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X-ray spectra diagnostics on warm and hot solid-density plasma created by direct and indirect impact of sub-PW picosecond laser pulses

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Though the importance of warm dense and/or high energy density matter states for a broad range of research on inertial fusion, astrophysical, and geophysical systems, such states are still hardly achievable in a controlled experimental conditions. Here we summarize the results of a series of experiments where the warm or hot plasmas of solid or near-solid densities were obtained and investigated under as direct as indirect energy impact by relativistic ps laser pulses of sub-PW power. Applying buried-type silicon targets the plasma of above 4e7 J/cm3 energy density, near-solid electron density was created and studied in the experiments with ultrahigh contrast OPCPA laser pulses [1]. The effect of near-solid plasma density on atomic structure of multicharged ions and corresponding ionization potential depression were quantitatively examined. The indirect isochoric heating approach was implemented when the relativistic laser pulse interacted with a tip of a thin titanium wires [2]. In turn the laser-accelerated relativistic electrons heated fully solid target matter up to ~30 eV several hundred microns deep along the wire.. The influence of laser energy and intensity on WDM heating is discussed. The densities and temperatures of the generated plasma were measured by means of K-shell emission and absorption spectroscopy and X-ray radiography.

References

[1] A.S. Martynenko et al., Phys. Rev. E 101, 043208 (2020)
[2] A.S. Martynenko et al., Optics Express 29, 12240-12251 (2021)

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