§32. Measurement of Particles Ablated by Intense Laser Irradiation

Konishi, S., Yamamoto, Y. (Kyoto Univ.)
Nishimura, H., Norimatsu, T. (ILE, Osaka Univ.)

For the development of laser fusion reactor, feasibility of the chamber that is anticipated to be exposed to several Hz or more frequent pulse irradiation will be a major technical issue. One of the possible difficulty is the evacuation of chamber that will be filled with vapor, mist or particles of chamber wall, regardless of it is made of liquid or solid. Particularly with fast-ignition target, lead from cone attached to the fuel is anticipated to be plated on the wall. Chamber wall will be ablated by energetic particles and the resulted vapor will recombine to form mist, cluster or particles that are suspected to stay in the chamber. This collaborative research will investigate the basic behavior of the ablated particles from the surface simulating laser fusion chamber.

Figure 1 (a) illustrate the setup of the experimental apparatus. In this study, plastic target simulating debris and ions from laser fusion target is irradiated with YAG laser. Ablated particles are observed with Thomson parabola for ion energy and for species with quadrupole mass spectrometer and the charge collector. Figure a (b) shows the configuration between plastic primary target, metal secondary target and the charge collector. Plastic target is first irradiated with YAG laser and secondary ablation by debris from plastic target as well as primary ions are analyzed. Ablation of metals by debris are important, both for EUV generation with tin and laser fusion chamber with lead metal. It is expected both phenomena would be described with a very similar model.

In the fiscal year 2004, two experimental campaigns of two 2 weeks each were performed to verify the performance of the apparatus. Thomson parabola detected Carbon ions of 1 to 3 charges. Figure 2 shows the example of the mass spectroscopy obtained from the irradiation of plastic target. As seen in the figure, 14n+1,2 peaks were observed that are considered to correspond clusters of ethylene (CH2)n. Such clusters were either formed by direct ablation or reactions between ablated particles. Charge collector detected the secondary ablation of tin and lead. However the results were unstable and further improvement in the experiment is considered to be needed.

In the fiscal year 2005, we plan to install broad range mass spectrometer of up to ca. 1000 to detect larger size particles. At the same time, laser intensity and pulse length will be changed to better simulate the laser fusion and EUV conditions.

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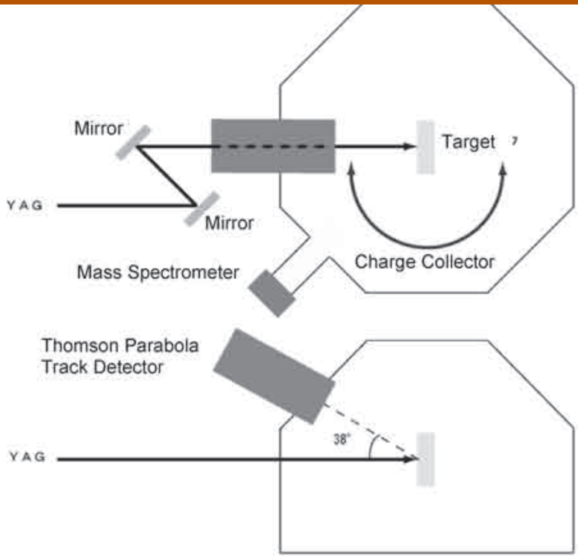

Fig.1 (a) Experimental Apparatus

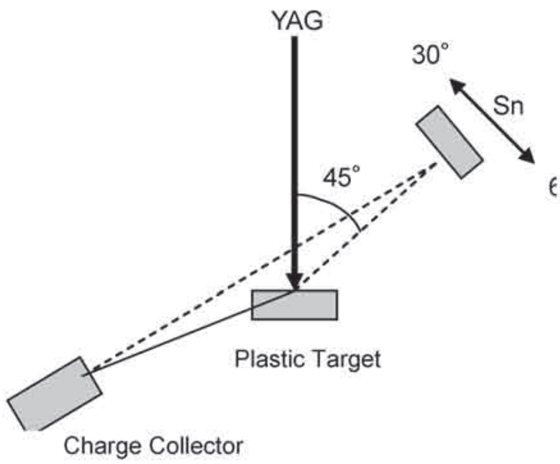

Fig.1 (b) Configuration of plastic target, metal target and charge collector

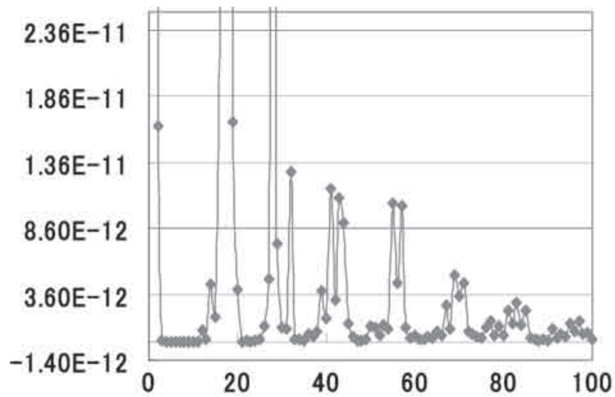

Fig.2 mass analysis of ablated particles