EPR and optical diagnostics of nanodiamonds

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Nitrogen is the main impurity in diamonds, which largely determines their properties. Nitrogen creates various paramagnetic centers in diamonds and exists as individual atoms and clusters. Recently, a great interest has been inspired by studies of nitrogen-vacancy centers (NV defects) in diamonds, for which the magnetic resonance on single defect was successfully observed at the room temperature. However, ND doping processes, formation and structure of intrinsic and impurity defects differ from those in bulk diamonds. In particular, the theoretical studies have shown that nitrogen impurities in ND seem to be metastable in contrast to bulk diamonds. The irradiation methods used to create the NV centers in diamonds/nanodiamonds are purely statistical and the effectiveness of creation of the NV centers in nanodiamond with the size less than 20 nm is still under the question.

Electron paramagnetic resonance (EPR) is one of the most informative and sensitive techniques for the diagnostics of defects in semiconductors. at the molecular level. Herein, we examine the defects in sintered nanodiamonds (ND) by EPR.

Our studies have shown that single nitrogen atoms occupy the stable position in nanodiamond lattice and can be observed in detonation ND sintered under different conditions. Under peculiar sintering conditions it is possible to observe the effect of self-organization of ND into micron size arrays, which is confirmed by orientation dependencies observed in the EPR spectra.

We have also detected very intense EPR spectra corresponding to NV centers in diamonds. Observation of these spectra with and without illumination of the samples allows us to conclude that NV centers can be fabricated in ND without any post or prior irradiation. The formation of NV centers is governed only by high pressure high temperature sintering of detonation ND. The EPR data are confirmed by measurements of photoluminescence (PL) spectra. To determine the best sintering conditions we have performed the series of PL in different types of sintered nanodiamonds and irradiated diamonds.

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