SCOPE FOR REDUCING THE SENSITIVITY OF A MICROTARGET TO ASYMMETRY IN LASER IRRADIATION

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Studies have been made [1, 2] of the effects of asymmetry in irradiation and errors in target manufacture on the symmetry in compression of solid and shell targets for LFS. It has been shown that to attain a compression of 10^4–10^5 the asymmetry in the irradiation should not exceed 5-10%. Here we present results from a numerical study of the perturbations occurring at the gas–glass boundary of a simple shell target irradiated by an unsymmetrical laser pulse. It is shown that the primary shock waves are the main source of perturbation. Two ways are indicated for reducing the sensitivity of the target to the asymmetry.

1. Calculations show that the perturbations may be substantially depressed by electron thermal conduction at an electron temperature in the corona of about 1 keV when the target absorbs only 10-15% of the energy in the pulse. Therefore, one expects that the requirements for symmetry derived in [1, 2] apply only to the first part of the energy, while the requirements for the main pulse are much weaker. The numerical calculations presented below on the compression of a shell target demonstrate this effect, whose possibility was pointed out in [3]. In our model we do not incorporate the spontaneous magnetic fields that can arise during the compression under certain conditions [4].

The target is a glass shell of density 2.7 g/cm^3 of outside radius R = 150 μm and thickness Δ = 3 μm filled with DT gas to a density of 10^{-3} g/cm^3. The absorption of the laser radiation was simulated as energy deposition at a critical density of $0.002 \leqslant \rho \leqslant 0.004$ g/cm^3. The perturbations in the flow were specified as

$$\omega(t, \varphi) = 1.35(1 + A\cos 12\varphi)\exp\left[-((t - 1.25)/0.481)^2\right] \text{ kJ/nsec},$$

where the perturbation amplitude $A = A_1$ for $t \leqslant t_*$ and $A = A_2$ for $t > t_*$; Table 1 gives the results, where ε is the pulse energy absorbed by the target up to time $t = t_*$, while δ is the ratio of the amplitude of the perturbations in the glass shell in the given calculation to the amplitude of the perturbation in calculation 1 for the moment of maximum compression.

Therefore, to decrease the perturbations at the gas–glass boundary one needs to irradiate the target with a symmetrical prepulse. Then the first shock waves [2] introduce weak perturbations, while those in the subsequent shock waves are smoothed out by the thermal conductivity in the corona.

2. Another way of reducing the sensitivity of the target to asymmetry in the irradiation [5] is to produce a special atmosphere around the target (even a low-temperature one) with a density of the order of the critical value and a thickness that provides for the time of emergence of the first shock wave in the shell after a corona temperature of about 1 keV has been produced.

To check this assumption we performed calculations on the compression of the target

TABLE 1

No.	A_1	A_2	t_*	ε, %	δ
1	0,05	0,05			1
2	0	0,05	0,79	7	0,05
3	0	0,05	0,58	1,5	0,3
4	0	0,3	0,79	7	0,5
5	0,05	0	0,79	7	0,85

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TABLE 2

No.	A	δ	ΔR
1	0,05	1	0
2	0,05	0,1	100
3	0,3	0,5	100

described in section 1 but additionally surrounded by a gas cloud $\Delta R = 100\ \mu m$, $0.008 \geqslant \rho \geqslant 0.002$ (g/cm^3). Table 2 gives the results.

This cloud can be produced by the evaporation of a special layer deposited on the target that involves energy losses negligible by comparison with the main pulse. In that case, the main specification for symmetry applies to the even weaker prepulse. However, the increase in the mass of the target requires an increase of 10-20% in the energy of the main pulse to produce the same compression characteristics. All the calculations were performed by the method of [6, 7].

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