RECOMBINATION OF AN ELECTRON-HOLE LIQUID IN THE LUMINESCENCE SPECTRA OF AN UNDOPED DIAMOND

A. S. POPOVA[1], A. A. KRYLOV[1,2] , D. S. VOYTENKO[1], E. I. LIPATOV[1,2]

[1]National Research Tomsk State University, Tomsk, Russia
[2]Institute of High-Current Electronics SB RAS, Tomsk, Russia

This paper reports the results of a study of the process and conditions of condensation of free excitons (FE) into electron-hole liquid (EHL) droplets under conditions of intense ultraviolet laser radiation at 222 nm, as well as under conditions of irradiation of a diamond sample with an electron beam.

Based on the obtained photoluminescence (PL) and cathodoluminescence (CL) spectra shown in figure 1 (a, c), temperature and energy dependences (figure 1 (b, d)) of the intensity of the dominant peak of luminescence caused by radiative recombination of FE with the generation of phonons were constructed and approximated.

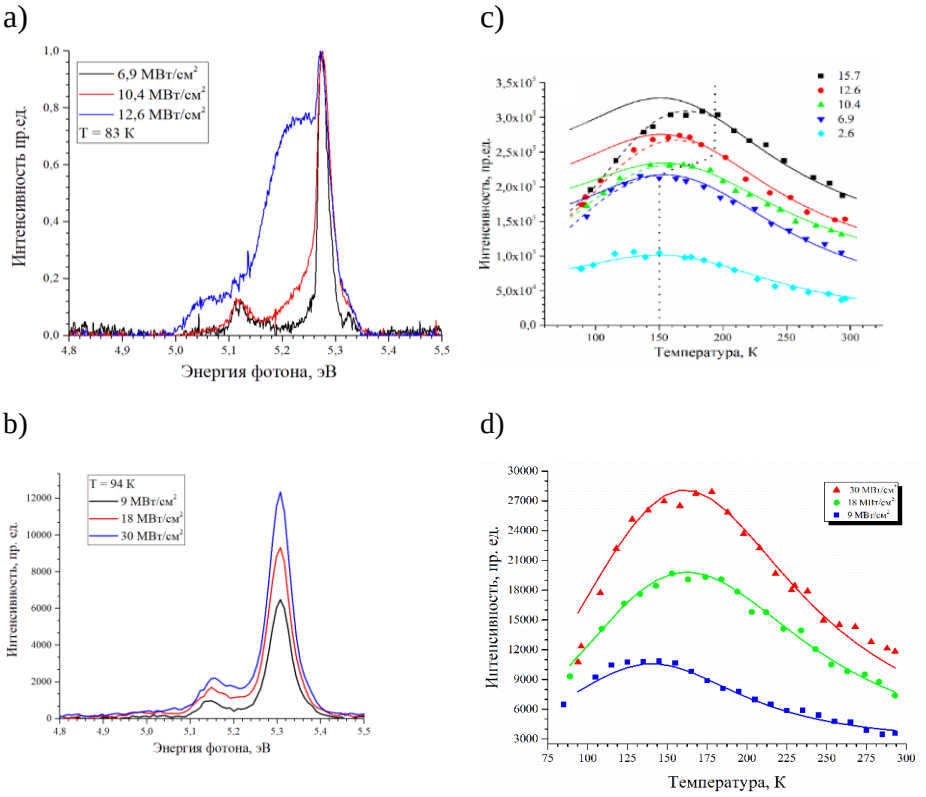

Fig.1. Edge luminescence of an undoped diamond at different excitation power densities. Spectra of a) photoluminescence and b) cathodoluminescence. Temperature dependences of peaks of free excitons in the spectra of c) photoluminescence and d) cathodoluminescence

The analysis of the obtained dependences for PL allows us to determine the conditions of condensation of FE in the EHL – from 152 K at an excitation density of 6.9 MW/cm^2 to 197 K at an excitation density of 15.7 MW/cm^2.

The bands responsible for EHL recombination are not observed in the CL spectra, however, based on the obtained temperature dependences, it is assumed that when the sample is irradiated with an electron beam, this process proceeds nonradiatively. This assumption is explained by the fact that at CL there is a higher concentration of hot charge carriers, which, during thermalization, emit a cascade of phonons that prevents the radiative recombination of EHL, as well as the formation of a sufficient concentration of droplets recombining with radiation to be able to observe them in the spectra of CL.

REFERENCES

[1] Fujii A., Takiyama K., Maki R., Fujita T. Lifetime and quantum efficiency of luminescence due to indirect excitons in a diamond // Journal of luminescence, 94-95, p.355-357, 2001