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Bulletin
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Combine M-screen with Alpha Diamond Analyzer and

Create *your own* Diamond Screening Lab!

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Natural or Lab-Grown?

The appearance of undisclosed lab-grown diamonds (both CVD and HPHT) on the market is currently a major concern for the diamond industry. It is happening more and more often that lab-grown diamonds are being mixed together with natural diamonds in parcels of melee sized goods.

As lab-grown diamonds have the same optical, physical and chemical properties as natural diamonds, it is impossible to distinguish a lab-grown diamond from a natural one by just using a loupe or an optical microscope. So how is it possible then to determine whether your parcel of natural (melee) diamonds contains lab-grown diamonds?

Photo: Parcel of diamonds

Currently available techniques on the market propose that it is possible to immediately detect a lab-grown diamond by analysing the phosphorescent character of the stone (Box 1).

In contrast to natural diamonds (where phosphorescence occurs rarely), colourless to near-colourless lab-grown diamonds are often characterised by a strong phosphorescence. However, not every lab-grown diamond shows (a clearly visible) phosphorescence and it can still occur in some natural diamonds as well. Presence of phosphorescence can therefore not be used as a single criterion in the detection of lab-grown diamonds. It is only by using multiple advanced spectroscopic techniques that the lab-grown origin of a diamond can be determined. This can only be performed in a sophisticated lab where not only high-tech equipment is available, but also the knowledge on how to identify lab-grown diamonds.

"Presence of phosphorescence cannot be used as a single criteria in the detection of lab-grown diamonds."

Box 1: Fluorescence and phosphorescence

When analysing a diamond under UV-light, most natural diamonds display a blue fluorescence. Fluorescence is a type of luminescence that occurs when the diamond emits visible light as long as it is exposed to (long wave or short wave) UV-radiation. Apart from blue, other colours that can be encountered are white, yellow, green, orange or red (Figure 1).

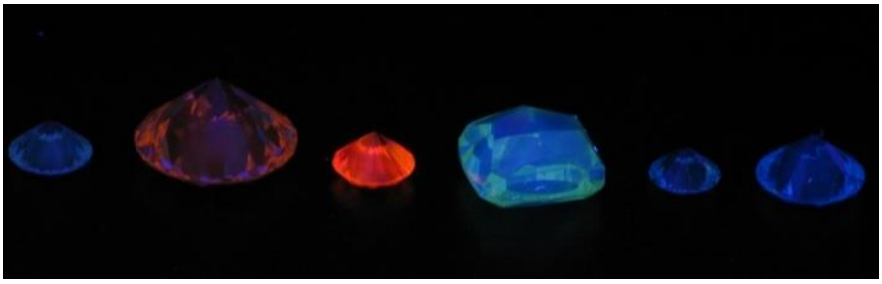

Figure 1: Series of fluorescent diamonds showing various colours under LWUV light.

In very rare cases, the diamond continues emitting light even though the source of radiation (especially the case for SWUV) is removed. This delayed light emission is called phosphorescence and is linked to the presence of certain impurities in the carbon lattice of the diamond. Natural type IIb diamonds, for example, show phosphorescence due to the presence of boron impurities (Figure 2).

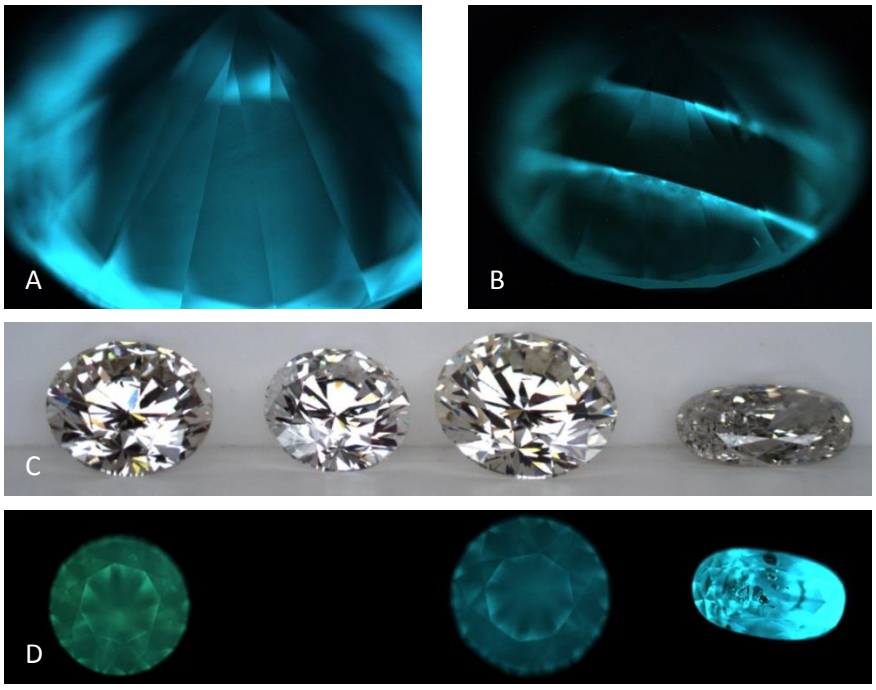

Figure 2: A) Greenish-blue phosphorescence displayed by a natural type IIb diamond. B) Example of a CVD lab-grown diamond showing phosphorescence caused by locally incorporated impurities. C) Series of lab-grown diamonds. D) Same series as C, showing presence or absence of phosphorescence.

Screening

Since a full analysis in a sophisticated lab can be expensive and time-consuming, it is not feasible for large amounts of melee diamonds. However, by screening diamond parcels, the amount of diamonds that need to be checked in a lab can be significantly reduced.

With the use of screening instruments, diamonds that are definitely natural can rapidly be separated from diamonds that need further testing in order to know their true origin. The best method to separate natural from 'potential' lab-grown diamonds is by using the diamond type classification as screening criteria (Box 2).

It has to be kept in mind that screening can only be used for colourless to near-colourless diamonds. For fancy coloured diamonds it is always recommended to bring them to a sophisticated lab, because not only can they be lab-grown, they also have to be checked whether or not they have been subject to colour treatments.

Photo: M-Screen

Box 2: Diamond type classification

Diamond is made entirely out of carbon atoms, but during diamond growth different impurities can be incorporated in the crystal lattice. Depending on the amount and the type of impurities present, diamonds can be divided into different types:

- **Type I:** nitrogen is present as impurity.
  - Type Ib: nitrogen is present as isolated atoms.
  - Type Ia: nitrogen is present in groups. Type Ia diamonds can be further subdivided depending on the aggregation state of the nitrogen atoms:
    - Type IaA: nitrogen in pairs.
    - Type IaB: four nitrogen atoms surrounding a vacancy.
- **Type II:** no significant amount of nitrogen is present (not detectable by FTIR*).
  - Type IIa: very pure carbon crystal.
  - Type IIb: boron impurities are present.

Whereas **type II diamonds are very rare in nature** (less than 2%), all colourless to near-colourless CVD and HPHT lab-grown diamonds are type II diamonds. Regarding HPHT colour treatments, both type II and type IaB diamonds are potential candidates. In general, most screening instruments will look for potential lab-grown AND potential HPHT colour treated diamonds. This means that both type II and type IaB diamonds will be referred for further testing.

**The type of a diamond can easily be determined by using Fourier Transform Infrared spectroscopy (FTIR). A few examples are shown in Figure 3.*

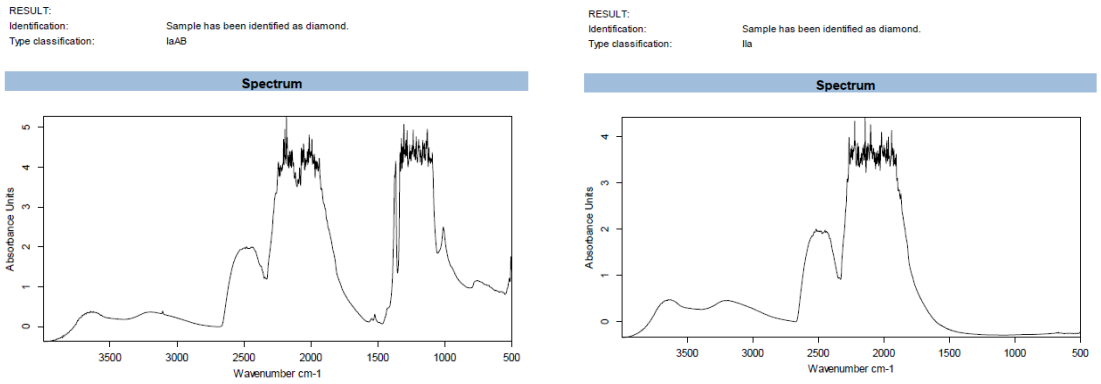

Figure 3: Different types of diamonds determined by FTIR (measurements executed with Alpha Diamond Analyzer). Left: FTIR result of a type IaAB diamond with high amounts of nitrogen present. Right: FTIR spectrum of a type IIa diamond with no detectable amount of nitrogen (area between 500 – 1500 cm^{-1}).

M-screen: the fastest way to screen your diamonds!

Photo: M-screen

In the past few years, HRD Antwerp launched various screening instruments including the **D-screen** and **Alpha Diamond Analyzer (ADA)**. Both instruments have already proven to be very useful for the screening of larger stones.

ADA can be used to screen melee sized diamonds, but the manual measuring of each stone separately would be rather inefficient for **large amounts of melee diamonds**. Consequently, the high need for a full automatic melee screening device resulted in the development of the **M-screen**. With M-screen all colourless to near colourless, round brilliants with **sizes from 0.01 to 0.20 ct** can be screened completely automatically. Parcels of up to 500 ct in total can be measured in one run and this at a speed of 2-3 stones per second.

This incredible high speed makes M-screen the fastest screening device that is currently available on the market! By using a combination of Short Wave UV transparency and a newly developed patented method, both potential lab-grown and potential HPHT treated diamonds will be separated from the natural diamonds. Furthermore, diamond imitations (e.g. cubic zirconia, moissanite,…) will be readily detected and separated from the rest of the parcel.

An example of a screened parcel is shown in Figure 4. In less than 6 minutes it was possible to screen a total of 10.98 ct. For this particular sample, only 8 out of 592 stones are referred for further testing. This means that 584 stones (98.6%) are definitely natural and do not need further analysis, while 1.4% of the specimen is "potentially lab-grown or HPHT colour treated".

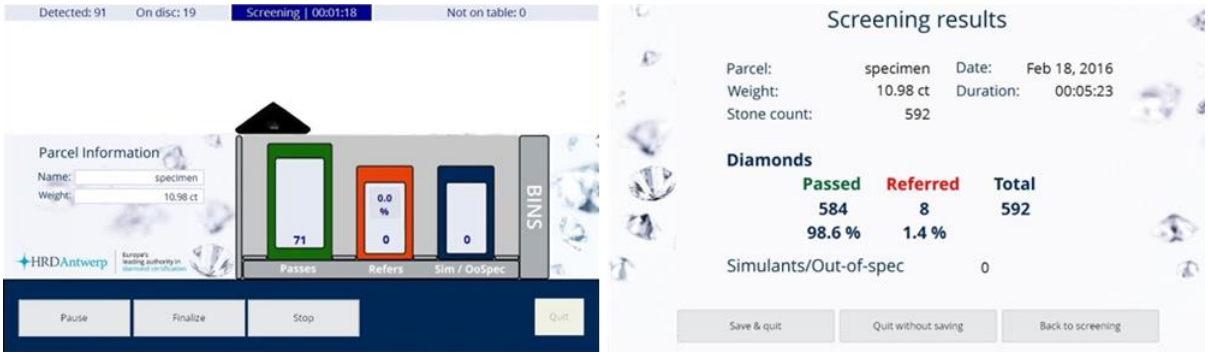

Figure 4: Example of the screening results of a sample of 10.98 ct in total. Left: Screenshot taken during the measurement. Here you can follow the progress of the screening. Right: Final screening results of the measured sample, indicating the amount of natural (584 passed) and referred (8) diamonds. No simulants were detected in this particular sample. The screening of 592 stones in total took less than 6 minutes.

M-screen + Alpha Diamond Analyzer: the perfect combination!

Photo: Alpha Diamond Analyzer (ADA)

After screening the parcel with M-screen, the diamond type of the referred diamonds can be identified by using Alpha Diamond Analyzer (photo left). This can reduce the amount of referred diamonds even further.

A few examples are shown in Table 1. The results in this table show that after screening the parcels with M-screen already more than 96% of each parcel is found to be natural and does not need further investigation.

After measuring the referred stones with ADA, the amount of stones that need further investigation in a sophisticated lab is less than 1%!

Total ct	# stones	Refer M-screen (%)	Refer after ADA (%)
10.00	910	0.55	0.00
15.05	794	3.53	0.38
50.10	1260	1.03	0.00
10.09	445	1.12	0.45
16.39	134	0.75	0.75
10.05	530	2.26	0.19
34.96	722	0.42	0.14

Table 1: *Overview of several parcels that were screened by using a combination of M-screen and Alpha Diamond Analyzer (ADA) (results expressed in percentages). By first screening the parcel with M-screen, a very rapid separation can be made between natural diamonds and stones that need further testing (Refer). By analysing the type of the referred diamonds with ADA, the total amount of stones that need to be tested in a lab is even further reduced.*

Conclusion

Since the appearance of undisclosed lab-grown diamonds on the market, different screening instruments are being developed to test parcels for potential contamination with lab-grown diamonds. In contrast to what certain techniques propose, it is not possible to detect a CVD or HPHT lab-grown diamond based on the results of one single analysis (e.g. the phosphorescent character of the stone). It is, on the other hand, possible to screen diamonds for their 'potential' lab-grown origin by using M-screen and Alpha Diamond Analyzer. By combining these two instruments you can create your own screening lab where up to 800 ct of melee sized diamonds can be screened in less than a day!

For more information on M-screen and Alpha Diamond Analyzer, please contact equipment@hrdantwerp.com