

Diamond

Diamond



A scattering of round-brilliant cut diamonds shows off the many reflecting facets.

General

Category Native Minerals

Chemical formula C

Identification

Molecular Weight 12.01 u

Color Typically yellow, brown or gray to colorless. Less often in blue, green, black, translucent white, pink, violet, orange, purple and red.

Crystal habit Octahedral

Crystal system Isometric-Hexoctahedral (Cubic)

Cleavage 111 (perfect in four directions)

Fracture Conchoidal - step like

Mohs Scale hardness 10

Luster Adamantine

Polish luster Adamantine

Refractive index 2.4175-2.4178

Optical Properties Singly Refractive

Birefringence None

Dispersion .044

Pleochroism none

Ultraviolet fluorescence colorless to yellowish stones - inert to strong in long wave, and typically blue. Weaker in short wave.

Absorption spectra In pale yellow stones a 415.5 nm line is typical. Irradiated and annealed diamonds often show a line around 594 nm when cooled to low temperatures.

Streak White

Specific gravity 3.52 (+/- .01)

Density 3.5-3.53

Diaphaneity Transparent to subtransparent to translucent

Diamond is an allotrope of carbon. It is the hardest known natural material and the third-hardest known material after aggregated diamond nanorods and ultrahard fullerite. Its hardness and high dispersion of light make it useful for industrial applications and jewelry.

Diamonds are specifically renowned as a material with superlative physical qualities; they make excellent abrasives because they can be scratched only by other diamonds, Borazon, ultrahard fullerite, or aggregated diamond nanorods, which also means they hold a polish extremely well and retain their lustre. Approximately 130 million carats (26,000 kg) are mined annually, with a total value of nearly USD \$9 billion, and about 100,000 kg (220,000 lb) are synthesized annually.

The name *diamond* derives from the ancient Greek *adamas* (ἀδάμας; "invincible"). They have been treasured as gemstones since their use as religious icons in ancient India and usage in engraving tools also dates to early human history. Popularity of diamonds has risen since the 19th century because of increased supply, improved cutting and polishing techniques, growth in the world economy, and innovative and successful advertising campaigns. They are commonly judged by the "four Cs": *carat*, *clarity*, *color*, and *cut*.

Roughly 49% of diamonds originate from central and southern Africa, although significant sources of the mineral have been discovered in Canada, India, Russia, Brazil, and Australia. They are mined from kimberlite and lamproite volcanic pipes, which brought to the surface

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1. Material properties

A diamond is a transparent crystal of tetrahedrally bonded carbon atoms and crystallizes into the face centered cubic diamond lattice structure. Diamonds have been adapted for many uses because of the material's exceptional physical characteristics. Most notable are its extreme hardness, its high dispersion index, and extremely high thermal conductivity (900 - 2320 W/m K), with a melting point of 3820 K (3547 °C / 6420 °F) and a boiling point of 5100 K (4827 °C / 8720 °F). Naturally occurring diamonds have a density ranging from 3.15 to 3.53 g/cm³, with very pure diamond typically extremely close to 3.52 g/cm³.

Hardness

Diamond is the hardest natural material known to man; hardness is defined as resistance to scratching. Diamond has a hardness of 10 (hardest) on Mohs scale of mineral hardness. Diamond's hardness has been known since antiquity, and is the source of its name.

The hardest diamonds in the world are from the New England area in New South Wales, Australia. These diamonds are generally small, perfect to semiperfect octahedra, and are used to polish other diamonds. Their hardness is considered to be a product of the crystal growth form, which is single stage growth crystal. Most other diamonds show more evidence of multiple growth stages, which produce inclusions, flaws, and defect planes in the crystal lattice, all of which affect their hardness.

The hardness of diamonds contributes to its suitability as a gemstone. Because it can only be scratched by other diamonds, it maintains its polish extremely well. Unlike many other gems, it is well-suited to daily wear because of its resistance to scratching—perhaps contributing to its popularity as the preferred gem in an engagement ring or wedding ring, which are often worn every day.

Industrial use of diamonds has historically been associated with their hardness; this property makes diamond the ideal material for cutting and grinding tools. As the hardest known naturally-occurring material, diamond can be used to polish, cut, or wear away any material, including other diamonds. However, diamond is a poor choice for machining ferrous alloys at high speeds. At the high temperatures created by high speed machining, carbon is soluble in iron, leading to greatly increased wear on diamond tools as compared to other alternatives. Common industrial adaptations of this ability include diamond-tipped drill bits and saws, or use of diamond powder as an abrasive. Industrial-grade diamonds are either unsuitable for use as gems or synthetically produced, which lowers their value and makes their use economically feasible.

Electrical conductivity

Other specialized applications also exist or are being developed, including use as semiconductors: some blue diamonds are natural semiconductors, in contrast to most other diamonds, which are excellent electrical insulators.

Toughness

Toughness relates to a material's ability to resist breakage from forceful impact. The toughness of natural diamond has been measured as $3.4 \text{ MN m}^{-3/2}$, which is good compared to other gemstones, but poor compared to most engineering materials. As with any material, the macroscopic geometry of a diamond contributes to its resistance to breakage. Diamond is therefore more fragile in some orientations than others.

Color

Diamonds can occur in nearly any color, though yellow and brown are by far the most common. "Black" diamonds are not truly black, but rather contain numerous dark inclusions that give the gems their dark appearance. Colored diamonds contain impurities or structural defects that cause the coloration, while pure or nearly pure diamonds are transparent and colorless. Most diamond impurities replace a carbon atom in the crystal lattice, known as a carbon flaw. The most common impurity, nitrogen, causes a slight to intense yellow coloration depending upon the type and concentration of nitrogen present. The Gemological Institute of America (GIA) classifies low saturation yellow and brown diamonds as diamonds in the *normal color range*, and applies a grading scale from 'D' (colorless) to 'Z' (light yellow).

A blue diamond recently fetched nearly \$8 million. The blue hue was a result of trace amounts of boron in the stone's crystal structure.

Identification

Diamonds can be identified via their high thermal conductivity. Their high refractive index is also indicative, but other materials have similar refractivity. Diamonds do cut glass, but other materials above glass on Mohs scale such as quartz do also. Diamonds easily scratch other diamonds, but this damages both diamonds.

2.Natural history

Formation

The formation of natural diamond requires very specific conditions. Diamond formation requires exposure of carbon-bearing materials to high pressure, ranging approximately between 45 and 60 kilobars, but at a comparatively low temperature range between approximately 1652-2372 °F (900-1300 °C). These conditions are known to be met in two places on Earth; in the lithospheric mantle below relatively stable continental plates, and at the site of a meteorite strike.

Diamonds formed in cratons

The conditions for diamond formation to happen in the lithospheric mantle occur at considerable depth corresponding to the aforementioned requirements of temperature and pressure. These depths are estimated to be in between 140-190 kilometers (90-120 miles) though occasionally diamonds have crystallized at depths of 300-400 km (180-250 miles) as well. The rate at which temperature changes with increasing depth into the Earth varies greatly in different parts of the Earth. In particular, under oceanic plates the temperature rises more quickly with depth, beyond the range required for diamond formation at the depth required. The correct combination of temperature and pressure is only found in the thick, ancient, and stable parts of continental plates where regions of lithosphere known as *cratons* exist. Long residence in the cratonic lithosphere allows diamond crystals to grow larger.



The slightly misshapen octahedral shape of this rough diamond crystal in matrix is typical of the mineral. Its lustrous faces also indicate that this crystal is from a primary deposit.

Through studies of carbon isotope ratios (similar to the methodology used in carbon dating, except with the stable isotopes C-12 and C-13), it has been shown that the carbon found in diamonds comes from both inorganic and organic sources. Some diamonds, known as *harzburgitic*, are formed from inorganic carbon originally found deep in the Earth's mantle. In contrast, *eclogitic* diamonds contain organic carbon from organic detritus that has been pushed down from the surface of the Earth's crust through subduction (see plate tectonics) before transforming into diamond. These two different source carbons have measurably different $^{13}\text{C}:^{12}\text{C}$ ratios. Diamonds that have come to the Earth's surface are generally very old, ranging from under 1 billion to 3.3 billion years old.

Diamonds occur most often as euhedral or rounded octahedra and twinned octahedra known as *macles* or *maccles*. As diamond's crystal structure has a cubic arrangement of the atoms, they have many facets that belong to a cube, octahedron, rhombicosidodecahedron, tetrakis hexahedron or disdyakis dodecahedron. The crystals can have rounded off and unexpressive edges and can be elongated. Sometimes they are found grown together or form double "twinned" crystals grown together at the surfaces of the octahedron. These different shapes and habits of the diamonds result from differing external circumstances. Diamonds (especially those with rounded crystal faces) are commonly found coated in *nyf*, an opaque gum-like skin.

Diamonds and meteorite impact craters

Diamonds can also form in other natural high-pressure events. Very small diamonds, known as *microdiamonds* or *nanodiamonds*, have been found in meteorite impact craters. Such impact events create shock zones of high pressure and temperature suitable for diamond formation. Impact-type microdiamonds can be used as one indicator of ancient impact craters.

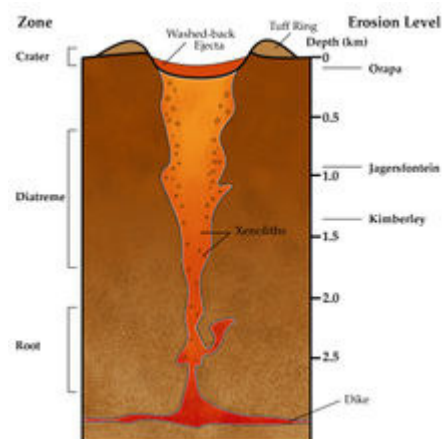
Extraterrestrial diamonds

Not all diamonds found on earth originated here. A type of diamond called carbonado diamond that is found in South America and Africa was deposited there via an asteroid impact (not formed from the impact) about 3 billion years ago. These diamonds formed in the intrastellar environment.

Presolar grains in many meteorites found on earth contain nanodiamonds of extraterrestrial origin, probably formed in supernovas.

White dwarf stars have been described as having a carbon core and were hyped in a 2004 news headline as diamond.

Surfacing



Schematic diagram of a volcanic pipe

Diamond-bearing rock is brought close to the surface through deep-origin volcanic eruptions. The magma for such a volcano must originate at a depth where diamonds can be formed, 150 km (90 miles) deep or more (three times or more the depth of source magma for most volcanoes); this is a relatively rare occurrence. These typically small surface volcanic craters extend downward in formations known as volcanic pipes. The pipes contain material that was transported toward the surface by volcanic action, but was not ejected before the volcanic activity ceased. During eruption these pipes are open to the surface, resulting in open circulation; many xenoliths of surface rock and even wood and/or fossils are found in volcanic pipes. Diamond-bearing volcanic pipes are closely related to the oldest, coolest regions of continental crust (cratons). This is because cratons are very thick, and their lithospheric mantle extends to great enough depth that diamonds are stable. Not all pipes contain diamonds, and even fewer contain enough diamonds to make mining economically viable.

The magma in volcanic pipes is usually one of two characteristic types, which cool into igneous rock known as either kimberlite or lamproite. The magma itself does not contain diamond; instead, it acts as an elevator that carries deep-formed rocks (xenoliths), minerals (xenocrysts), and fluids upward. These rocks are characteristically rich in magnesium-bearing olivine, pyroxene, and amphibole minerals which are often altered to serpentine by heat and fluids during and after eruption. Certain *indicator minerals* typically occur within diamondiferous kimberlites and are used as mineralogic tracers by prospectors, who follow the indicator trail back to the volcanic pipe which may contain diamonds. These minerals are rich in chromium (Cr) or titanium (Ti), elements which impart bright colors to the minerals. The most common indicator minerals are chromian garnets (usually bright red Cr-pyrope, and occasionally green ugrandite-series garnets), eclogitic garnets, orange Ti-pyrope, red high-Cr spinels, dark chromite, bright green Cr-diopside, glassy green olivine, black picroilmenite, and magnetite. Kimberlite deposits are known as *blue ground* for the deeper serpentinized part of the deposits, or as *yellow ground* for the near surface smectite clay and carbonate weathered and oxidized portion.

Once diamonds have been transported to the surface by magma in a volcanic pipe, they may erode out and be distributed over a large area. A volcanic pipe containing diamonds is known as a *primary source* of diamonds. *Secondary sources* of diamonds include all areas where a significant number of diamonds, eroded out of their kimberlite or lamproite matrix, accumulate because of water or wind action. These include alluvial deposits and deposits along existing and ancient shorelines, where loose diamonds tend to accumulate because of their approximate size and density. Diamonds have also rarely been found in deposits left behind by glaciers (notably in Wisconsin and Indiana); however, in contrast to alluvial deposits, glacial deposits are not known to be of significant concentration and are therefore not viable commercial sources of diamond.

3. History and gemological characteristics

Diamonds are thought to have been first recognized and mined in India (Golconda being one of them), where significant alluvial deposits of the stone could then be found along the rivers Penner, Krishna and Godavari. Diamonds have been known in India for at least 3000 years but most likely 6000 years. The most familiar usage of diamonds today is as gemstones used for adornment a usage which dates back into antiquity. The dispersion of white light into spectral colors, is the primary gemological characteristic of gem diamonds. In the twentieth century, experts in the field of *gemology* have developed methods of grading diamonds and other gemstones based on the characteristics most important to their value as a gem. Four characteristics, known informally as the *four Cs*, are now commonly used as the basic descriptors of diamonds: these are *carat*, *cut*, *color*, and *clarity*.

4. The diamond industry



A round brilliant cut diamond set in a ring

The diamond industry can be broadly separated into two basically distinct categories: one dealing with gem-grade diamonds and another for industrial-grade diamonds. While a large trade in both types of diamonds exists, the two markets act in dramatically different ways.

Gem diamond industry

A large trade in gem-grade diamonds exists. Unlike precious metals such as gold or platinum, gem diamonds do not trade as a commodity: there is a substantial mark-up in the sale of diamonds, and there is not a very active market for resale of diamonds. One hallmark of the trade in gem-quality diamonds is its remarkable concentration: wholesale trade and diamond cutting is limited to a few locations. 92% of diamond pieces cut in 2003 were in Surat, Gujarat, India. Other important centers of diamond cutting and trading are Antwerp, London, New York, Tel Aviv, Amsterdam. A single company—De Beers—controls a significant proportion of the trade in diamonds. They are based in Johannesburg, South Africa and London, England.

The production and distribution of diamonds is largely consolidated in the hands of a few key players, and concentrated in traditional diamond trading centers. The most important being Antwerp, where 80% of all rough diamonds, 50% of all cut diamonds and more than 50% of all rough, cut and industrial diamonds combined are handled. This makes Antwerp the de facto 'world diamond capital'. New York, however, along with the rest of the United States, is where almost 80% of the world's diamonds are sold, including at auction. Also, the largest and most unusually shaped rough diamonds end up in New York. The De Beers company, as the world's largest diamond miner holds a clearly dominant position in the industry, and has done so since soon after its founding in 1888 by the British imperialist Cecil Rhodes. De Beers owns or controls a significant portion of the world's rough diamond production facilities (mines) and distribution channels for gem-quality diamonds. The company and its subsidiaries own mines that produce some 40 percent of annual world diamond production. At one time it was thought over 80 percent of the world's rough diamonds passed through the Diamond Trading Company (DTC, a subsidiary of De Beers) in London, but presently the figure is estimated at less than 50 percent.

The De Beers diamond advertising campaign is acknowledged as one of the most successful and innovative campaigns in history. N. W. Ayer & Son, the advertising firm retained by De Beers in the mid-20th century, succeeded in reviving the American diamond market and opened up new markets, even in countries where no diamond tradition had existed before. N.W. Ayer's multifaceted marketing campaign included product placement, advertising the diamond itself rather than the De Beers brand, and building associations with celebrities and royalty. This coordinated campaign has lasted decades and continues today; it is perhaps best captured by the slogan "a diamond is forever".

Further down the supply chain, members of The World Federation of Diamond Bourses (WFDB) act as a medium for wholesale diamond exchange, trading both polished and rough diamonds. The WFDB consists of independent diamond bourses in major cutting centres such as Tel Aviv, Antwerp, Johannesburg and other cities across the USA, Europe and Asia.

In 2000, the WFDB and The International Diamond Manufacturers Association established the World Diamond Council to prevent the trading of diamonds used to fund war and inhumane acts.

WFDB's additional activities also include sponsoring the World Diamond Congress every two years, as well as the establishment of the *International Diamond Council* (IDC) to oversee diamond grading.

Industrial diamond industry

The market for industrial-grade diamonds operates much differently from its gem-grade counterpart. Industrial diamonds are valued mostly for their hardness and heat conductivity, making many of the gemological characteristics of diamond, including clarity and color, mostly irrelevant. This helps explain why 80% of mined diamonds (equal to about 100 million carats or 20,000 kg annually), unsuitable for use as gemstones and known as *bort*, are destined for industrial use. In addition to mined diamonds, synthetic diamonds found industrial applications almost immediately after their invention in the 1950s; another 3 billion carats (600 metric tons) of synthetic diamond is produced annually for industrial use.

The dominant industrial use of diamond is in cutting, drilling, grinding, and polishing. Most uses of diamonds in these technologies do not require large diamonds; in fact, most diamonds that are gem-quality except for their small size, can find an industrial use. Diamonds are embedded in drill tips or saw blades, or ground into a powder for use in grinding and polishing applications. Specialized applications include use in laboratories as containment for high pressure experiments (see diamond anvil), high-performance bearings, and limited use in specialized windows.

With the continuing advances being made in the production of synthetic diamonds, future applications are beginning to become feasible. Garnering much excitement is the possible use of diamond as a semiconductor suitable to build microchips from, or the use of diamond as a heat sink in electronics.

Diamond supply chain

The diamond supply chain is controlled by a limited number of powerful businesses, and is also highly concentrated in a small number of locations around the world.

Mining, sources and production

Only a very small fraction of the diamond ore consists of actual diamonds. The ore is crushed, during which care has to be taken in order to prevent larger diamonds from being destroyed in this process and subsequently the particles are sorted by density. Today, diamonds are located in the diamond-rich density fraction with the help of X-ray fluorescence, after which the final sorting steps are done by hand. Before the use of X-rays became commonplace, the separation was done with grease belts; diamonds have a stronger tendency to stick to grease than the other minerals in the ore.

Historically diamonds were known to be found only in alluvial deposits in southern India. India led the world in diamond production from the time of their discovery in approximately the 9th century BCE to the mid-18th century AD, but the commercial potential of these sources had been exhausted by the late 18th century and at that time India was eclipsed by Brazil where the first non-Indian diamonds were found in 1725.

Diamond production of primary deposits (kimberlites and lamproites) only started in the 1870's after the discovery of the Diamond fields in South Africa. Production has increased over time and now an accumulated total of 4.5 billion carats have been mined since that date. Interestingly 20% of that amount has been mined in the last 5 years alone and during the last ten years 9 new mines have started production while 4 more are waiting to be opened soon. Most of these mines are located in Canada, Zimbabwe, Angola, and one in Russia.

While no commercial diamond production exists in the US, Arkansas and Colorado are the only states to have a verifiable source of diamonds.

Today, most commercially viable diamond deposits are in Russia, Botswana, Australia and the Democratic Republic of Congo. In 2005, Russia produced almost one-fifth of the global diamond output, reports the British Geological Survey. Australia boasts the richest diamondiferous pipe with production reaching peak levels of 42 metric tons (41 LT/46 ST) per year in the 1990's.

There are also commercial deposits being actively mined in the Northwest Territories of Canada, Siberia (mostly in Yakutia territory, for example Mir pipe and Udachnaya pipe), Brazil, and in Northern and Western Australia. Diamond prospectors continue to search the globe for diamond-bearing kimberlite and lamproite pipes.



Diamond output in 2005

"Blood" diamonds

In some of the more politically unstable central African and west African countries, revolutionary groups have taken control of diamond mines, using proceeds from diamond sales to finance their operations. Diamonds sold through this process are known as *conflict diamonds* or *blood diamonds*. Major diamond trading corporations continue to fund and fuel these conflicts by doing business with armed groups. In response to public concerns that their diamond purchases were contributing to war and human rights abuses in central Africa and West Africa, the United Nations, the diamond industry and diamond-trading nations introduced the Kimberley Process in 2002, which is aimed at ensuring that conflict diamonds do not become intermixed with the diamonds not controlled by such rebel groups, by providing documentation and certification of diamond exports from producing countries to ensure that the proceeds of sale are not being used to fund criminal or revolutionary activities. Although the Kimberley Process has been moderately successful in limiting the number of conflict diamonds entering the market, conflict diamonds smuggled to market continue to persist to some degree (approx. 2-3% of diamonds traded today are possible conflict diamonds^[24]). According to the 2006 book *The Heartless Stone*, two major flaws still hinder the effectiveness of the Kimberley Process: the relative ease of smuggling diamonds across African borders and giving phony histories, and the violent nature of diamond mining in nations which are not in a technical state of war and whose diamonds are therefore considered "clean."

The Canadian Government has setup a body known as Canadian Diamond Code of Conduct to help authenticate Canadian diamonds. This is a very stringent tracking system of diamonds and helps protect the 'conflict free' label of Canadian diamonds.

Currently, gem production totals nearly 30 million carats (6,000 kg) of cut and polished stones annually, and over 100 million carats (20,000 kg) of mined diamonds are sold for industrial use each year, as are about 100,000 kg of synthesized diamond.

Distribution

The Diamond Trading Company, or DTC, is a subsidiary of De Beers and markets rough diamonds produced both by De Beers mines and other mines from which it purchases rough diamond production. Once purchased by sightholders, diamonds are cut and polished in preparation for sale as gemstones. The cutting and polishing of rough diamonds is a specialized skill that is concentrated in a limited number of locations worldwide. Traditional diamond cutting centers are Antwerp, Amsterdam, Johannesburg, New York, and Tel Aviv. Recently, diamond cutting centers have been established in China, India, and Thailand. Cutting centers with lower cost of labor, notably Surat in Gujarat, India, handle a larger number of smaller carat diamonds, while smaller quantities of larger or more valuable diamonds are more likely to be handled in Europe or North America. The recent expansion of this industry in India, employing low cost labor, has allowed smaller diamonds to be prepared as gems in greater quantities than was previously economically feasible.

Diamonds which have been prepared as gemstones are sold on diamond exchanges called *bourses*. There are 26 registered diamond bourses. This is the final tightly controlled step in the diamond supply chain; wholesalers and even retailers are able to buy relatively small lots of diamonds at the bourses, after which they are prepared for final sale to the consumer. Diamonds can be sold already set in jewelry, or as is increasingly popular, sold unset ("loose"). According to the Rio Tinto Group, in 2002 the diamonds produced and released to the market were valued at US\$9 billion as rough diamonds, US\$14 billion after being cut and polished, US\$28 billion in wholesale diamond jewelry, and retail sales of US\$57 billion.

5. United States

The Crater of Diamonds State Park is an Arkansas State Park located near Murfreesboro in Pike County, Arkansas, USA containing the only diamond bearing site in the world that is open to the public.

Synthetics, simulants, and enhancements

Natural diamonds have formed naturally within the earth. Synthetic diamonds are created by a man-made process. A diamond simulant is defined as a non-diamond material that is used to simulate the appearance of a diamond. Diamond-simulant gems are often referred to as diamante.

The gemological and industrial uses of diamond have created a large demand for rough stones. The demand for industrial diamonds has long been satisfied in large part by synthetic diamonds, which have been manufactured by various processes for more than half a century. However, in recent years it has become possible to produce gem-quality synthetic diamonds of significant size.

The majority of commercially available synthetic diamonds are yellow in color and produced by so called High Pressure High Temperature (HPHT) processes. The yellow color is caused by nitrogen impurities. Other colors may also be reproduced such as blue, green or pink which are a result of the addition of boron or from irradiation after synthesis.

At present the annual production of gem quality synthetic diamonds is only a few thousand carats, whereas the total production of natural diamonds is around 120 million carats. Although the production of colorless synthetic diamonds is dwarfed by that of natural diamonds, one can only find one fancy colored diamond for every 10,000 colorless ones. Since almost the complete production of synthetic diamonds consists of fancy diamonds, there is a high probability that the larger fancy colored diamonds (over 1.5 carats) will be synthetic.

Today, trained gemologists can generally also distinguish between natural diamonds and synthetic diamonds. Although synthetic and natural diamonds are theoretically identical and indistinguishable from each other, diamonds from each of the two categories usually incorporate their own characteristic imperfections, arising from the circumstances of their creation, that allow them to be distinguished from each other. In the case of synthetic diamonds, for example, depending on the method of production (either HPHT produced or CVD produced) and the color of the diamond (colored, D-Z color range or D-J color range), several methods of identification can be attempted by a gemologist or gemlab: CVD diamonds can usually be identified by an orange fluorescence, D-J colored diamonds can be screened through the Swiss Gemological Organization's (SSEF) Diamond Spotter, and stones in the D-Z color range can be examined through the DiamondSure UV/visible spectrometer which is a tool developed by De Beers. Similarly, natural diamonds usually have minor imperfections and flaws, such as inclusions of foreign material, that are not seen in synthetic diamonds. The origin of a truly *perfect* diamond (natural or synthetic) cannot be determined and is largely moot, but perfect diamonds are currently rare from both sources.

A diamond's gem quality, which is not as dependent on material properties as industrial applications, has invited both imitation and the invention of procedures to enhance the gemological properties of natural diamonds. Materials which have similar gemological characteristics to diamond but are not mined or synthetic diamond are known as *diamond simulants*. The most familiar diamond simulant to most consumers is cubic zirconia (commonly abbreviated as CZ); recently moissanite has also gained popularity and has often been mischaracterized as a diamond simulant, although it is sold and retailed as a replacement for diamond. Both CZ and moissanite are synthetically produced. However, CZ is a diamond simulant. Diamond enhancements are specific treatments, performed on natural diamonds (usually those already cut and polished into a gem), which are designed to better the gemological characteristics of the stone in one or more ways. These include laser drilling to remove inclusions, application of sealants to fill cracks, treatments to improve a white diamond's color grade, and treatments to give fancy color to a white diamond.

Currently, trained gemologists with appropriate equipment are able to distinguish natural diamonds from simulant diamonds, and they can identify all enhanced natural diamonds. Coatings are more and more used to give a diamond simulant such as cubic zirconia a more "diamond-like" appearance. One such substance, which is heavily advertised, is what scientists refer to as "diamond-like carbon". This is an amorphous carbonaceous material that has some physical properties which are similar to that of the diamond. Advertising suggests (rightfully so or not) that such a coating would transfer some of these diamond-like properties to the coated stone, hence enhancing the diamond simulant. However, modern techniques such as Raman Spectroscopy should easily identify such as treatment.

Producing large synthetic diamonds threatens the business model of the diamond industry, and the ultimate effect of the ready availability of gem-quality diamonds at low cost in the future is hard to predict at this time.

The screening machine use for referring treated or enhanced diamonds as well as synthetics is the DiamondSure, and the definitive analytical machine is the DiamondView produce by the DTC and supplied marketed by the GIA. All of the major diamond testing laboratories world wide are required to have these machines.