Identification of melee size synthetic coloured diamond for jewellery

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Introduction

Synthesis methods to produce large and high-quality diamond for jewellery have been improved over the years, and large, colourless faceted stones weighing more than 50 ct have been realized (Eaton-Magaña *et al*., 2024). In addition, melee size fancy-coloured diamonds are also useful as components of jewellery, and the melee size synthetic coloured diamonds have been seen at jewellery shows in Japan and at the Tucson Show in USA. Jewellery assembled with the melee size diamonds is also sold in shops. Two methods are used to produce synthetic diamonds for jewellery: the HPHT method and the CVD method. It is important for gemmological identification to know clearly the different characteristics of the synthetic diamonds made with the two methods.

Material and Methods

Samples we bought at the 2024 IJT (International Jewelry Tokyo) for the present study are 35 pieces of melee size synthetic fancy-coloured diamonds with size of 0.10 ct or less which were labeled as CVD synthetic diamonds. After testing with standard gemmological instruments, the 35 samples were classified into seven categories according to colour, with five pieces for each category: (1) Green, (2) Greenish Blue, (3) Yellow, (4) Pink, (5) Orangy Pink, (6) Reddish Orange and (7) Orange (Figure 1).

These stones were observed under a gemmological microscope, and were measured with infrared and UV-VIS absorption spectroscopy. Deep UV luminescence images were obtained using DiamondView™. Photoluminescence spectra were taken for all samples being immersed in liquid nitrogen, using a Raman spectrometer with microscope with five different lasers for excitation at 457, 488, 514, 633 and 830 nm.

Figure 1: Fancy colour melee size diamond studied in this study (Upper row, from left: Orange, Reddish Orange. Middle row, from left: Yellow, Pink, Orangy Pink. Lower row, from left: Green, Greenish Blue)

Results and Discussion

(1) Green and (2) Greenish Blue: In all samples in these categories, the concentrations of nitrogen were below the detection limit according to the IR absorption spectroscopy, and deep UV fluorescence images showed characteristic patterns of HPHT synthetic diamond. From both green and greenish blue samples, a distinct 741 nm (GR1) peak was observed in the UV-VIS absorption spectra (Figure 2) and PL spectra. For green samples, peaks at 575 nm (NV^0), 741 nm (GR1), 488.9 nm and 470.2 nm (TR12) were detected in the PL spectrum. The 575 nm peak was stronger than the 741 nm peak. These results suggest that the green and greenish blue samples have been produced by irradiation of type IIa HPHT-synthetic diamonds. The greenish blue samples have been annealed at a lower temperature (around 500 °C) after the irradiation.

(3)Yellow: All samples are type Ia with high concentrations of A-centre nitrogen according to the IR absorption measurements. Weak C-centre and 3107 cm^{-1} (N_3VH) peaks were also detected. In addition, deep UV fluorescence images confirmed that all of them are HPHT synthetic diamond. 544.5 nm and 523.8 nm peaks associated with cobalt were detected in PL spectra (Figure 3). These suggest that they are so called "HIH" diamond which means a HPHT diamond were irradiated and treated in a HPHT condition (Hainschwang and Notari, 2011.)

(4)Pink, (5)Orangy Pink, (6)Reddish Orange and (7)Orange: In all samples, faint nitrogen-related absorption was observed in the IR absorption spectra. A very strong 575 nm (NV^0) peak and a weak 637 nm (NV^-) peak were observed in

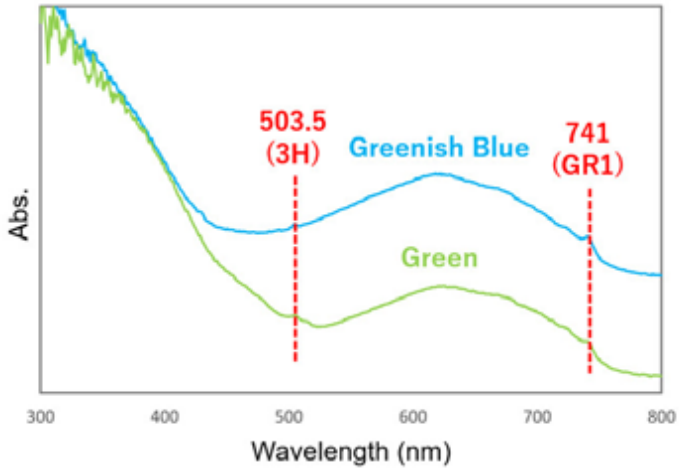

Figure 2. UV-VIS absorption spectra of the blue and greenish blue samples

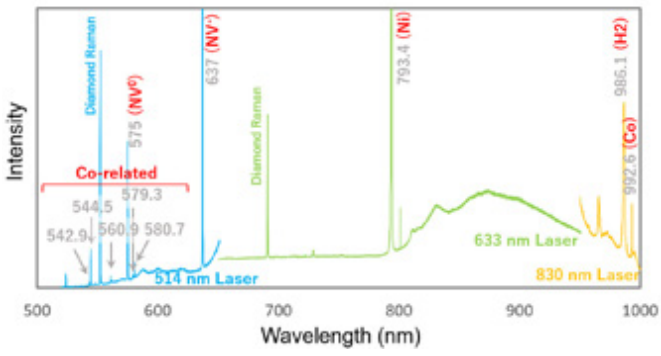

Figure 3. PL spectra of yellow samples (514, 633 and 830 nm laser excitation)

a PL spectrum, while in reddish orange samples a 741 nm (GR1) peak was observed in both UV-VIS absorption s and PL spectra. The 575 nm (NV^0), 637 nm (NV^-) and 741 nm (GR1) centers were formed by irradiation and subsequent annealing. The intensity ratio of the 575 nm (NV^0) peak to the 637 nm (NV^-) peak was in the order of pink < orangy pink < reddish orange < orange. This is the same order as the concentration of C-centres, and the concentrations may influence the colour. For two of the orange samples? There are five right?, the deep UV fluorescence image and the presence of 737 nm in the photoluminescence spectra indicate that they are CVD synthetic diamond, while all the others are HPHT synthetics due to their specific fluorescence images (Fig. 4).

Conclusion

In this study, gemmological examinations were carried out on melee-sized fancy coloured synthetic diamonds in loose form. We bought all 35 samples which were labelled as CVD synthetic diamonds, but 33 pieces of them were HPHT synthetic diamond and two of them were CVD synthetic diamonds. They had undergone multiple treatments with irradiation, annealing and HPHT treatments. If these were submitted in the form of gems set in jewellery for identification, the analysis methods would be limited and poor report may have been published. Therefore, we need to have full knowledge of characteristics of all type synthetic diamond made with the different methods and treated in the different ways so that error-free reports on the identification are published.

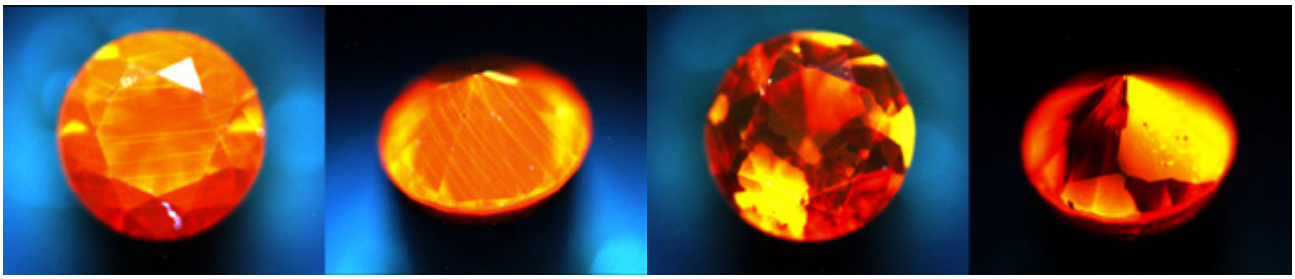

Figure 4. Step-flow structure specific to CVD synthetics (left) and sector zoning structure specific to HPHT synthetics (right)

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