

DIAMOND WORLD: WHAT OPPORTUNITIES DOES THE MARKET OFFER ON NATURAL, SYNTHETIC AND RECYCLED DIAMONDS

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INTRODUCTION

A lot has happened since the first commercial production of synthetic diamonds (industrial diamonds) in the 1950s. In the meantime, laboratory-grown diamonds have become part of the diamond market. In some ways, the battle lines have been drawn between the proponents and skeptics of laboratory-grown diamonds. But what exactly do laboratory-grown diamonds mean in the day-to-day work of jewelers, when selling and accepting repairs? How can they be reliably tested in the goldsmith's or jeweler's shop? There are also questions about possible legal pitfalls that need to be avoided. And what exactly do customers care about? We wanted to find out so we conducted a customer survey. And to explain some of the pros and cons, as well as the environmental impact of the different options. Are synthetic diamonds as important to consumers as they are to jewelers? Especially when it comes to pricing. Synthetic diamonds also open new possibilities in jewelry design, partly because of the size at which laboratory-grown diamonds can be produced, and partly because of the variety of colors that are now affordable.

TERMS AND DEFINITIONS

Many terms have been used recently to describe diamonds, but which of them are scientifically and legally correct, and which are just made up to market diamonds? Here is a list of the current definitions of diamonds according to the International Standard ISO 24016:2021en and the Federal Trade Commission (FTC), as well as the terms used in this paper.

Following are the definitions of diamonds by the International Standard ISO 24016:2021 en (Charter 3.1.1 -3.1.3):

Diamond (3.1.1)

A mineral consisting essentially of carbon crystallized in the isometric (cubic) crystal system, with a hardness on the Mohs scale of 10, a specific gravity of approximately 3.52 and a refractive index of approximately 2.42, created by nature.

<u>Note 1</u> to entry: The denomination "diamond" without further specification always implies "natural diamond". These two terms are equivalent and carry the same meaning.

Treated diamond (3.1.2)

A diamond (3.1.1) having undergone any human intervention other than cutting, polishing, cleaning and setting, to permanently or non-permanently change its appearance. Example: coating, fracture filling, heating, irradiation, laser drilling, HPHT treatment or any other physical or chemical process.

Synthetic, laboratory-grown, and laboratory-created (3.1.3)

An artificial product that has essentially the same chemical composition, crystalline structure and physical (including optical) properties as a diamond (3.1.1).

Note 1 to entry: The English terms "laboratory-created diamond" or "laboratory-grown diamond" may be used synonymously with "synthetic diamond". Where there is no acceptable local direct translation of the English terms "laboratory grown diamond" or "laboratory created diamond", then only the translation of the term "synthetic diamond" should be used.

<u>Note 2</u> to entry: Abbreviations such as "lab grown", "lab created", "lab diamond", or "syn diamond" shall not be used.

<u>Note 3</u> to entry: The word "laboratory" refers to a facility which produces synthetic diamonds. This should not be confused with a gemological laboratory dedicated to the analysis, authentication, identification, and classification (grading) of diamonds.

The Federal Trade Commission (FTC) accepts the following terminology for synthetic diamonds: laboratory-grown, laboratory-created, or [manufacturer name]-created. The term "cultured" can be used, too, the FTC says, but it must be "immediately accompanied, with equal conspicuousness" by one of the three aforementioned terms. Advertising terms such as "genuine", "real", "precious" and "natural" cannot be used for laboratory-grown diamonds. If the word "diamond" appears on its own, it will be taken to mean a natural diamond.

When synthetic diamonds are referred to in this paper, they are uniformly referred to as laboratory-grown diamonds, and natural diamonds are always referred to as natural diamonds. Other terms used in this paper are:

Diamond imitations

Materials that look like diamonds but do not have the same chemical, physical, and optical properties as a diamond, such as cubic zirconia (cubic zirconium oxide), synthetic moissanite (silicon carbide), natural or synthetic colorless sapphire (aluminum oxide), synthetic spinel (magnesium aluminate), and synthetic YAG (yttrium aluminum garnet).

Recycled or recut diamond

These are natural diamonds that have been used in jewelry before. In the jewelry recycling process, the stones are cut out of the settings. They are then cleaned, re-cut if necessary, certificated and returned to the market.

ORIGIN OF DIFFERENT TYPES OF NATURAL DIAMONDS

Although natural diamonds are mined from the Earth's upper crust, they are formed at depths of more than 93 miles (150 km) at pressures of 4-5 GPa (40-50kbar) and temperatures of 1832°F and 3092°F (1000°C and 1700°C). Diamonds are found primarily in kimberlite pipes (Figure 1). But they are also found in secondary places (layers of rock, gravel or sand).

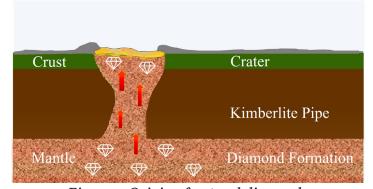


Figure 1: Origin of natural diamonds

HPHT TECHNOLOGY OF LABORATORY DIAMOND GROWTH

Since its development in the 1970s, the High-Pressure High-Temperature (HPHT) method has been used to produce laboratory-grown diamonds. The process begins with one or more small natural or laboratory-grown diamond crystals that serve as "seeds" in the growth capsule to initiate growth. The number of seeds determines the number of crystals. The capsule also contains a solid metal-based material that melts when heated and serves as both a solvent for the graphite and a catalyst for crystal growth. The solvent/catalyst is a proprietary mixture of iron-nickel or iron-cobalt, such as boron or aluminum, which affects properties such as color. Either graphite or diamond powder is added to the capsule as the type of carbon from which the diamond grows.

Once the capsule is assembled, it is placed in the press where it is pressurized to 5-6 Gpa. While under pressure, electrical resistors heat the capsule up to 2732F (1500°C). The heat is carefully controlled so that the upper end containing the carbon source is approximately 30°C (86°F) hotter than the end containing the diamond seed. The greater the temperature difference, the faster the diamond will grow. But a balance must be found because faster growth of the laboratory-grown diamond increases the potential for more metallic (dark) inclusions. Laboratory-grown diamond crystals up to 100 ct. in size have been produced by the HPHT method, most of which weighed less than 3 ct. In the mid-1980s, it was discovered that adding other elements to the metal alloy affected the resulting color. Aluminum and titanium act as "nitrogen catchers" by bonding nitrogen atoms and making them inaccessible to the growing crystal. When there is less nitrogen in a crystal, the result is a less-saturated yellow to a colorless laboratory-grown diamond.

Market Presence: Historically, laboratory-grown HPHT diamonds have been more prevalent, especially in larger sizes and fancy colors.

Smaller laboratory-grown diamonds, approximately 1-2 ct., can typically be grown in 2-5 days with the HPHT method. The accelerated growth time is due to the smaller size of the stone, which requires fewer carbon atoms to coalesce into the desired crystal structure.

For laboratory-grown diamonds in the 3- to 4-ct. range, the growth process can take 5-12 days with the HPHT method. The time required to produce a laboratory-grown diamond increases as the size increases. The production of a large laboratory-grown diamond over 5 ct. can take over two weeks with the HPHT method, especially for high quality stones with few imperfections.

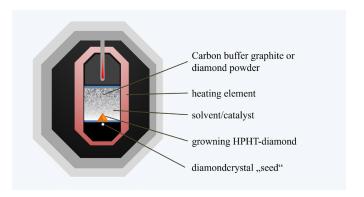


Figure 2: A schematic view of an HPHT growth chamber

CVD TECHNOLOGY OF LABORATORY DIAMOND GROWTH

Chemical Vapor Deposition (CVD) is the second method of producing laboratory-grown diamonds for the jewelry industry. Under high temperatures of 700-1300°C (1292-2372°F) and very low pressure in a vacuum chamber, single-crystal CVD stones are created. It starts with an atomically flat substrate of laboratorygrown diamond (usually an HPHT-grown Ib yellow stone) as a seed. This laboratory-grown diamond seed is placed in a CVD reactor vessel which is depressurized. A gas consisting mainly of hydrogen (95-99%) and methane (1-5%) is then injected into the chamber to a tenth of an atmosphere and heated by a microwave beam, which heats the gas to very high temperatures to release the carbon and hydrogen atoms. These atoms are attracted to the colder, laboratory-grown diamond substrate at the bottom of the chamber and deposit on the seed plates as a thin layer of laboratory-grown diamond. The process is akin to how water molecules condense from the air to form frost on a window.

Several tabular crystals can be produced during a single growth cycle. Most CVD crystals are brownish or grayish. Colorless crystals can be produced with this method, but they require a longer growth time. Most CVD laboratory-grown diamonds are rapidly produced brown crystals, which can be reduced in imperfection through processes such as HPHT treatment to improve color and clarity. Advanced techniques continue to improve the growth efficiency and quality of the diamonds produced, ensuring that CVD laboratory-grown diamonds meet high standards. CVD crystals are typically less than 10 ct., and most are less than 2 ct. as cut stones.

Laboratory-grown CVD diamonds are increasingly gaining market share, especially for smaller diamonds. Smaller, laboratory-grown diamonds of approximately 1-2 ct. can typically be grown in 7-10 days using CVD methods. The shorter growth time is due to the smaller size of the stone, which requires fewer carbon atoms to form the desired crystal structure.

For laboratory-grown diamonds in the 3- to 4-ct. range, the CVD growth process can take 10-19 days. The time required to produce a laboratory-grown diamond decreases as the size increases. The production of a large laboratory-grown diamond of more than 5 ct. can take more than three weeks using the CVD process, especially for high-quality stones with few flaws.

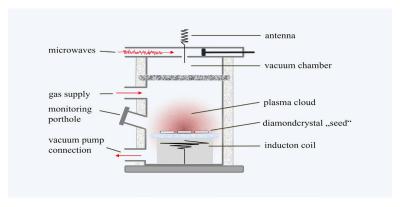


Figure 3: A schematic view of a CVD growth chamber.

TESTING METHODS

The question of how to reliably test diamonds is an important one. In the industry, there are accepted testing methods. These include using a thermal conductivity meter and the Scharffenberg formula to calculate weight. There are also a few wild instructions in the media that are by no means practical or meaningful.

Three examples that are not recommended are:

- 1. The grinding test, in which a piece of abrasive paper with corundum (Mohs hardness 9) is rubbed over the stone. Although this test provides information about the hardness of the stone, you should be aware that the stone may be permanently damaged.
- 2. The heat test, in which the stone is heated for 30 seconds and then cooled abruptly in water. Depending on the characteristics of the stone, this can also cause damage to a diamond.

3. The condensation test, where the stone is breathed on and, supposedly, on a real diamond, the stone should fog up for a few seconds, which was the case in our test with all stones, not just the diamond (we tested with cubic zirconia, synthetic moissanite, crystal and diamond).

One test that can be done without equipment and will give at least some meaningful results is the transparency refraction test. To do this, draw a dot on white paper with a black pen. Then place the stone on top of the dot with the table facing down. If the dot is visible through the stone, it is most likely not a diamond. The basis for this test is the single- or double-refraction of gemstones. It should be noted that all single-refraction or CVD-coated stones will pass this test.

Figure 4 shows a compilation of diamond testing tools used to examine diamonds and eliminate imitations. This is important when it comes to testing stones before accepting a piece of jewelry to be repaired or resized at the goldsmith/jewelers. This legal protection is discussed in more detail in the section titled Possible Legal Pitfalls.

Diamond testing tools in Figure 4, from left to right: Diamond cloth, loupe, tweezers, color card, thermal conductivity meter (diamond tester), UV light, test blade for diamond tester, and gauge, scale. (The set, depending on brand and equipment standard, runs about \$700). Special HPHT-CVD testers are used to exclude synthetic diamonds (Figures 9-11).



Figure 4: Diamond testing tools

A test sequence is shown in Figure 5. It is important to follow the test sequence to obtain meaningful results. It is important to use

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the thermal conductivity meter (diamond tester) first to rule out imitation diamonds such as cubic zirconia or moissanite. This is the first part of the test. Only if the first part shows that it is a diamond can further testing be done, because some HPHT-CVD testers only check if it is a type Ia diamond (natural diamond) or a type IIa diamond (HPHT-CVD laboratory-grown stone and a 1-2% chance of a natural diamond). Older generation instruments cannot detect diamond imitations.

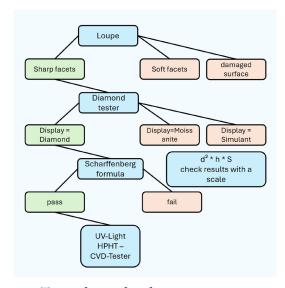


Figure 5: Test scheme for the correct sequence of the diamond test procedure

The following test methods are available for the professional testing of diamonds. Part 1 of the test is designed to eliminate diamond imitations, and can also identify treatments applied to the stone.

Loupe

Use an aplanat (distortion-corrected) and achromat (color-corrected) loupe with 10x magnification. First, clean the stone with a lint-free cloth before you begin to magnify. Pay special attention to the cut edges of the stone, the table and the culet. Check that the cut edges are sharp, cleanly polished and that there are no rounded or soft edges. Check the table for scratches and chipping, and the culet for chipping.







Figure 6: A diamond with typical sharp facets (left), a cubic zirconia with a polished table (middle), a moissanite with soft facets (right)

Thermal Conductivity Meter (Diamond Tester)

The thermal conductivity meter, also known as a diamond tester, is used to determine the thermal conductivity of a gemstone. Since diamonds are heat conductors, a diamond will give off heat immediately when exposed to heat. If the stone does not give off heat immediately, it is not a diamond. It is important to note that the Thermal Conductivity Meter can only separate metal/simulant/moissanite/diamond. A CVD-coated moissanite can give a false result as a "diamond", and this result includes natural diamonds and laboratory-grown diamonds.



Figure 7: Diamond tester in use; the test needle is at a 90-degree angle to the stone table

Scharffenberg Formula

The Scharffenberg formula is used to calculate the carat weight of a diamond, as follows:

$$d^2 * h * S$$

 $d\!=\!diameter,\,h\!=\!height,\,S\!=\!Scharffenberg\,\,coefficient\,\,(S\!=\!0.0063)$

The Scharffenberg coefficient depends on the thickness of the girdle. For a thin girdle it is 0.0061, and for thicker girdles goes up to 0.0064.

Example:

$$6.4^2 * 3.9 * 0.0063 = 1.0063872$$
 ct.

The stone weighs 1.00 ct., confirming that it is a diamond.

Part 2 of the test is designed to separate laboratory-grown diamonds and natural diamonds.

UV Lights

A distinction must be made between fluorescence as a property of the diamond (long-wave UV light, 320-400 nm) and the testing of diamonds with long-wave light (365 nm) and short-wave light (255 nm), to determine if the diamond is natural or laboratory-grown.

Fluorescence as a Characteristic of the Stone

The "standard" test for fluorescence in a diamond uses a lamp with long-wave UV light. A distinction is made here between none, faint, medium, strong and very strong fluorescence. Fluorescence does not affect the quality of the stone, but overall, fluorescent diamonds tend to be less expensive than comparable non-fluorescent stones, making them attractive to price-conscious buyers. They offer an excellent opportunity to purchase a high-quality diamond at a lower price.



Figure 8: The different grades of fluorescence in a natural diamond

The test to identify the difference between a natural diamond and laboratory-grown diamond uses 365 nm long-wave light and 255 nm short-wave light. When working with open UV light sources, it is important to wear appropriate safety goggles. Both natural and laboratory-grown diamonds exhibit fluorescence. In natural diamonds, the luminescence is stronger in long wavelength light, whereas in laboratory-grown diamonds, the luminescence is stronger in short wavelength light. In addition, long-lasting phosphorescence is common. The same fluorescence pattern applies to CVD laboratory-grown diamonds as to HPHT-grown stones. In some cases the fluorescence is equally pronounced in the short-wave and long-wave light.

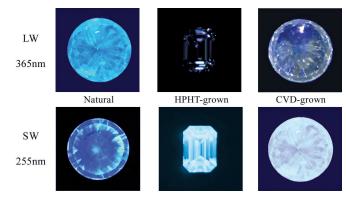


Figure 9: Different fluorescent pattern in HPHT-CVD laboratory-grown and natural diamonds

Depending on the number of stones to be tested and the budget available, there are different types of testing equipment. It ranges from flashlights with short-wave and long-wave UV light (\$300), to devices that can test individual stones (\$800-2,000). Some of these models can also detect simulant stones and moissanite. Then there are instruments that can test entire batches at once for retailers or large jewelry manufacturers. High-end machines are fully automated, using air pressure to sort each tested category, including a fully automated test report (\$8,000-unlimited).





Figure 10: UV Flashlights and safety goggles (left), HPHT-CVD tester for single stones and rings (right)





Figure 11: A single stone tester with a testing needle, for small stones down to 0.015 ct. (left); a tester that can screen loose as well as mounted diamonds (right). Both devices are capable of recognizing cubic zirconia and moissanite as well.

Magnetism

In addition to the testing methods mentioned above, there is also the possibility of detecting laboratory-grown diamonds by testing them with a strong magnet. Natural diamonds do not contain magnetic inclusions and will not be attracted to a magnet. If the metallic inclusions are large enough, you can hang the stone on a strong magnet. If the metallic inclusions are small, the magnetism may be difficult to detect. By floating a piece of paper in the middle of a full glass of water and then placing the stone on top, even weak magnetism can be detected. The latest generations of laboratory-grown diamonds have a higher clarity and are therefore often free of metallic inclusions. Therefore, this test is inconclusive for most laboratory-grown diamonds.

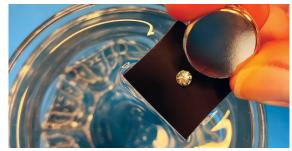


Figure 12: Magnetic test on a laboratory-grown diamond. The stone is attracted to the magnet by the metallic inclusions.

POSSIBLE LEGAL PITFALLS

Even in the days before the major marketing of laboratory-grown diamonds, there were legal pitfalls in everyday practice. They begin with the acceptance of jewelry for repair. Many jewelers have a

fixed camera that they use to photograph or film the jewelry when they accept it for repair. It is generally not advisable to use stone descriptions such as "natural diamond" or "laboratory-grown diamond" on repair bags. This can cause a right for indemnity when there is "diamond" written on a repair bag, but the stone is a moissanite. Unfortunately, there have also been cases of stones being exchanged in rings. This "scam" has been around for a long time with moissanites, but CVD-coated moissanites and especially laboratory-grown diamonds represent a new level of fraud. Therefore, it is always advisable to check the stones before accepting a repair.

To avoid discussions about replacement, it is a good idea to check the stones in the presence of the customer. (If the stone is always in the customer's field of vision, arguments such as "the employee was in another room and then came back and said 'something is wrong with the stone, it is not X, Y, Z', can't happen.) If the stones are to be brought back to the dealer, it is best to check the stones in the customer's presence. If the goods are tested in a central laboratory and only an incoming inspection is carried out, all steps should be monitored by camera and as soon as the goods are moved without a camera, they should be packed into safe bags. If the chain of custody is broken, the retailer's chances of recovery in the event of a lawsuit are minimal.

CUSTOMER SURVEY

To really understand what is important to our customers, we conducted a survey of 125 participants with some surprising results. Only 25% of the customers think of diamonds as an investment product, but most respondents have heard of laboratory-grown diamonds (86%). At the beginning of the survey, you can see that more than half of the participants are generally aware of diamonds, but 34.4% have not really dealt with them yet.

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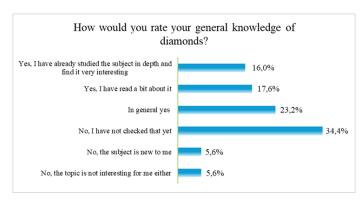


Figure 13: Chart of general customer knowledge about diamonds

When asked how high the proportion of synthetic diamonds is today, most customers' views differ widely. Contrary to the widespread assumption of 30% or even 70%, the current share of laboratory-grown diamonds is actually lower, but rising (9.6% in 2022, 14.3% in 2023, 14.6% in 2024 and a forecast of 21% in 2025).

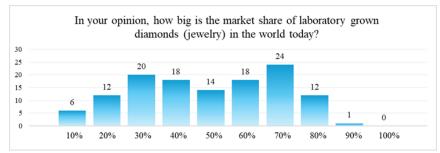


Figure 14: Chart on customer estimates of laboratory-grown diamond market share

However, most customers agreed with the growth forecasts for laboratory-grown diamonds and saw growth in this market in the future.

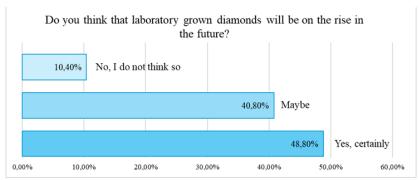


Figure 15: Assessing the laboratory-grown diamond market from a customer perspective

Many customers have not made a clear preference between laboratory-grown or natural diamonds, and do not yet understand the pros and cons. Following this customer survey, we will take a closer look at these aspects and address the question of the extent to which laboratory-grown diamonds are "green" diamonds. But what are the most important factors when buying a diamond? Table 1 provides some insight into this question.

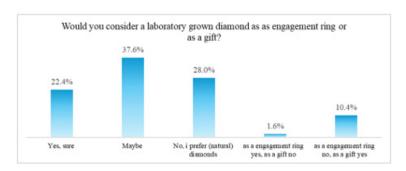


Figure 16: Chart on the purchase decision for laboratory-grown or natural diamond

When asked what criteria are important when buying a diamond (natural or laboratory-grown), respondents indicated that the most important factors were price, diamond quality, diamond certificate and buying advice. Expert advice when buying a diamond is particularly important, firstly because it plays a significant role in closing the deal, and secondly because it is important that the customer is satisfied with the product they have chosen, whether it is a laboratory-grown or a natural diamond.

Table 1: Importance of each factor when buying a diamond

	very important	important	50/50	less important	un- important	no influence
Price	47	49	16	1	2	9
Diamond Quality	62	34	15	2	2	3
Diamond Certificat	40	46	18	7	4	3
Preservation	40	46	18	7	4	9
Labor conditions	41	40	17	7	4	16
Environment protection	37	46	14	8	4	16
Resource-efficient work practices	33	41	24	8	4	15
CO ² neutrality	22	39	28	9	9	18
Expert advice	62	43	10	2	0	7
Recommendation	19	35	33	13	6	18
Origin of the stone	31	37	24	15	7	11

Participants could simply write down their ideas in response to the question, "In your opinion, what are the strongest factors that will lead to a change in diamond buying behavior?"

The top answer was "price" with over 30% of responses, followed by "information", "the economy", "more laboratory-grown diamonds", "environmental protection", "diamond certification", "marketing", and "diamond scarcity".

Another interesting question was, "How much are you willing to pay for a natural diamond versus a laboratory-grown diamond?"

- 55.2% would pay more for a natural diamond
- 41.6% would pay the same for a natural diamond as for a laboratory-grown diamond
- 3.2% would pay more for a laboratory-grown diamond

Currently, there is no way for customers to resell their laboratory-grown diamonds. There is no way to tell what a laboratory-grown diamond is worth when it is sold back to a jeweler. Tables such as the Rappaport for natural diamonds do not exist for laboratory-grown diamonds at the moment. When a jeweler takes back a piece of jewelry or a laboratory-grown stone, it is a matter of the jeweler's goodwill, not a product that can actually be traded on the secondary market. At the moment, going from customer to customer through the private market is one of the few ways to get laboratory-grown stones back on the market.

The market is growing but there are still some challenges to overcome.

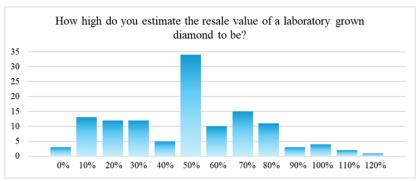


Figure 17: Chart on the customer estimation of the resale value of laboratory-grown diamonds

CHALLENGES

Some dealers who used to repurchase diamonds are afraid of the risk of buying laboratory-grown diamonds at the price of natural diamonds due to inadequate or insufficient testing procedures.

There are also sometimes large markdowns because there is always the risk that the stones will be damaged during disassembly and must be recut. This results in a loss of value due to the loss of size. However, the usual margins for natural diamonds in a jewelry store are 30-50% of the purchase price. If the customer decides to sell to a pawn shop, the price is 20-30% of the originally paid price. This is of course also because the goods are often only on loan. In addition, there are now dealers who specialize in the used diamond market. There, prices of 60-70% are possible for some natural diamonds. However, most traders will only pay good prices if the stones are certified by a respected institution. A diamond grading

certificate is one of the most important factors in determining a diamond's resale value, as it provides an authoritative assessment of the stone's quality.

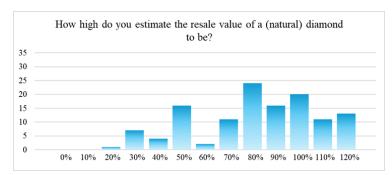


Figure 18: Chart on the customer estimation of the resale value of natural diamonds

Even if the prices (Figures 17 and 18) are generally overestimated by customers, most of them are aware that the sale of a natural diamond is associated with higher prices.

An alternative to the classic natural diamond has been available for several years now in the form of so-called "recut" stones or, somewhat unflatteringly, "recycled" stones. These can be especially interesting for cost-conscious customers. In terms of price, these stones give the customer the advantage of better affordability, about 30% cheaper than new polished natural diamonds. These stones are set from old jewelry that has been melted down and the diamonds are recut/polished and certified. As these stones only need to be recut/polished and shipped, they have a small environmental footprint and are a good alternative for buyers who want to purchase cost-conscious and environmentally mindful diamonds. And over 60% would also select a recut stone.

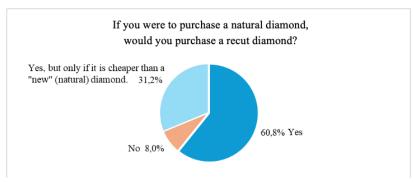


Figure 19: Buying decision chart for recut natural diamonds

In summary, this survey shows that customers already have some information in some areas. But the question of the individual advantages and disadvantages of the different variants and an ecofriendly working method is not yet really apparent to customers. This is also the area where the customer has a strong desire for comprehensive guidance from a jeweler.

DIFFERENT TYPES OF DIAMONDS: PROS AND CONS

The different types of diamonds all have their own advantages and disadvantages. A new natural diamond, in theory, is a product that no one else has; the buyer is the first to wear it. For many customers, this is a convincing argument that they are the one (and only) to wear this natural diamond after its millions of years in the earth. It represents a value compared to other variants in resale, even if this value is significantly lower than the retail price.

Laboratory-grown diamonds are a man-made product, which is also an argument for some customers. In addition to the lower price compared to a natural diamond, these customers are also fascinated by the fact that they can hold a Made in USA or Made in Europe laboratory-grown diamond in their hands.

The biggest advantage of recut diamonds is that they give new life to a product that was already on the market. These stones and pieces of jewelry are often referred to as "preloved". Recut natural diamonds must deal with the basic material that is available.

Older stones often need to be recut and are limited in size. In comparison, laboratory-grown diamonds have an unlimited amount of material available. However, the most important argument for buyers of recut natural diamonds is often that these stones leave

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almost no environmental footprint.

This brings us to the most central of all statements when comparing the different variants.

ARE LABORATORY-GROWN DIAMONDS "GREEN"?

A laboratory-grown diamond is more sustainable than a natural diamond. Following this argument, laboratory-grown diamonds are preferable, especially in terms of social standards and the environmental footprint of production.

Sustainability is defined as an approach that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is economically efficient, socially fair, and ecologically sustainable. Producers can ensure that their production methods and business practices differ positively from those of others in terms of sustainability.

It means ensuring that rough diamonds are not mined in so-called conflict areas. These are usually areas of the world where wars and civil wars are raging, and attempts are made to raise capital with the country's natural resources to buy weapons with the proceeds. To prevent this, the Kimberley Process was developed—a international collaboration designed to prevent the trade of conflict diamonds by requiring participating nations to keep such diamonds out of legitimate commerce channels. This potential for conflict no longer applies to around 98% of the diamonds that are for sale today.

We can ensure that working conditions in the production and processing of rough diamonds (natural or laboratory-grown) meet high standards in terms of fair wages, health and safety, social benefits and the protection of human rights; especially in India, where 99% of laboratory-grown diamonds are cut and polished.

Reducing the carbon footprint and protecting biodiversity are both growing in importance. Both the natural and laboratory-grown diamond industries face the challenge of decarbonizing their respective carbon footprints in line with global climate goals. This means, for example, focusing on the use of renewable energy, participating in carbon offset projects and investing in carbon sequestration programs. For the diamond industry, this means investing in carbon sequestration and water recycling. The laboratory-grown diamond industry needs to face up to the fact that most rough diamonds produced, mainly in India and China, are produced using coal-fired electricity, and take action.

In summary, it can be said that neither the synthetic diamond nor the natural diamond is more sustainable. Neither product is, by definition, more economically efficient than the other, nor is the production and processing per se more socially just. In terms of ecological sustainability, there is also no advantage for one or the other type of product. Nevertheless, there are positive examples of both product types where the respective manufacturer is taking its own more sustainable approach.

DESIGN OPPORTUNITIES OF LABORATORY-GROWN DIAMONDS

Laboratory-grown diamonds open a world of new possibilities for jewelry designers. But often, laboratory-grown diamonds are seen as a cheap alternative to natural diamonds. A truly impressive example of the new design possibilities is the ring shown here, which was produced by the Dutch Diamond Group® in 2017-2018. This is one of the first wearable, laboratory-grown, all-diamond rings. The 'Project D' ring has been made from a large piece of 155 ct. rough CVD laboratory-grown diamond. It takes up to five weeks to grow a diamond plate of this exceptional size. It was polished, using laser cutting and traditional techniques, into a ring with 133 facets (compared to 57 facets for a standard brilliant cut).

The ring has a total weight of 3.86 ct. (155 ct. wafer). It wasn't until 2017 that it became technically possible to grow large enough monocrystalline laboratory-grown diamond plates. This is not the first ring to be created from a single diamond. In 2011, Shawish, the Swiss jeweler, unveiled the world's first wearable ring made from a single crystal of natural diamond.



Figure 20: Picture of an all-diamond, laboratory-grown, CVD diamond ring, created by the Dutch Diamond Group® in 2017 © Pietraverde

Another possibility that laboratory-grown diamonds offer is the ability to work with richly colored stones. The typical colors are yellow and blue, but pink and pink-orange are also possible.



Figure 21: Color chart of different laboratory-grown diamonds

CONCLUSIONS

The diamond market is constantly changing. Laboratory-grown diamonds have changed a lot, especially when it comes to the financial value of diamonds as an investment. According to the customer survey, 86% of all participants have heard of laboratorygrown diamonds and only 25% of customers still see diamonds as an investment product. In addition to the various types of natural and laboratory-grown HPHT/CVD diamonds, there are now more and more natural recut stones on the market. This makes it even more important to provide customers with comprehensive advice on the various options when buying a diamond. After all, from the customer's point of view, expert advice was one of the most important aspects in addition to quality and certification. This is the only way the customer can feel they are making the right decision when buying a diamond, regardless of the type of diamond they choose. Customers who are price conscious now have the option of choosing between laboratory-grown and recut stones. This has led to an expansion of the market until recently, as one of the main arguments for choosing a laboratory-grown diamond was the lower price as compared to a natural diamond.

An important first step was to establish industry-wide standardized terminology that would allow customers to receive accurate information. Due to the increasing mixing of different types of diamonds in the market, test methods and procedures need to be reviewed and rewritten or supplemented as necessary. To minimize false results, it is important to follow the testing process and first rule out imitation diamonds and then conclude the testing with the question of whether the diamond is natural or laboratory grown; especially in melee stones, which, in contrast to larger laboratory-grown stones of 0.5 ct. and larger, are not laser-inscribed for technical and purely economic reasons. The greatest risk of inadvertently mixing stones is when setting mixed stones

in jewelry, when replacing stones for repairs, and when mixing batches of diamonds for repurchase and resale. It is also important to point out the possible legal pitfalls when accepting diamonds for repair and repurchase.

However, there are now different testing devices for every need and every company size to detect laboratory-grown diamonds. Regarding the much-vaunted environmental compatibility of laboratory-grown diamonds, it must be made clear that these stones are grown in factories, not in "laboratories," and that a great deal of energy is required to produce them. This means that laboratory-grown diamonds can be green diamonds if environmental and human rights standards are met, if they are produced using only sustainable energy sources, and if the supply chain is kept short. However, this is not possible for the consumer without access to a traceable and transparent supply chain. One of the greatest opportunities offered by laboratory-grown diamonds is the new design possibilities of creating entire rings or pieces of jewelry out of a single diamond. There are also many new possibilities in the field of colored diamonds, with stones produced using the HPHT or CVD process.

In summary, all diamond varieties have their advantages and disadvantages. Laboratory-grown diamonds are cheaper than natural diamonds and have very colorful variations. But at the moment there is no opportunity to repurchase them. These stones are usually seen only as a cheap alternative to natural diamonds. Natural diamonds still often have the reputation of being a product for illegal financing, even though the Kimberley Process (document A/78/L.54) has filtered conflict diamonds out of the market. But in the field of natural diamonds, the area of recut stones has become very interesting. Customers who want a natural product that is not "fresh" from the earth can find a diamond that meets their needs. The diamond industry is in a period of continuous evolution and there will be many exciting developments to come.

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