

ASDI

Automated Diamond Spectral Inspection

*A solution for the authentication of
colourless melee batches*



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Introduction

Context

Each year, the worldwide output values of all diamonds below 0.07 ct overpasses that of all polished diamonds over 1ct.

Carat and Size Distribution of Global Polished Output					
Size Range	Carats (millions)	Stones (millions)	Avg \$/carat	Value (\$ million)	Price \$/stone
1ct plus	1.27	1.05	4,800	6,096	5,806
0.50-0.99 cts	1.70	2.10	2,100	3,570	1,700
0.20-0.49 cts	3.64	10.51	825	3,003	286
0.07-0.19 cts	6.93	52.56	425	2,945	56
Below 0.07 cts	18.46	919.78	350	6,461	7.02
Total	32.00	986.00		22,075	

Credit: *Diamond Intelligence Briefs*, vol 29 No. 800 p. 8477 (from *Tacy Ltd.*)

Introduction

The birth of the ASDI project (part 1 of 3)

1. In 2000 SSEF is invited at the Kimberley Process launch a local journal evokes the presence of synthetic diamond in melee batches.
2. SSEF decides to serve the Swiss watch industry by launching a quality control service for melee batches (2004)



The Swiss trade may use several millions of melee per month



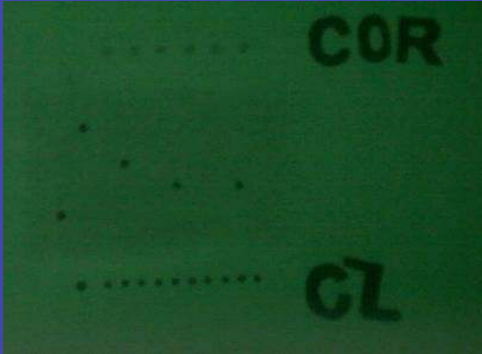
SSEF set three series of melee masters for clarity, symetry & polish

Introduction

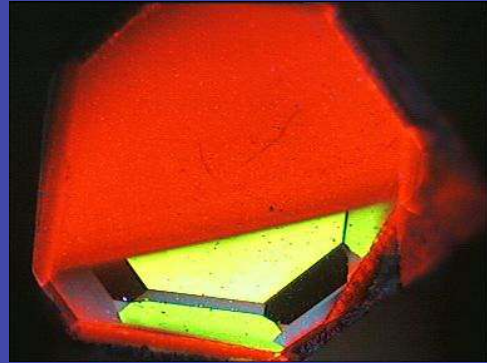
The birth of the ASDI project (part 2 of 3)

At SSEF Quality Control first means "AUTHENTICATION"

"SSEF has more than ten years of experience in authenticating melee batches"



X ray transparency of a batch of Diamonds plus 5 diamond imitations
A batch authentication



UVSW fluorescence of a CVD on its HPHT synthetic seed
A batch authentication

Introduction

The birth of the ASDI project (part 3 of 3)



CVD reactor in used in 2007 at the LIMHP, Villetaneuse, France

1. In 2007, SSEF studies some CVD grown by the french CNRS
2. No NV centres are present.
Thus, the UVSW tests will no longer be pertinent
3. 2007 SSEF LAUNCHES the ASDI project
(no more batch authentication but stone per stone authentication)

Goal of analysis

1. Melee definition
 - Round
 - Polished
 - Clean
 - Colourless (D to about H)
 - Size : diameter ranges from 1.0 mm to 3.8 m
2. Authentication of natural diamonds of natural colour
 - No diamond imitations
 - No synthetic diamonds (CVD, HPHT)
 - No diamond HPHT treated
3. Gemmological strategy
 - Authenticate diamonds with a Raman analysis
 - Authenticate natural diamonds by UVSW transparency (type II & type IaB)
4. The UVSW transparency rejection
 - Any colourless synthetic (CVD & HPHT)
 - Any colourless HPHT treated diamond
 - Any type II and type IaB natural diamond (about 3% of natural diamonds)

Technical aspects

Analytics: University of Basel
Automation: OPTEC industries



Step by step description

Technical aspects

Analytical systems (University of Basel)



Laser source and Raman probe for sorting out of diamond imitations
Electromagnetic arm for rejecting any diamond-imitations

Technical aspects

Analytical systems (University of Basel)



UVSW diode source and the optic fiber conducting the signal to a spectrometer for sorting out UVSW transparent diamonds.

Technical aspects

Analytical systems (UniBasel)



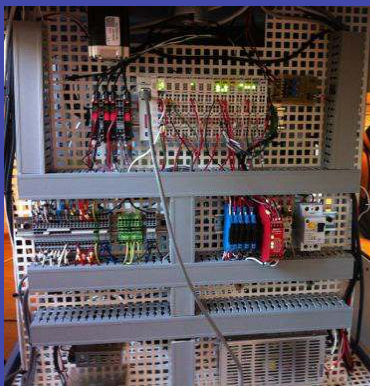
ASDI screen for the display of the Raman and the UVSW transparency signals.

Technical aspects

Analytical systems (UniBasel)

Electronics

- a Raman signal of only 70 pW - 10^{-12} watt or one trillionth of a watt - is analysed in only 30 ms
- A real time operating system (screens are only for displaying the results)



Technical aspects

Automation: OPTEC Industries



vibrating bowl

Technical aspects

Automation: OPTEC industries

1. Mechanical positioning
2. Optical controls for conformity of: size, position & clearance.

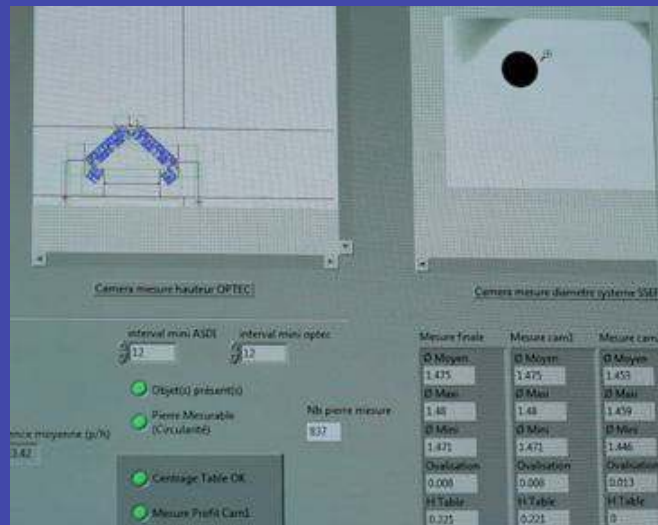


Technical aspects

Automation: OPTEC industries



Optical measurements for each authenticated diamond (14)



Development

2007 - 2012: Experiences and validation tests on a manual ASDI prototype at the University of Basel (project frozen for 2 years)

Testing of:

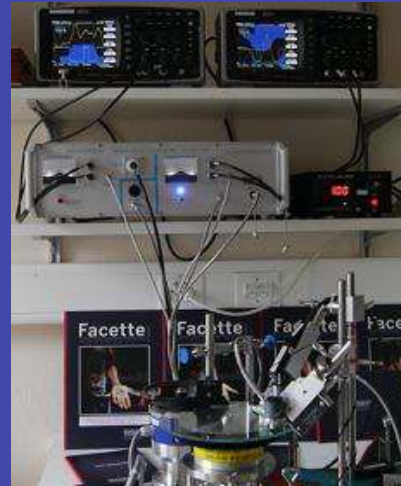
1. Colourless diamond imitations
2. UVSW transparency of:
 - type I diamonds &
 - type II diamonds



ASDI prototype: manual feeding

Development

- July 2012 - July 2013: One year of real situation testing at SSEF (with agreement of SSEF's clients)
- More than 10'000 stones were tested and placed manually on the ASDI prototype
- Each rejected stone was double checked by FTIR and/or low t° PL



Video
February 2013 ASDI prototype

Development



Finally the first ASDI machine is delivered at SSEF in July 2013
(enhancement of ASDI performance)

Using the ASDI machine

ASDI is autonomous

- Needs one operator for starting the machine
- Operating system on a mother board (independant from any other OS, such as Windows™)
- Auto detection of the glass rotating plate cleanness by the Raman probe

Using the ASDI machine

New service at SSEF

Melee batches authentication with ASDI

- Since January 2014
- Sorting of diamond imitations
- Sorting of UVSW transparent diamonds

SSEF
SWISS FEDERATION OF DIAMOND RESEARCHERS INSTITUTE
SWISS GEMMOLOGICAL INSTITUTE
INSTITUT SUISSE DE GEMMOLOGIE

Rapport d'analyse ASDI

Date d'analyse : 11 mars 2014

Identité du lot

N° SSEF : 73391
Client : nom du client SSEF
N° lot du client : 1329060

Ø déclaré (mm) : 1,75
Poids déclaré (ct) : 15,24
Poids du lot pesé (ct) : 15,242
Quantité déclarée : 710
Quantité comptée⁽¹⁾ : 710

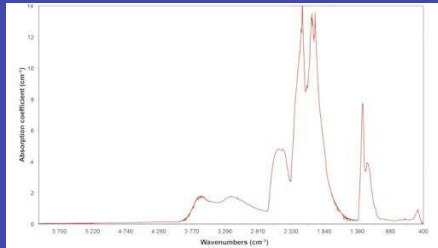
Résultat analyses ASDI		
Quantité ⁽²⁾ de diamants naturels de couleur naturelle :	697	98,2%
Quantité ⁽²⁾ de diamants transparents aux UV courts :	13	1,8%
Quantité d'imitations ⁽³⁾ :	0	

(1) La quantité comptée égale la quantité déclarée si leur différence est inférieure ou égale à 3%.
(2) Les pourcentages sont basés sur la quantité comptée.
(3) La nature des éventuelles imitations n'est pas déterminée.

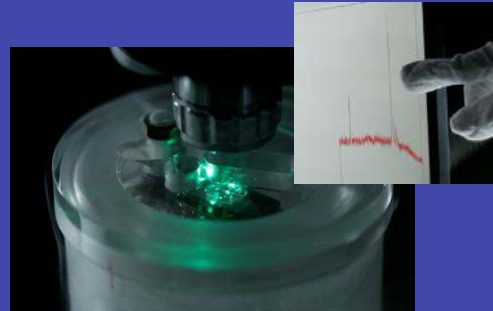
Using the ASDI machine

The rejected percentage needs further testing

- Strategy based on the statistical significance of the percentage (<< 3%, <3%, =3%, >3%, >>3%)
- FTIR
- Low t° PL



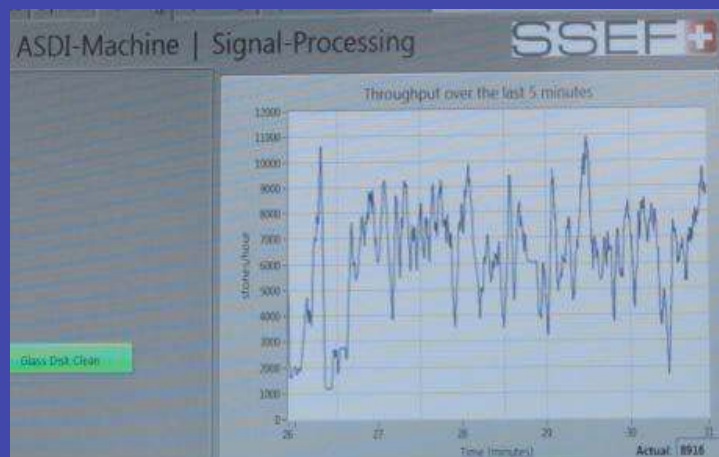
FTIR spectrum



Low t° PL

Specifications

- Dimensions: 1700 x 900 x 1600 mm
- Poids: 200 kg
- Speed rate: 4'000 stones / hour (analytics validated for >20'000 stones / h)

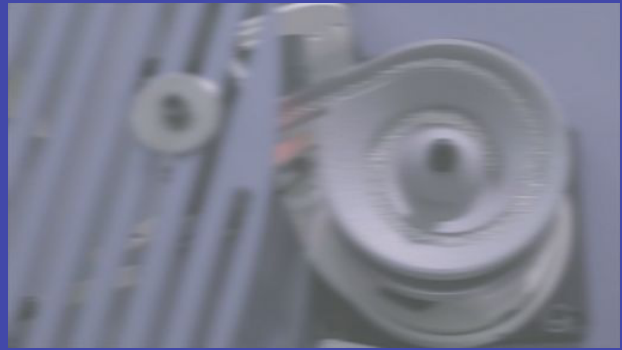


Variation of the ASDI speed rate

Conclusion

Since July 2013, among more than 400'000 tested colourless meleees

- No synthetic were found (except one salted in a lot for a blind test)
- Ten diamond imitations were found (in a batch of a peculiar origin)



SSEF - ASDI video

Conclusion

Thank you for your attention

SSEF mission is to protect
the Swiss Jewellery and watch-making industries