§34. Design Study on Foam-cryogenic Targets by Integrated Simulations

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The purpose of this study is to analyze the recent fast ignition experiments with cone-guided targets and carry forwards a design of form-cryogenic targets, on the basis of the integrated code system, FI^3. The major results in FY2009 are shown below.

1. Effect of shell surface perturbation on implosion[1]

The shell surface perturbation will be a seed of the Rayleigh-Taylor (RT) instability and affect the implosion performance. Using 2D radiation-hydro code "PINOCO", the effect of surface perturbation on implosion performance is evaluated for Au-cone (open angle of 30 deg) attached CD shell target (radius of 250μm and thickness of 7μm) in FIREX-I. The obtained results are compared to the case without cone (spherical implosion). The initial amplitude of perturbation is determined by imposing the modeled laser imprint on the measured target surface roughness.

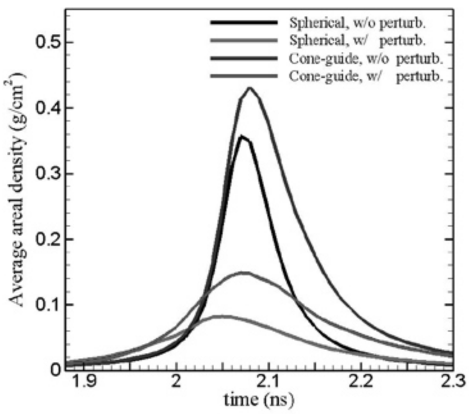

Fig.1 Effect of shell surface perturbation on temporal evolution of imploded core ρR for spherical shell and cone-shell targets.

The temporal evolution of core ρR averaged over azimuthal direction is shown in Fig.1. For the case without perturbation, ρR value becomes higher in the cone-shell target since the compression ratio in radial direction is large due to the outflow of central hot spot from the core center into the cone-tip direction. On the other hand, if the perturbation exists, it grows during implosion due to the RT instability and generates the azimuthal velocity. As the result, the conversion from kinetic energy to internal one at the stagnation phase becomes small, and the maximum density and ρR are decreased. This effect is smaller in the cone-shell target since mode = 1 perturbation essentially exists due to the cone. Further investigation is going on for more practical evaluation of implosion performance of cone-shell target in FIREX-I.

2. Cone tip effect on core heating via fast electron transport[2]

In the last year, we evaluated the dependence of core heating on tip material on the basis of 1D coupled PIC and Fokker-Planck (FP) simulations, and showed that the low-Z material having small collisional effects is preferable for the cone tip. In this year, we have started 2D evaluation. First, we focused our interest on the fast electron transport process and evaluated the cone effect on the heating process via the fast electron transport on the basis of 2D FP simulations.

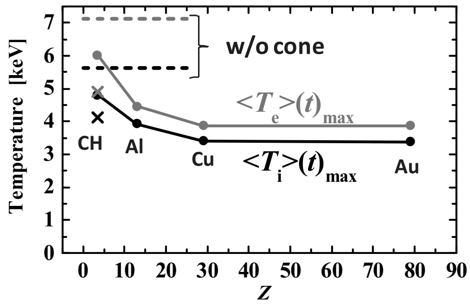

Fig.2 Dependence of core heating performance on tip material.

The fast electron beam is injected 10μm inside of the cone tip located 50μm away from the center of a spherically-imploded CD core (Gaussian density profile with $\rho = 200 g/cm^3$ at the center and $\rho R = 0.2 g/cm^2$). The injected electron beam has 1MeV temperature, 30μm beam diameter, 1PW power and 5ps duration. The simulations were carried out for different tip material; from high-Z Au to low-Z CH. The heated core temperatures obtained for different tip materials are shown in **Fig.2**. It is found that for the high-Z cone tip cases, in addition to the direct collisional effects (scattering and slowing down), the scattering by the strong resistive B-field (a few thousands T) generated due to the resistivity jump at the contact surface between imploded plasma and cone tip is remarkable. Thus the beam quality deteriorates during the transport in the only 10 μm-thickness, which results in low core heating efficiency. On the other hand, for the low-Z tip case, the collisional effects and the resistivity jump are small. Thus the tip effect on the core heating via the transport process becomes smaller than that for high-Z tip case. These 2D FP simulation results indicate that the low-Z tip is preferable for core heating.

Major publications

1. H, Nagatomo, et al., Nucl. Fusion **49** 075028 (2009).
2. T. Johzaki, et al., Phys. Plasmas **16** , 062706 (2009).
3. T. Goto, et al., Nucl. Fusion, **49**, 075006 (2009).
4. H. Sakagami, et l., Nucl. Fusion **49**, 075026 (2009).
5. H.-B. Cai, et al., Phys. Rev. Lett. **102**, 245001 (2009).
6. H. Sakagami, et al., Proc. of 36th EPS conf. on Plasma Phys.2009, ECA Vol.**33E**, P-2.039 (2009).
7. T. Johzaki, et al., Proc. of 36th EPS conf. on Plasma Phys.2009, ECA Vol.**33E**, P-2.038 (2009).