Chameleon Diamonds: A Proposed Model to Explain Thermochromic and Photochromic Behaviors

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Chameleon diamonds are an unusual variety of colored diamond that typically change from grayish green to yellow when heated (thermochromic behavior) or kept in the dark (photochromic behavior). This report is based on a study of more than 40 chameleon diamonds, including the 22.28 ct Green Chameleon and a 31.31 ct oval gem, the largest documented chameleon diamonds known to date.

As described previously for chameleon diamonds, the samples were type IaA, indicating that A aggregates largely dominated the nitrogen speciation. They contained moderate-to-large amounts of hydrogen, in addition to some isolated nitrogen and traces of nickel. Their UV-Vis absorption spectra comprised the continuum typical of type Ib material—even if this character is not detectable with IR spectroscopy—and, in addition, a 480 nm band and a broad band centered at around 800 nm. It is mainly in the red part of the visible spectrum that the color change occurs because when heated or kept in the dark, the essential change in the UV-Vis absorption spectrum is the significant decrease of the very broad band at 800 nm.

We propose an electronic model that is consistent with all observed color behaviors in chameleon diamonds. The model is based on the premise that, from a physical standpoint, yellow is the stable color whereas green is the metastable one. According to the literature (i.e., Goss et al., 2002), the most plausible model for the hydrogen-related center in diamond is N…H-C (in which the hydrogen atom is located near a bond center between N and C, but closer to C than to N). Since chameleon diamonds are predominantly type IaA, with moderate-to-large amounts of hydrogen, it therefore seems reasonable to suggest that a possible center responsible for the chameleon effect is a nitrogen-hydrogen complex involving the sequence N…H-C.

REFERENCE

Goss J.P., Jones R., Heggie M.I., Ewels C.P., Briddon P.R., Öberg S. (2002) Theory of hydrogen in diamond. *Physical Review B*, Vol. 65, No. 11, pp. 115207-1–115207-13.