GJEPC INDIA
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GEM TESTING LABORATORY
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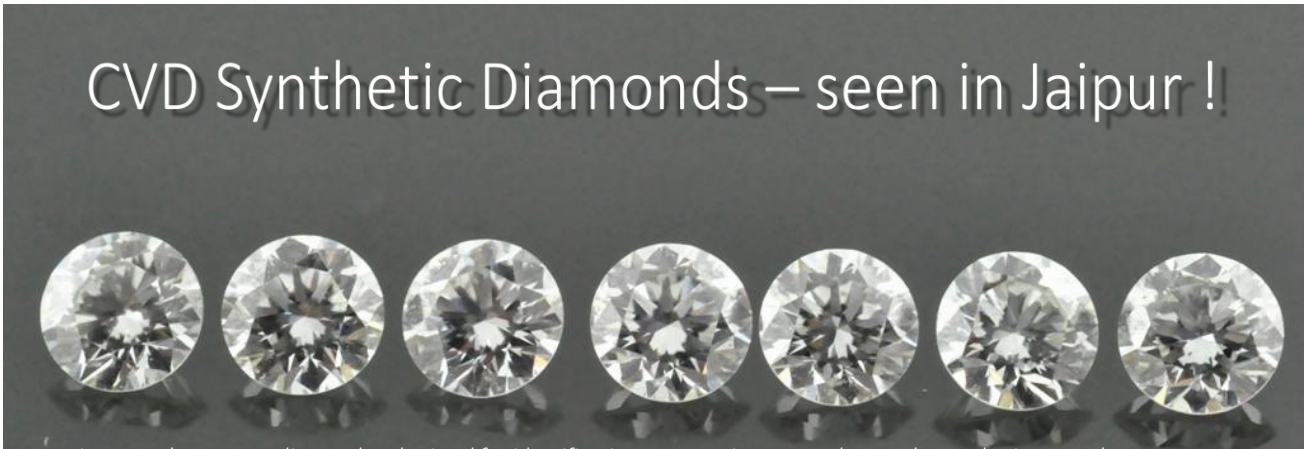


Figure 1: These seven diamonds submitted for identification at GTL Jaipur, turned out to be synthetic grown by CVD process

After the report of more than 600 undisclosed CVD synthetic diamonds submitted at one of the major gem lab (IGI) last year, in May 2012 in Antwerp, which stirred the diamond industry at large, there have been other reports from various parts of the world as well. The diamonds reported in May 2012 by IGI ranged in size of 0.30 - 0.70 ct, F-J in Colour and in clarity of VVS-VS (see e.g. http://www.jckonline.com/2012/05/21/undisclosed-synthetic-diamonds-appearing-on-market), however, the National Gemstone Testing Center (NGTC) in China has recently observed 200 undisclosed CVD synthetic diamonds in sizes around 0.30 ct, colour range of G-I, and in clarity of VS-SI (see e.g. http://www.jewellerynewsasia.com/en/most_view/8184/Shenzhen-association-warns-of-undisclosed-high-quality-synthetic-diamonds.html).

However, recently, at the Gem Testing Laboratory (GTL) Jaipur, in end of June 2013, we also encountered a parcel of seven round brilliant diamonds, which turned out to be synthetic, grown by CVD process. The submitted diamonds (figure 1) were much smaller in size ranged in between 0.09 - 0.12 ct, with colour of G-I and clarity of VVS - VS.

Most of the samples displayed fine pinpoints under the microscope, which were too small to resolve under a standard gemmological microscope. Further, two samples also contained minute dark (black) inclusions, assigning them VS grade. In addition, the samples also displayed weak to medium degree of strain pattern under cross-polarizers. Under shortwave ultraviolet lamp, they gave weak to moderate yellowish green fluorescence; while under long wave, the reactions were much weaker. We had no clue regarding their synthetic origin until we checked infra red spectra. Amazingly, all seven samples turned out to be Type IIa i.e. they lacked detectable nitrogen impurity, which otherwise, was expected in a diamond of yellowish tint (colour grade G-I).

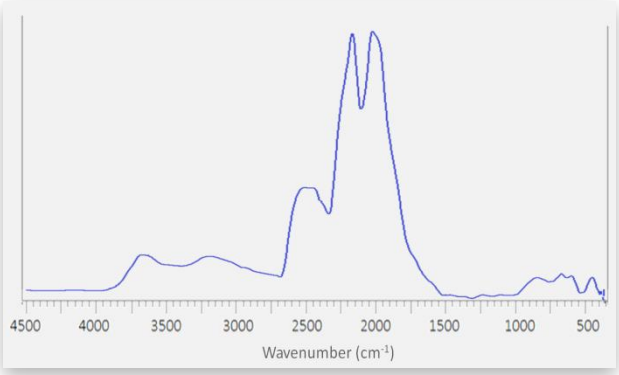


Figure 2: Representative FTIR spectrum of seven Type IIa CVD synthetic diamonds seen at the Gem Testing Laboratory, Jaipur

Because of the rarity of Type IIa colourless or near-colourless diamond in nature, it was surprising to see all near-colourless diamonds lacking nitrogen impurity, which raised doubts regarding their origin.

Therefore, all these samples were carefully studied for their growth patterns and photoluminescence spectra. DiamondView imaging system, which uses a high-intensity ultra short wavelength of ~225 nm, proves to be very useful in detection and separation of natural from synthetic diamonds (HPHT as well as CVD grown). All the samples displayed distinct fluorescence patterns.

Figure 3: DiamondView images of CVD synthetic diamonds were dominated by yellow-green, blue and intermediate blue green fluorescence. Also note fine striations, typically associated with CVD synthetic diamonds.

DiamondView Imaging

A strong blue to green fluorescence was revealed under DiamondView (figure 3), with two samples dominated by green fluorescence, while three by blue and two by intermediary blue-green. All the samples showed fine striations or growth lines (figure 4) typically seen in CVD synthetic diamonds (see e.g. Wang et al. "CVD Synthetic Diamonds from Gemesis Corp.", *Gems & Gemology*, Vol. 48, No.2, pp 80-97). In addition, these samples also displayed blue phosphorescence of varying intensity, the effect usually caused by boron impurity, which is added to decolourize or make the diamond appear colourless (D.S. Misra, "Method for growing white color diamonds by using diborane and nitrogen in combination in a microwave plasma chemical vapor deposition system," International Patent No. 2012044251).

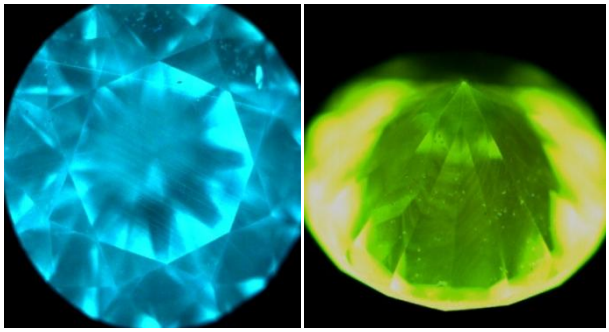


Figure 4: DiamondView fluorescence images showing layered, striated and step-like structures

Photoluminescence (PL) Spectroscopy

In addition to DiamondView imaging, photoluminescence spectra were collected using a 532nm laser, in the range 700 - 770nm, operated at room temperature. Spectra collected at liquid nitrogen temperature produces much sharper features. All the samples displayed doublet peaks at ~736.4 and 736.9 nm (commonly referred to as 737 nm). These peaks are attributed to silicon- vacancy $[Si\text{-}V]^-$ defects, where silicon impurity is introduced in the growing diamond by etching of Si-containing components in the reactor, such as silica windows (e.g. Wang et al. "CVD Synthetic Diamonds from Gemesis Corp.", *Gems & Gemology*, Vol. 48, No.2, pp 80-97).

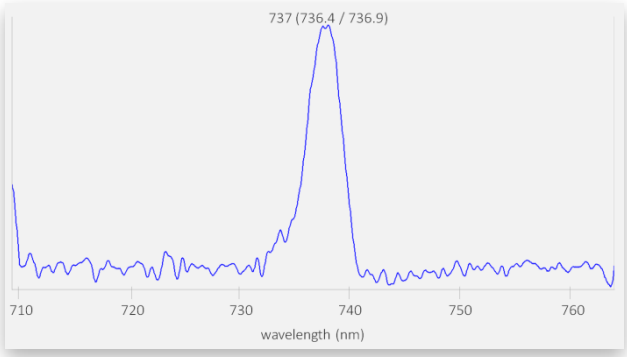


Figure 5: PL spectrum of CVD synthetic diamonds displaying $[Si\text{-}V]^-$ related doublet peaks at ~737nm.

These CVD synthetic diamonds can be identified with a combination of techniques, such as, DiamondView imaging and photoluminescence spectroscopy; however, in the absence of these techniques, the identification will be quite difficult and challenging or in some cases, almost impossible. Further, the diamonds encountered at the GTL were quite small in size, but larger sizes of up to 1.119ct (~1.12ct) have already been reported. Considering their colour (G-I) and clarity (VVS-VS), these diamonds belong to top-quality segment, and hence, they are priced quite high, which is another matter of concern.

This was the first encounter of CVD synthetic diamonds at GTL Jaipur, but higher penetration of these diamonds into the trade along with HPHT grown synthetic diamonds cannot be ruled out. Therefore, it is now high time to show more alertness while buying diamonds, whether colourless or coloured, eye clean or heavily included!

Figure 6: Natural amber (a & b), 'greened' amber (c), reconstructed amber (d) and copal (e).

In the recent times there has been higher number of encounters of amber and copal at the laboratory, which suggests the wider demand and use of these materials. However, the major concern is not only the separation of these two natural resins but also the treatments done on them. Along with the usual colours, yellow or brown, green colour, referred to as 'greened amber' has also gained a lot of popularity in the past few years. However, majority of 'greened' amber is copal and much of this material has been sold as naturally coloured. This is to be noted that green is not a natural colour of amber (unless green is caused by fluorescence). With heat and pressure, amber or copal can be reconstructed, where chips of amber / copal are fused together, or they can be clarified, or a simple heating can darken the surface or produce stress cracks / discs, known as 'sun-spangles'.

Other than the copal, amber is imitated by plastic, whose separation is quite straightforward. Plastics usually have specific gravity of 1.16 or more while the value goes up to 1.08 for both natural resins. Hence, saturated salt water can be used to separate the two natural resins from plastic, where amber and copal will float while plastics will sink. Due to the increased numbers of treatments performed on both, amber and copal, their separation with existing gemmological tests (such as UV fluorescence, hot point test or reaction to solvents) has now become inconclusive. This is mainly because of the fact that heating modifies chemical as well as physical properties of copal (i.e. artificial ageing).

FTIR spectroscopy - the conclusive tool

Fourier Transform Infra Red (FTIR) spectroscopy has proved to be very useful and conclusive for identification and separation of various types of resins, artificial or natural (such as amber or copal). The main region of interest for resins is from 400 - 4000 cm^{-1}, while key information on separation of copal and amber is available in the region 1300 - 1100cm^{-1}, known as 'Baltic shoulder', present in amber - natural or treated; while this feature is absent in copal. The features in this shoulder are attributed to C-O molecular bonds, characteristic of Baltic succinate resin.

Analyses with FTIR give consistent features to separate amber from copal, while the treatments performed can be detected by visual observations, or using a microscope.

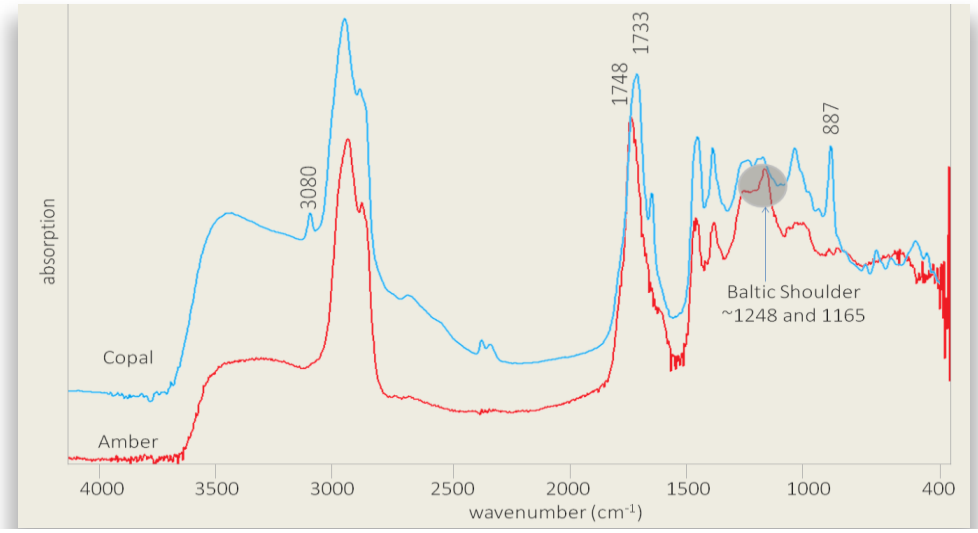


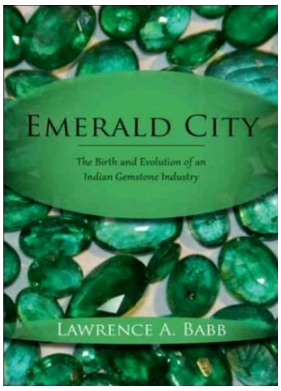
Figure 7: FTIR spectra revealing differences between amber (red trace) and copal (blue trace). Note the pattern of 'Baltic shoulder', providing key separation feature.

GTL offered 'Free Gem Testing and Diamond Grading' services at the India International Jewellery Show 2013

The Gem Testing Laboratory (GTL) Jaipur offered gem testing and diamond grading services 'free of cost' to the exhibitors as well as visitors at the recently concluded India International Jewellery Show (IIJS) 2013, from 8th to 12th August in Mumbai. GTL has been participating in this largest jewellery show of India on a regular basis, but did not offer the services of gem testing in the past few editions. This year, we took a step ahead and established an on-site laboratory equipped with all classical gemmological instruments, facilitating testing and grading. However, in order to accommodate higher number of stones and reducing the waiting time, 'spot identification reports' were issued in place of formal reports with photograph. Although, the stones and diamonds were tested without the use of sophisticated spectrometers, the knowledge and experience of the gemmologist and grader proved to be of great importance.

Most of the exhibitors and visitors appreciated the efforts, as this 'on-site' testing and grading services helped them to make important buying decisions. Hundreds of loose and studded coloured stones and diamonds were tested and graded.

Book Review: Emerald City - The Birth and Evolution of an Indian Gemstone Industry



GTL recently acquired a book titled, 'Emerald City - The Birth and Evolution of an Indian Gemstone Industry', authored by Lawrence A. Babb. This engrossing book, based on oral-historical investigations and interviews of family firms, illustrates an intriguing portrait of the gem industry of Jaipur. The author has effectively illustrated the tradition of business as per various classes of the industry, namely, polisher, stringer, craftsman, owner, broker, etc. The book describes the organisation of the industry, its development and characteristic features, its evolvement, specifically in social context and impact of culture on the business, with emphasis on the role of religion. The author also compares the Jaipur's gemstone business with that of New York's diamond industry. A must read for every individual associated with the Jaipur gem & jewellery industry!

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