Analysis of Reflection Signal from EUV Multilayer Mirror for Irradiation Induced Damage Study

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Abstracts: *The soft x-ray laser (SXRL) pulse makes damage structure on an EUV multilayer mirror. The profile of detected intensity of reflected SXRL from damaged surface is modified. In the same manner, the latter part of pulse duration in the SXRL will be affected by the damage structure, which is formed by the former part of duration, if the pulse width is longer than damage process sufficiently. In the presentation, we will discuss the analysis of SXRL pulse reflected from EUV multilayer mirror for study of laser induced damage process.*

The interactions between lasers with short pulse duration and matter are interesting in both of technological applications and theoretical studies. Lasers having short pulse widths such as pico and/or femto seconds have abilities to make ablation and/or modification structures on material surfaces accompanying the creation of unusual condition of high temperature and high pressure, so called warm dense matter (WDM). The x-ray laser is an interest laser source, because of the features of high photon energy, short duration, and highly spatial coherence. The soft x-ray laser (SXRL) pulses having a wavelength of 13.9 nm and a duration of 7 ps, which are generated from Ag plasma mediums, can make the nanometer scale ablation and/or modification structures on materials. We found that unique structures were formed on Al, Cu, Au, and Si surfaces by the irradiations of focused SXRL pulses. The mechanisms of surface modifications induced by SXRL pulses were also investigated theoretically. The atomistic model for the interaction between SXRL pulse and materials reveals that the tensile stress created in materials by SXRL pulse can produce spallative ablation of surface even for low fluence without plasma production. The theoretical model also predicted that the damage formation in irradiated surface started in a few picosecond. This time scale is comparable to the pulse width of SXRL beam.

Recently, we irradiated the focused SXRL pulses to EUV multilayer mirrors to study the ablation phenomena on optics. On multilayer mirror surfaces, we can confirm the damage structures. In this experimental series, we also observed the SXRL signals reflected from multilayer mirrors. The profiles of SXRL signals captured by an x-ray CCD camera, which were reflected from damaged mirror, were modulated, because the detected SXRL pulse was reflected on mirror surface including the damage area. This damage area was formed by the former pulse. If the pulse width of SXRL is sufficiently longer than damage time, which means degradation of periodical structure in EUV multilayer mirror, the reflection signal includes the information of damage process. In the presentation, we discuss the possibility of signal analysis reflected from EUV multilayer mirrors for irradiation induced damage study.