Abstract

“Hard X-ray generation under interaction of femtosecond laser pulses with large molecular clusters”

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Investigation of hard (2-5 keV) characteristic X-rays generation produced by moderate intensity (≤10^{16} W/cm2) femtosecond laser pulses (energy 5-7mJ) under interaction with large clusters, formed by molecules CF_3I, CF_2Cl_2 in the presence with noble gas (Ar, He), was done for the first time .

The clustering process was studied using pyroelectrical detector and Rayleigh scattering methods. The optimization of X-ray yield from cluster nanoplasma depending on focusing lens position and laser pulse duration has been performed. The X-ray spectra are measured using Amptek spectrometer. Conversion efficiency to the characteristic X-ray chlorine line in the mixture of CF_2Cl_2-He (1:9) of $(2.0\pm0.2)\cdot10^{-5}$ is achieved.

Production of CF_2Cl_2-Ar mixed clusters is firstly testified by the presence of chlorine (~2,6 keV) and argon (~3,0 keV) Kα lines in the X-ray spectra. For the first time the investigation of ternary mixture was studied. It was shown that the helium doping to CF_2Cl_2-Ar mixture leads to the characteristic argon line generation growth. This may be the evidence of the argon concentration increasing in mixed clusters.

It was started a methodical study launched on the supersonic flow into a vacuum of high pressure gas which can be presented in a supercritical state. The use of supercritical fluids with dissolved metal salts allows one to obtain new types of clusters, which may be useful as a source of new characteristic X-ray radiation. In the first phase of the research, the clustering of carbon dioxide in the wide range of pressure up to 60atm was analyzed using Rayleigh scattering and we investigated Xe-CO2 mixture for testing methodology. Using X-ray spectrum, it was determined that the mixed Xe-CO2 clusters could be detected if the xenon concentration not less than 1:15.