X-ray line poralization spectroscopy for hot electron transport in ultra-intensity laser produced plasma

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X-ray polarization spectroscopy is suggested as a useful diagnostic method to measure directly anisotropic velocity distribution function (VDF) of hot electrons inside of ultra-short intense laser produced plasma. Upton the assumption of two-dimensional Maxwellian distribution of hot electrons, relation between the anisotropy of the hot electron temperatures and polarization degree was calculated for various spectroscopic tracers. The polarization degrees were found to be given as a similar-solution, given as a function of normalized energy with the excitation threshold energy for He_alpha lines. Laser plasma experiments were performed to confirm feasibility of the spectroscopy. Polarization of Cl-He_alpha line (2.79 keV) from a triple-layer target irradiated with a 130 fs laser pulse was observed, and polarization degree was given as a function of overcoat thickness of the target. It was found that the line from a layer closer to the target surface is polarized in parallel to the surface direction whereas that from a deeper region in perpendicular to it. Comparison with the model, the VDF in the target surface is a pancake-like shape and that in the depth of the target is a cigar-like one.The experimental result validated the x-ray line polarization spectroscopy as a diagnostic tool for the hot electron transport in laser produced plasma.

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