STUDY OF AU PLASMA OPACITY, CREATE, AND IRRADIATE BY THE POWERFUL Z-PINCH X-RAY RADIATION at THE ANGARA-5-1 FACILITY [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2020.47.1.091

1Aleksandrov V.V., 1Branitski A.V., 1Grabovskiy E.V., 1Gritsuk A.N., 1Laukhin Y.N., 1Mitrofanov K.N., 1Oleinik G.M., 1Frolov I.N., 2Basko M.M., 2Sasorov P.V.

1Troitsk Institute for Innovation and Fusion Research, Troitsk, Moscow, 108840 Russia  
2Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences, Miusskaya pl.  
 4, Moscow, 125047 Russia

Reliable information about the equations of state and spectral tranmission over a wide range of temperatures and densities is required for substances with a high atomic number, which are part of the structural materials of new generation nuclear elements. An experimental study and numerical simulation using the RALEF2D code [1] of the expansion and spectral transmission of an Au plasma layer created by a powerful flow of soft X-ray radiation (SXR) generated by a radiating Z-pinch, which is formed upon implosion of wire arrays with a current of up to 4 MA and and a rise time of up to 100 ns. For irradiation, multilayer targets with a gold layer 0.05-0.1 μm thick were used. Numerical modeling shows that a composite foil is very hot under the influence of radiation incident on it, ionizes, and rapidly expands. The target layers facing the pinch are heated to temperatures of 35–40 eV by the time of the maximum of the heating radiation; the density of the gold plasma layer is in the range of 1–10 mg/cm3. To obtain data on the spatial and temporal dynamics of the spectral distribution of the X-ray radiation and Z-pinch radiation passing through the test target with plasma gold layer used in the experiments grazing incidence diffraction spectrograph with a spatial and temporal resolution. To determine the opacity of the target plasma in one shot, three emission spectra were simultaneously determined: 1) the Z-pinch, 2) the spectrum recorded behind the target, 3) and the spectrum of the own radiation of the target plasma. The time dependence of the transmission of targets with an Au plasma layer was obtained, its form differs significantly in the spectral dependence for a “cold”, non-irradiated target, and its value changes several times during exposure to an x-ray pulse. An analysis of the results shows that 15–20 ns before the maximum SXR, the transmission of the target corresponds to its “cold” state, and the increase in transmission induced by the radiation of the pinch (in the region λ≥50 Å) begins ~ (9 - 10) ns before the maximum of the SXR pulse . 5–6 ns before the peak of the SXR pulse, the intense own radiation of the target plasma is recorded; its duration is 15–20 ns. The figure shows that there is good agreement between the experimental data and the calculation of the transmission according to the RALEF2D code in the wavelength range of 40-150 Å. However, the strong absorption in the range 160–190 Å obtained in the calculations is not confirmed experimentally.

The work was financially supported by the Russian Foundation for Basic Research (project nos. No. 18-02-00170 and No. 18-29-21005) for partial financing of experiments on the Angara-5-1 facility and simulations.

References

1. M.M. Basko, J. Maruhn, and A. Tauschwitz, J. Comput. Phys. 228, 2175 (2009).

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/It/ru/CX-Alexandrov.docx) [↑](#footnote-ref-1)