CATHODOLUMINESCENCE SPECTRA OF DIAMOND COLOR CENTERS DEPENDING ON ELECTRON ENERGY AND BEAM CURRENT DENSITY *

A.A. KRYLOV[1,2], *A.G. BURACHENKO*[1,2], *V.S. RIPENKO*[1,2], *E.I. LIPATOV*[1,2], *A.V. VUKOLOV*[3]

[1] *High Current Electronics Institute SB RAS, Tomsk, Russia*
[2] *Tomsk State University, Tomsk, Russia*
[3] *Tomsk Polytechnic University, Tomsk, Russia*

Diamond is a promising material for high-temperature radiation-resistant semiconductor electronics and photonics, including its use in optoelectronic detectors of ionizing radiation and high-energy particles, converting their energy into optical radiation across a wide range of wavelengths (from vacuum UV to mid-IR). Such detectors (Cherenkov and scintillation) can operate under conditions of high temperatures and intense radiation exposure [1, 2]. The primary energy of the electron beam [2] at which the high-energy particle detector operates ranges from tens to hundreds of keV and units of MeV. The aim of this work is to spectrally investigate the influence of the current density of the electron beam and their energy on the excitation of luminescent centers in synthetic diamond samples with different impurity-defect compositions. The studies were conducted on two different setups: the NORA electron accelerator with a detached IMA3-150E electron tube, which generated an electron beam with energies ranging from tens to hundreds of keV, and the MI-6 microtron, which generated a monoenergetic electron beam with an energy of 5.7 MeV. The investigations were carried out on samples synthesized by the temperature gradient method under high pressure and high temperature (HPHT) conditions and by the chemical vapor deposition (CVD) method.

It is shown that the luminescence spectra of diamond samples obtained by different synthesis methods (HPHT and CVD) under the influence of a low current density electron beam (tens of nA/cm2) with an energy of units of MeV significantly differed from each other. Meanwhile, the luminescence spectra of these same diamond samples obtained under the influence of an electron beam with a high current density (hundreds of A/cm2) but lower energy (tens to hundreds of keV) were practically indistinguishable. It is suggested that the difference in the luminescence spectra of these samples is associated with the different volumetric excitation density of the diamond samples.

The obtained results will be useful in the creation and design of both scintillation and Cherenkov detectors capable of operating in extreme conditions.

REFERENCES

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