Treatment of Natural Gem Diamond and Its Identification

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Diamond is the most important gem stone in the jewelry industry. Next to the carat weight, a diamond's color may be the most important valuation characteristic. Both colorless/near-colorless as well as highly saturated (fancy colored) diamonds are in high demand, and are of great value in the diamond market. However, only a few percent of natural diamonds are gem quality and much less show an attractive color. In fact, many gem-quality diamonds may display undesirable brown coloration with varying saturations or a diamond's inherent color may not be intense enough to qualify for the "fancy" category. Therefore, treatment techniques such as irradiation and HPHT are currently being employed to decolorize and/or enhance a diamond's color to potentially increase its value.

Artificial radiation with or without annealing has been applied to improve diamond color appearance for nearly a century, and continues to be an effective technique. The side band of the GR1 defect, which may be introduced by all types of radiation, extends into red light region and imposes additional blue coloration. For example, a light yellow diamond will show a clear green coloration after a simple irradiation. Depending upon properties of the starting material, annealing of irradiated diamonds could generate H3, H4, and N-V defects, consequently producing intense yellow, green, or pink-purple coloration. Commercial annealing of diamond under high pressure and high temperature (HPHT) started in late 90s in order to improve color appearance. This technique, for example, could turn type IIa brown diamonds into colorless/near-colorless or turn gray type IIb diamonds into intense blue. Varieties of other attractive colors (e.g., yellow, greenish yellow, orange, etc) could also be produced when type Ia diamonds are annealed under HPHT. Intense red color, which is very rare in nature, could be produced with a combination of HPHT and radiation/annealing techniques.

Currently, many attractive diamond colors are being produced in treatment laboratories and are being introduced into the gem market. Proper identification of these treated diamonds is crucial to protecting the diamond industry. In addition to many gemological properties, defects in the diamond (extended and point defects) supply essential identification criteria. Since conditions (radiation energy and intensity, pressure, temperature) applied to a diamond during laboratory treatment (radiation/annealing or HPHT annealing) are very different from those that occur in nature, it is expected that the varieties and concentrations of defects in a treated diamond differ from defects that occur in a natural diamond. Finding this difference is the basis for proper identification. Spectroscopic features of various types of natural and treated diamonds will be reviewed and some details about identification of diamond treatment will be discussed.