# §34. Research on Dynamics of Ablated Vapor from Liquid Wall in Laser Fusion Reactor by Discharge Method

Norimatsu, T., Nakai, M., Oshige, T., Wakabayashi, D. (ILE, Osaka Univ.),
Konishi, S., Yamamoto, Y. (Kyoto Univ.),
Kasuya, K. (Inst. Tokyo Technol.),
Furukawa, H. (Inst. Laser Technol., Osaka),
Kozaki, Y., Sakagami, H.

In a future laser fusion reactor with a liquid wall, the surface is heated with alpha particles from fusion burns. The thermal load is expected to be 0.4 MJ/$m^2$ per shot in the case of the fast-ignition, laser fusion reactor KOYO-F[1]. Ten kg of LiPb will be ablated after each fusion burn and the ablated materials condense on the opposite surface in 200 ms to allow the next target injection and laser-irradiation.

To increase reliability of this scheme, detail analysis on behavior of ablated materials is necessary. Up-to-date, numerical simulation based on experimental data is the powerful tool to know the behavior of ablated materials.

In this study we have developed an integrated ablation simulation code DECORE ( Design Code for Reactor ) to clarify the ability of the chamber clearance[2]. We estimate temperatures, densities, and velocities of ablated lead ( liquid wall material ) using the simulation code DECORE for the case of first ignition with 200 MJ power output The purpose of this study is to produce data base for this simulation code.

To experimentally simulate the ablation process by alpha particles, we heated a 5mm x 10 mm x 5 μm Pb membrane by a 15 kA, 40 μs pulse discharged from a 300J capacitor bank. Evaporated materials were captured on glass plates located at 20 mm apart. In this experiment Pb was used for simplification, while the actual liquid metal is $L_{i17}Pb_{83}$. The temperature of the Pb membrane was estimated by the intensity ratio of visible emission obtained using 460 and 660 nm band-pass-filters. Since Pb has no strong line emission in these spectral bands, we assume a black body emission. The Pb membrane was fabricated by physical vapor deposition on a glass plate. The glass plate stands for the residual liquid Pb in the actual chamber.

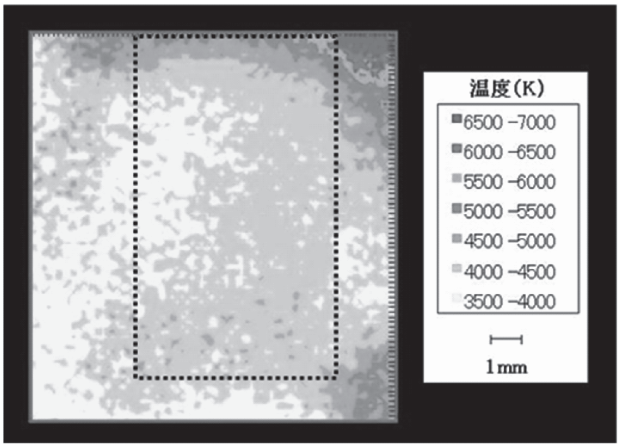


Fig. 1 Temperature of Pb plasma heated with 300J energy.

Figure 1 shows the temperature of the heated Pb membrane. Consumed energy in the membrane plasma was estimated to be 300J which were calculated from the potential between the electrodes and the current. Temperature distribution is quite uniform but hot region is much larger than the initial membrane size. This means that the part of the current runs through expanding gas,

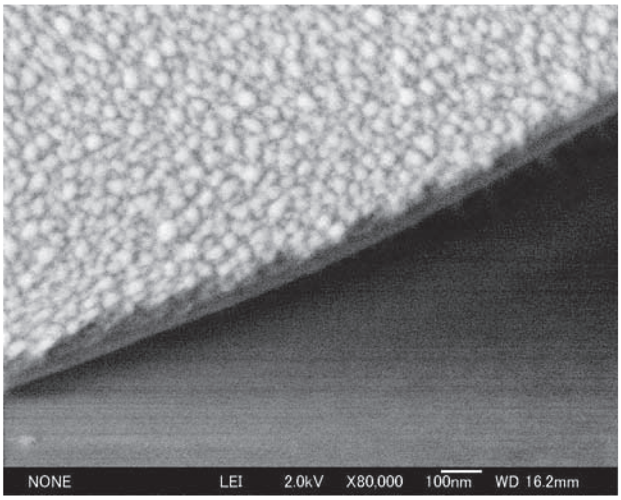


Fig. 2 Cross section of captured material on a witness plate

Figure 2 shows a cross section of deposited materials on a witness plate located at 20 mm from the Pb membrane. Many aerosols whose diameters range around 30 nm were captured on a continuous membrane whose thickness is about 10 nm.

This result indicates that ablated plume consists of a leading component with no aerosols and trailing component with many aerosols. This can be explained with a numerical simulation result obtained by DECORE. Figure 3 shows distribution of the diameter of the aerosols in 1-D expanding plume. A 8 mm thick, 3000K vapor sheet at z = 0 expands both direction and aerosols were formed only in the central portion (trailing component of plume) The leading portion is supper cooled vapor that forms continuous membrane on the witness plate.

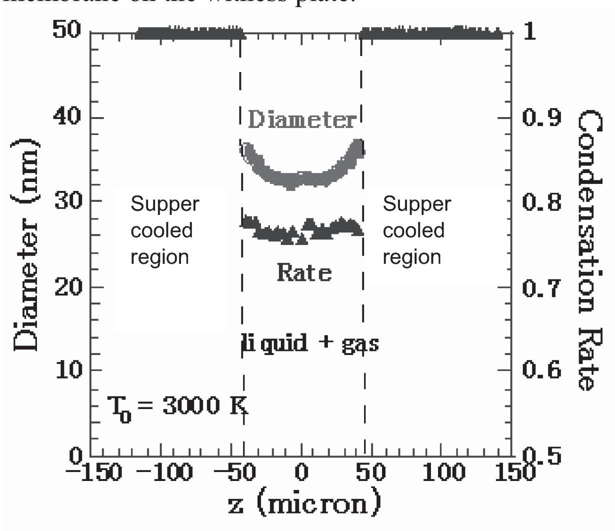


Fig. 3 Diameter of aerosols and the distribution

1) Norimatsu, T., Fusion Sci. Technol. **52** (2007)893.
2) Furukawa, H., J. Plasma Fusion Res. **82** (2006) 617.