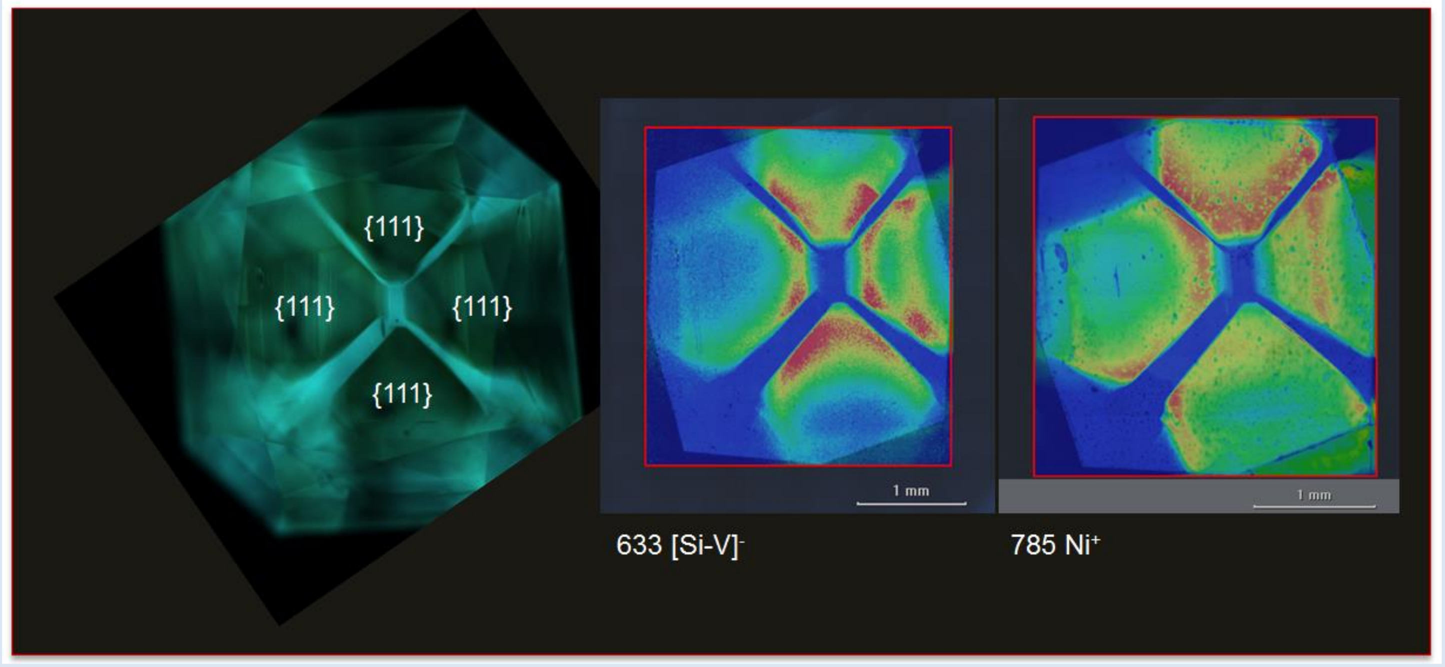
HPHT Synthetic Diamond with Intense Green Coloration

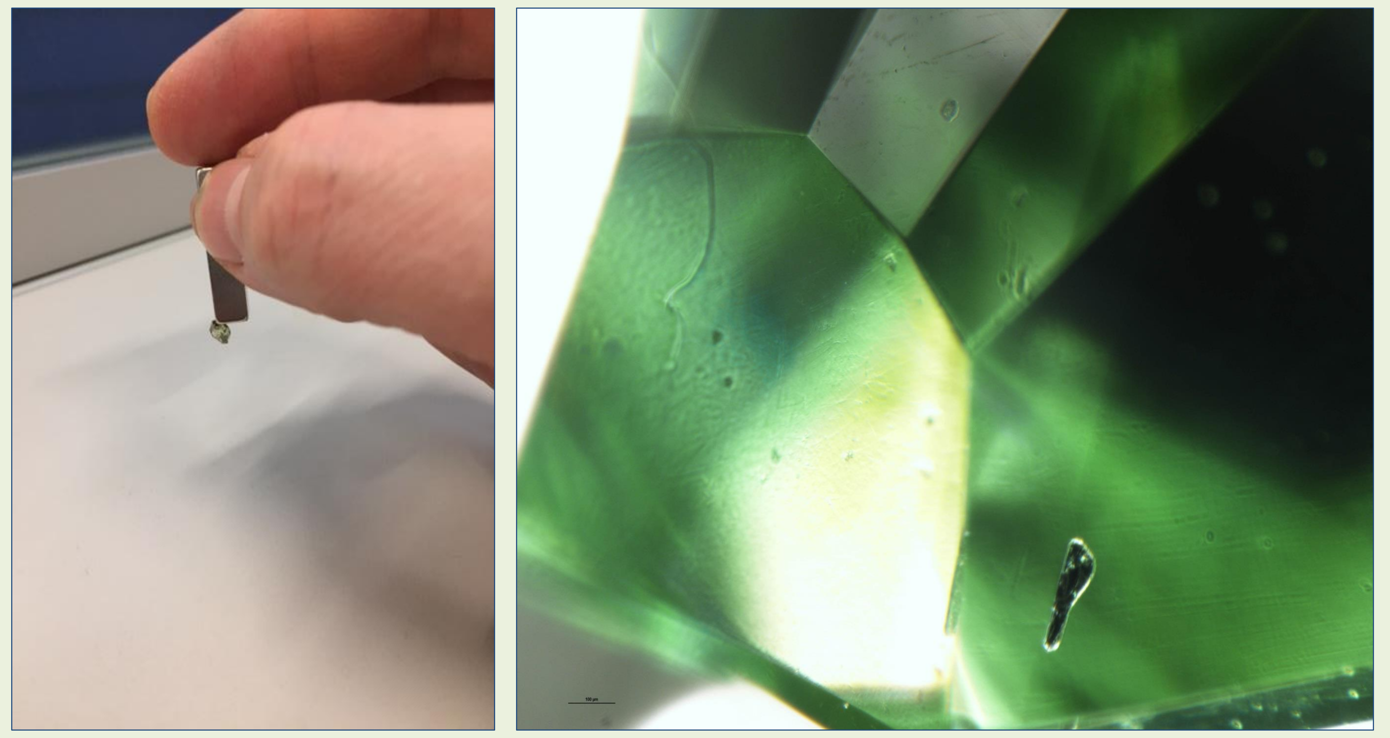
Paul Johnson[1] Kyaw Soe Moe, Lorne Loudin and Elina Myagkaya
[1] Gemological Institute of America (GIA), New York, NY, USA.

Although rarely observed in natural diamonds a green color can occur related to natural nickel defects in a diamonds crystal lattice[1]. Nickel is commonly used as a catalyst in the production of HPHT (High Pressure High Temperature) grown synthetic diamonds. However it is rarely responsible for the color of these synthetic diamonds. This is the first observation of nickel contributing to an intense green color in a HPHT grown gem quality synthetic diamond.
Here we examine a green HPHT synthesized diamond, this diamond has similar properties to most diamonds grown using the HPHT temperature gradient method. Differences are noted in the absorption spectra that account for the rare green body color observed. The use of a metallic flux (Mn, Fe, Co, Ni) as a solvent can allow diamond crystals to grow at lower temperatures and pressures than those grown in nature. Usually an iron rich solvent is used with traces of nickel, the metal acting as a flux allows the source carbon to enter solution and migrate to a diamond seed crystal and deposit growing into a larger crystal. Sometimes this metal i.e. nickel is trapped into the growing crystal as metallic inclusions. Rarely does this Nickel contribute to the color of the crystal.

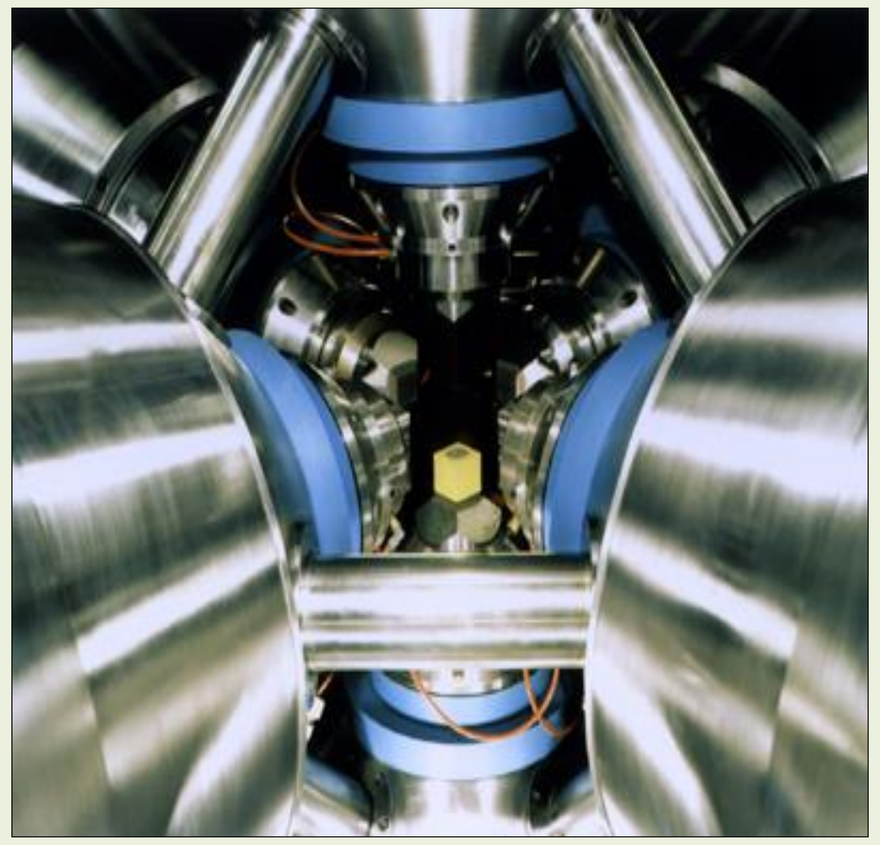


In addition to boron and nickel, this diamond also contains [Si-V]⁻ impurity in its crystal lattice. Recent studies have shown that while this impurity is common in CVD grown diamonds it can also be observed in HPHT grown diamonds[2]. Using Raman mapping techniques and different laser excitations the distribution of silicon and nickel impurities were mapped and the results proved consistent with previous studies of near colorless HPHT grown diamonds also observed in the trade[3], with both the Ni+ and [Si-V]⁻ being confined to the {111} growth sectors. Typically observed in HPHT grown diamonds, these {111} sectors are the most developed and dominate the diamond crystal's morphology. The [Si-V]⁻ center does not contribute to the color of these synthetic diamonds and it is either intentionally or unintentionally incorporated during crystal growth.

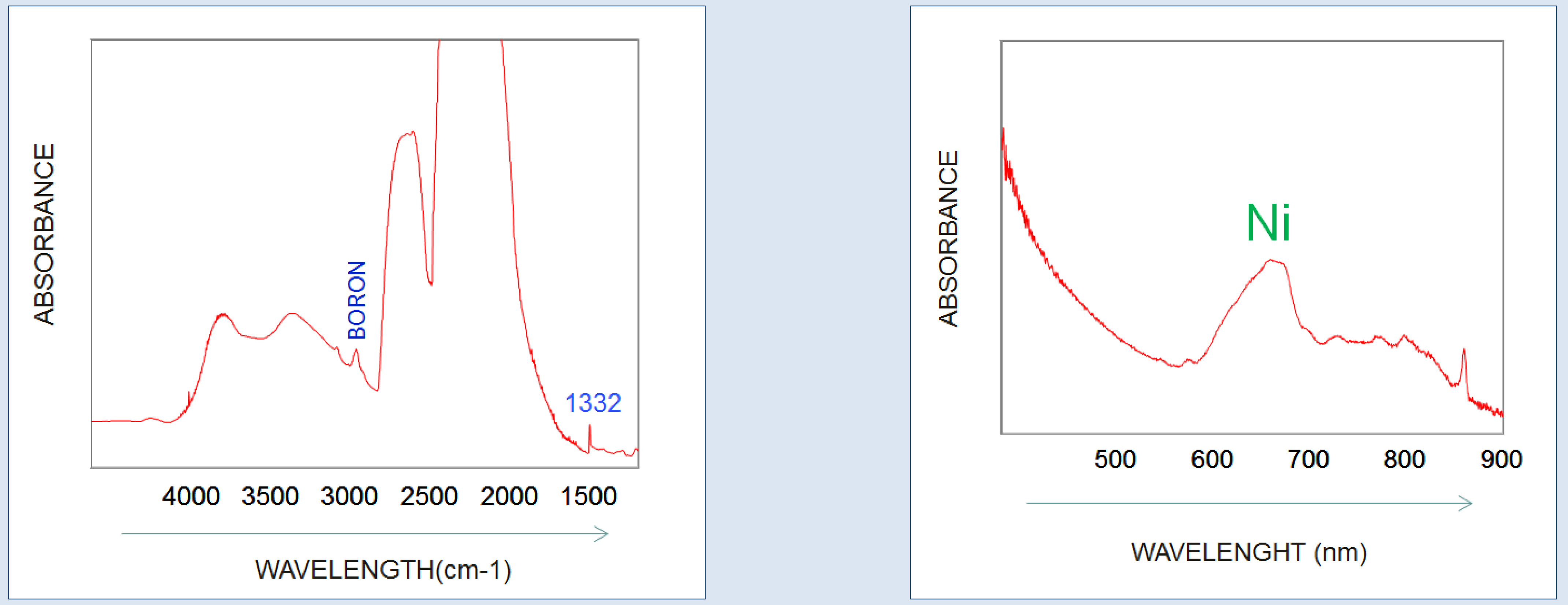
0.42 carat (4.42x4.34x2.59mm) HPHT grown diamond, obvious color zoning is observed and the {111} and {100} growth sectors are clearly defined.



With a high Ni content this synthetic diamond contains many metallic inclusions and displays strong magnetism.



The type of press and diamond growth cell greatly determine the diamond crystals size and morphology.



The Mid-IR spectrum shows Boron related absorption. Strong Nickel related absorption is observed in the UV-Visible spectrum, post growth treatment is needed to activate this Nickel impurity annealing at ~ 1600-1800°C can active interstitial Ni⁺ and causing the green color.

References

T. Ardon, Diamond with High Concentration of Nickel, Gems & Gemology, Fall 2013, Vol. 49, NO. 3

U. F.S. D'Haenens-Johansson, K. S. Moe, P. Johnson, S. Y. Wong, R. L. Lu, W. Wang, Near-Colorless HPHT Synthetic Diamonds from AOTC Group, Gems & Gemology, Spring 2014, Vol. 50, NO. 1

P. Johnson, K. S. Moe, U. F.S. D'Haenens-Johansson, A. Rzhevskii, Discovery and Distribution of the [Si-V]⁻ Defect in HPHT-Grown Gem-Quality Diamonds, 2015 GSA Annual Meeting, Paper No. 300-12

S.C. Lawson, H. Kanda, Nickel in diamond: an annealing study, Diamond and Related Materials, 2 (1993) 130-135.

GSA 2017
22-25 October
Seattle, Washington, USA