FST-LAYERING FOR APPLICATION TO HIGH-GAIN DIRECT-DRIVE CRYOGENIC TARGETS

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In inertial fusion energy (IFE) research, a considerable attention has recently been focused on the ability to inexpensively fabricate large quantities (~ 1 million each day) of free-standing targets (FST) by developing a specialized layering module (LM) of repeatable operation. For this reason, the IFE target factory is centered at methods that will scale to a high rep-rate and cost-effective target production. To meet the above requirements, at the Lebedev Physical Institute (LPI), significant progress has been made in the technology development based on rapid fuel layering inside moving free-standing targets, which refers to as FST layering method [1].

In this report, we consider a baseline design of high-gain direct-drive target (~ 4 mm in diameter) developed by Bodner and coauthors [2]: «...a new direct-drive target design that has a predicted energy gain of 127 using a 1.3 MJ KrF laser, and a gain of 155 using 3.1 MJ». The pure DT (190-µm) fuel is surrounded by an ablator that consists of a CH foam (~10 mg/cc) filled with frozen DT (261-µm). The ablator is surrounded by a one-micron plastic coating (polystyrene, kapton, etc.) that serves primarily to contain the DT vapor. The plastic coating is then surrounded by an overcoat of a thin high-Z material such as gold to withstand the thermal chamber environment. We use this target (for simplicity, the BODNER-Target) to examine issues affecting the possibility of its inexpensive fabrication by the FST-layering method. The main obtained results are as follows:

1. The FST-layering time does not exceed 30 s, which is a necessary condition for mass manufacturing of BODNER-Scale targets. It is of great importance for a tritium inventory minimization as well.
2. The CH foam stimulates the formation of multiple crystals of different orientations for obtaining isotropic ultra-fine fuel layers, and so for avoiding the formation of anisotropic layers like a single crystal.
3. The CH foam has a little effect on the fuel layer symmetrization because the BODNER-Target design includes a spherical uniform layer of the pure DT (190-µm thickness), which is over the CH foam layer.
4. BODNER-Target can be uniformly fabricated in n-fold-spiral layering channels (LC) at
n = 2, 3.
5. A three-fold spiral LC was manufactured and tested. The target residence time in the LC is about 35 s, which allows developing the FST-LM of repeatable operation using a target batch rolling along the LC.

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References

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