

This Ph. D. thesis is focused on the study of modern semiconductor materials, diamond, and silicon nanocrystals, by methods of laser spectroscopy. A new experimental setup, the generator of mid-infrared laser pulses, was built to study diamond in detail. With its help, we observed the dynamics of high-density excited carriers, their condensation into electron-hole liquid, and their interaction with light around their plasma frequency. Thanks to the high sensitivity of these measurements on the excited carrier temperature we could observe the thermalisation dynamics which was described by the quantum theory of free carrier absorption.

In the doped silicon nanocrystals embedded into  $\text{SiO}_2$  matrix, we studied the potential presence of free carriers which could be used to create a PN junction. We also found an important recombination channel in these samples which manifests at high excitation intensities. We identified its origin and described its interaction with nanocrystals. At last, we analyzed the influence of incorporated boron atoms on the distribution of decay times according to the emitted wavelength.