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Testing and screening of melee-sized near-colorless HPHT synthetic diamonds using a multi-spectral induced luminescence imaging system (GV5000) in China

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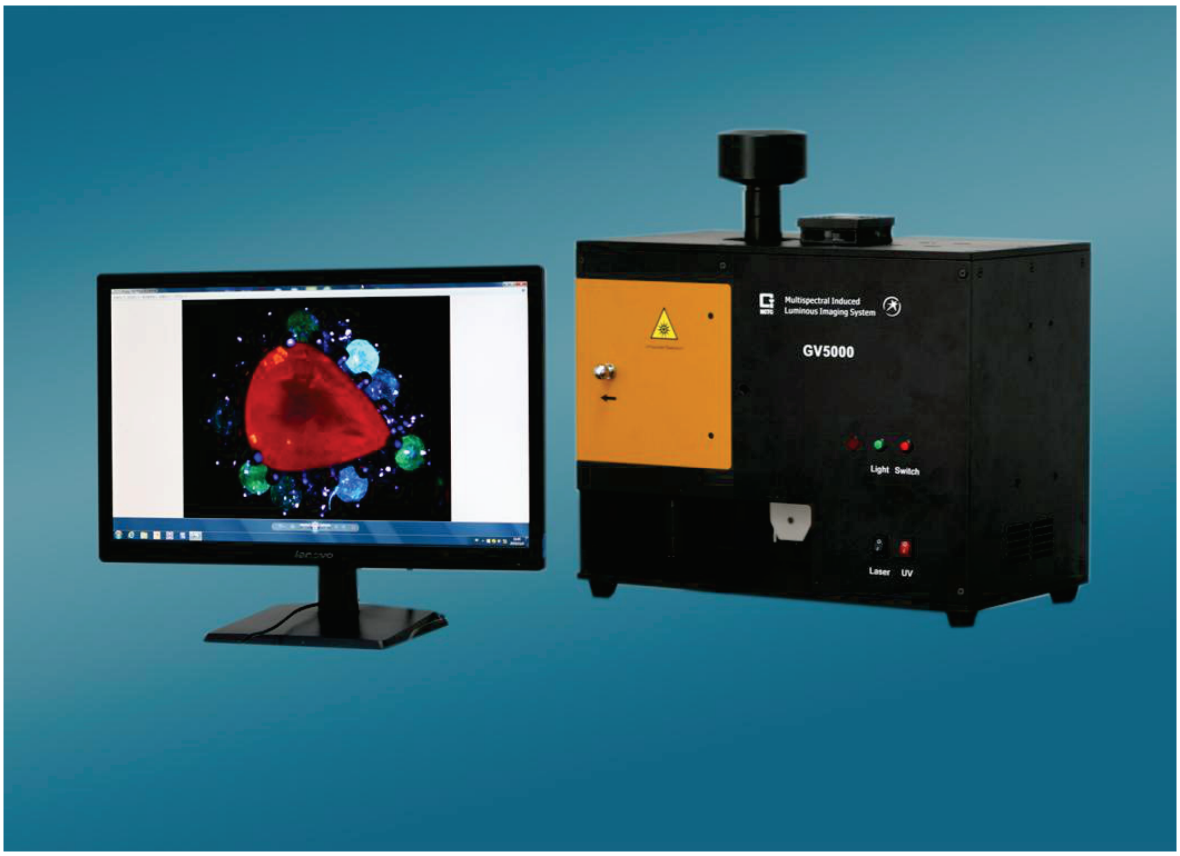

Figure 1. Multi-spectral induced luminescence imaging system (GV5000).

Since the time industrial grade diamonds were first successfully synthesized in China in 1963, the production scale of HPHT synthetic diamond production in China has been expanded in the past several decades. Now, China is the most important producer for the industrial grade HPHT synthetic diamonds in the world. In May 2015, researchers from National Gemstone Testing Center (NGTC), China visited a number of HPHT synthetic diamond manufacturers in Zhenzhou, Henan Province, China for on-site investigation on production situation of HPHT synthetic diamond in China. There are over ten factories have sufficient capacity to produce gem-quality near- colorless HPHT synthetic diamonds, and their products weighing from (0.005ct to 0.06ct). Melee-sized weighing from (0.005ct to 0.01ct) near-colorless HPHT synthetic diamonds possess advantage in market competitiveness, due to the relatively low production cost. HPHT synthetic diamonds, rather than the CVD synthetic diamonds, are more likely to be cut into melee-sized particles being used as gems. However, there is no effective instrument for the rapidly testing and identification of the melee-sized colorless HPHT synthetic diamonds, particularly, for those mounted diamond jewelries and the stones weighing less than 0.01ct. To solve this problem, NGTC researchers together with Nanjing Baoguang Test Technology Company Ltd, China have jointly developed a multi-spectral induced luminescence imaging system (GV5000) which can effectively test and screen melee-sized near-colorless HPHT synthetic diamonds (Fig1).

Instrument is equipped with a broadband UV-light source to induce the luminescence (fluorescence and phosphorescence) characteristics of gemstone, which are shown by real-time imaging and spectrum. It can offer rapidly screening and testing for natural, synthetic, and enhanced/treated gem materials, based on the differences of luminescence characteristics. Meanwhile, with a highly sensitive CCD camera and video system, and a specially designed sample stage adjustable in X-Y-Z three directions, the instrument can accurately collect, display and store the data of luminescence (fluorescence and phosphorescence) characteristics.

Light source (Wavelength)	183nm-240nm	Spot Size	20mm×25mm
Switch Control Mode	Rotated Shutter	CCD pixels	1360x1024
Bingning Mode	2×2, 2×3, 2×4	Microscope	2.5× - 18×
Zoom Ratio	1:7	Adjustment of Sample Dimensional Platform	75 mm×36mm
Focusing Range	40mm	Equipment Size	460×250×450mm
Weight	18KG	Power Supply	220V, 50Hz, 100W
Radiation Triple Protection	Included	Laser Focus	Optional

Table 1 Basic parameters of the multi-spectral induced luminescence imaging system (Gv5000)

The HPHT synthetic diamonds display greenish blue fluorescence and cuboctahedral growth patterns when irradiated by the high –intensity short-wave UV light source of the GV5000. When the UV light source is turned off, the HPHT synthetic diamonds display strong greenish blue phosphorescence with lifetime of more than three seconds to one minute. Note that 97 percent of natural diamond display blue fluorescence, without visible phosphorescence; the remaining 3 percent of natural diamond display other color fluorescence with weak to medium phosphorescence.

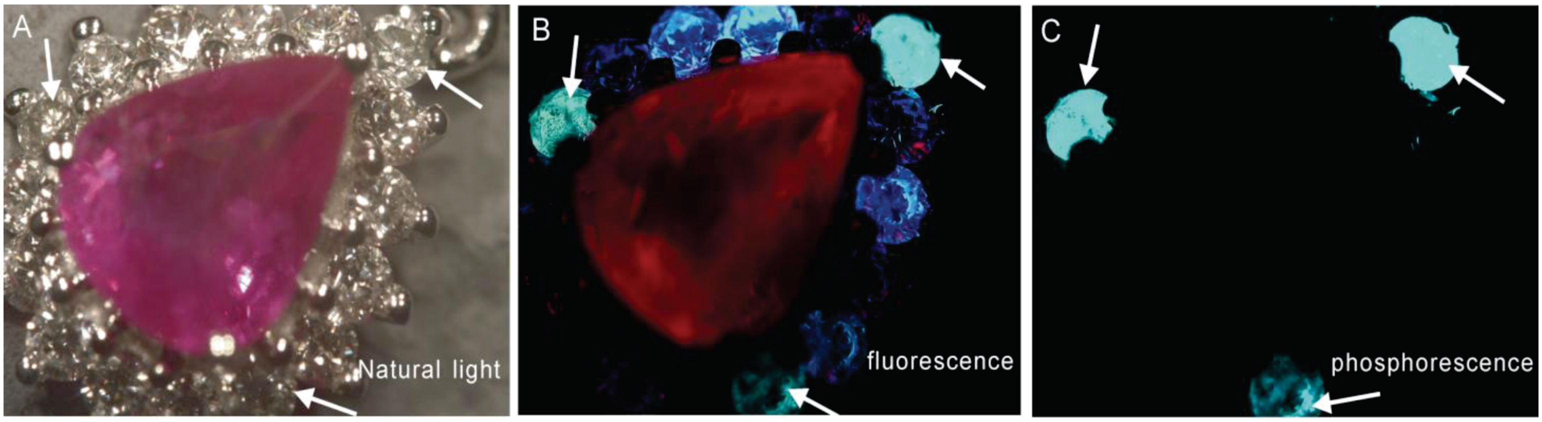

Figure 2. Photograph and corresponding luminescence images of a ruby pendant examined by the multi-spectral induced luminescence imaging system (GV5000). Three HPHT synthetic diamonds were mixed with natural diamonds mounted in a ruby pendant(The arrows point to HPHT synthetic diamonds)

Figure 2 shows an example. Three near-colorless HPHT synthetic diamonds were mixed with natural diamonds mounted in a ruby pendant (Fig. 2A). When the ruby pendant was examined by GV5000, HPHT synthetic diamonds showed greenish blue fluorescence as seen in Fig. 2B and strong lasting greenish blue phosphorescence(Fig. 2C). While the natural diamonds show blue fluorescence （Fig.2B） without obvious phosphorescence as seen in (Fig. 2C).

In summary, in a multi-spectral induced luminescence imaging system (GV5000) has been successfully developed by National Gemstone Testing Center (NGTC), China for rapidly testing and screening of melee-sized colorless to near colorless HPHT synthetic diamonds. Over 97% HPHT synthetic diamonds in the form of both loose and mounted can be rapidly detected using this instrument. All the HPHT synthetic diamonds could be detected and identified using a combination of GV5000 together with a magnetic property measuring device and a digital electrical conductivity device.

Identification of Dye-treated Golden South Sea Pearls

Kook-Whee Kwak, Jong-Kyu Lee, and Eun-Ah Jeong
Wooshin Gemological Institute of Korea

White or golden seawater cultured pearls are formed within Pinctada Maxima oysters that live in the South Pacific. Pearls with naturally deep and uniform gold color are rare because the color of pearls is greatly influenced by the state of mother oysters as well as the marine environmental factors such as water temperature. Ever since the appearance of deep gold color South Sea pearls dye-treated from white or light yellow pearls in the late 1990s, distinction between natural-color and dye-treated golden pearls has been an important issue. Earlier dyed golden pearls could be identified with routine gemological tests including the detection of dye traces on the surface or within drill holes, as well as long-wave UV fluorescence test. However, as the identification became much more difficult due to the continual improvement of treatment techniques, spectroscopic analysis including UV-Vis became a necessity.

Figure 1. Typical natural-color (top) and dye-treated pearls (bottom) used in this study

112 South Sea golden pearl samples with no drill holes, 51 natural-color and 61 dye-treated pearls, were studied using gemological and spectroscopic tests. Even though some of the samples displayed artificial colors which suggested dye treatment, most of the natural-color and dyed pearls were indistinguishable in their color. Dye traces were not observed on the surface under magnification test, and considerable number of dyed pearls showed fluorescence similar to that of natural-color pearls under long-wave UV light. In short, the role of gemological test was limited in the identification of dye-treated golden pearls.

The representative UV-Vis spectra of 51 natural-color golden pearls with a variety of color variations are shown in Figure 2. The natural-color pearls tend to have deeper conchiolin-related absorption at 280nm than the dyed pearls, and show a broad absorption band between 310nm and 500nm with local reflectance troughs at about 360 and 430nm. The absorption at 360nm tends to be deeper than the absorption at 430nm.

As shown in Figure 3, 61 dyed golden pearls could be classified into three groups by UV-Vis spectral patterns. The first group has a broad absorption band centered at around 450nm (green spectrum in Figure 3). This is the most common pattern observed in the dyed golden South Sea pearls, and is easy to distinguish from that of the natural-color pearls due to the obvious difference in their pattern shapes.

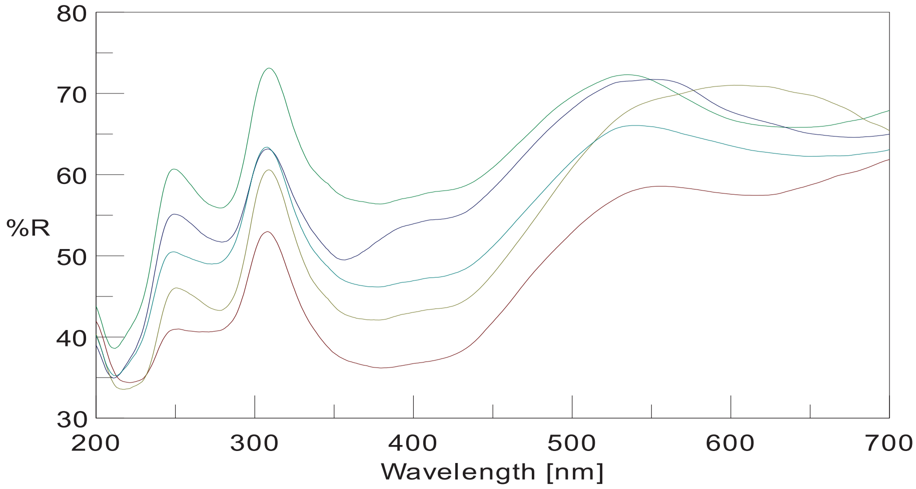

Figure 2. UV-Vis spectra of natural-color golden pearls

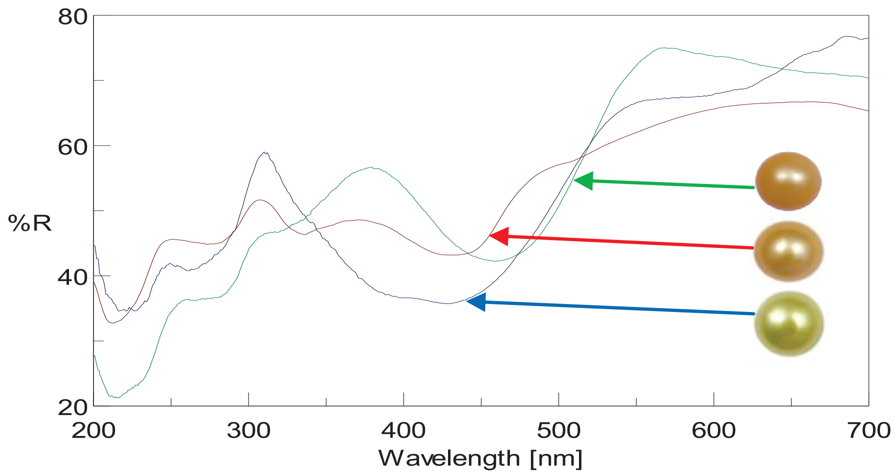

Figure 3. UV-Vis spectra of dye-treated golden pearls

The absorption pattern of the second group appears similar to that of natural-color pearls, but a 390nm peak clearly divides the broad 310~500nm band into two sub-bands (red spectrum in Figure 3). This group includes a sub-group with absorption peaks of the sub-bands at 330nm and 430nm respectively, and another sub-group with absorption peaks of the sub-bands at 370nm and 440nm respectively. The UV-Vis pattern of this group is different from that of natural-color pearls in the sense that the positions of absorption peaks are different and the absorption of the 430/440nm peak tends to be deeper than or similar to that of the 330/370nm peak. The third group exhibits the most similar pattern to that of natural-color pearls, the pattern often seen in recent years, having a broad absorption band between 310nm and 500nm with local reflectance troughs at about 380 and 430nm (blue spectrum in Figure 3).

However, The absorption at 430nm is deeper than the absorption at 380nm, which is a strikingly different feature from that of natural-color golden pearls.

In summary, dye-treated golden pearls could be classified into three groups, based on the measured UV-Vis absorption patterns. Dyed pearls whose UV-Vis patterns were similar to that of natural- color pearls could be separated by comparing the depths of absorption peaks near 360nm and 430nm, identifying the pearls with deeper 430nm absorption as dye-treated pearls.

Reference : C. Zhou, et al. (2012), Update on the Identification of Dye Treatment in Yellow or "Golden" Cultured Pearls, Gems & Gemology, Vol. 48 No. 4, pp. 284-291

Treated blue diamond

Tay Thye Sun & Loke Hui Ying
Far East Gem Lab, Singapore

In October of 2015, one piece of "blue diamond" was brought for identification. The diamond weighed 5.619 carats with measurement 10.09 x 8.77 x 6.94mm, the colour was greenish-blue and radiant faceted (Fig.1). Under microscopic observation, very small included crystals of probably diamonds (Fig.2), and growth marking (Fig.3) could be seen. As synthetic diamonds by various manufacturing methods are around, one has to be careful during examination. On using cross-polariser to observe the growth structure showed irregular „patchy pattern" interference indicating Type Ia (Fig.4) (Simic & Deljanin, 2010). When the diamond was observed under the ultraviolet light, it showed strong blue fluorescence under long wave and weak blue under short wave pointing towards natural origin. Using infrared spectrometer, the type of diamond was determined to be Type IaAB, i.e. peaks at 1281cm-1 and 1176 cm-1 (Fig.5). Natural blue diamond exists as Type IIb, and the cause of natural blue colour is the presence of boron. For natural blue diamond, the IR absorption spectrum would show no absorption between 1000 to 1500 cm-1 (Harris, 2010).

Fig.1. One radiant cut 'greenish-blue' diamond 5.619 carats

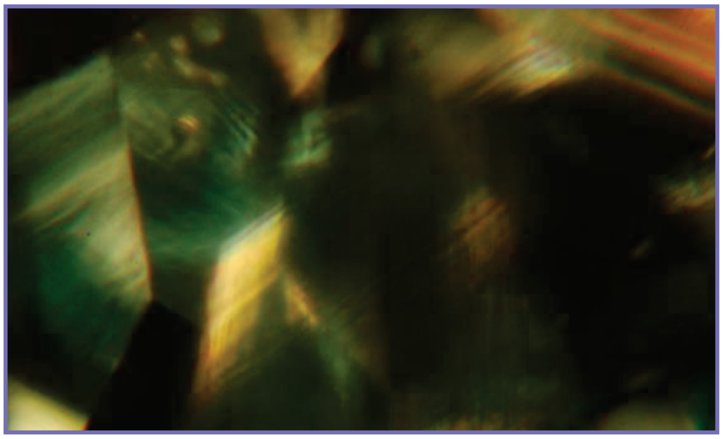

Fig.3. Growth marking could be seen through the crown of the faceted diamond (magnified 20x).

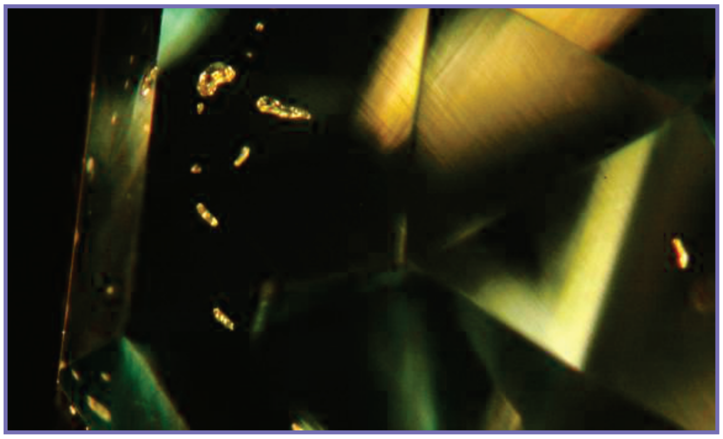

Fig.2. Included crystals probably diamond (magnified 20x)

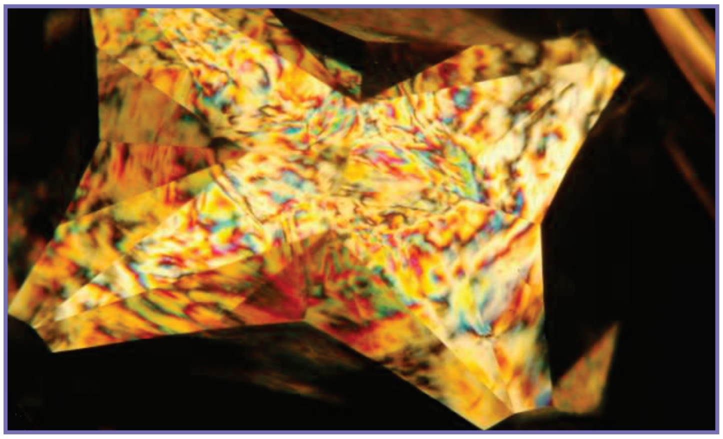

Fig.4. Under cross-polariser, the diamond show irregular patchy pattern of interference colours an indication of low-nitrogen Type Ia diamond (magnified 10x).

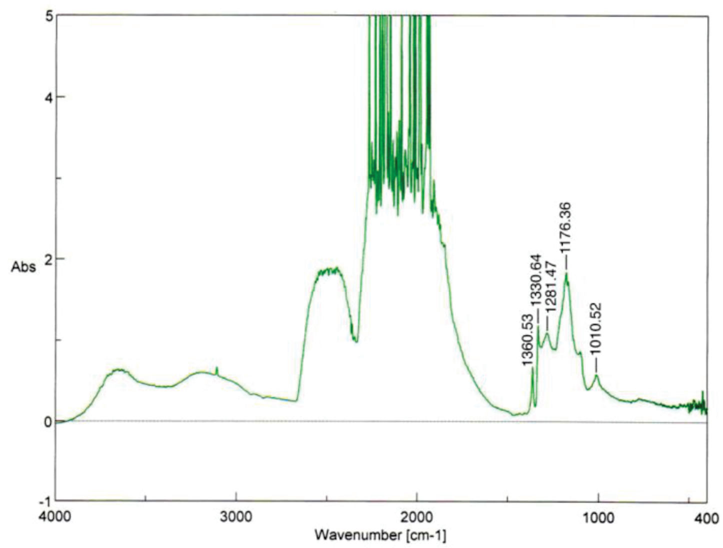

Fig.5. Infrared spectrum of the 'blue diamond' show peaks of 1281 and 1176cm-1, indicate Type IaAB diamond

Conclusion:

A large „greenish-blue‟ diamond was examined. Based on the gemological properties it was found to be a natural diamond, but the colour was in question. Further examination using cross-polariser showed an irregular patchy pattern interference colours indicating low-nitrogen Type Ia diamond. Using infrared spectrometer, the absorption spectrum of this diamond was found to be Type IaAB i.e. the peaks at 1282 and 1176cm-1. It was concluded that the „greenish-blue‟ diamond was not Type IIb, instead it was Type IaAB, and indirectly indicating that the colour was not natural blue but had been caused by irradiation.

References:

1. Dusan Simic and Branko Deljanin, "Identifying Diamond Types and Synthetic diamonds with CPF (Cross Polarized Filters),Second Edition. 2010.
2. Harvey Harris "Fancy-Color Diamonds" Fancoldi Registered Trust, Liechtenstein, 1994 – especially Chapter 3 – Potent Properties: Part I – Caused of colour in Diamond by George Bosshart.

Dr. Thomas Hainschwang along with Dr. Jayshree Panjikar & Mr. Aatish Panjikar at the Symposium

Mr Jean-Pierre Chalain seen presenting his paper

Symposium on Diamond: "Advances in Technology & Detection"

Bharat Diamond Bourse along with De Beers and GII organised a Symposium on Diamond: "Advances in Technology & Detection" on 14th December 2015 in Mumbai. Prominent speakers at the Symposium were: Dr Philip Martineau who spoke on the detection of synthetic diamonds: the current situation. Dr. Thomas Hainschwang presented on UV and laser excited luminescence techniques for efficient detection of HPHT and CVD synthetic diamonds of all sizes and colors.

Dr. P. K. Pujari elaborated on positron life time studies on diamonds. Dr Wuyi Wang explained the Advances in CVD/ HPHT Technology – Challenges for Detection of Lab Grown Diamonds whereas Mr Jean-Pierre Chalain showed Quick Testing Methods And their Amenability for small sizes and colored diamonds. Dr Taijin Lu elaborated on-Testing of HPHT and CVD Lab Grown Diamonds in China. Ms Ellen Barrie of HRD demonstrated the Screening and Testing of Lab Grown Diamonds.

Dr Taijin Lu's presentation on-Testing of HPHT and CVD Lab Grown Diamonds is given in this Newsletter on Page 1.

Introducing ICGL Member from Australia

Mr Bill Sechos

Name of the Laboratory: ***GSL (Gem Studies Laboratory) Australia***

Full Name of the Owner of the Laboratory: ***Bill Sechos***

Year of Establishment: ***1982***

Gemmological Qualifications of the Owner/Founder: *B.Sc. (Sydney University 1969), Diploma of Education (Dip Ed) Cert IV in Training and Assessment, FGAA, Diploma of Diamond Technology (Dip DT), Diamond Grading Certificate (GIA) Coloured Stone Certificate (GIA), Jade Appreciation Certificate (Far East Gemmological Laboratory, Singapore)*

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Email: info@gsl.net.au or gemstudy@ozemail.com.au
Website: www.gsl.net.au

What Standard Gem Testing Equipment do you have? *All standard gem testing equipment including: Balances, Refractometers UV light sources, Spectroscopes, Dichroscopes, Polariscopes with collimating spheres, Microscopes ,Chelsea filters and Hanneman Hodgkinson filters,Hot point testers, Thermal conductivity diamond probe and newer moissanite capable probes.*

What Advanced Instruments do you have: ***In-House*** *DeBeers DiamondSure, HRD D-Screen,SSEF Type II diamond spotter, GIA Diamond Check, Pearl X-ray unit (Phillips),GemmoRaman532SG with DiamondGuard attachment (for identifying diamond type) and liquid nitrogen (LNT) capability for identification and photoluminescence studies. Gemmo Sphere UV-Vis-IR spectrometer with LNT capability.Nicolet IS5 Fourier Transform Infra Red (FTIR) Spectrometer. Sarin Diamension for analysis of proportions of diamonds Sarin Dia Scribe for laser inscription of diamonds and other gems* ***Outsourced:*** *Access to LIBS, LA-ICP-MS, SEM through our connection with University of Western Sydney materials analysis department.*

Have you published or presented papers at conferences/magazines/seminars? ***Yes in Australian Gemmologist***

Are you a Member of a Gem Trade Organization? *Honorary Life Member of the Gemmological Association of Australia, The National Council of Jewellery Valuers The Diamond Guild of Australia (Laboratory Member). Member of the Jewellers Association of Australia .*

Are you giving lectures and educational programs to trade? *Chairman of the Board of Studies and Examinations overseeing the development of education programs for the Gemmological Association of Australia and the initial application to become a Registered Training Organisation (RTO) in Australia held the post of Chief Examiner for the Gemmological Association Senior lecturer with the Gemmological Association for the Diploma of Diamond Technology. Have also held workshops and given lectures to international gemmologists in conferences in Thailand (1999), to the Valuers Association Conference in NZ (2006), and the APEC Conference in Melbourne (2000) and the International Coloured Stone Association in Sydney.*

Why did you decide to found GSL? *In 1982 the company Diamond Grading Laboratories ceased operations in Australia so Gem Studies Laboratory was founded. GSL has been operating since that time and has become the best known and most patronised laboratory in Australia .*