Image Registration Of Dense Plasma Clots In The Hard X-ray Range

[1]Pavlov G.A., [2]Suslov N.A., [3]Treushnikov V.M, [2]Garanin R.V., [3] Treushnikov V.V., [2]Zhidkov N.V.

[1]IPCP RAS, Chernogolovka, Moscow region, 142432, Russia
[2]RFNC-VNIIEF, Sarov, 607190, Russia
[3]PC "Reper-NN", Nizhny Novgorod, 603003, Russia

The research of the thermophysical properties of plasma in extreme states is important both in principle and for different applications. In experiments on the measurement of these properties, as a rule, were observed their averaged values of plasma formation. To increase the accuracy of experimental data, you must know the degree of homogeneity in the study of plasma clot. Application of optical methods in the visible range with this purpose, it is often impossible because of the powerful background thermal radiation of the plasma, which must be eliminated. Therefore, plasma diagnostics is proposed in the hard X-ray range using X-ray polymer refractive lenses with axial symmetry, combined in a compound lens (10-12 single lenses) with the desired characteristics.

To produce refractive lenses we have been developed manufacturing technique of lenses with axial symmetry and a parabolic profile of the cavity using shape memory polymer. These lenses are tested [1] and showed high radiation resistance. Achieved technological advantages enable qualitatively improve a focusing of radiation and resolution of images by the single and compound lenses compared with existing analogues. Other advantages of the shape-memory polymer refractive lenses are cheapness and safe of use. To manufacture X-ray lenses the oligomers of methacryl series have been synthesized and photopolymerizable composition of strictly defined properties found. The original one-step variant of frontal photopolymerization method is used to get the defect-free products of precisely shape without destructive processes and thermal shrinkage. Lack of defects in the polymer product, in turn, is one of the basic conditions of their abnormally high resistance to various factors, including the hard X-rays. This circumstance gives the maximum possibility to adapt the characteristics of these lenses with the requirements of X-ray optics.

Compound X-ray lens was used to record hard X-ray image of laser plasma at laser facility «Iskra-5» [2]. To create plasma laser emission with λ=1.315 μm and energy of 280 J in pulse of 0.4 ns length was focused onto copper target. The images of laser plasma in hard X-rays of 8 keV were recorded by compound X-ray lens and pinhole camera. Dimensions of spatial inhomogeneities in the image, recorded by X-ray lens, are 10-20 μm and characterized resolution possibility of compound X-ray lens.

Thus, it is shown that the use of the compound X-ray lenses proposed design enables to receive local and sufficiently detailed experimental data on dynamics of plasma clots in extreme condition (which study is difficult by optical methods). One can explore the geometrical sizes, the degree of inhomogeneity, the spectral composition of X-ray radiation, etc of plasma clots. A set of experimental characteristics appropriates to compare with the data of computer modeling of the relevant gas-dynamic processes.

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