§59. Evaluation of Liquid Metal Mirror for Heating Beam of Fast-Ignition, Laser-Fusion Plant

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In a laser fusion power plant, the final optics that is directly irradiated with 14MeV neutrons is one of the critical issues of laser fusion power plant. Our plan is to replace multi-coat mirrors every 2 month with remote handling system. Another option is to use a grazing incident metal mirror (GIMM) before the multi-coat mirror. The GIMM can reduce the neutron damage of the multi-coat mirror by $1/10^3$[1]. In this reference paper, the influence of swelling on the GIMM was not discussed. Our estimation showed the life time of GIMM is only couple of days. We are now testing a liquid metal mirror that can cover the deformation of the base plate due to swelling. The depth of pool would be a few mm. The merit of the Liquid GIMM is large. Damages will be automatically recovered by the surface tension.

In 2013 we measured the motion of He surface after laser irradiation by interference technique and the damage threshold of liquid Pb. The damage threshold of liquid Pb was 160 mJ/cm^2 but we could not obtain reliable numerical data for the motion of Hg surface because the intensity signal obtained by a photodetector contains interference signals and pointing signals simultaneously.

In 2014 we used a laser vibration meter that measures the velocity of an object by detecting Doppler shift of a probe beam as shown in Fig.1. By this method influence of pointing signal could be eliminated.

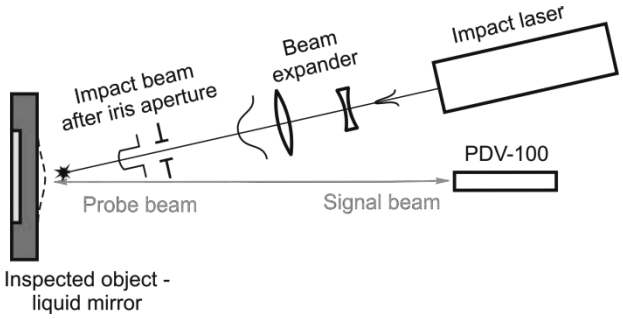

Fig. 1. Experimental setup

A laser vibration meter PDV-100 was used for the detection of laser-induced movement of mercury surface. Its probing beam was focused in the center of the gold plate and, correspondingly, center of the impact area. Specular reflection of the probe is used as a signal beam. After signal processing, output voltage was proportional to the surface movement speed.

Liquid mirror, vibration meter and optical components in the probe/detection path were installed on air-suspended vibration-proof optical table. The impact laser was installed separately to exclude its influence on vibration environment.

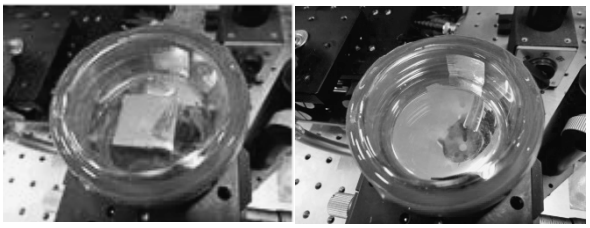

Fig. 2: Petri dish with an amalgamated gold plate (left) and the mercury mirror (right).

In these experiments, mercury over an amalgamated gold plate was used to simulate a liquid mirror (Figure 2). The amalgamated gold plate makes it possible to realize mercury layers much thinner than in mercury-on-glass conditions.

The vibration of Hg surface after a laser impact consists of two components. One is vertical vibration mode including supporting equipment of glass beaker and the other component is a surface wave reflected from the edge of the Hg pool. The first component appeared in less than 20 ms and the latter component appeared after 40ms. This indicated that the propagation velocity of the surface wave, which theoretically depends on the wave length, was 100m/s

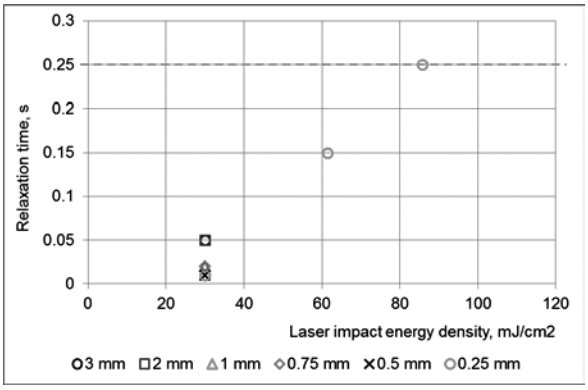

Fig. 3. Relaxation time vs. laser impact energy density. The reflected wave is included in the evaluation.

Preliminary result for the relaxation time of the vertical motion is shown in Fig. 3. The broken line at 0.25s comes from the reprate of laser beam of a commercial reactor KOYO-F. We are now analyzing influence of the surface wave reflected at the edge of the pool

[1] L. L Snead, et al., FUSION SCIENCE AND TECHNOLOGY VOL. 56 AUG. 2009 pp1069