

## Study on Behaviors of Evaporated Gas in Liquid Wall Chamber of Laser Fusion Reactor II

レーザー核融合炉液体壁チェンバー内の蒸発ガスの挙動に関する研究 II

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An integrated ablation simulation code DECORE ( D Esign C Ode for R Eactor ) has been developed to analyze characteristics of plumes produced by ablation, and to clarify the ability of the chamber clearance. Characteristics of a plume produced by ablation in liquid wall chamber of KOYO-fast have been analyzed. A plume produced by ablation moves with velocities of a few km/s. Formation of clusters in a plume with hydrodynamic motion is carried out. Diameters of clusters in a plume in liquid wall chamber of KOYO-fast is mainly from 10 nm to 20 nm.

### 1. Introduction

A design of laser fusion reactor with a liquid wall, KOYO-fast, is reported in Refs. 1-3. Fig. 1 shows the simple outline of the first wall of KOYO-fast.

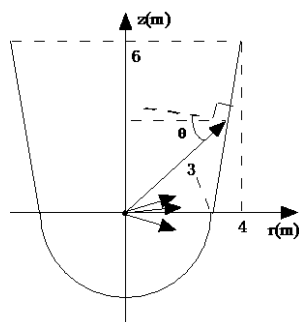


Fig. 1 The simple outline of the first wall of KOYO-fast.

One of the critical issue of a laser fusion reactor with a liquid wall is the chamber clearance. After micro explosion with 100 MJ nuclear yield, about 10 kg of liquid metal evaporates from the surface due to heating by  $\alpha$  particles, ions and debris from the target[4]. Contribution of X-ray on the ablation is negligible in the case of direct implosion[4]. The evaporated plume makes, then, mist and clusters after expansion cooling[5]. Such clusters would attach on the injected target surface and degrade the target performance through RT instabilities and preheat of the fuel. Fig 2 shows phenomena which occurs nearby first wall of KOYO-fast.

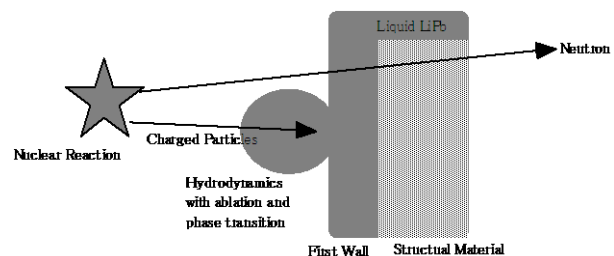


Fig 2 Phenomena which occurs nearby first wall of KOYO-fast.

To experimentally simulate the ablation process, laser irradiation is often used. We, however, found that ablation process by ions is quite different from that by lasers. The range of  $\alpha$  particles in liquid Pb is about 10  $\mu\text{m}$ . As the result, superficial liquid Pb evaporates as a high density, low temperature, plasma with low ionization rate.

In this study, we have developed an integrated ablation simulation code DECORE ( D Esign C Ode for R Eactor ) to analyze characteristics of plumes produced by ablation, and to clarify the ability of the chamber clearance. In this integrated simulation code, effects of condensation of a plume, the formation of clusters in the ablated plume, phase transition from liquid to neutral gas to partially ionized plasma, absorption of energies of charged particles, equation of state, hydrodynamics, and radiation transport are included.

## 2. Results and Discussions

Fig. 3 shows number density and velocity profiles of lead at the time a plume reaches to the center of the chamber. As shown in Fig. 3, ablated lead moves with velocities of roughly 40 km/s. To estimate number density and velocity is very important for analysis of collisions between plumes at the center of the chamber.

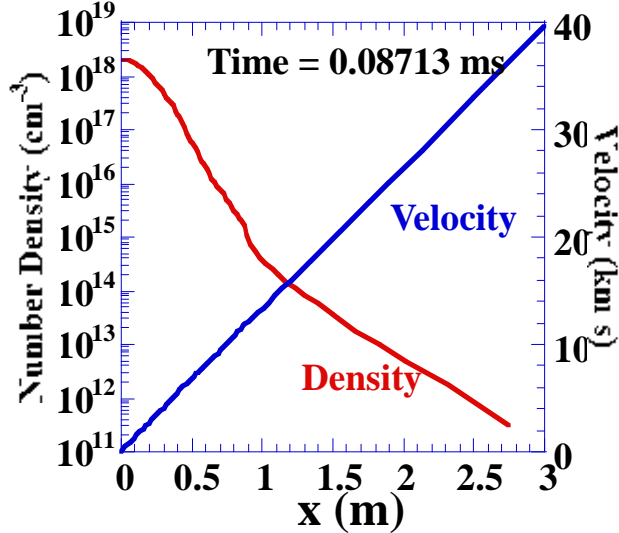


Fig. 3 Number density and velocity profiles of lead.

Fig. 4 shows diameters of clusters and condensation rate at the same time in Fig. 3. The regime  $x < 0.5\text{m}$ , clusters are created.

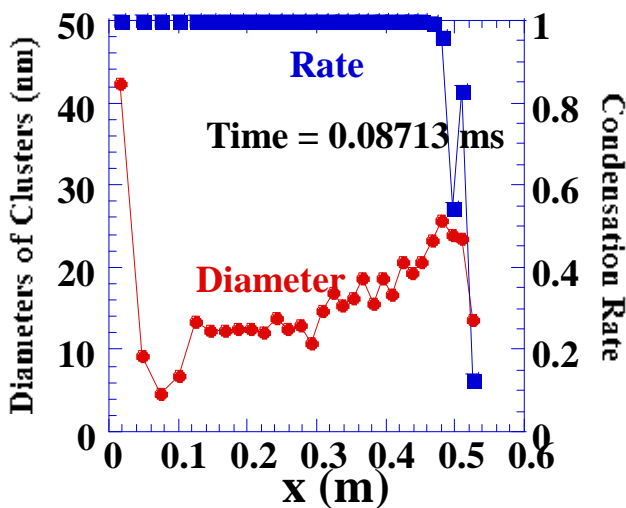


Fig. 4 Diameters of clusters and condensation rate

Collisions between plumes produced by ablation at the center of the liquid wall chamber are estimated. Collisions between plumes strongly affect a design of laser fusion reactor. Fig. 5 shows the time development of pressure distribution. Note that in Fig. 5, times from a collision starts are described. As shown in Fig. 5, at the time = 1.97 ms,

near by the center of the chamber, pressure is roughly 2000 Torr. Pressure near by the center are decreasing and pressure distributes widely after time 1.97 ms.

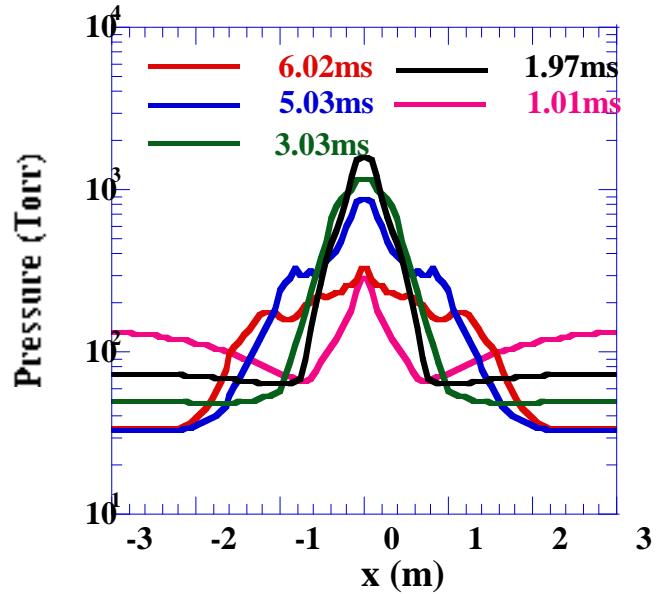


Fig. 5 The time development of pressure distribution.

## References

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