Analysis of HPHT-Treated Diamonds Using Fluorescence Observations

Sally Eaton-Magaña and Karen Chadwick
GIA Laboratory, Carlsbad

Recent reports have chronicled a potential method of visually identifying HPHT-treated diamonds using fluorescence microscopy (e.g., I. A. Dobrinets and A. M. Zaitsev, "'Fluorescence cage': Visual identification of HPHT-treated type I diamonds," *Gems & Gemology,* Vol. 45, No. 3, 2009, pp. 186–190). The diagnostic observation was described as an "unusually intense fluorescence at the facet edges and junctions," and termed a "fluorescence cage." A similar effect is often seen in irradiated samples (see, e.g., figure 2 in T. Hainschwang et al., "A comparison of diamonds irradiated by high fluence neutrons or electrons, before and after annealing," *Diamond and Related Materials,* Vol. 19, 2009, pp. 1223–1234). To our knowledge, though, Dobrinets and Zaitsev (2009**)** is the first report of HPHT-treated diamonds exhibiting preferential fluorescence at facet edges.

To evaluate this reported fluorescence characteristic, we obtained 44 HPHT-treated diamonds that were color graded Fancy to Fancy Vivid yellow (20 of these samples were examined in test 1, 24 in test 2), along with nine colorless to near-colorless (E–J) HPHT-treated stones that were examined using test 1 methodology. All 53 diamonds were supplied by Nice Diamonds, which also provided the samples studied in Dobrinets and Zaitsev (2009). FTIR spectroscopy identified the yellow stones as type Ia (with various ratios of A and B aggregates), while the colorless to near-colorless samples were type IIa or type IaB. Photoluminescence spectroscopy confirmed the HPHT treatment.

For test 1, we examined the first 29 HPHT-treated diamonds using fluorescence microscopy with two 5-watt GIA Instruments lamps under standard short- and long-wave UV radiation, available to many gemologists. Using the microscope, the diamonds were inert to weak blue under short- and long-wave UV. The UV radiation highlighted feathers in some stones and cubic structure in others. For test 2, we examined the HPHT-treated diamonds with a 100-watt long-wave UV lamp (UVP Model B 100; this test was analogous to the method described by Dobrinets and Zaitsev). The 24 samples in this test showed weak to strong blue fluorescence and similar evidence of feathers and cubic structure. In both tests, we searched for fluorescence features that corresponded to the "cage" described previously.

In test 1, seven samples (all yellow) exhibited a slight fluorescence concentration at the crown facet edges under short-wave UV illumination (see figure 1). We did not observe any fluorescence concentration at the facet edges on the pavilion side. Two of the seven samples showed similar concentrations at the facet edges under long-wave UV. In each, this effect occurred along a portion of the table edges or at a few facet junctions on the remainder of the crown. In test 2, we observed fewer instances of fluorescence concentration at the facet edges (in only three of the 24 diamonds; see figure 2).

S. Eaton-Magaña and K. Chadwick. Analysis of HPHT-treated diamonds using fluorescence observations. News from Research, December 1, 2009. http://www.gia.edu/researchresources/news-from-research

In every sample we tested, these fluorescence concentrations were a very subtle blue that matched the color of the fluorescence throughout the treated stone. The effect was fleeting, disappearing when the sample was tilted. The samples exhibited a similar effect under the ultra-short-wave UV radiation of the DiamondView; although we saw concentration at facet edges on both the crown and pavilion, again the concentration would disappear with slight tilting. Therefore, we concluded that the fluorescence concentration at the facet junctions was a geometric artifact based on position.

We collected photoluminescence spectra on six of the HPHT-treated diamonds from test 2, using 325 nm laser excitation to approximate the UV-activated fluorescence. The PL spectra were typical of type Ia diamonds, with dominant N3 and subordinate H3 defect centers (zero phonon lines at 415.2 and 503.2 nm, respectively), accounting for the blue fluorescence.

Based on the HPHT-treated diamonds we examined, these fluorescence observations were ambiguous and ineffectual in identifying HPHT-treated type Ia diamonds. Spectroscopic analysis is a much more reliable identification method.

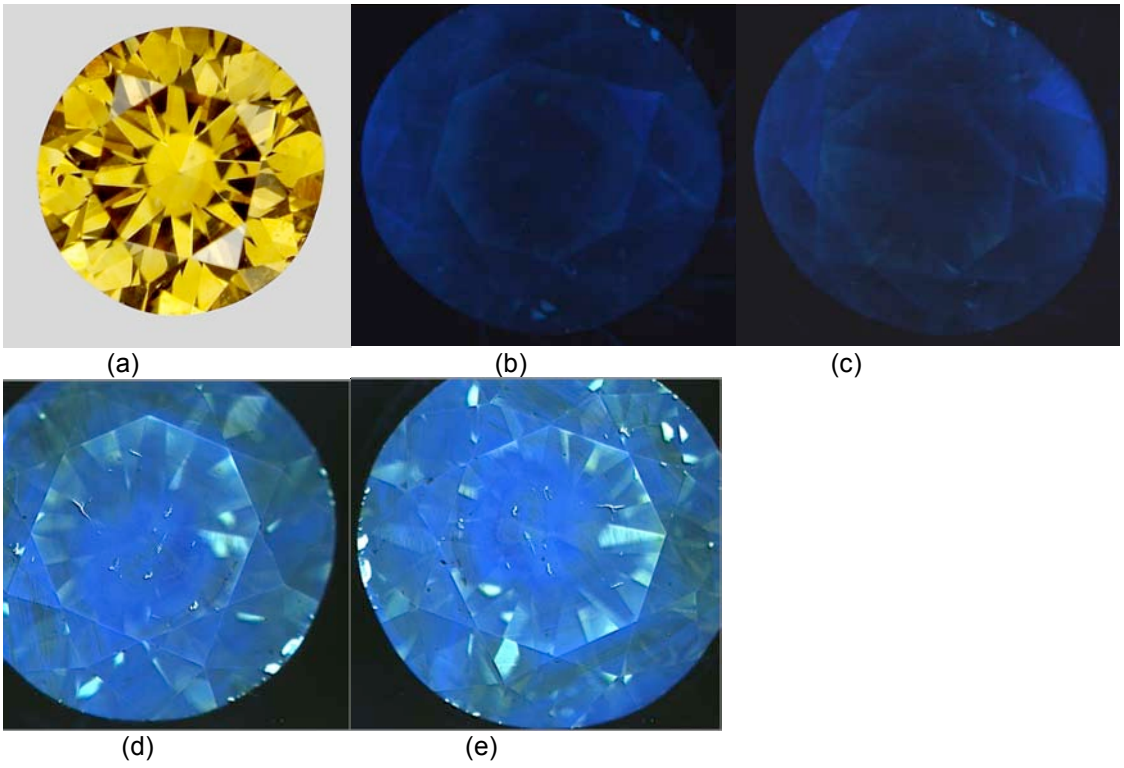
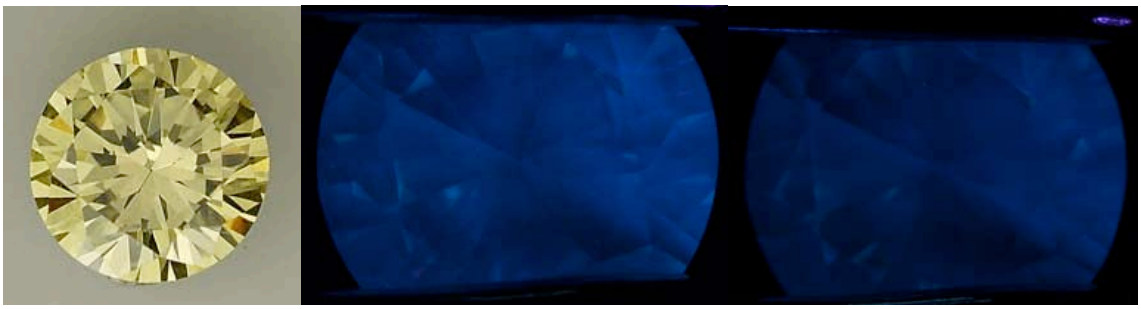


Figure 1. In this 0.21 ct type IaB>A Fancy Intense yellow HPHT-treated diamond (a), we observed a concentration of fluorescence at the crown and table facet junctions when the stone was exposed to radiation emitted by a short-wave UV lamp (b). The effect was faint and would disappear when the sample was tilted (c). This sample showed a stronger fluorescence concentration than the others. DiamondView imaging also showed that any apparent concentration at facet edges changed with orientation (d and e).



(a) (b) (c)

Figure 2. This 0.15 ct type IaA Fancy Intense yellow HPHT-treated diamond (a) displayed faint concentration at the facet junctions when exposed to 100-watt long-wave UV (b), which would alter or disappear when the stone was tilted (c).