.66 carats x $770 per carat = $3,588.20
10.36 carats x $800 per carat = $8,288.00
List price for entire parcel **$22,486.90**

The next step is to compare this price with the lot price of $16,595. Divide the lot price by the total list price.

Lot Price ÷ List Price = Discounted Price (percent)

$16,595 ÷ $22,487 = 0.7379 (about 74 percent)

Calculate a per-carat price for each category by multiplying the per-carat list price by the percentage.

Per-Carat List Price x Discounted Price = Per-Carat Price

$1,130 x 0.74 = $836 per carat

Another way to evaluate the lot price is to calculate the difference between the lot price and the list price.

List Price – Lot Price = Price Difference

$22,487 – $16,595 = $5,892

Divide that difference by the list price for the discount percentage.

Price Difference ÷ List Price = Discount (percent)

$5,892 ÷ $22,487 = 0.2620 (about 26 percent)

Many dealers quote prices based on percentages of published price lists. In those terms, the price for this parcel is 26 percent "back of" the price sheet. Become familiar with price levels in your market so you can determine what is a good deal.

Lab-Grown Diamond Pricing

Before 2010, lab-grown diamond manufacturers sold their diamonds primarily for industrial purposes. With the technological advancements since then, manufacturers were able to produce gem-quality lab-grown diamonds. More competitors entered the market and began selling large volumes of lab-grown diamonds in the gem and jewelry industry. As a result, more pricing data became available.

In 2018, De Beers's synthetics division launched the new brand Lightbox, which sold its lab-grown diamonds at $800 per carat. This was the lowest retail price of any producer and set a new benchmark in lab-grown diamond pricing. At the time, a 1.00-ct. lab-grown diamond price averaged about $4,200, while an equivalent natural diamond sold for approximately $6,000.

Lightbox was one of the first lab-grown diamond brands to follow a cost-plus pricing model. In a *cost-plus model*, the final sale price is based on the cost of producing the product plus a small markup in order to achieve a profit. Prior to De Beers introducing cost-plus pricing, most lab-grown diamond producers used a model known as price skimming. In a *price-skimming model*, manufacturers charge the highest initial price that customers will pay and lower it over time as new competitors enter the market.

KEY CONCEPTS

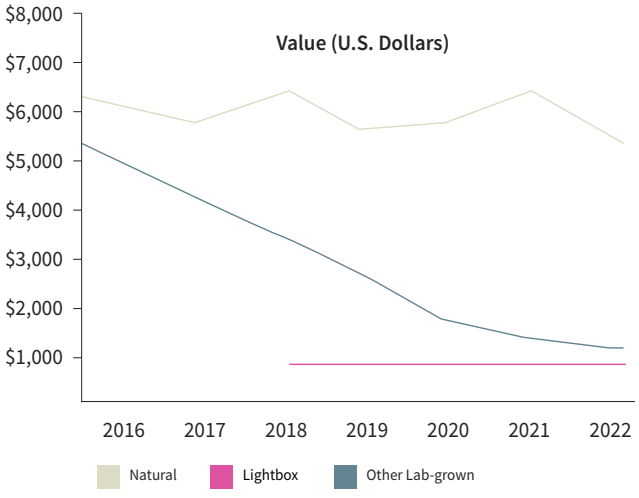
Become familiar with price levels in your market so you can assess a potential deal.

Lab-grown diamonds are priced at a significant discount to natural diamonds.

Cost-plus model—Model in which final sale price is based on the cost to produce the product plus a small markup.

Price-skimming model—Model in which manufacturers charge the highest initial price that customers will pay and lower it over time as new competitors enter the market.

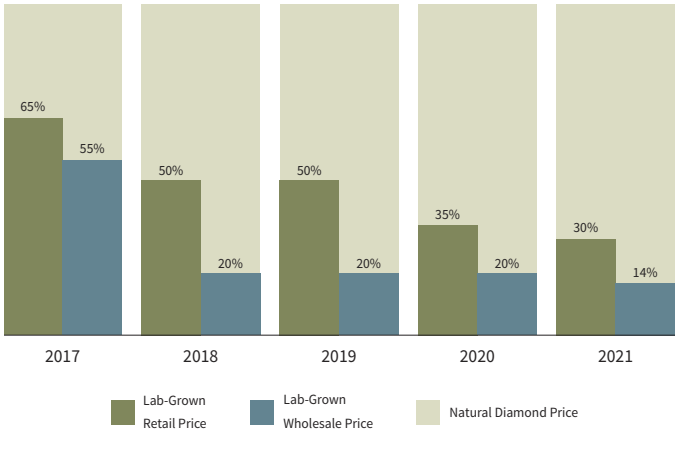
1.00-ct. Diamond Prices: Natural, Lightbox, and Other Lab-Grown



Christopher Bonine/GIA

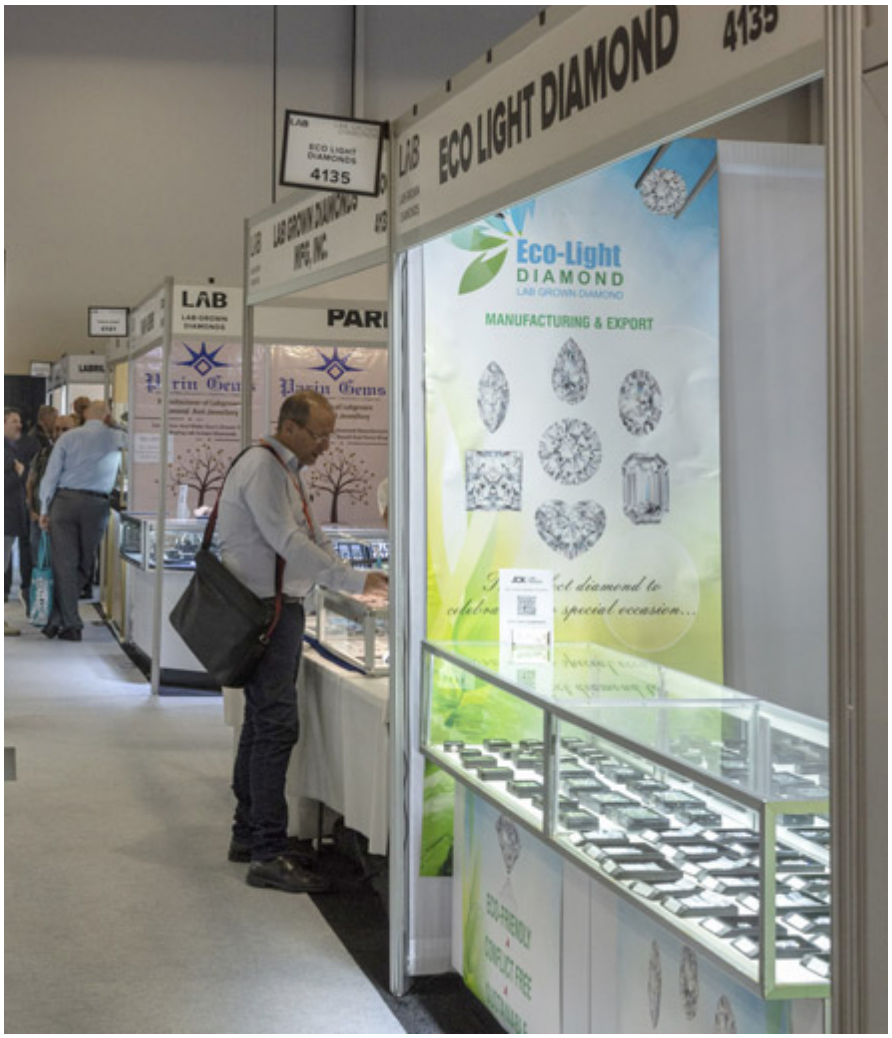
Prices of 1.00-ct. natural and lab-grown diamonds (2016–2022). Prices were somewhat competitive until 2018, when De Beers introduced the Lightbox lab-grown diamond line.

Diamond Pricing: Lab-Grown vs. Natural



Christopher Bonine/GIA

Retail and wholesale prices of lab-grown diamonds compared to natural diamonds (1 ct., G color, VS clarity).



Emily Lane/GIA

One of the many booths of lab-grown diamonds at JCK Las Vegas in 2019.

Currently, lab-grown diamonds are priced at a significant discount to natural diamonds. Most industry analysts project lab-grown diamond prices to trend downward as production costs decrease and new competitors enter the market.

Developing Market Awareness

- Why is market awareness important in today's diamond industry?
- How does market awareness help you succeed in the marketplace?
- How can you develop market awareness?

KEY CONCEPTS

Market awareness helps you make better decisions, generate new ideas, and solve problems more effectively.

Understanding pricing is only part of success in the marketplace. Economics, technology, and trends affect business, no matter the sector of the gem and jewelry industry. Market awareness means staying up to date with what's happening in the industry—to make better decisions, generate new ideas, and solve problems more effectively. Market awareness also includes anticipating customers' changing needs and understanding internal factors, such as your company's strategic goals.



Emily Lane/GIA

Knowing what's happening in your industry and the economy helps you anticipate your customers' changing needs.

One way to stay current with the industry is to follow trade publications, whether online or in print. Joining a trade organization, attending trade shows, and recognizing trends can also expand your market awareness. Networking can build relationships and help you learn about the industry.

Trade Publications

A great way to start developing market awareness is by following trade publications. A *trade publication* is a magazine, newspaper, journal, website, or other publication that shares information on news, trends, and other topics relevant to a specific industry. Many trade publications also publish lists of industry events. In the gem and jewelry trade, these publications include *National Jeweler*, *INSTORE Magazine*, *JCK*, and *Rapaport Magazine*. Many offer print subscriptions, online access, and daily e-mails with industry updates.

Trade publication—A magazine, newspaper, journal, or website that shares information on news, trends, and other topics relevant to a specific industry.



Emily Lane/GIA

Trade publications can help keep you informed about hot topics in the gem and jewelry industry.



Emily Lane/GIA

Networking can help you learn from other people's experiences and create a sense of community.

KEY CONCEPTS

Networking can provide opportunities to succeed within your industry.



Emily Lane/GIA

The recruiting area at GIA's Carlsbad Career Fair, 2019.

Networking

Networking—Exchanging information and developing contacts among people with a common professional or special interest.

Trade events provide an opportunity to network by exchanging information and developing contacts with people who share a common professional or special interest. *Networking* can help establish relationships and broaden professional horizons. For a retailer, networking might lead to new customers, suppliers, or business partners. For someone just starting out, the connections made through networking provide opportunities to succeed within the industry.



Kevin Schumacher/GIA

GIA alumnus H. “Gio” Giovanni, CEO/senior designer for BlackSmith Motoring Company, discusses building a jewelry brand in a fast-changing industry and the importance of being a visionary in a crowded market.



GIA

GIA Alumni Association chapters often organize events to give alumni an opportunity to connect and share knowledge. This event hosted by the San Diego chapter focused on estate jewelry.

Trade Organizations

To help expand your networking opportunities, consider joining a *trade organization*: a committee, club, society, or association of people invested in a similar purpose. Trade organizations can promote and establish standards, educate their members and the public, and promote economic growth within the industry. The Jewelers Vigilance Committee (JVC) is one example of a trade organization through which members can access education, guidance on legal compliance, webinars, and more.

Trade organization—A committee, club, society, or association in which a group of people, or members, are united for a similar purpose.

KEY CONCEPTS

Many trade shows offer educational seminars and panel discussions to help you stay up to date with the industry.

You might consider joining a trade organization with a strong local presence in your area or one that aligns with your goals.

After completing this course, you will be part of a large network of alumni and a member of the GIA Alumni Collective. Like many trade organizations, the GIA Alumni Collective has chapters—local branches—throughout the U.S. and the world. GIA Alumni Collective chapters are run independently. Chapter meetings offer opportunities to network and attend seminars about current gemological topics.

Trade Shows

Trade show—An event at which businesses promote and sell their products and services.

At *trade shows*, businesses come together to promote and sell their products and services. Many trade shows offer discounts or special "show prices." Trade shows provide an opportunity to network face to face with potential vendors and business partners. Some trade shows offer educational seminars and panel discussions to help you stay up to date with what's new in the industry.

Vendors rent exhibit space for the duration of the show. You do not need to be a vendor to participate in a trade show.



Emily Lane/GIA

Exhibitors at the 2020 AGTA GemFair in Tucson, one of the top trade shows in the industry.



Russell Shor/GIA

Trade shows provide an opportunity for vendors and attendees to network and interact, potentially fostering new business relationships.



Kevin Schumacher/GIA

Trade shows may offer educational seminars and panel discussions to help you stay up to date with the industry.

Popular trade shows in the gem and jewelry industry include JCK Las Vegas, JA New York, the Tucson Gem & Jewelry Show, and the Hong Kong Jewellery & Gem Fair. Not all trade shows are open to the general public, so you may be required to prove you are a member of the gem and jewelry trade.

There's a lot to see and do at trade shows, and it's easy to become overwhelmed. It's best to plan ahead by determining some objectives or tasks to accomplish before the show is over.

Prior to a show, it's a good idea to prepare a business card. Even if you are not currently employed, a card with your name and e-mail address is helpful to leave with a vendor if you find yourself short on time.



De Beers Diamond Promotion Service

One example of a trend is the princess cut, which has varied widely in popularity since the early 2000s.

Recognizing Trends

KEY CONCEPTS

Trends present lucrative opportunity if recognized early.

Trend—Something currently in demand or popular among consumers.

A *trend* is something currently in demand or popular among consumers. A short-lived trend may also be known as a fad. There are many trends in the diamond and jewelry industry. It is important to understand that trends fluctuate. In the span of 5 to 10 years, a particular diamond shape and cutting style might go from the most popular to least popular. For example, among fancy shapes, the demand for princess cuts has varied widely since the early 2000s.

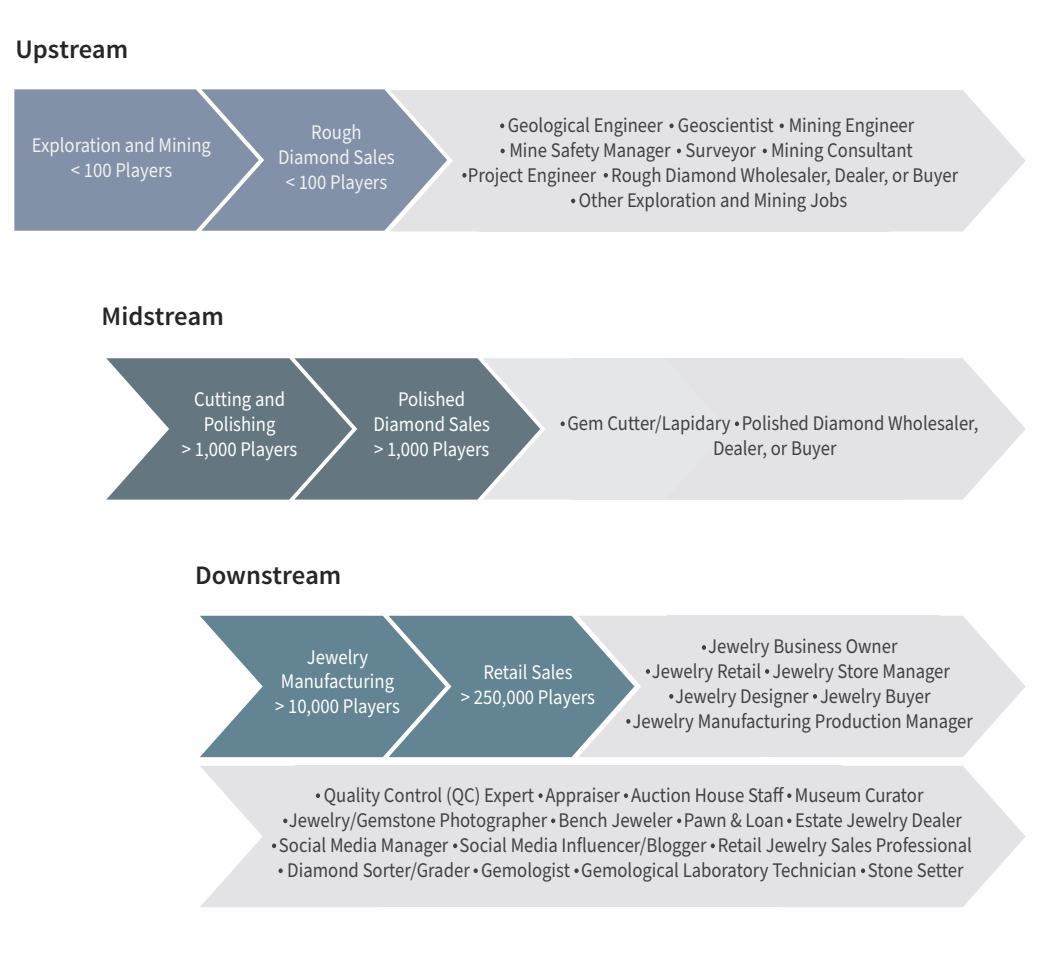
Trends present lucrative opportunity if recognized early. For example, when brown diamonds first became popular, the retail company Le Vian trademarked the term "Chocolate Diamond." Le Vian now has exclusive rights in countries across the globe to market their diamonds as "Chocolate."

Trends do not always benefit those that market based on them, especially if they were too late to recognize them. If you purchased a large inventory of a particular product that is now losing popularity, you might be stuck with inventory you can't sell. Fortunately, trends can repeat as time passes.

Careers in the Industry

Even in an uncertain world, there's a future for gemologists. With the growing popularity of diamond reports among consumers, there's demand for those who can grade stones. With advances in treatments and lab growth processes, there's a demand for those who can tell the difference between treated and untreated stones and between lab-grown and natural stones. And because information is essential, the industry needs people who know diamonds and can communicate that knowledge to others. These factors and more should assure holders of Graduate Diamonds (GD) and Graduate Gemologist (GG) diplomas from GIA that their skills will always be in demand.

Trade publications contain articles on industry trends, job requirements, and salaries. Job market events, like the annual Career Fairs at GIA, can also help in your search for career possibilities.



Christopher Bonine/GIA

In addition to jobs for gemologists, the gem and jewelry industry has career opportunities in many other areas.



Dave Brosha, copyright © 2016 Rio Tinto

An environmental technician conducts air quality monitoring near the Diavik mine.

KEY CONCEPTS

Sustainability in the gem and jewelry industry usually involves economic, environmental, and social considerations.

Sustainability—The ability to continue a specific behavior indefinitely.

Beneficiation—A commitment to reserve a portion of the resources derived from a country for the economic development of that country.



Russel Samson/GIA

In the gem and jewelry industry, sustainability is based on economic, environmental, and social factors.

Sustainability

- How does sustainability apply in the diamond and jewelry industry?
- How are product transparency and traceability related?
- How can you contribute to a sustainable diamond and jewelry industry?

"Sustainable" and "green" are two terms widely used to describe the same concept. *Sustainability* is defined as the ability to continue a specific behavior indefinitely. In the gem and jewelry industry, sustainability is typically related to economic, environmental, and social issues. Sustainable development can be described as making responsible and ethical decisions regarding natural resources and improving quality of life.

In the diamond industry, sustainability includes reducing waste and environmental impact and implementing social initiatives that give back to the source country and its people. These and other practices are key in ethical sourcing.

More consumers now have a heightened awareness of sustainably and ethically sourced products. In an attempt to be transparent, many diamond mining companies publish sustainability reports annually that disclose their goals and progress. Sustainable business practices will continue to grow as consumers demand them.

Beneficiation

One of the best examples of sustainability in the diamond industry is beneficiation. In a social context, *beneficiation* is a commitment to reserve a portion of the resources derived from a country for the economic development of that country.



Eric Welch/GIA



Brendan Laurs/GIA

Some mining companies in Africa ensure that some of the proceeds from diamond mining go toward schools, hospitals, and infrastructure.

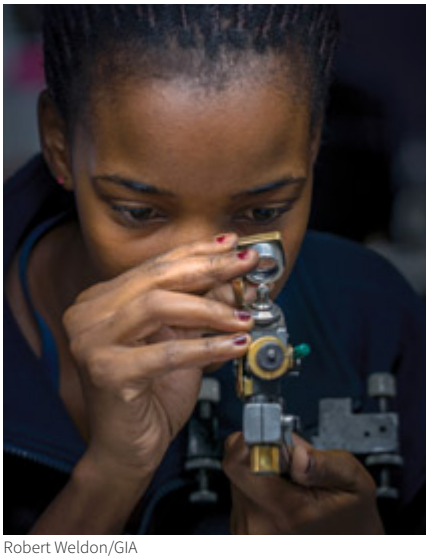
In Botswana, for example, approximately 80 percent of diamond revenues go back to the country and local communities. Much of the proceeds from diamond mining are put toward schools, hospitals, and infrastructure. However, a significant portion goes to the development of industries outside diamond mining. The intent is that as diamond resources are gradually depleted, new industries will provide jobs and produce revenues.

Beneficiation can include cutting and polishing in-country to maximize contribution to the local economy. In Botswana, beneficiation initiatives have led to the development of more than 20 diamond manufacturing companies, as well as the creation of more than 3,000 jobs directly and several thousand more through ancillary businesses serving the diamond sector.



Robert Weldon/GIA

Cutting operations like these offer thousands of jobs to the citizens of Botswana.



Robert Weldon/GIA

A diamond cutter in Gaborone, Botswana, examines her work.

KEY CONCEPTS

Diamond mining creates jobs in remote areas where employment opportunities are limited.

The environmental challenges of diamond mining include soil erosion, deforestation, ecosystem and biodiversity disturbance, energy use and emissions, waste and recycling, and water use.

The creation of jobs is an important social aspect of sustainability. Diamond mining creates jobs in remote areas around the world where employment opportunities are limited.

Thanks in part to beneficiation, nations such as Botswana, Namibia, South Africa, Angola, and others have emerged as significant players in the diamond industry. Beneficiation is becoming a key focus for the many organizations now implementing sustainability initiatives.

Environment

Environmental impacts are a topic of concern in the diamond and jewelry industry. Increasingly more consumers and investors seek assurance that their money goes to products and companies committed to minimizing their environmental footprints. While challenges exist at all levels of the diamond supply chain, most environmental challenges occur in the mining sector.

Mining of any type can significantly impact the environment. Unlike mining precious metals, diamond recovery does not require the use of hazardous chemicals. The main challenges in diamond mining involve soil erosion, deforestation, and ecosystem and biodiversity disturbance. In most cases diamond mining methods require the movement or removal of large quantities of earth. While this is inevitable for most mining operations, the most profitable/cost-effective methods move as little earth as possible—so mining



Philip Mostert, courtesy Petra Diamonds

Zebra in the protected nature reserve at Petra's Cullinan mine.

companies have incentive to minimize their footprints. Diamond mining also presents a number of other challenges, including energy use and emissions, waste and recycling, and water use.

To address these challenges, most mining companies implement policies and processes to reduce environmental impacts and increase operating efficiency, known as *environmental management systems*. These systems help ensure that mining companies actively pursue methods and initiatives to address environmental challenges. For example, the world's major diamond producers—members of the Diamond Producers Association—protect more than 1,000 square miles of natural land. This is approximately three times the amount of land used for mining operations. To address water use, a variety of water management strategies are implemented to improve efficiency and eliminate potential water contamination. For example, the Ekati mine in Canada recycles approximately 98 percent of water used in the diamond recovery process.

Environmental management system—A set of policies and processes that enable an organization to reduce environmental impacts and increase operating efficiency.

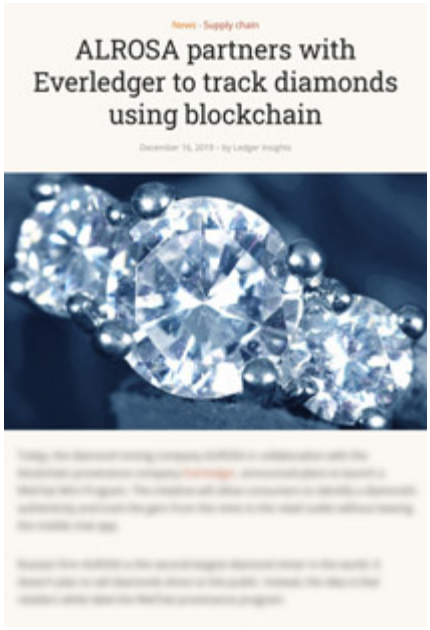
Energy efficiency and renewable energy programs are widely used in the diamond mining industry. Electric vehicles and new energy sources such as solar panels and wind farms serve as alternatives to burning fossil fuels. In 2012 Canada's Diavik mine installed four wind turbines, reducing diesel consumption by approximately 5 million liters per year.

The initiatives mentioned here are a small sample of the ongoing measures implemented by mining companies to address environmental challenges. While there is still much to be done, advancements are being made to ensure a more environmentally friendly diamond industry.



Dave Brosha, copyright © 2016 Rio Tinto

Close to 10 percent of the energy that powers the Diavik mine comes from its wind farm, which lowers the mine's carbon footprint and thus its environmental impact.



LedgerInsights.com

Major mining companies such as ALROSA track diamonds using blockchain technology.



Emily Lane/GIA

The GIA Diamond Origin Report uses scientific methods to assess a diamond's origin.

Traceability

KEY CONCEPTS

Traceability in the diamond industry is the ability to track a diamond's journey from the mine to the end consumer.

Blockchain—A shared, unalterable ledger used to record transactions and track assets through a supply chain or business network.

Many consumers want to know they are supporting products that are responsibly or ethically sourced and businesses that give back to the community. Traceability in the diamond industry means being able to track a diamond's journey from the mine to the end consumer. Transparency begins with traceability. Several organizations have traceability programs in place, and many others are developing them.

With the onset of consumer demand for transparency, many organizations have turned to technology to implement traceability in mainstream markets. Several in the gem and jewelry industry have teamed up with companies like IBM to use blockchain technology in order to track their diamonds through the supply chain. *Blockchain* is a shared, unalterable ledger used to record transactions and track assets through a supply chain or business network. The aim of blockchain is to offer many benefits to the industry along with transparency, including origin information, increased awareness of sustainable and ethical practices, and streamlined regulatory and compliance requirements for participating suppliers.

GIA promotes traceability through its Diamond Origin Report, which uses scientific evaluation to provide confirmation of a diamond's origin.

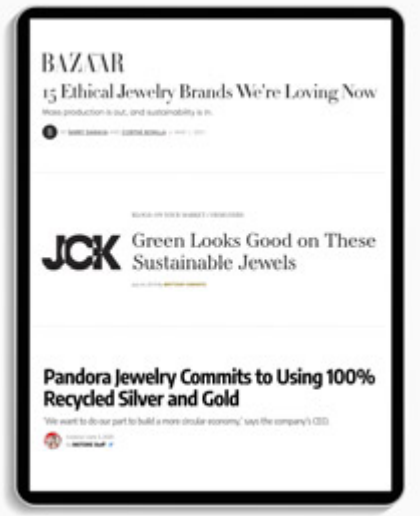
From mining to retail, many organizations are beginning to see the importance of product traceability in the supply chain and its role as a crucial step toward sustainability. But there is still much to be done to achieve full transparency.

Doing Your Part

There are many ways to contribute to a sustainable diamond and jewelry industry. Be transparent about your supply chain and conduct business responsibly. Give back to the community when you can. Establish goals and practices to better use resources and minimize waste. Look to others in the industry for examples. Big changes do not happen overnight, but understanding sustainability and taking action toward it can have a large impact.

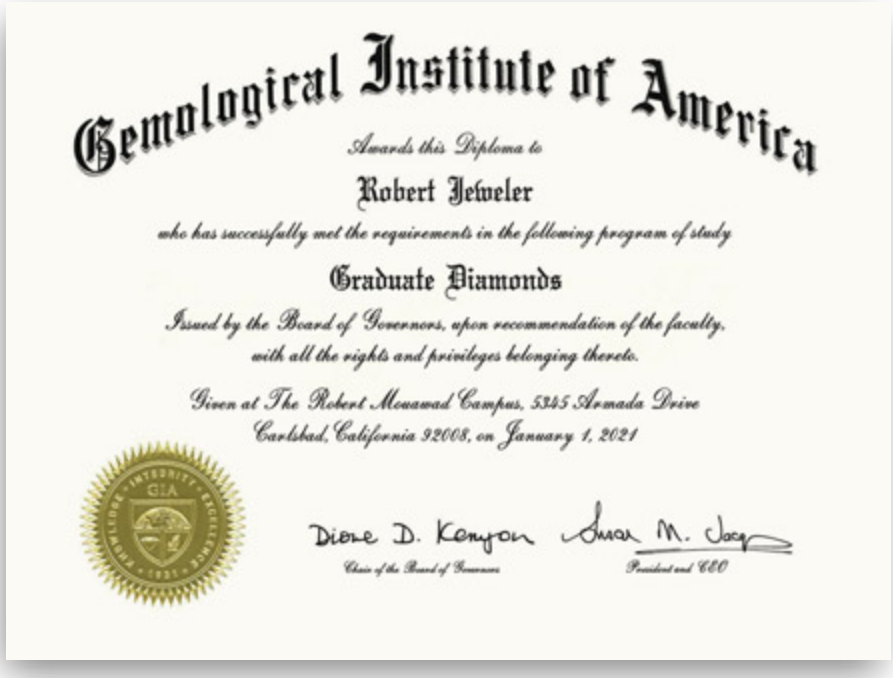
Summary

The concepts presented in this course are the foundation for success in the diamond industry. They will help you evaluate and compare suppliers' goods and make informed buying decisions. You might never grade a diamond yourself, but you know how diamonds are graded and how grades relate to quality and value. You share a language with diamond professionals worldwide. This knowledge is a key component of your success as a diamond professional. These newly acquired skills and knowledge are the keys to success in the rapidly changing jewelry trade.



Christopher Bonine/GIA

Many companies are adopting more sustainable and ethical practices to contribute to a more sustainable diamond and jewelry trade.



GIA

Graduate Diamonds diploma.

KEY CONCEPTS

Fluctuations in the diamond market often occur as a result of world events.

Factors other than the 4Cs can affect the retail price of a polished diamond or diamond jewelry.

Dealers usually offer better prices for immediate payment in full.

Establishing trust between parties is an important part of buying and selling in the market.

Most price lists quote per-carat prices.

Price lists estimate wholesale diamond prices in a specific market, so it's important to understand how those estimates relate to your market.

When you calculate the price of stones in a parcel, consider the time and effort involved in evaluating the parcel.

Become familiar with price levels in your market so you can assess a potential deal.

Lab-grown diamonds are priced at a significant discount to natural diamonds.

Market awareness helps you make better decisions, generate new ideas, and solve problems more effectively.

Networking can provide opportunities to succeed within your industry.

Many trade shows offer educational seminars and panel discussions to help you stay up to date with the industry.

Trends present lucrative opportunity if recognized early.

Sustainability in the gem and jewelry industry usually involves economic, environmental, and social considerations.

Diamond mining creates jobs in remote areas where employment opportunities are limited.

The environmental challenges of diamond mining include soil erosion, deforestation, ecosystem and biodiversity disturbance, energy use and emissions, waste and recycling, and water use.

Traceability in the diamond industry is the ability to track a diamond's journey from the mine to the end consumer.

Key Terms

Beneficiation—A commitment to reserve a portion of the resources derived from a country for the economic development of that country.

Blockchain—A shared, unalterable ledger used to record transactions and track assets through a supply chain or business network.

Consignment—A long-term agreement in which a dealer or manufacturer loans goods to a retailer.

Cost-plus model—Model in which final sale price is based on the cost to produce the product plus a small markup.

Environmental management system—A set of policies and processes that enable an organization to reduce environmental impacts and increase operating efficiency.

Lot price—A discounted price for buying an entire parcel or a substantial part of it.

Memo—A short-term agreement in which a dealer entrusts goods to a client without requiring immediate payment.

Networking—Exchanging information and developing contacts among people with a common professional or special interest.

Per-carat price—The price of a gem divided by its carat weight.

Pick price—A premium price paid for selecting stones from a parcel.

Price-skimming model—Model in which manufacturers charge the highest initial price that customers will pay and lower it over time as new competitors enter the market

Provenance—In the jewelry industry, the origin and history of ownership of a gemstone or piece of jewelry.

Sustainability—The ability to continue a specific behavior indefinitely.

Terms of payment—Conditions of a sale agreed upon between buyer and seller stating how and when an invoice is to be paid.

Trade organization—A committee, club, society, or association in which a group of people, or members, are united for a similar purpose.

Trade publication—A magazine, newspaper, journal, or website that shares information on news, trends, and other topics relevant to a specific industry.

Trade show—An event at which businesses promote and sell their products and services.

Trend—Something currently in demand or popular among consumers.

Questions for Review

- What factors influence the price of a polished diamond?
- How do payment terms affect price?
- How does lab-grown diamond pricing differ from natural diamond pricing?
- Why is market awareness important in today's diamond industry?
- How does market awareness help you succeed in the marketplace?
- How can you develop market awareness?
- How does sustainability apply in the diamond and jewelry industry?
- How are product transparency and traceability related?
- How can you contribute to a sustainable diamond and jewelry industry?

For Further Reading

Gems & Gemology (G&G), GIA's professional journal, provides in-depth feature articles on the latest gemological research, from gem treatments, synthetics, and the evaluation of gem quality to developments in gem production, market sources, and more.

To give you the opportunity to learn more about the subjects you are studying and enrich your gemological knowledge, a list of *G&G* articles relevant to each *Diamonds & Diamond Grading* assignment is provided below. It is important to note that this reading is optional. You will not be tested on the content of these articles.

Scan the QR code above or go to https://www.gia.edu/library to access articles for further reading.

All *G&G* articles are available for download free of charge on GIA's website, www.gia.edu. Copies of these articles are also available at your GIA campus location. Check with your instructor for access to them.

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