LABORATORY EXPERIMENTS ON AEROSOL FORMATION AND ITS DIRECTED TRANSPORT BY ABLATION JET RECOIL

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Along with repeated implosions, the interior of an inertial fusion reactor is exposed to short pulses of high-energy x-ray, unburned DT-fuel particles, He-ash and pellet debris. As a result, chamber wall materials are subjected to ablation, emitting particles in the plasma state. Ablated particles will either be re-deposited elsewhere or collide with each other, perhaps in the centre-of-symmetry region of the chamber volume. Colliding ablation plasma particles can lead to the formation of clusters to grow into aerosol, possibly floating thereafter, which can deteriorate the subsequent implosion performance via laser scattering, etc. This clearly points to a need for the development of a method of in-situ removal of aerosol particles from the position of laser-ignition.

In a laboratory-scale YAG laser setup, the formation of nano-scale aerosol has been demonstrated in vacuum at irradiation power densities of the orders of 108–10 W/cm−2 at 10 Hz, each 6 ns long, simulating the situation in a high-repetition rate inertial fusion reactor. Interestingly, when laser-ablated plasma plumes emitted from two carbon targets collide with each other, carbon aerosol has been found to be generated in the form of fullerene onion, nano- and micro-tubes. In contrast, colliding plasma plumes of metals tend to produce aerosol in the form of droplets under identical ablation conditions [1, 2].

In the present work, the behavior of these aerosol particles will be reported when they are ablated by a secondary YAG laser beam for the transport by recoil momenta via ablation. Observed in the ICCD camera images, shown in Fig. 1, is a strong light emission crossing straightly a carbon aerosol cloud, indicative of the emission from the debris along with the passage of the secondary YAG laser. This allows us to expect the directed transport of aerosol particles by ablation jet recoil although the details of it are unclear at this point.

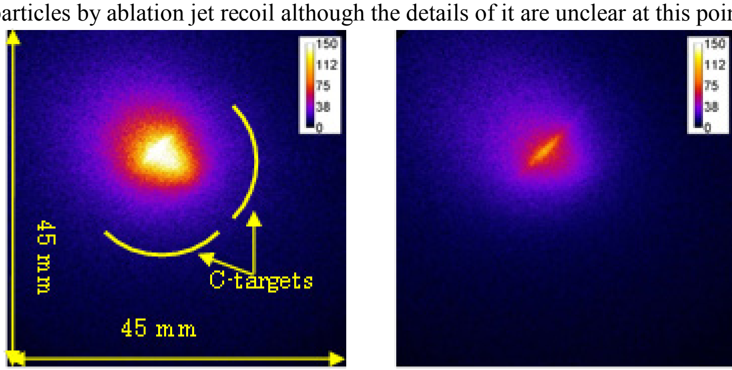

Fig. 1 Fig. 1 ICCD-camera images of the emission from the C-aerosol and its debris.

[1] Yoshi Hirooka et al., Nucl. Fusion 54(2014)022003(6pp).
[2] Yoshi Hirooka et al., Fusion Eng. and Des. 87(2012)1760-1764.