Abstract

Intense few-cycle laser pulses can significantly affect the properties of transparent solids during the interaction. These processes take place on femtosecond time scales and they can be studied using ultrafast spectroscopic methods. This dissertation deals with highly nonlinear processes in diamond. In the interaction with a crystalline diamond, we observed a strong nonlinear broadening of the spectrum due to self-phase modulation effect, which allowed us to create a simple technique for compression of pulses from laser oscillator. At the same time, strongly nonlinear five-photon absorption was observed, in which we found a significant anisotropy and dependence on the polarization state. With two-beam pump and probe experiments we present a study of anharmonic phenomena in the dynamics of coherent phonons in diamond, additionally we created a new detection technique of lattice vibrations using multiphoton absorption. Finally, the high time resolution of the experiments revealed that the sub-picosecond electron dynamics strongly depends on the composition and morphology of the polycrystalline diamond thin films. The experimental results of this work provide comprehensive research into the interaction of diamond with few-cycle laser pulses and the development of new spectroscopic methods.