

Supercontinuum generation in the propagation of high-power femtosecond laser radiation in a supercritical and colloidal media

The interaction of high-power laser radiation with a transparent medium gives rise to filamentation (self-channeling of pulse) and supercontinuum generation (broadband coherent light). These phenomena are of interest for remote spectroscopy of the atmosphere, micromachining of materials, generation THz radiation and etc. Supercritical fluids (SCF) are novel nonlinear optical objects for research, as they provide a unique opportunity to control and research the impact of properties of the medium to filamentation and its accompanying generation of supercontinuum, as SCF has high nonlinear properties and easily controlled media parameters. The resulting spectrum of supercontinuum can be broadened by adding nanoparticles in the medium. There are two methods, suggested in this work: adding nanoparticles of the same size in SCF, and the formation of a colloid in another way – by ablation of a metal disk inside the cell with the SCF, which leads to the formation of nanoparticles of different sizes and cluster structures.

Carbon dioxide ($T_{cr}=31.10\text{ }^{\circ}\text{C}$ and $p_{cr}=72.8\text{ atm}$) and xenon ($T_{cr}=16.60\text{ }^{\circ}\text{C}$ and $p_{cr}=57.5\text{ atm}$) were used for research of the processes of interaction of high-power femtosecond laser (wavelength of 1240nm, pulse duration 200 fs) with SCF media.

It was found that SCF are a unique source of multioctaving supercontinuum generation, appeared during filamentation of high-power femtosecond laser pulses. Spectra of supercontinuum were obtained from 300nm to 1900nm for CO₂ and xenon. The “red” wing of supercontinuum of the molecular supercritical CO₂ is a plateau, which extends from 1400nm to 1900nm, with almost complete attenuation of “blue” wing of spectrum. The spectrum in supercritical regime of molecular and atomic gases was investigated by the example of carbon dioxide and xenon. A comparative analysis of the IR spectra of supercontinuum was made. Works in the field of laser radiation interaction with colloids solutions were analyzed and conclusions about the kind of metal and shape of nanoparticles were made. Also, two ways of broadening the spectra of supercontinuum by using colloids on SCF were analyzed.