§34. Laboratory Experiments on Aerosol Formation by Colliding Ablation Plumes (LEAF-CAP)

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It is predicted that, along with pellet implosions in a high-repetition rate inertial IFE reactor, the interior of target chamber will repeatedly be exposed to intense pulses of 14MeV neutrons, X-rays, high-energy unburned DT-fuel and He ash particles, and pellet debris such as hydrocarbon ions with the total power deposition reaching of the order of $10J/cm^2$/pulse,.

As a result, wall materials will be eroded by various thermal and physical processes, including evaporation, sputtering and ablation (the ejection of materials in the plasma state), etc. Some of the eroded materials may collide with each other perhaps in the center of symmetry region of target chamber to form aerosol, which can then scatter laser beams, affecting the subsequent implosions.

On the other hand, materials that are not associated with aerosol formation will be re-deposited elsewhere after travelling across the chamber, which extends the wall lifetime. However, it is also possible that tritium may continuously be incorporated into these re-deposits, leading to the radio safety problem. Despite their importance, the aerosol formation and tritium build-up issues have not yet been addressed in the IFE research community.

In our previous work [1,2], some of the fundamental aspects of aerosol formation by colliding ablation plumes were investigated, using the LEAF-CAP facility in which two curved targets are irradiated by 3ω–YAG laser at 10Hz, each 6ns long, at power densities up to $30J/cm^2$/pulse.

The present work is intended to investigate more details of aerosol formation and hydrogen co-deposition behavior. Employed as the target samples are Li and Pb, the eutectic alloy of which is currently considered to be used for the liquid wall protection in a fast ignition reactor study: KOYO-FAST [3].

Shown in Fig. 1 are colliding ablation plumes of Li and Pb, generated at laser power densities around $10J/cm^2$/pulse. Also, colliding ablation plumes of C are shown for comparison. No reactions such as C_2 formation [1] are observed for Li and Pb, confirmed by visible spectroscopy.

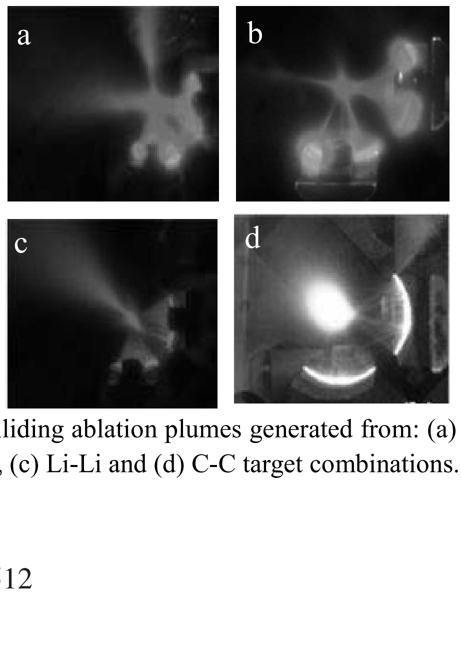

Fig. 1 Colliding ablation plumes generated from: (a) Li-Pb, (b) Pb-Pb, (c) Li-Li and (d) C-C target combinations.

Optical micrographs of aerosol particles formed after colliding ablation plume experiments are shown in Fig. 2. Notice that all target combinations form aerosol in the form of droplet, the diameter of which are of the order from 100nm to 10μm. As to co-deposition, hydrogen retention in Li-Li ablation plume deposits at room temperature has been found to reach (H/Li)~0.3, just as high as carbon plume deposits.

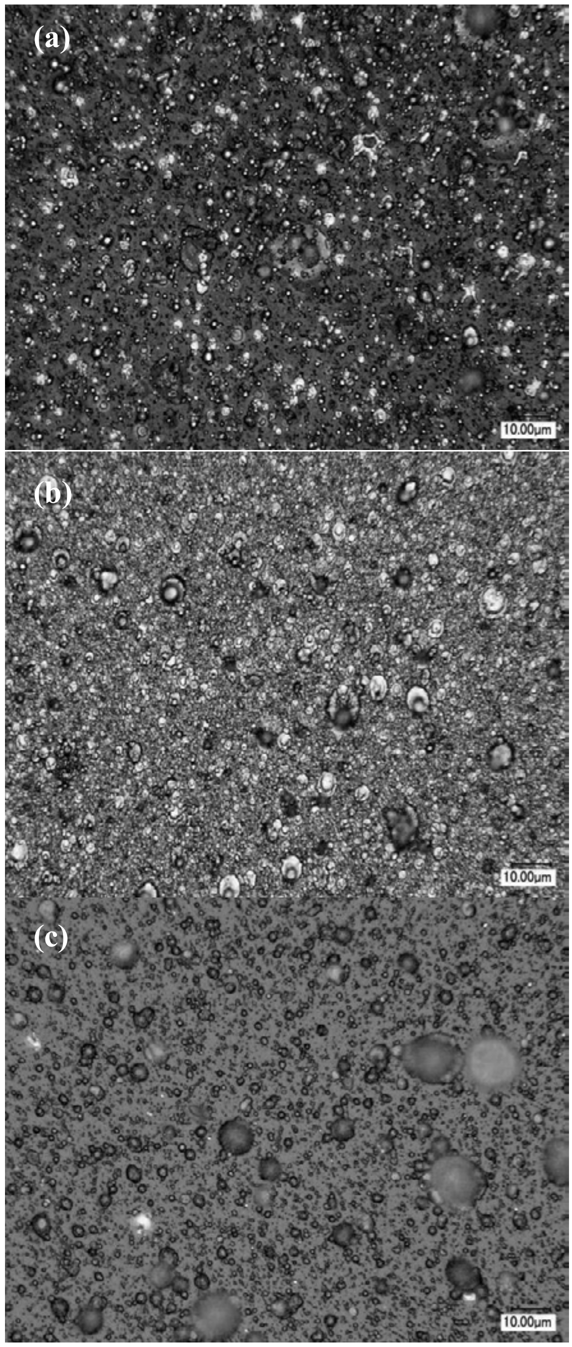

Fig. 2 Aerosol particles generated by colliding ablation plumes for (a) Li-Pb, (b) Pb-Pb and (c) Li-Li target combinations.

[1] Hirooka Y. et al., J. Phys. Conf. Ser. **244**(2010) 032033.
[2] Sato, H. et al. J. Plasma Fusion Res. Ser. **9**(2010)432.
[3] Kunugi T. et al., Fusion Eng. & Design **83**(2008)1888.