SSEF Swiss Gemmological Institute

# DETECTION OF GE POL TREATED DIAMONDS

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## NEWS FLASH

*In Rapaport (March 11, 2000)*, the SSEF Swiss Gemmological Institute announces its ability to detect GE POL treated diamonds. Since then, the SSEF offers an identification service for GE POL treated diamonds based on photoluminescence properties of diamonds cooled down by liquid nitrogen (-180 °C). The photoluminescence spectra are taken with a Raman microprobe.
*In Rapaport (June 19, 2000)*, the SSEF Swiss Gemmological Institute announces that it has developed the *SSEF type IIa Diamond Spotter™*, a simple device designed for diamond dealers, which enables them to identify type IIa diamonds very easily.
Most if not all GE POL treated diamonds are of type IIa (Gems & Gemology Fall 1999, pp. 17). The *SSEF type IIa Diamond Spotter™* together with a short wave UV-lamp sorts the diamonds (approx. 1% of all diamonds) that potentially could have been treated by General Electric. After identification with the *SSEF type IIa Diamond Spotter™* type IIa diamonds may be checked by SSEF to determine whether it is a GE POL treated diamond or not.

## WHAT IS A GE POL TREATED DIAMOND

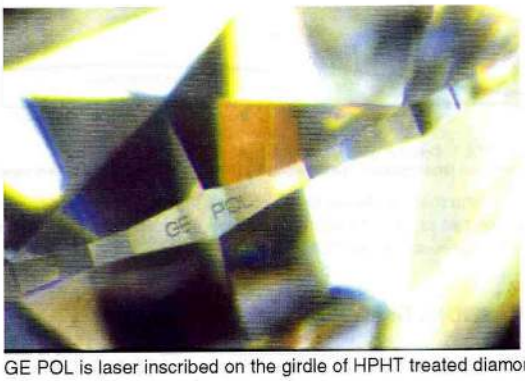
Since May 1999 colourless diamonds, which owe their good color grade to a high pressure and high temperature (HPHT) treatment, reached the jewelry trade. The quantity of this new material is low because the treatment is only effective on type IIa diamonds. This type of diamond only amounts to 1% of the total gem diamond production. A diamond of type IIa contains an extremely low quantity of nitrogen which is not detectable by infrared spectroscopy.
A related property of this type of diamond is their transparency to ultraviolet short waves (254 nm).
The HPHT-process is carried out by General Electric (GE) and involves the treatment of brownish to brown diamonds of type IIa. It decreases their colour and makes them as colorless as possible. Fisher & Spits suggest that temperatures over 1960°C are involved (Gems & Gemology Spring 2000, pp.47). In Rapaport Trade Alert (March 19, 1999) Lazare Kaplan International (LKI) announced that the weight of GE POL treated diamonds ranges approximately from 0.3 ct to 6 ct. The colours of 23 GE POL diamonds have been graded at SSEF and range from D to L, the majority being from E to H. Their purity ranges from Internally Flawless to SI2.
The GE POL treated diamonds have been originally marketed by Pegasus Overseas Limited then Monarch and now Bellataire, a subsidiary of LKI .
This company inscribes GE POL in their girdle. In the mean time, the GIA Gem Trade Laboratory has recognized a few GE POL treated diamonds with their GE POL inscription removed (Gems & Gemology, summer 1999, p. 144).
A detection method for GE POL treated diamonds which is not only based on the presence of an inscription on their girdle became urgent. The method proposed by SSEF in March 2000 is based on photoluminescence spectroscopy at low temperature using a Raman microprobe.

## N-V CENTRES IN TYPE IIa DIAMONDS

The electronic link of a nitrogen atom (N) to a vacancy (V - a lack of a carbon atom in the diamond lattice) is optically active. It can be detected by absorption- and photoluminescence (PL)-spectroscopy. As shown by Mita (1996), the N-V centre can be in its negative charge state $(N\text{-}V)^-$ showing a peak at 637 nm or can be in its neutral charge state $(N\text{-}V)^0$ resulting in a peak at 575 nm. Both features are most common in type I diamonds.
Type IIa diamonds contain such little nitrogen atoms (some ppm), that the presence of nitrogen is not detectable by infrared spectroscopy. In December 1999, based on a photoluminescence study of type IIa diamonds, carried out by a Raman microprobe at room temperature, Chalain et al. (1999) mentioned first the unexpected presence of N-V centres in type IIa diamonds.
Measuring the 637/575 ratio peak height with PL spectrometers, Fisher and Spits (2000) consider it is indicative for the detection of GE POL treated diamonds. SSEF confirms this statement by means of their study undertaken with a Raman system, the samples being cooled this time at liquid nitrogen temperature.

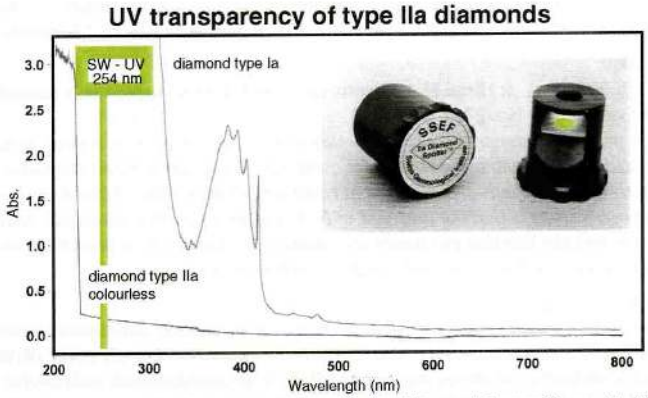
## STUDIED MATERIAL

In July 2000, the detection method of GE POL treated diamonds as performed at SSEF is confirmed by the study of 21 GE POL treated diamonds, 18 untreated colourless and 15 untreated brown diamonds, all of type IIa.
The 21 GE POL diamonds were provided to SSEF by the following companies: Horovitz & Totah (Geneva), Ernst Färber (Munich), Deutsche Stiftung für Edelstein Forschung (Idar-Oberstein), Gemmological Association of all Japan (Tokyo), De Beers D.T.C. Research Centre (Maidenhead), Gemmologisches Labor Austria GmbH (Vienna), Museum of Natural History (Vienna), Central Gem Laboratory (Tokyo). All brown and colourless untreated diamonds were sorted at various diamond dealers in Geneva by means of the *SSEF type IIa Diamond Spotter™*.

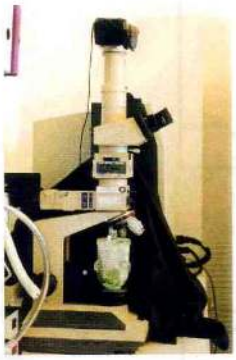


GE POL is laser inscribed on the girdle of HPHT treated diamond

**UV transparency of type IIa diamonds**



To detect a type IIa diamond the *SSEF type IIa Diamond Spotter™* uses its UV short wave transparency property. The *SSEF Type IIa Diamond Spotter™* can be ordered from SSEF (e-mail gemlab@ssef.ch) for US $ 150.



## SSEF RAMAN SYSTEM AND COOLING CELL

The RENISHAW 1000 Raman spectrometer used at SSEF Swiss Gemmological Institute is equipped with a CCD Peltier-cooled detector, and an argon ion laser of 25 mW power, with a green ray at 514.5 nm. The laser beam is focused on the table of the sample using a Olympus BH 5x magnification lens. The beam is perpendicular to the table of the diamond.
Both, sample and Raman microprobe are wrapped in an opaque black fabric to avoid external lighting to interfere with the experiment. Five scans in the visible range are averaged. The sample is cooled by liquid nitrogen (LN) in a transparent cryogenic sample stage especially designed at SSEF. The temperature of the sample was estimated with a Chromel/Alumel thermocouple. It varies from approximately -170°C to - 196°C.

## CONCLUSION

Despite claims that the GE POL treatment was not detectable, within one year of intense work research scientists of SSEF and two European universities (Nantes and Basel) have found a spectroscopic detection method. At the same time research scientists of De Beers DTC have presented their method (Fisher & Spits). While De Beers DTC based its study on photoluminescence (PL) induced by and measured with PL spectrometres, the SSEF Swiss Gemmological Institute achieved the breakthrought of GE POL identification by means of a Raman system. This instrument is already at the disposal of all important international gemmological laboratories. Therefore we believe that our identification method will be reproduced by other laboratories.
In order to separate those potentially treated diamonds, the diamond traders are now ready to sort type IIa diamonds by means of the *SSEF type IIa Diamond Spotter™*.

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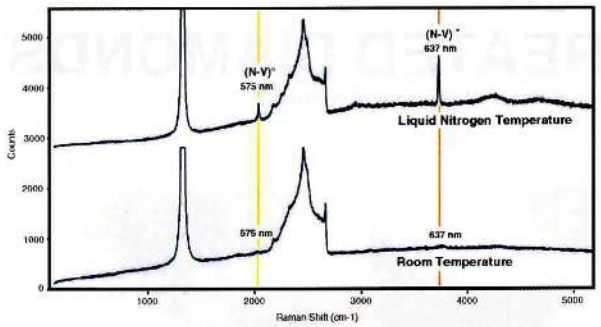



Sample: GE POL 1, Colour E (yellow), round, brilliant, 0.75 ct
**at liquid nitrogen temperature: peak ratio 637/575 = 2.8 FWHM of 637nm peak = 16**

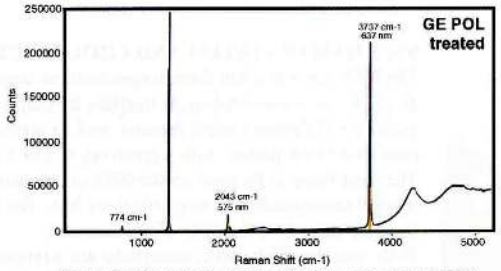
Evidence of the thermal dependance of the 637 and 575 nm optical centres, as shown on two photoluminescence spectra collected with a Raman system (514.5 nm) on the same GE POL diamond.

## SSEF PUBLICATIONS ON GE POL IDENTIFICATION

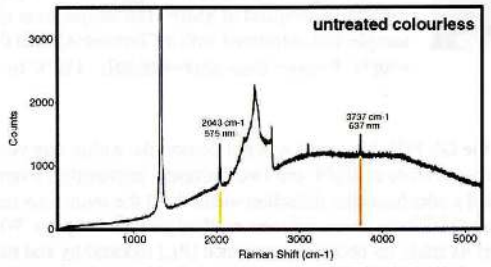
December 1999:
Chalain J.-P., Fritsch E. & Hänni H.A: Identification of GE POL Diamonds:a first stage. Revue de Gemmologie No. 138/139 pp.30-33
*This article describes the gemmological properties of two GE POL diamonds. It also shows for the first time the unexpected presence of N-V centres in type IIa diamonds.*

February 2000:
Chalain J.-P., Fritsch E. & Hänni H.A.:Identification of GE POL diamonds: a second step. Journal of Gemmology No. 27, 2, pp. 73-78.
*This article presents a comparison of the photoluminescence properties of three families of type IIa diamonds. 7 untreated colourless diamonds, 3 untreated brown diamonds and 5 GE POL treated diamonds are analyzed at room temperature with a Raman system. The conclusion ofthis study is that the presence of N-V centres in GE POL diamonds might not be consistent with the fact that the stones are colourless. This criterion presents a promising hypothesis which must be confirmed by further analyses.*

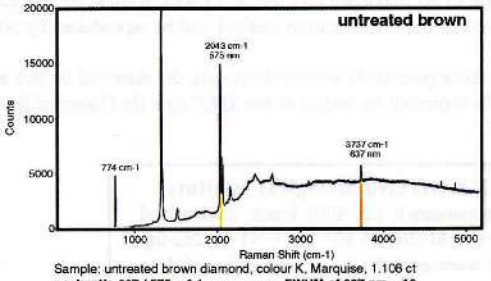
March 2000:
*In Rapaport (March 11, 2000) SSEF Swiss Gemmological Institute announces its ability to detect GE POL treated diamonds. This statement is based on the study of the photoluminescence properties of the untreated and GE POL treated diamonds collected at liquid nitrogen temperature with a Raman system.*



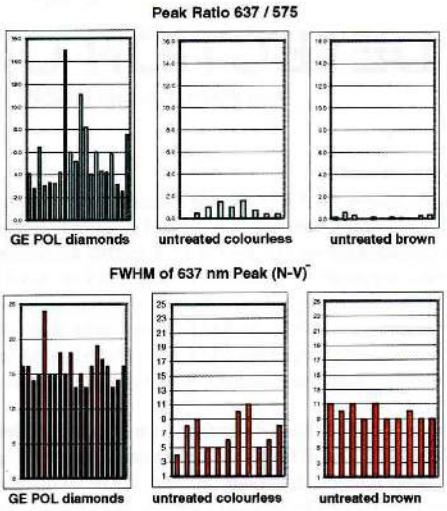

Sample: GE POL treated diamond No.12, colour L, pear-shaped, 1.120 ct
**peak ratio 637 / 575 = 11.1 FWHM of 637nm peak = 13**

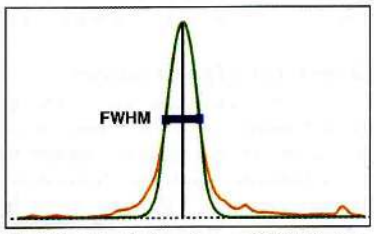



Sample: untreated colourless diamond, colour D, IF, Marquise, 1.613 ct
**peak ratio 637 / 575 = 0.5 FWHM of 637 nm peak = 8**




Sample: untreated brown diamond, colour K, Marquise, 1.106 ct
**peak ratio 637 / 575 = 0.1 FWHM of 637 nm = 10**




The full width at the half maximum (FWHM) of a peak is measured with GRAMS™ software. SSEF has shown that the FWHM of the 637 nm peak of type IIa diamonds is indicative for the detection of GE POL diamonds.

### DETECTION OF COLOURLESS HPHT TREATED GE POL DIAMONDS

**Before submission to a laboratory:**
- Check for girdle inscription (GE POL).
- Check if the diamond is a type IIa (only 1% of all diamonds). You may use a DiamondSure™, the *SSEF type IIa Diamond Spotter™* or crossed polarizers.
- Check inclusions: halo of expansion surrounding inclusions, haziness, etc. (see Gems & Gemology, Vol. 35, No. 3, pp. 14-22).

**Laboratory Procedure:**

**Observations:**
- a yellow body colour is suspicious. So far type IIa untreated colourless or near-colourless diamonds have only a green, brown, pink or pinkish brown hue.
- Inclusions, strength and quality of the graining will be checked for more data.

**Infrared spectrum (FTIR):**
- to confirm the diamond being of type IIa.

**Raman spectrum at Liquid Nitrogen Temperature:**
- Untreated colourless and brown diamonds of type IIa show a 637/575 ratio at 1.6 or lower and a FWHM at 11 $cm^{-1}$ or lower.
- GE POL treated diamonds show a 637/575 ratio at 2.5 or higher and a FWHM at 13 $cm^{-1}$ or higher
- When a diamond does not show any 637 and/or 575 peaks SSEF refers to further spectroscopic features.

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