Abstract

Photonic crystal is an artificial diffractive structure with a spatially periodic distribution of permittivity that has a unique ability to manipulate and control light propagation. Therefore, such structures provide a perfect basis for the construction of various photonic devices. Most of these devices are based on the presence of the Fano resonance, which refers to an interference between localized and continuum states. The present thesis is generally devoted to the study of optical properties of the Fano resonances in dielectric photonic crystals. Reflectance of four different types of photonic crystals is analysed experimentally and numerically. Reflectivity is investigated by two different methods: incident angle resolved spectra as well as omnidirectional reflectivity maps. The reflectivity of the photonic crystal slab is simulated using the rigorous coupled-wave analysis method. A great emphasis was put on the influence of individual photonic crystal slab parameters. The investigation of these features revealed the possibility to use a photonic crystal slab as a dispersive element for spectroscopy purposes. A semi-analytical model of 2D photonic crystal reflectivity, based on the superposition of Fano resonances onto a reflectivity of a dielectric layer given by Fresnel equations as well as a comprehensive analysis of radiative and guided modes are presented and explained. The second part of the thesis is devoted to the study of the possibilities and advantages of using the picosecond LIBS for the analysis of materials based on Molybdenum and Tungsten. The electron temperature and concentration are investigated by Boltzmann and the Saha-Boltzmann plots. Main benefits over the nanosecond LIBS are less amount of ablated material and lower Stark broadening, which result to a better depth resolution and more precise determination of plasma properties.