Application of polycapillary lenses for focusing x-ray radiation from a laser-plasma source

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Laser-plasma femtosecond x-ray sources are promising for studying the dynamics of ultrafast changes in the crystal structure of solids. Due to the large divergence of radiation from such a source, optics are required that capture the divergent radiation and focus it on the sample to form a diffraction pattern in the region of the applied pump pulse. The main criteria for the effectiveness of such optics are the photon flux through the optics and angular resolution. Experimental results of using an x-ray polycapillary lens to solve this problem are presented. Characterization was carried out using a microfocus x-ray tube and an MCP 2D detector made in Russia. The obtained size of the exit spot of the lens was 900 μm with 10 mm length. Than the lens was used in laser experiments.

Copper tape was used as a target for terawatt laser excitation of x-rays, and the signal was recorded by an x-ray CCD (charge-coupled device) camera. The lens increased the useful signal from such an x-ray source by 100 times.

The focal spot size is 800 μm for the $K_{\alpha 1}$ and $K_{\alpha 2}$ copper lines. The angular resolution was about 3' for diffraction on a Si(111) crystal. The geometric parameters of such lens can be adjusted for optimal intensity or angular resolution for a particular experiment. Thus, the possibility of pump–probe experiments with TW fs pulses and a polycapillary lens has been demonstrated. Another advantage of this approach is that a domestically produced detector can be used to test and adjust x-ray optics. In order to improve the angular resolution a polycapillary half-lens is preferable.