PLASMA EXPANSION FROM MATERIAL ABLATION BY INTENSE LASER DRIVEN EXTREME ULTRAVIOLET (EUV) LIGHT

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Recent progress on extreme ultraviolet (EUV) sources enables us to utilize shorter wavelength of few to few tens of nanometer for micro machining of materials [1]. Since the critical density of EUV is beyond the solid density and the corresponding photon energy exceeds 100 eV, the ablation mechanism, especially heating mechanism, is expected to be quite different from that of laser ablation such that the EUV light penetrates through the ablation plasma and directly heats the material or high-density plasma, and it induces photoionization of the inner orbit electrons. Although differences in ablation characteristics in EUV and laser ablation are reported [2], many aspects in the physics of EUV energy deposition and transportation remain unclear. An effective approach to understand the material ablation is to study the expanding plasma because the energy spectrum of isothermal expansion during material heating is preserved even after the irradiation is stopped. This study aims 1) to understand the EUV ablation mechanism, and 2) to clarify the unique characteristics of EUV ablation by comparing with conventional laser ablation.

An intense laser produced plasma EUV source at ILE Osaka University[1] was used in the experiments [4]. EUV emission from a solid xenon target ranging 11-20 nm was focused onto the sample material with an intensity of ~5 x 10^9 W/cm^2. A Nd:YAG laser (1064 nm) was used for laser ablation experiments. A charge collector array with four charge collectors was used to measure the angular distribution of ion number and energy spectra. The species of expanding particles were measured by the Thomson parabola mass and charge analyzer.

The experimental results showed noticeable difference between EUV and laser ablation especially in the energy spectra. The spectrum for EUV ablation followed exponential decay curve having high kinetic energy component, and that for laser ablation showed convex spectrum having drastic cut off near 100 eV. The angular distribution of expanding ions from EUV ablation plasma shows narrower distribution than that from laser ablation plasma. The results were compared with a theoretical expansion model [6] and discussed using ablation parameters simulated by STAR 1D code [5]. Detailed discussion and presumed ablation mechanisms will be presented in the presentation.

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