Hydrodynamics and X-ray emission from tampered copper foils irradiated by kJ-laser

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We have studied the plasma expansion at tampered copper targets by means of high-resolution space resolved X-ray spectroscopy near 8 keV. Two X-ray spectrometers equipped with identical spherically bent quartz Bragg crystals covered the whole spectral interval from the Cu He-alpha until the K-alpha transitions. The plasma emission was simultaneously observed at two line of sights corresponding to 0° and 57° relative to the target surface. The first configuration provided spatial resolution in z-direction (normal to the target surface, i.e., in the direction of the laser propagation) whereas the second spectrometer recorded the spectra with a mixture of spatial resolution along and perpendicular to the target surface. Copper foil targets of different thickness (1.5 μm, 3 μm and 6 μm) have been irradiated with the kJ laser PALS at 1 ω (λ=1. 315 μm), pulse duration of τ = 350 ps and energies of about 500 J.

We have identified irradiation conditions at which i) both spectrometers provide almost identical spectral distribution and ii) significant differences appear in intensities emitted from different charge states between Cu II and Cu XIX. In particular, the spectral region near K-alpha emission shows characteristic variation if tampered targets are used whereas the spectral features near He-alpha turns out to be less sensitive. First interpretation of observed data based on hydrodynamic simulations and atomic physics analysis will be presented.

X and XUV opacity measurements in dense plasmas

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We present the recent experimental work at the LULI-2000 facility about X and XUV opacity measurements in mid-Z laser produced plasma. The aim of this work was, first, to simultaneously measure absorption structures in X and XUV range using different approaches to estimate the plasma temperature and validate the atomic physic codes, and second, to implement a new target design. We were interested in plasma conditions characterized by temperatures between 20eV and 25eV and densities of the order of magnitude of 10^{-3}g/cm^3 to 10^{-2}g/cm^3. We sought to investigate the Ni, Fe and Cu 2p-3d x-ray absorption structures as well as the 1s-2p transition of an additional aluminum layer to confirm the in-situ temperature. Under these conditions in medium-Z plasma the Planck and Rosseland average opacities are often dominated by XUV $\Delta n=0$ (n=3) transitions. And the strength of these structures is highly sensitive to plasma temperature.

The experimental scheme was based on two different target designs. The first one was a thin foil of main material, inserted between two gold cavities that were heated by two nanosecond doubled-frequency 300J beams. The plasma was probed by an x-ray backlighter created by a third nanosecond beam with an energy E~20J. This x-ray source was along the axis defined by the two cavities and the foil. In the second set-up, designed to reduce the effect of the Hohlraum self-emission, the two cavities were perpendicular to the radiography axis. For these two schemes, the temperature gradient inside the sample was reduced during the spectroscopic measurement because of both-side irradiation of the foil by the cavities.

In addition to the main spectrometer, several other diagnostics were used. An independent measurement of the radiative temperature of each cavity was performed with a broad-band spectrometer. The x-ray source was measured by two time-integrated spectrometer with different spectral resolution and different viewing angle. Finally a pinhole camera was placed to observe the x-ray emission of the cavities and the backlighting source..

The association of all these diagnostics allowed us to better characterize the sample and constrain the opacity data.