§41. Development of Gas Gun for Target Injection in Laser-Fusion Reactor

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The prototype of a gas gun for target injection in laser-fusion reactor has been being developed at Hiroshima University. The gas gun is composed of a high-pressure gas reservoir, an acceleration tube, a pressure-release tube at the end of the acceleration tube, a diagnostic chamber, a vacuum pump, and some pipes and valves. The pressure-release tube was a 590-mm-long tube of the same inner diameter as the acceleration tube with many small holes on its side wall, which was installed to minimize disturbances by the accelerating gas. A projectile we are now using is a cylinder made of Duracon acetal copolymer (a kind of polyoxymethylene resin), which was 21 mm in length and 10.15 mm in diameter. The cylindrical projectiles are surrogates of sabots for target injection in laser-fusion reactor. In FY 2007, we developed a new acceleration tube with three-line guide pins for projectile rifling. Figure 1 shows the acceleration tube and a projectile we used in experiments. In experiments, the flight speed, flight attitude, and flight direction of each projectile were measured.

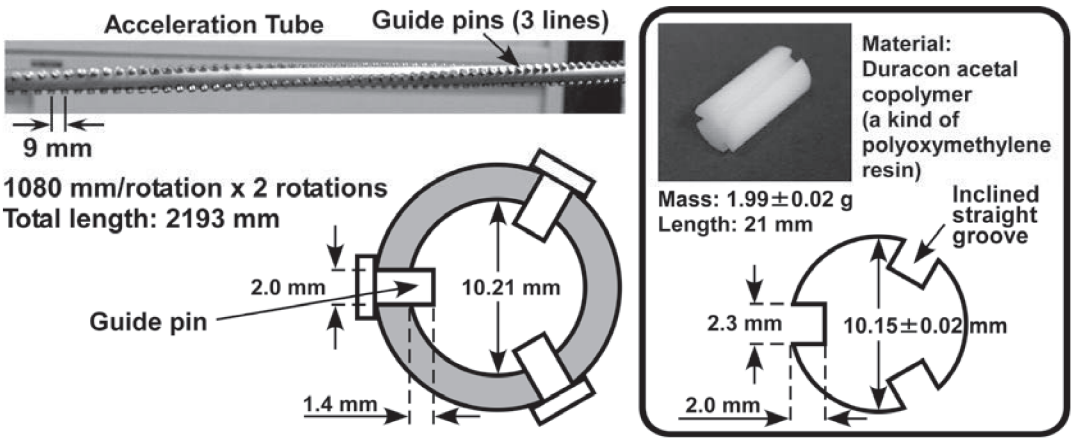

Fig. 1 Acceleration tube with three-line guide pins for projectile rifling and projectile with three-line grooves.

In the experiments, we used N_2 gas at room temperature as the accelerating gas. The initial pressure of the high-pressure gas reservoir was 300 kPa, whereas that of the diagnostic chamber was 300 Pa. The open duration of the valve between the high-pressure gas reservoir and the acceleration tube was 20-25 ms, which was minimum duration for the projectiles to reach their maximum speed. The flight speed of the projectiles was around 100 m/s.

Figure 2 shows the experimental results on the flight direction. The origin of Fig. 2 is the average flight direction at each experimental condition. Namely, Fig. 2 shows the repeatability of the flight direction. The required repeatability of the flight direction is about 1 mrad. Therefore, more improvement is needed.

Figure 3 shows the experimentally observed flight attitude. As shown in Fig. 3, the flight attitude of the projectile was significantly improved by the pressure-release tube. However, more improvement is needed because the allowable tilt angle of the target is only 2 deg. in fast-ignition-type laser-fusion reactor.

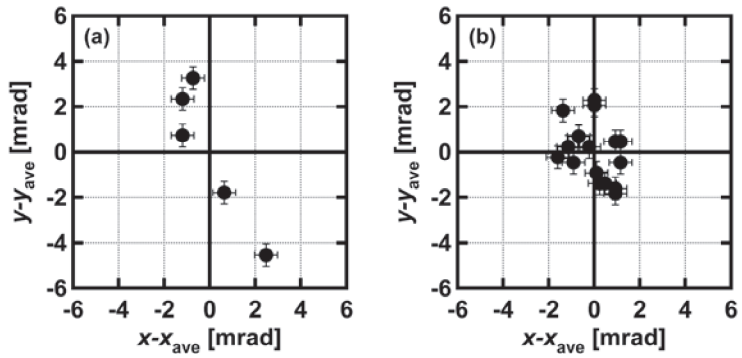

Fig. 2 Flight direction. (a) w/o the pressure-release tube. (b) w/ the pressure-release tube.

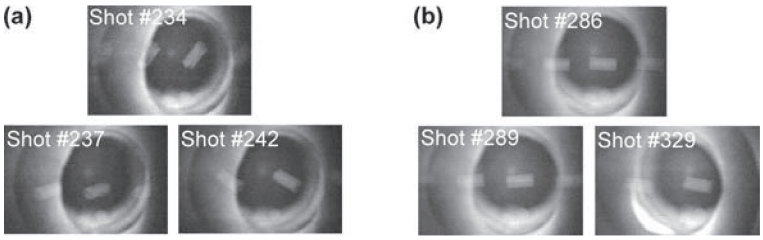

Fig. 3 Flight attitude. (a) w/o the pressure-release tube. (b) w/ the pressure-release tube.