# ORIGINALLUXURY

## Extract from ORIGINALLUXURY Technology For Transparency
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# OPSYDIA

E4S · IMD · UNIL | Université de Lausanne HEC Lausanne · EPFL · SCLR THE SWISS CENTER FOR LUXURY RESEARCH · ORIGINALL

Opsydia is a technology & security company dedicated to securing the gemstone, jewellery and luxury goods industries. Our vision is to equip companies with the means to provide greater transparency and enhance traceability through cutting-edge innovation and technology, securely bridging material product and digital worlds.

## ORIGINS

Founded in 2017, the company spun out from the University of Oxford's Dynamic Optics & Photonics Group at the Department of Engineering Science.

The company has created an innovative set of technology solutions for the traceability of diamonds and coloured gemstones, linking gemstones, jewellery and luxury goods pieces to their unique provenance and traceability stories.

## TECHNOLOGY & APPLICATIONS

Using patented sub-surface laser inscription technology, the method allows anyone handling loose polished diamonds or coloured gemstones to place microscopic 'identifiers' inside or on the surface of a gemstone.

Revealed using Opsydia's specially designed loose and mounted jewellery viewers, Opsydia's identifiers are perfect for any luxury brand, manufacturer or retailer looking to add another level of transparency and security to their product.

The applications of Opsydia's technology stretches beyond gem and jewellery: it is being explored in diamond-based devices, semiconductors, quantum computing and beyond.

## GEMSTONE IDENTIFIERS

Opsydia's systems can create three types of gemstone identifiers: 2 sub-surface and 1 surface. These can be designed as a brand logo, serial number or custom designs.

### 1 NANO-ID (SUB-SURFACE)

Nano-IDs are microscopic, ultra-fine identifiers placed inside a diamond or coloured gemstone. Sitting directly below the gem's table, Nano-IDs are discrete but permanent, unable to be removed without re-cutting the stone, and with no impact on the structural integrity of a stone.

As confirmed with SSEF Gem Lab in Switzerland, they also have no impact on the clarity grade, remaining invisible under a jeweller's loupe or standard microscope, and revealed only with Opsydia's specially designed loose stone or mounted jewellery viewers.

Nano-IDs are the perfect solution for any brand looking to secure their diamond and gemstone supply chain and protect against counterfeiting. They can integrate with and complement existing traceability programmes, making the critical connection between physical and digital in a way which is visual, direct and easy-to-understand.

### 2 LOUPE-ID (SUB-SURFACE)

Loupe-IDs are also sub-surface, placed at a depth below the gemstone table which also renders them impossible to remove without re-cutting. Whereas Nano-IDs are invisible, Loupe-IDs are designed to be visible under a 10x loupe, where clarity grading is not a consideration.

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Lightbox from De Beers is currently using Loupe-ID technology for its lab-grown diamond range, placing a brand Loupe-ID logo under the table of every stone, and providing assurances and authentication to its customers.

## 3 SURFACE-ID

Opsydia's Surface-IDs are transparent identifiers, which very discretely convey a brand logo or other type of design. As standalone identifiers, or used in combination with the Nano-ID, Surface-IDs are an easy reference for anyone looking to visually identify their product with a loupe and microscope. Surface-IDs can be polished off from the surface, but can be used in conjunction with sub-surface technology.

## LASER SYSTEMS

Opsydia's commercially available laser systems are capable of placing identifiers either on the surface, under the surface, or both:

    D-4000 – Surface-ID

    D-5000 – Nano-ID and Loupe-ID (sub-surface only)

    D-6000 – All ID types (surface and sub-surface)

The systems are fully compatible with existing frameworks and gemstone traceability programmes, comfortably scaling from small trading offices to the largest manufacturing operations.

Deployed across the world with leading manufacturers and luxury brands, the systems are extremely easy to use, with only 1day training required when a system is commissioned.

Their semi-automated process means an single operator and machine has the capacity to inscribe up to 100,000 stones per annum 60-90 seconds per stone.

## GEMSTONE SIZE & SHAPE

Capable of inscribing diamonds and coloured gemstones of all shapes and sizes, Opsydia's shape recognition software automatically calculates size and recognises the centre of a stone based on its shape.

Each system is optimised for diamonds and coloured gemstones greater than 0.20cts in weight, and is capable of placing identifiers up to 0.5mm in diameter inside stones.

Opsydia worked closely with the Natural Diamond Council on it's Project ASSURE 2.0 Program and Diamond Verification initiative, placing alpha-numeric sequences inside every stone to assess the effectiveness of natural diamond screening equipment. Over 3,000 stones – natural, lab-grown, and simulants  - were successfully inscribed, with some measuring less than 1mm in diameter.

## QUALITY CONTROL

Immediately after placing an identifier during the process, a high-quality QC image is available for upload to a traceability programme, blockchain or certification process. This could include details of the date, time, location and person where the inscription took place.

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## DATA SECURITY, ENCRYPTION & SUPPORT

Opsydia takes data security and encryption very seriously, recognising that branding and authentication are some of the guarantees companies deliver to their customers. All laser systems are backed up with sophisticated software encryption, managed by a team in Oxford which keep the systems secure.

For further protection, Opsydia itself manages the central uploading of inscription types and designs from Oxford, making it not possible for anyone else with an Opsydia system to replicate another brand logo.

Frequent and granular data reporting from the systems allow customers to also verify their suppliers are sending them the correctly inscribed stones.

Whether it's a fixed inscription such as a brand logo or a variable one like a unique serial number, Opsydia is flexible and responsive to the needs of client requests.

Opsydia supports its clients with regular maintenance and system check-ups at the client site, while regular remote diagnostics are carried out to ensure the system(s) run(s) smoothly.

## THE OPSYDIA VIEWER

Opsydia's new viewers reveal the identifiers, leveraging optical technology both in loose stones and mounted jewellery. Currently entering the final stages of product development, the viewers have been designed with luxury retail stores and gem labs in mind. Fully customisable in colour, materiality and finishes, they look and feel at home in all luxury retail environments whilst also comfortable authenticating loose stones or finished pieces behind-the-scenes in a gem lab.

Authenticating a jewellery piece with a consumer and providing an extra layer of trust with the viewer is just the first step; the viewers are a powerful storytelling and sales tool for any brand looking to differentiate their product with consumers.

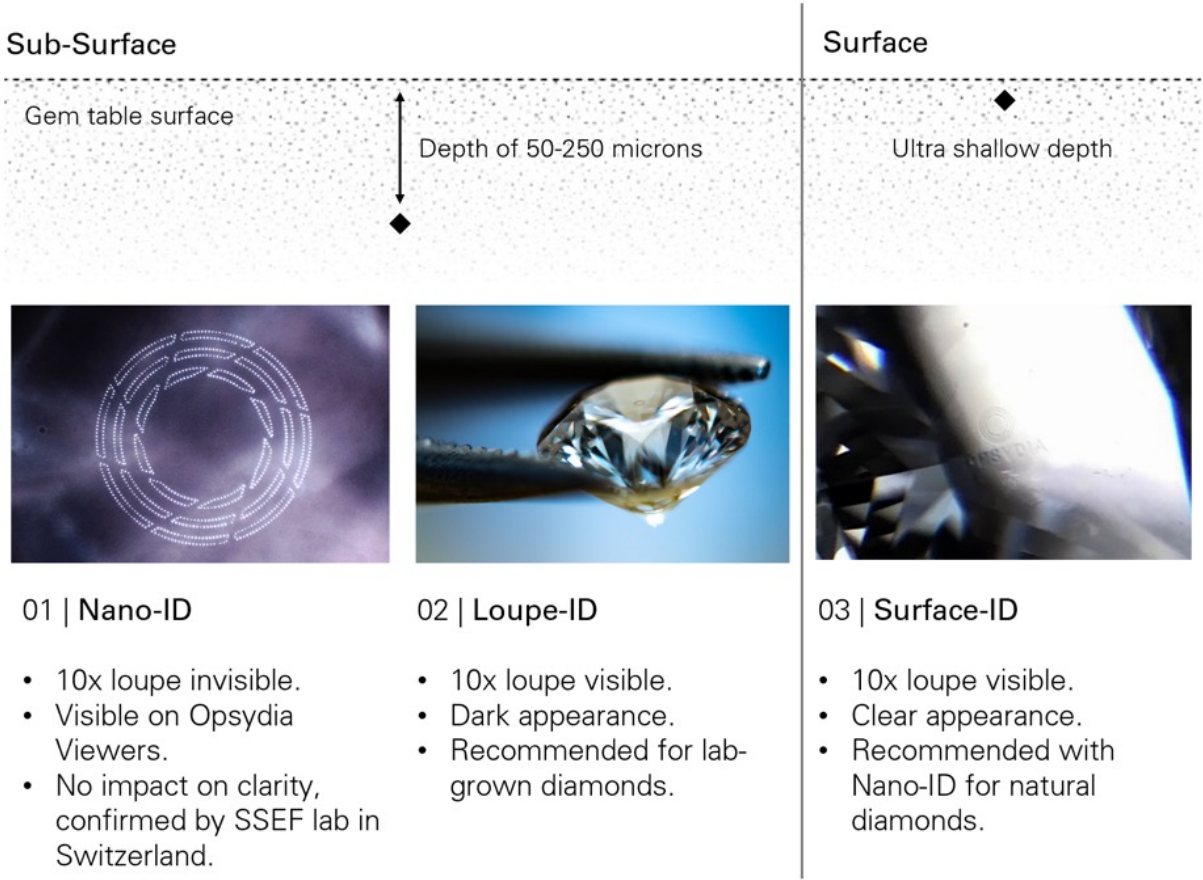## INNOVATION FROM UNIVERSITY OF OXFORD

With innovation, craftsmanship and precision at its core, Opsydia is a trusted partner to luxury brands and manufacturers across the world.

Designed, assembled and tested in Oxford by Opsydia's development team, the D4/5/6000 laser systems are the product of 15 years R&D at the University of Oxford, where underlying the tech was originally developed. Opsydia's development team continues to collaborate with leading professors and academics in their respect fields at Oxford, exploring new applications and projects.

Opsydia adds another dimension of secure traceability to jewellery and luxury goods products. The technology adds to the consumer experience with ease, security, and simplicity, making a connection that lasts beyond the store.

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**Diagram 1: Opsydia identifier types**

The technology can place **3 types of microscopic identifiers** either sub-surface, surface, or both.

| Sub-Surface | Surface |
|---|---|
| Gem table surface | |
| Depth of 50-250 microns | Ultra shallow depth |



01 | Nano-ID

- 10x loupe invisible.
- Visible on Opsydia Viewers.
- No impact on clarity, confirmed by SSEF lab in Switzerland.

02 | Loupe-ID

- 10x loupe visible.
- Dark appearance.
- Recommended for lab-grown diamonds.

03 | Surface-ID

- 10x loupe visible.
- Clear appearance.
- Recommended with Nano-ID for natural diamonds.

**Image 1: Opsydia laser system**
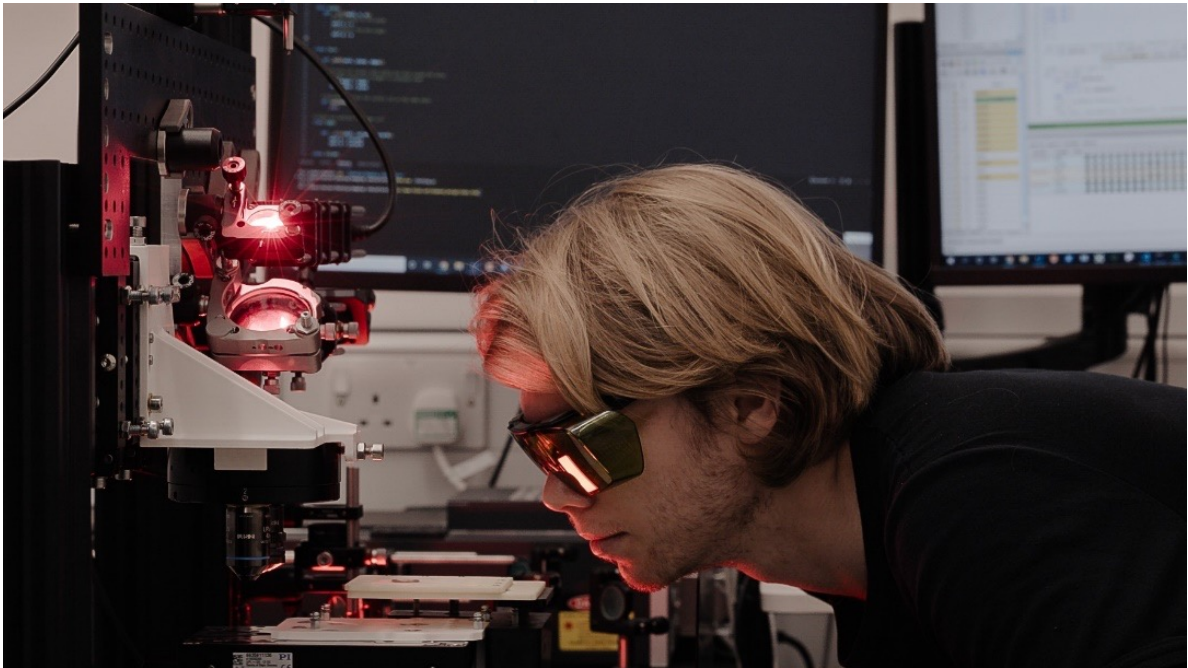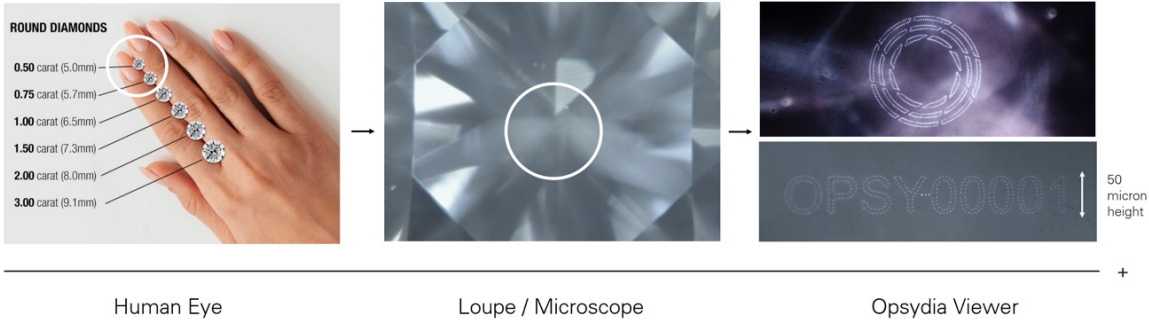
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*Image 2: In the Opsydia lab*



*Diagram 2: Opsydia Nano ID*

## 01 | Nano ID

- Sub-surface Nano ID perfect for natural diamonds.
  - Invisible, does not impact clarity grade.
  - Visible with Opsydia Viewers.

- Sub-surface IDs placed **inside** stone, and can't be removed without re-cutting.



ROUND DIAMONDS

0.50 carat (5.0mm)
0.75 carat (5.7mm)
1.00 carat (6.5mm)
1.50 carat (7.3mm)
2.00 carat (8.0mm)
3.00 carat (9.1mm)

OPSY·00001

50 micron height

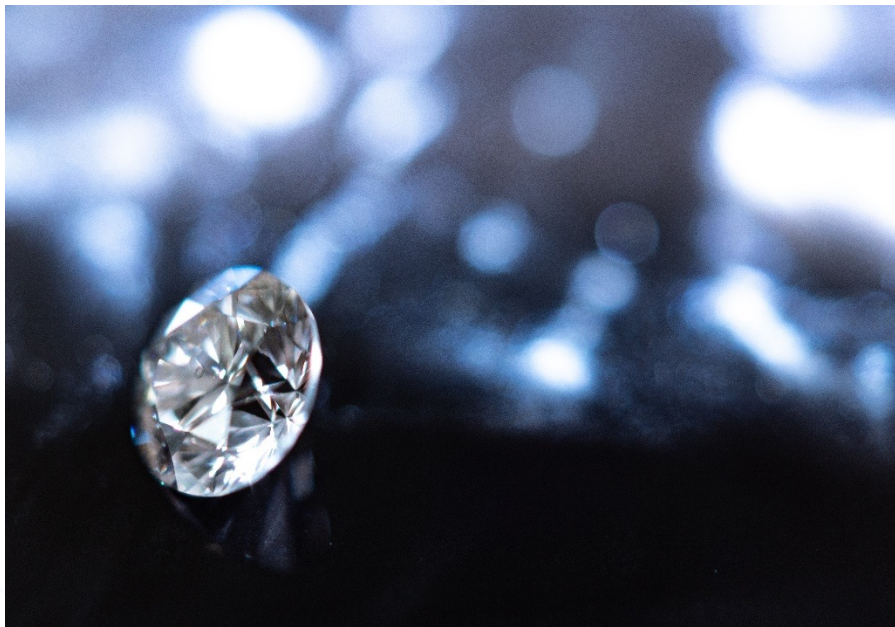Human Eye          Loupe / Microscope          Opsydia Viewer

*Image 3: Mounted stones*



## USE CASE 1: LIGHTBOX (OF DE BEERS GROUP) SUB-SURFACE ID FOR LAB-GROWN DIAMONDS (2019)

University of Oxford spinout Opsydia secured the first order for its Opsydia D5000 (sub-surface) Diamond Marking System in 2019.

*Image 4: Opsydia Loupe ID*



 The sale, to industry leader De Beers for their Lightbox Jewelry business, followed over a year of development work and was a major step forward for Opsydia's ground-breaking technology that helps address tampering and counterfeiting in diamonds.

Using high precision laser and optics, the Opsydia D5000 can make identifiers less than 1/50th of the size of a human hair.

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Unlike current surface marking techniques, these highly refined, microscopic marks are secured below the surface of gemstones so that they cannot be polished off economically. The sub-surface marks can be so small that they have no effect on the grading or quality of the gems.

After proving the concept within the laboratory of the University of Oxford's Department of Engineering Science, Opsydia began work to scale the laser process for use in diamond processing facilities at high volumes. The result was the Opsydia D5000 & D6000 systems, which allow customers to apply Opsydia's secure marking technology on an industrial scale.

An early adopter of the technology were De Beers Group's new lab-grown diamond initiative, Lightbox Jewelry, which is using the sub-surface laser marks to distinguish lab-grown diamonds from natural and serve as a guarantee of quality.

"Opsydia's technology has already proven itself to be a highly effective method of including a quality mark and tamperproof tag into our laboratory grown diamonds. We are excited to now be purchasing our first D5000 marking systems from Opsydia, which will support the significant expansion of our production in 2020 as our new manufacturing facility near Portland, Oregon in the US comes online" said Steve Coe of Lightbox.

"Having been adopted by one of the iconic names in the diamond industry, we aim to show the wider diamond, gemstone and jewellery community how our laser technology can transform security and support initiatives to prevent counterfeiting and tampering," said Andrew Rimmer, CEO of Opsydia.

Opsydia's technology uses laser pulses shorter than one trillionth of a second in length to create tiny lines which can be written as numbers or logos within the diamond. The marks are invisible to the human eye and the smallest ones are not detectable with a jeweller's loupe, but can be viewed using a microscope. Marking in any facet of the stone means security can be maintained even when gems are mounted in jewellery.

Opsydia's technology can also be used to securely mark any translucent material, such as plastics and polymers, and the company also envisages future applications writing electrical circuits within industrial diamond to create advanced sensors.



*Image 5: Opsydia Loupe ID*

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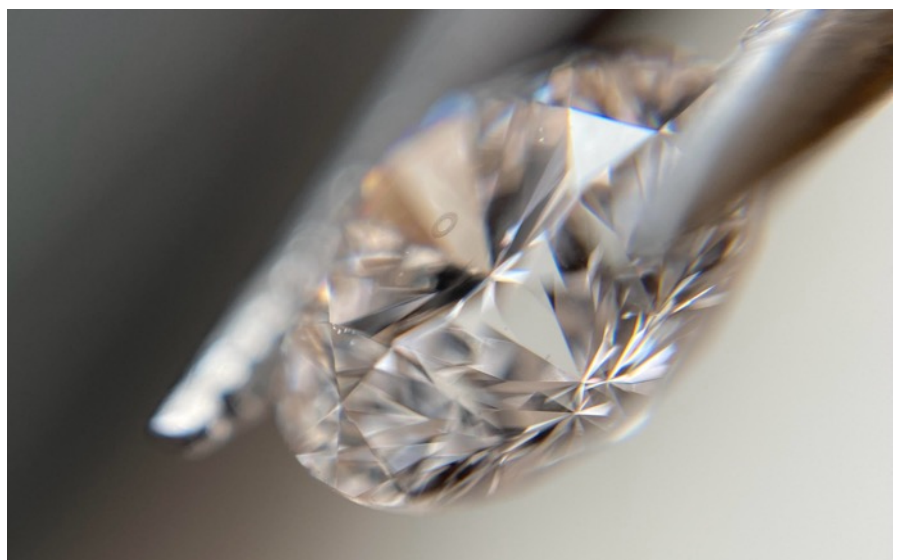
## USE CASE 2: SUB-SURFACE IDS FOR MELEE DIAMONDS WITH NATURAL DIAMOND COUNCIL (2021)

In 2021, Opsydia honed its sub-surface laser technology to such an extent that it can now place permanent identifiers in melee diamonds without affecting their surface polish.

Diamonds that are just 0.5 millimetres in diameter can have an alphanumeric sequences, coded shapes or logos placed beneath their surface to create a physical link to a supply chain record or branded jewellery origin.

Opsydia directed this technological advancement towards supporting the trade by collaborating with the Natural Diamond Council (NDC) on the latest phase of its ASSURE Diamond Verification initiative.

The ASSURE Program 2.0, which assesses the relative performance of Diamond Verification Instruments available on the market, utilises an 'ASSURE Sample' of melee stones (including individual stones of less than 1mm in size) to test each device on its effectiveness at identifying and/or recognising natural diamonds, laboratory-grown diamonds and diamond simulants.

*Image 6: Opsydia melee Loupe ID*
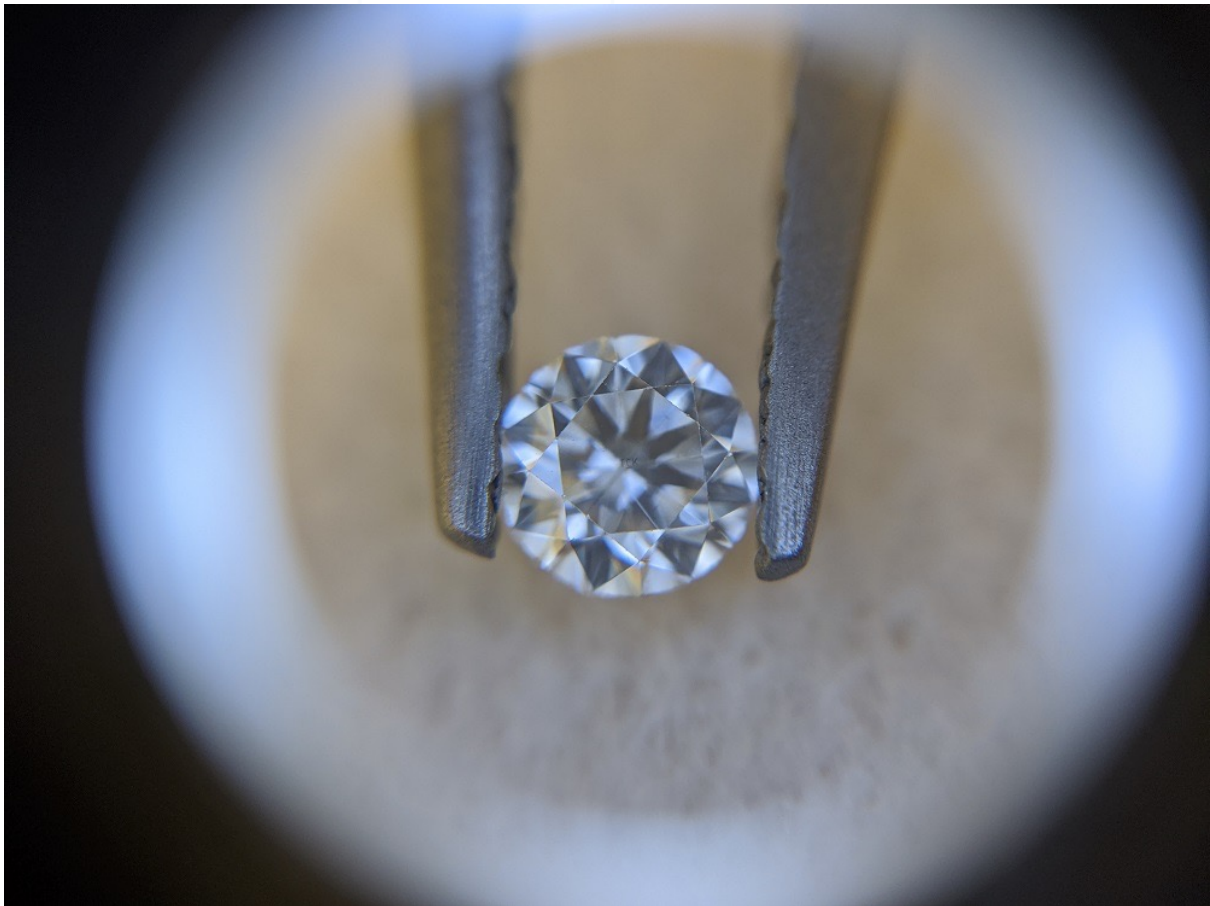


This is an important advancement for volume manufacturers, who may be searching for a unique and forward-thinking methodology to secure their supply chain and protect against undisclosed lab-grown diamonds.

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Chief Executive Officer, Andrew Rimmer, says: "With this technology, the natural diamond trade has more opportunities to secure the identity of its products and use sub-surface features to create 'fail safes' within its supply chain. Similarly, luxury jewellery brands wishing to fight back against counterfeiting may wish to include an identifier in a specific pavé diamond and assure their customers that only pieces with this nano-scale identity feature are legitimate."

*Image 7: Opsydia melee Loupe ID*



The precise capabilities of the Opsydia system allow for high-resolution lines, approximately ~1um (0.001mm) in width, meaning legible characters can be achieved at much smaller sizes in comparison to other, industry-standard surface marking systems.

## ASSURE PROGRAM SAMPLE

To aid the testing of instruments submitted to the ASSURE programme, Opsydia has placed unique serial numbers beneath the surface of all stones in the ASSURE Sample, therefore allowing the testers of ASSURE Tested Diamond Verification Instruments to discover which stones the devices have mis-identified.

This valuable information, which will be accessible to manufacturers, will allow engineers to improve the effectiveness of their diamond detection devices and will, as a result, benefit the trade as it fights for accurate disclosure.

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Raluca Anghel, Head of External Affairs and Industry Relations at the Natural Diamond Council, says: "We are pleased to collaborate with Opsydia on this latest phase of the ASSURE Program as we value their ongoing commitment to innovation. Being able to accurately identify melee diamonds, laboratory-grown diamonds and diamond simulants will allow the ASSURE program to provide greater feedback to manufacturers and will contribute towards further learning, technical advancement and above all, ensure consumer protection."

## OPSYDIA MELEE DIAMOND

Opsydia's systems use a high-precision, ultrafast laser to place logos, alphanumeric sequences or coded shapes (known as 'identifiers') beneath the surface of a diamond. This laser is tightly focused only once it passes the surface of a diamond, therefore only creating the identifier at a selected depth without affecting the surface condition or polish. It can be applied beneath the surface of a diamond in a range of locations, such as the table or a specific facet.

By adapting its techniques to suit melee and larger diamonds, Opsydia is introducing the natural diamond sector to a unique methodology for addressing its core challenges, such as enhancing stone security, establishing bold traceability initiatives and protecting against fraud, non-disclosure and other counterfeiting concerns.

The Opsydia systems (approx. one metre wide and standard doorway accessible) is based on cutting edge laser technology developed at the University of Oxford. It can place unique identity features in diamonds and is capable of processing up to 100,000 stones per year in an industrial environment. Encryption techniques ensure that each Opsydia system can only write authorised logos or identifiers preventing counterfeiting and protecting brand integrity.

Opsydia technology is deployable across the globe and can be utilised by natural diamond and laboratory-grown diamond specialists.

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**Pioneering Transparency Through Technology in the Luxury Sector**