A White Diamond

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Colourless or near-colourless diamonds are often referred to as white diamonds, however, there is a fancy colour called 'white'. Such diamonds have a strong milky appearance and are not to be confused with highly fluorescent diamonds that are also termed 'milky'. Delta Diamond Laboratory in Perth, Western Australia, had an opportunity to examine a 2ct white diamond with even colouring (Figure 1), and to describe some of its characteristics.

Figure 1. A 2ct diamond (origin unknown) classified as 'white' showing even colouring.

Being of white colouration, the absorption spectrum was relatively flat and featureless with a slightly increasing absorption towards the red end of the visible spectrum and a small 415nm N3 absorption peak (Figure 2). In reality, the white colouration is not a result of absorption but due to the scattering of light from minute inclusions.

The long wave ultraviolet (LWUV) fluorescence colour was blue, consistent with N3 defects; the short wave ultraviolet (SWUV) fluorescence colour was similarly blue albeit slightly more intense than the reaction to LWUV (Figure 3).

The photoluminescence (PL) spectrum using 405nm excitation showed only an N3 spectrum without any additional features (Figure 4). This contrast is normally indicative of nitrogen-free Type II diamonds (including laboratory-grown), but also those with low concentrations of A-centres (ie, Type IaB diamonds). A short phosphorescence lasting about one second after SWUV illumination was also observed.

An infra-red (IR) spectrum confirmed the lack of A-centres and showed about 200ppm of nitrogen that was all present as B-centres (Figure 5). The spectrum was consistent with a pure Type IaB diamond with no A-centres present, but interestingly with no platelets either. These features are usually formed with B-centres. Hydrogen, with a signature at 3107cm^{-1} and 1405cm^{-1}, was also present in a moderate concentration.

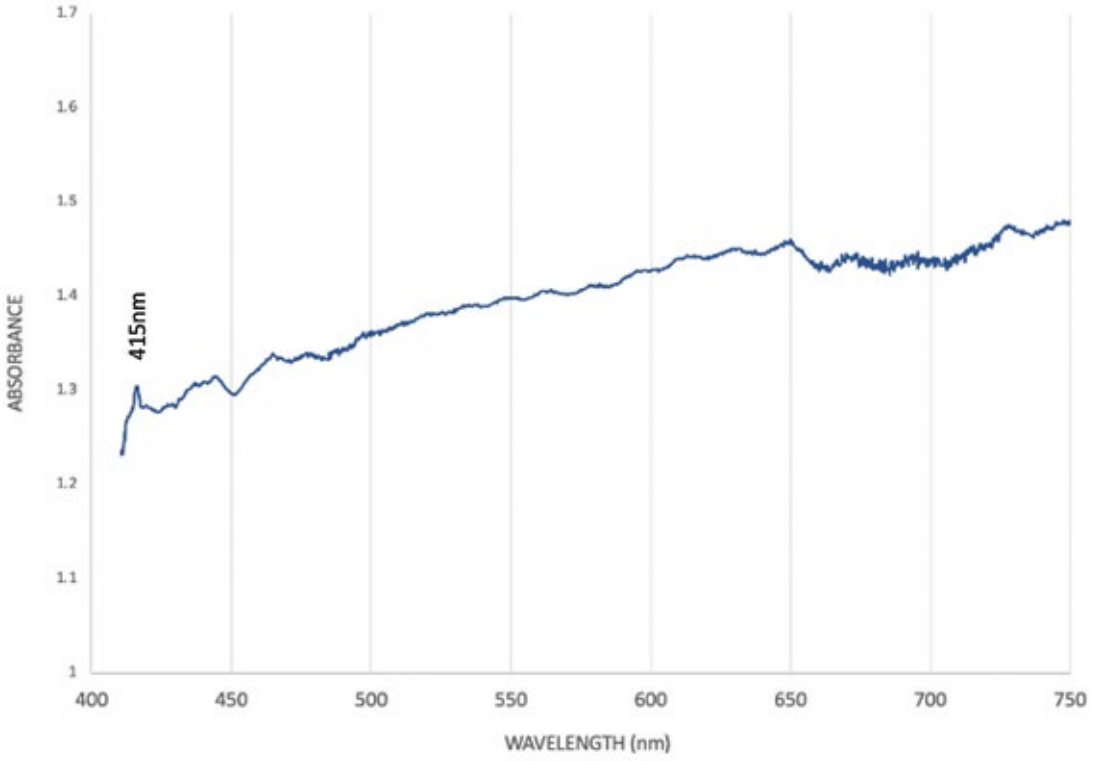

Figure 2. The absorption spectrum of the white diamond with a small 415nm N3 peak.

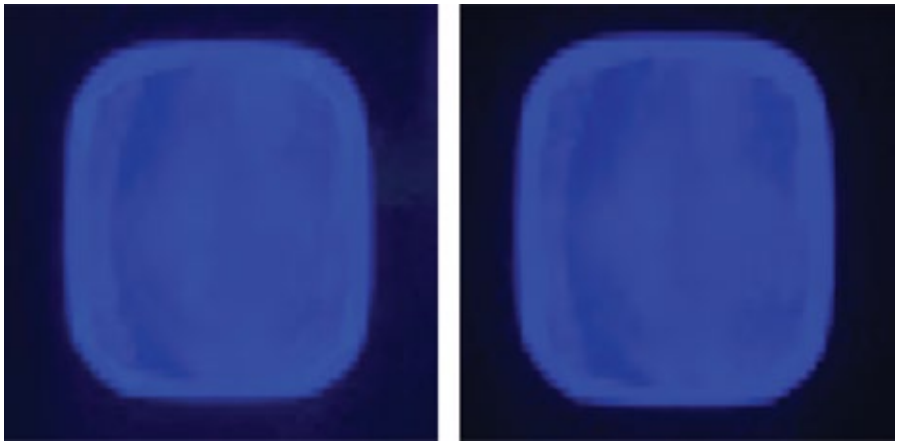

Figure 3. The LWUV (left) and SWUV (right) fluorescence showing similarity in colour and intensity.

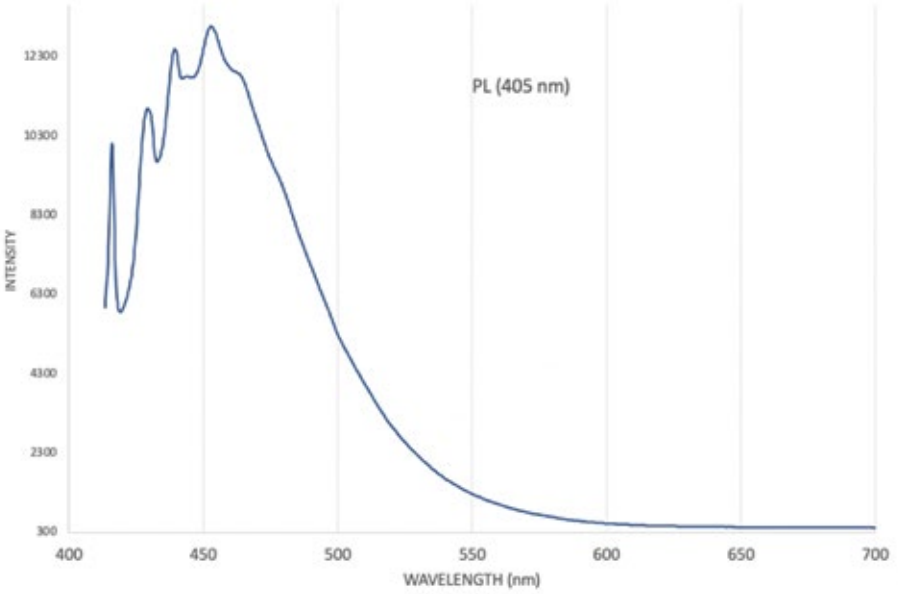

Figure 4: The PL spectrum of the white diamond showing typical N3 emission.

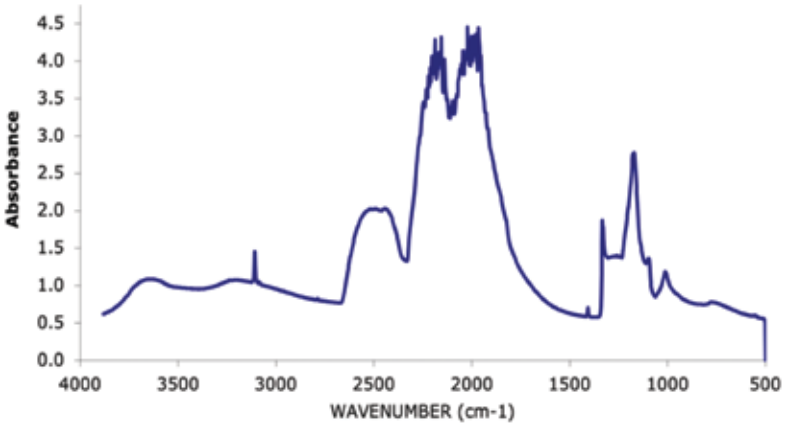

Figure 5. An IR spectrum of the white diamond showing nitrogen present as 100% B-centres.

Under crossed-polarising filters, the birefringence showed anomalous patterns typical of natural diamonds, though with a slight suggestion of plastic deformation as shown by directional features (Figure 6).

White diamonds are considered to owe their colour to nano-inclusions that scatter light (Eaton-Magaña *et al.*, 2019). The extreme nitrogen aggregation state of this diamond is suggestive of high or prolonged temperatures that can be found at depths greater than the depths where most diamonds are formed. Studies of diamond inclusions indicate the lower mantle as the zone of formation. The structure of the inclusions has eluded scientists, but there has been suggestion that they could be dislocation loops, a structural defect that does not involve impurity atoms (Gu *et al.*, 2019).

References

Eaton-Magaña, S., Ardon, T., Breeding, C. and Shigley, J., (2019). Natural-color fancy white and fancy black diamonds: where color and clarity converge. *Gems & Gemology*, 55(3), pp.320-337. DOI:10.5741/GEMS.55.3.320

Gu, T., Ohfuji, H. and Wang W., (2019). Origin of milky optical features in type IaB diamonds: dislocations, nano-inclusions, and polycrystalline diamond. *American Mineralogist*, 104(5), pp.652-658. DOI:10.2138/am-2019-6699

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Editor's Note: The author has a commercial interest in Delta Diamond Laboratory.

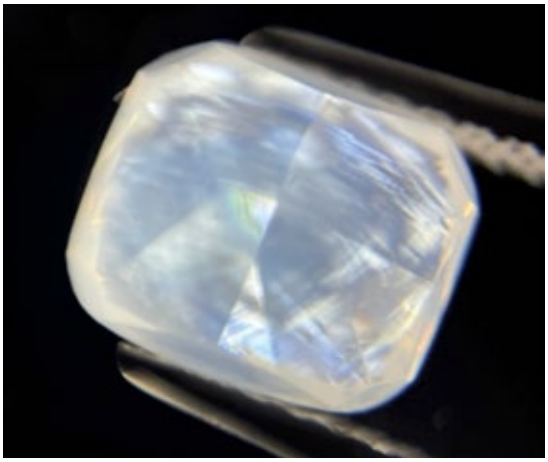

Figure 6. The birefringence pattern showing indications of plastic deformation.