The observation of transient thin film structures during the femto-second laser ablation process by using the soft x-ray laser probe

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Abstracts: *We have succeeded in the observation of temporal evolution of thin film structures above the solid (or liquid) surface in the femto-second laser ablation process of metals (Au) by using the soft x-ray laser probe. The thin film was smooth and dense (a few nm roughness and near the sold density) so as to work as the soft x-ray beam splitter within 1 ns after the laser irradiation, and the spatial profile of the thin film depended on the local fluence of the femto-second laser. It implies that a possibility to create novel transient soft x-ray optics.*

The dynamical processes of the formation of the unique structures, such as the submicron scaled ripple and bubble structures [1], by the irradiation of the ultra-short pulse lasers come to attract much attention for the novel laser processing. In order to precisely control the laser ablation, the detailed observation of the laser ablation dynamics is required. In this study, we have succeeded in simultaneous observation of temporal evolution of two different surfaces by using the soft x-ray laser (SXRL) probe at the wavelength of 13.9 nm. Fig. 1 (a) shows a snap shot of the interferogram of the ablating surface (= ablation front: AF). The height of AF in the central part was measured to be only 20 nm at t = 78 ps. Fig. 1 (b) shows a reflective image at t = 607 ps. The multiple concentric rings show the Newton's rings generated between the AF and the thin film structure above AF (= expansion front: EF). The Newton's rings were observed until t ~ 1ns. The reflectivity of the soft x-ray strongly depends on the surface roughness and density gradient, therefore it implied that EF was thin (< 10 nm), dense (near a solid), and smooth (roughness < 3 nm) so as to work as the beam splitter for the soft x-ray. EF was kept until t ~ 0.8 μs and the spatial profile of EF depended on the local fluence of the femto-second laser. These results show a possibility to create novel transient soft x-ray optics.

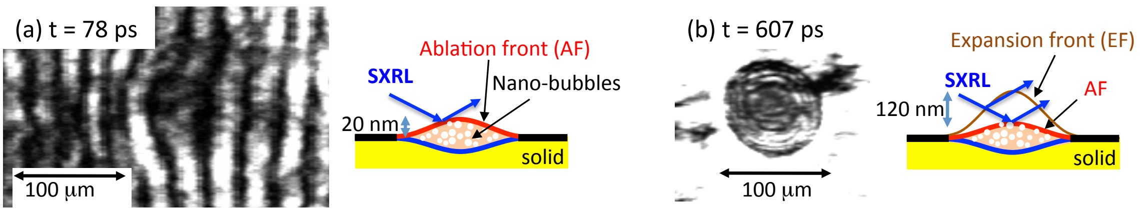

Fig. 1) Soft x-ray interferogram (a) and reflective image (b) of the fs laser ablation process of Au.

[1] M Fujita and M. Hashida: J. Plasma Fusion Res. **81** 195 (2005).