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EFFECT OF IRRADIATION AND HIGH TEMPERATURE ANNEALING WITHOUT STABILIZING PRESSURE ON THE OPTICAL PROPERTIES OF HPHT SYNTHETIC DIAMONDS

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The most common way to control the state of impurity centers in diamonds for a certain high-tech application is ionizing irradiation followed by high-temperature annealing. Annealing at high pressure is usually used to prevent graphitization. But recently, much attention has been paid to annealing at normal (atmospheric) pressure, which reduces the risk of crystal destruction and simplifies (reduces the cost) of the equipment used.

The HPHT synthetic diamonds with nitrogen concentration ~300 ppm were grown in the Fe-Ni-C system. A 0.4 mm thick plate containing colorless area (octahedral sector, type Ia+Ib, with dominant nitrogen A-centers) and yellow areas (cubic sectors, type Ib, C-centers) was cut and polished. This plate was irradiated with fast 3 MeV electrons with dose up to 10^{18} e^-/cm^2 and heated at different temperatures (600, 900, 1200, 1500 and 1800°C) without stabilizing pressure. The changes in optical properties occurring during such processing were studied in detail using optical (absorption and luminescence) spectroscopy including absorption Fourier spectroscopy in the mid-IR. Attention was paid both to spatial distribution (mapping) and spectroscopic features.

It is shown that the color of the crystal at different stages is determined by vacancies, nitrogen (Si) and nitrogen-vacancy centers (NV, N_2V) in different charge states. The conditions of formation and the limits of stability of these defects during annealing are determined. The state of these defects, as well as of nickel and nitrogen-nickel centers, was monitored by photoluminescence (PL) spectra. The obtained data are compared with the available information on the HPHT annealing.