LAB-GROWN DIAMOND SCREENING

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A laboratory-grown diamond, commonly referred to as "laboratory-created," "synthetic," "man-made," or simply "lab-grown," is a diamond that appears optically identical to natural diamonds. It possesses virtually the same chemical composition and physical properties as its natural, earth-mined counterpart.

During the past decade, thanks to advancements in the lab-grown diamond's growth technology, lab-grown diamonds have become increasingly popular, offering consumers attractive price and quality options they previously may not have been able to afford.

FIGURE 1. *UV transparency and reflectance screeners. Sources: Stuller.com; Kassoy.com*

In recent years, the industry media has covered dozens of improper disclosure and stone swapping issues reported by jewelers and leading gemological institutes. The frequent news reported on all types of goods, including loose stones, mixed melee parcels, mounted jewelry, and estate antique items. This trend repeatedly demonstrates the increased prevalence of these cases in the market and fuels consumer awareness of the new issue.

The main drive for these practices is the lack of easy identification. The continuous improvement in the color, clarity, and size of the lab-grown diamonds generated extreme difficulty visually identifying them, even by an experienced gemologist using magnification.

Moreover, traditional handheld thermal and electrical conductivity probes, known in the trade as "diamond testers," and other basic gemological tools used by the trade for years, have proved ineffective for such stones.

THE SCREENING CONCEPT

Lab-grown diamonds can only be identified correctly using advanced techniques that unveil properties invisible to the human eye. These new effective techniques command deep scientific understanding and access to state-of-the-art spectrometers and imaging instruments that can record and display the diagnostic features.

For the individual jeweler (or gemologist/appraiser), gaining such a scientific laboratory expertise level is virtually impossible in terms of budget and knowledge. Therefore, a series of simplified versions of the comprehensive instruments were introduced to the market to ease the trader's daily work and overcome the knowledge barrier. The more affordable tools, occasionally called "screeners," aim to serve the average retailer. Their concept is simple: One does not need to understand the science behind it—the device will give a simple visual (color-coded) or binary (Pass/Refer) answer.

Most screeners' goal is straightforward. They are designed to inspect one property unique to natural or lab-grown diamonds. Basically, the majority of instruments are trying to identify properties related to nitrogen defects within the diamond's atomic structure.

Nitrogen atoms can be found in many formations within a diamond. Some of these arrangements, such as a cluster of nitrogen atoms, result from a slow process taking millions of years. Therefore, aggregated nitrogen defects within a diamond prove that the stone is of a natural origin. These structures, known as "Type Ia,"make up 98% of natural diamonds.

On the other hand, less than the remaining 2% of natural diamonds bear negligible nitrogen levels (if any) and are labeled as "Type IIa." Like these rare natural stones, almost all colorless and near-colorless lab-grown diamonds are grown as nitrogen-free type IIa, and finding a type Ia lab-grown diamond is virtually impossible.

This means that nearly all natural diamonds could be easily sorted out by implying a quick type-identification method, and the rest will be referred to further testing for verification. Most screeners do exactly that, and each technology is looking for a different property related to the type Ia structure.

Some screeners also look for other properties related solely to the lab-grown growth process. Finding such a unique feature and knowing it cannot be present in natural diamonds, assists immediately pointing to the true origin.

This article reviews the current technologies in the market for screening and identification of colorless to near-colorless diamonds, their features, and, most importantly, their limitations and blind spots.

The information is based on published literature and the author's personal research experience on these instruments. Please note that some devices might have additional rarer exceptions not covered in this article.

UV TRANSPARENCY/REFLECTANCE

This technology is the market's most affordable solution and is considered the first generation of screeners. It is used widely by many manufacturers (GemLogis, Presidium, SSEF, SmartPro, to name a few). Figure 1.

Its main idea is to separate type IIa diamonds (natural or lab-grown) from the other types by illuminating the stone with one or more short-wave ultra-violet (SWUV) light wavelengths and recording its absorbance (or transmittance) within the material.

These devices are divided into two groups. The first group is based on the transmission of the SWUV through the gem, and these devices usually include a closed chamber for testing. The second is based on SWUV reflectance from the diamond's total internal reflectance property and looks like a handheld device with a small tube (resembling the old diamond conductivity testers).

Every device has a SWUV light source, usually of an LED type, and a detector. Some of these devices use one light source, while others use two sources of different wavelengths. The primary role of the second source is to provide the device with the ability to separate synthetic moissanite stones as well.

The concept is straightforward. Natural type Ia diamonds absorb the SWUV energy almost completely, and no transmitted fluorescencecan be recorded. On the other hand, type IIa stones act as a transparent material for the UV light rays and enable them to continue on their path toward the detector.

As the first generation, this technology has several weaknesses in the continuously evolving diamond market. First, melee stones of 0.02 ct or smaller, and larger stones of elongated shapes (such as marquise and long oval), might display inferior internal reflectance performance, which causes a false reading by the detector. Also, low clarity grades may interfere with the stone readings.

Second, some new HPHT-grown stones in the market were modified to include boron in their structure. Although its coloring effect could be negligible in low quantities and the diamond displays a colorless appearance, boron creates two diamond types (IIa and IIb) within one gem. This type-mixture might block the SWUV from moving through the diamond, hence being falsely identified as natural type Ia.

Third, many of these devices struggle with identifying cubic zirconia and synthetic moissanite. Initially, they were intended to be used on diamonds only, and later, the manufacturers added new features for simulants. Yet, these solutions are not perfect and have many exceptions. Therefore, even if the manufacturer declares that the instrument can identify a simulant, it is advised to take this ability with caution and use another method to support the stone's identity.

UV FLUORESCENCE AND PHOSPHORESCENCE IMAGING

This technology is also pervasive and currently led by three manufacturers (Yehuda, OGI Systems, and DRC Techno). The main idea is to separate natural diamonds from lab-grown stones and simulants by illuminating them with intense SWUV energy and recording their fluorescence with a camera. Figure 2.

FIGURE 2. *UV fluorescence and phosphorescence screeners. Sources: Stuller.com; Kassoy.com; DRCtechno.com*

The device's box comprises a chamber with a drawer or a tray for the tested gems and jewels. Inside the chamber, a SWUV light array and a digital camera are integrated at the top. Some models use an embedded smartphone or a tablet as a monitor, and others are controlled from the user's smartphone using a dedicated app.

The concept is based on the fact that under intense UV energy, like the one used within these devices, almost every diamond will fluoresce. The color of the fluorescence is affected by the diamonds' atomic structure.

The device bombards the gems with an intense SWUV energy, and the camera records their fluorescence color. Then, it turns off the light source but continues recording to look for any long-term phosphorescence. Once finished, the results are displayed on the screen for the user to interpret.

Most natural type Ia diamonds show a unique blue fluorescence, which virtually does not exist in lab-grown stones. HPHT-grown stones show a typical neon-like bright green fluorescence with a long-term (>10sec) phosphorescence. CVD-grown ones can present any warm spectrum shade (yellow, orange, red, pink, purple, or a color similar to HPHT-grown stones if treated at a very high temperature). Cubic zirconia and synthetic moissanite will display dark green and black (inert) responses, respectively.

This technology also has some limitations and weaknesses. First, some manufacturers incorrectly instruct the users to label every warm shade of fluorescence as a CVD-grown lab diamond. However, the truth is that many natural stones (type IIa, pure type IaA, hydrogen-rich, etc.) can also fluoresce in these shades, and further testing shall be required.

Second, the software automatically marks every phosphorescing diamond as an HPHT-grown stone with a red dot. Although it is convenient for the operator, some HPHT-grown stones of shorter-term phosphorescence may miss the red marking threshold. In these cases, the user must be vigilant and identify the fluorescence body color.

FLUORESCENCE SPECTROSCOPY

The fluorescence spectroscopy technology is considered very reliable for natural diamond sorting and is primarily offered via two instruments (GIA® iD100 and MAGILABS EXA). Figure 3.

These screeners are a simplified version of an advanced fluorescence spectrometer. The devices include a box with a monitor and a flexible goose-neck probe, connected to a spectrometer inside the box. The probe can transmit long-wave ultra-violet (LWUV) energy of 365nm from the box outside and convey any emitted light from outside into the spectrometer. The idea is to illuminate the diamond with the LWUV energy, and the probe will transmit the stone's emitted fluorescence to the spectrometer for analysis.

The testing is based on the fact that aggregated nitrogen atoms within the atomic structure of a natural diamond commonly create a defect called N3. This defect, which these spectrometers can see, is a unique feature of natural type Ia diamonds, and it is almost impossible to replicate it in lab-grown diamonds and simulants.

The sole disadvantage of this machine is that it is less efficient in identifying lab-grown diamonds than it does with naturals. It means that this device is aimed to serve jewelry traders seeking only to prove natural origin.

FIGURE 3. *iD100 (left) and EXA (right). Sources: GIA.edu; Gemmoraman.com*

FIGURE 4. *SynthDetect. Source: ignite.debeersgroup.com*

PHOSPHORESCENCE DECAY

This technology is based on a "time-resolved" surface luminescence analysis of a diamond. Due to patent protection, the SynthDetect screener by De Beers' Ignite® is the only machine that offers this technology. Figure 4.

The SynthDetect includes a large chamber, capable of loading even large jewelry items, and a monitor. The machine excites the diamonds inside with strong deep-UV energy (a very short UV energy of <240 nm) and imaging the results on the monitor, stacked by very short time delay intervals (of milliseconds). The operator interprets the results according to the luminescence color of the gem and the particular time delay the image was taken.

FIGURE 5. *Multi-technological screeners. Sources: sattgems.ch; ignite.debeersgroup.com; alrosa-inspector.com*

Natural type Ia diamonds fluoresce in ink blue or green colors (depending on their atomic defects), while HPHT-grown stones display a bright greenish-blue glow. CVD-grown stones can show a range of colors, depending on the existence of a post-growth treatment and the selected time delay.

The SynthDetect technology excels in spotting natural diamonds. However, it may miss some HPHT-grown stones with gentle post-growth treatment processes and incorrectly identify some simulants as natural diamonds.

MULTI-TECHNOLOGICAL SCREENERS

Some screeners use two or even three combined technologies that can check for several features, thus reducing the risk of error. They usually combine the above technologies with photoluminescence or Raman spectroscopies.

Some more recognized devices include AMS2 by De Beers Ignite, ASDI by SSEF, and Diamond Inspector by Alrosa. These instruments (except for the Diamond Inspector) are usually larger and more expensive than single-technology devices but provide better performance. Figure 5.

ADVANCED TESTING

These diamond screening technologies allow easy separation between natural diamonds and their lab-grown counterparts without the operator's need for deep scientific background.

As mentioned, these devices are not offering 100% accuracy. Other screening and testing technologies are also available. Due to their higher level of technology and some protecting patents, they are more expensive than the basic screeners.

The advanced instruments that can execute these testing are not screeners. Instead, they are fully functional spectrometer and imaging systems capable of many features, including the sorting of diamonds by type, growth method, treatments, and other factors.

The results there are not presented as a screener-like binary answer. It means that the operator should have the proper scientific knowledge to interpret the figures they produce correctly. As a result, they are less suitable for jewelry traders and more common in gemological laboratories, where the know-how is available.

WHICH INSTRUMENT TO BUY?

Every gem and jewelry industry member needs to define the right instrument for their business needs and primary use. Factors that should be taken into consideration are the business' common type of goods (loose stones vs. mounted jewelry), the expected volume (single stone vs. bulk testing), the skill set of the operator, the need to sort out simulants, and the preferred results (user interpretive or definitive machine).

To facilitate the comparison, the Natural Diamond Council offers an unbiased testing program for diamond verification instruments called the "ASSURE Program." ASSURE uses a third-party laboratory to assess the relative performance of the diamond screeners available on the market. To date, 32 devices have been tested with the results published online on its website (naturaldiamonds.com/council).

The program provides the diamond jewelry industry with reliable, third-party-approved insights that support their purchasing decisions regarding the suitable instrument for their need. The program does not endorse or rank the testing technologies. Instead, it provides a library of the instruments' data sheets with their performance results.

Considering the high infiltration of undisclosed lab-grown diamonds into the market, all diamonds cannot be blindly trusted, whether purchased from a reliable source or bought back from the public. Ignoring this fact threatens one's reputation as a jeweler and places the business on a fast slide towards professional mistakes and legal disputes.

Therefore, a proactive approach is critical for traders to verify their diamond origin. A chain of custody documentation might be good against legal disputes, but it would not block the damage to reputation, especially in today's social media environment.

Having a diamond screening instrument in one's business is the new standard, and having a second technology is ideal. Of course, these devices are not offering a whole solution and cannot replace a fully equipped lab. Yet, their ability to minimize the risk of damage is significant. ◆

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