# Chameleon Diamond

John Chapman

There are some diamond types that a gemmologist might read about, but never actually see. One notable example is a 'Chameleon' diamond, named as a result of its colour-changing character, switching between a khaki greenish colour to a golden yellow. These diamonds are more of a collector's item because of their colour-changing characteristic, a change that is usually induced by heating above 130˚C or darkness for a period that can vary from a few minutes for some specimens to several days for others. Such diamonds have not been able to be produced artificially and while there have been several scientific studies on these diamonds, the defect structures responsible for the colour change remains a mystery.

Recently, Delta Diamond Laboratory in Perth had access to a 0.87ct specimen of unknown origin and analysed it using several instruments at its disposal. The observations are summarised below.

*Figure 1. The dramatic colour change exhibited by a 0.87ct Chameleon diamond after heating from a candle.*

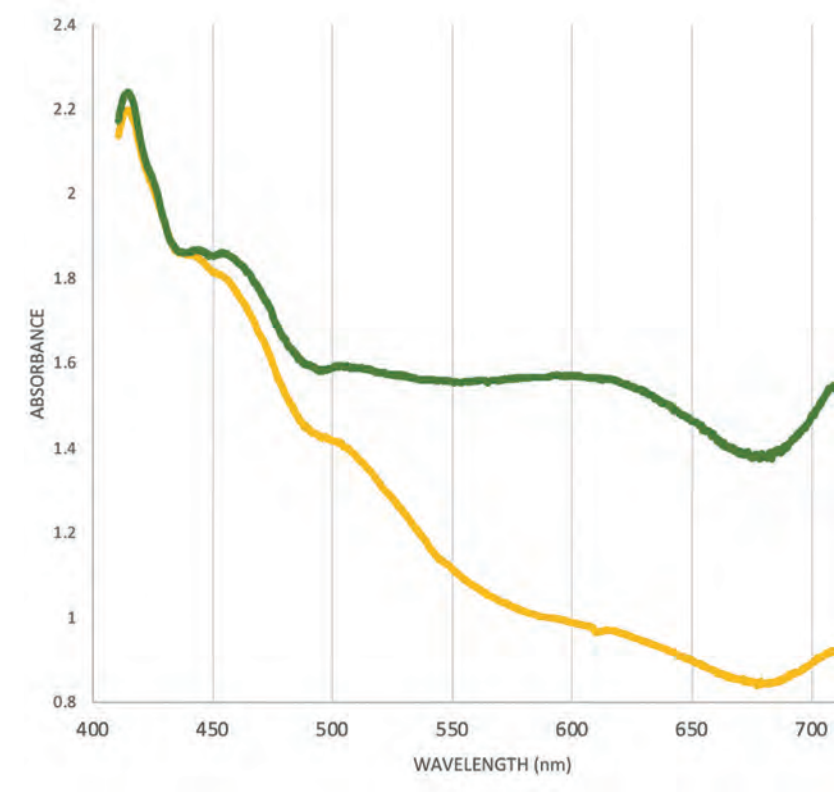


*Figure 2. The visible absorption spectrum of the Chameleon diamond in its two colour states.*

## *Appearance*

Figure 1 shows the appearance of the stone in ambient daylight and immediately after heating by a candle. The intense yellow colour persisted for less than a minute, returning to its original green colour over a duration of several minutes. Darkness is also an environment that is known to convert a Chameleon to its yellow state over a few days, however with this specimen the yellowing was only partially developed after darkness for several days.

## *Absorption spectrum*

The absorption spectrum was measured in the two colour states. The spectra are shown in Figure 2. They show a 415nm absorption related to N3 and an absorption change that decreases with longer wavelengths. Literature reports describe an absorption at 480nm for Chameleon diamonds (Breeding *et al.*, 2020; Fritsch *et al.*, 2007), however such absorption is not present in this diamond, instead showing an absorption band centred near 460nm.

## *Luminescence*

Under LWUV the stone showed clear zoning of conventional N3-related blue fluorescence and a yellow fluorescence (Figure 3, left photo). Using SWUV the diamond showed a weaker version of the LWUV pattern, but curiously when the light was extinguished, the resultant yellow phosphorescence showed no zoning (Figure 3, right photo) and lasted several seconds.

Recording the photoluminescence (PL) spectrum of the two different regions using a 405nm laser showed the yellow area having a strong broad emission centred at 550nm (Figure 3b) superimposed on a weaker N3 blue emission (Figure 3a). While the central emission was at a green wavelength, the significant red component was able to result in a net yellow hue.

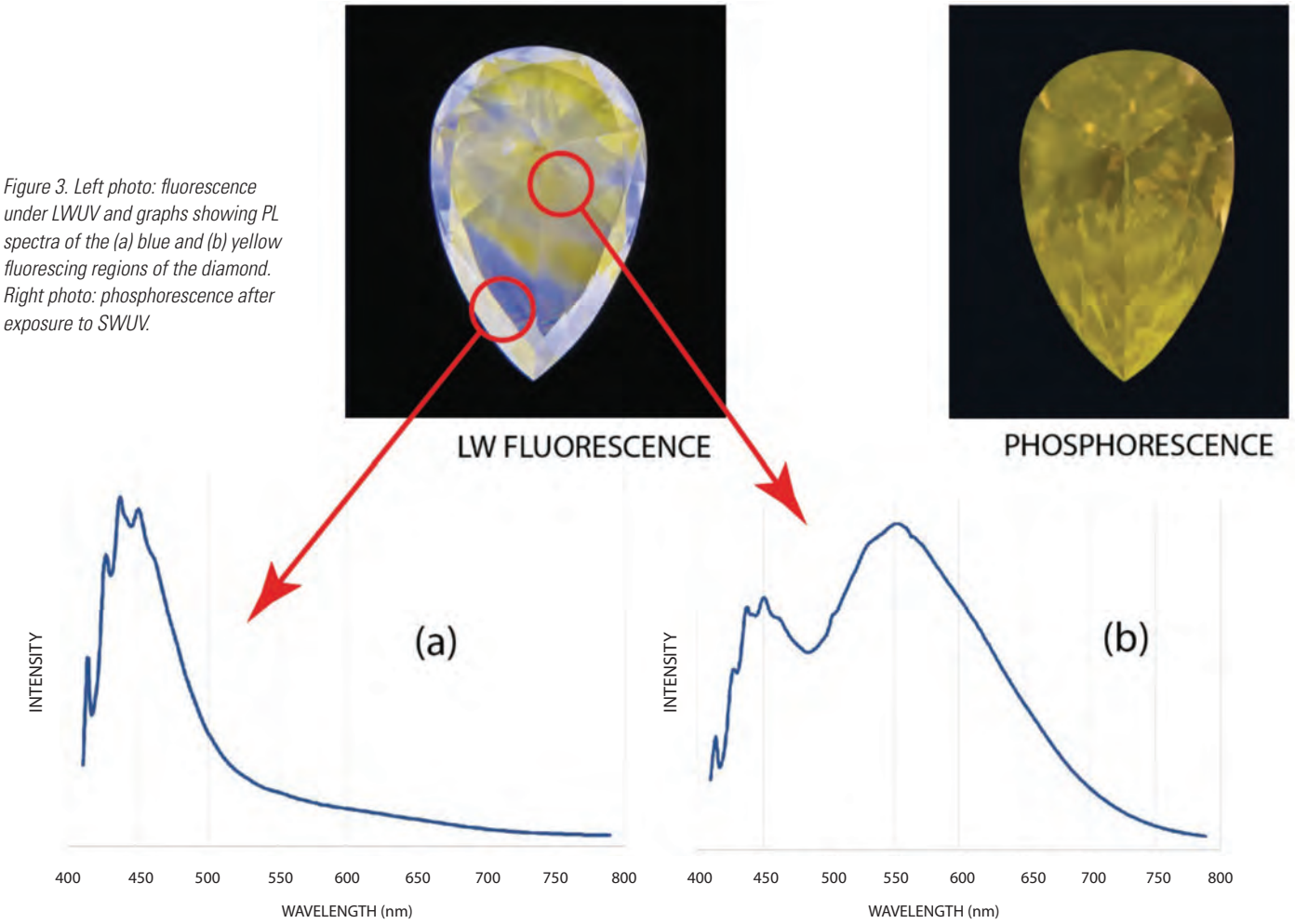


*Figure 3. Left photo: fluorescence under LWUV and graphs showing PL spectra of the (a) blue and (b) yellow fluorescing regions of the diamond. Right photo: phosphorescence after exposure to SWUV.*

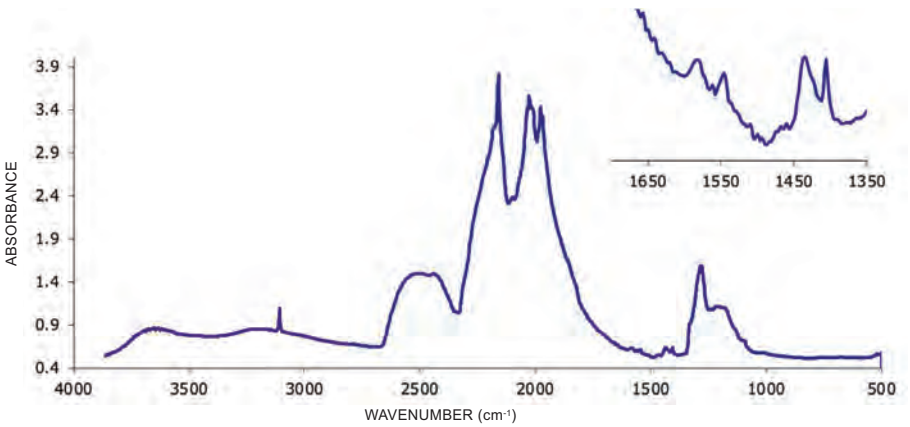


*Figure 4. An IR absorption spectrum of the diamond showing a low N concentration and modest hydrogen-related defects at 3107cm$^{-1}$. The inset shows some of the lower absorption peaks.*

### *Infra-red spectrum*

*The diamond was a Type IaAB with relatively low amounts of nitrogen – 75ppm in the A-aggregate state and 50ppm in the B-aggregate state. The hydrogen-related peak at 3107cm$^{-1}$* was conspicuous, while a few small peaks in the region 1400–1600cm$^{-1}$ region were noted (Figure 4). Of these, the 1404cm$^{-1}$ and 1433cm$^{-1}$ are recognised as related to hydrogen, whereas the 1542cm$^{-1}$ and 1578cm$^{-1}$ peaks are undocumented and may be related to the specific defect responsible for the Chameleon character.

### *Birefringence*

*Between crossed-polars, no internal strain could be seen. Such lack of strain is unusual in colourless natural diamond but can be observed in some yellow diamonds (such as from the Ellendale deposit) and some other natural colour diamonds.*

*All images courtesy of the author.*

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

## References

Breeding, C., Eaton-Magaña, S. and Shigley, J., 2020. Naturally colored yellow and orange diamonds: the nitrogen factor. *Gems & Gemology*, 56(2), pp.194-219. [online] Available at:< https://www.gia.edu/gems-gemology/summer-2020-naturally-colored-yellow-orange-diamonds> [Accessed 22 March 2022].

Fritsch, E., Massi, L., Rossman, G., Hainschwang, T. and Dessapt, J., 2007. Thermochromic and photochromic behaviour of "chameleon" diamonds. Diamond and Related Materials, 16 (2), pp.401–408. [online] Available at: <https://doi.org/10.1016/j.diamond.2006.08.014> [Accessed 22 March 2022].