# ICF Target Support Highlights

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General Atomics, with our partner Schafer Corporation, serves as the ICF Target Support Contractor, providing target development and fabrication and target system engineering development to support the ICF program at five ICF Labs — LLNL, LANL, NRL, SNL, and UR/LLE. This informal newsletter contains highlights of that support for June 1999.

GA/Schafer onsite staff at LLNL, LANL, and SNL fabricated, machined, assembled and characterized about 150 targets of various kinds for experiments on Omega, Trident, and Z. We fabricated, characterized, and delivered more than 350 targets and target components, including micromachined hohlraums, witness plates, foams and plastic and glass microballoon capsules, and flat foil targets of various materials and configurations to LLNL, LANL, NRL, SNL and UR/LLE for experiments on Nike, Omega and Z.

Ignition targets for the NIF contain spherical shells of DT solid surrounding a volume of DT gas. The roughness of the inner surface of the cryogenic fuel layer is a source of imperfections which can cause the target to deviate from perfect one-dimensional performance during implosion. An inner surface finish smoothness of ~1 µm RMS is expected to be needed. Furthermore, proposed target designs require a density of DT gas inside the shell corresponding to the saturated vapor pressure of DT held at 18.3 K.

We have previously demonstrated the capability of producing layers of the required smoothness by controlling nucleation of the solid at temperatures just below the triple point of DT (19.7 K). But as the layer is cooled to the final temperature of 18.3 K, the solid shrinks about 1%. The stress due to shrinkage of the DT solid causes the layer to deform. It has been shown experimentally that the magnitude of the deformation depends not only on the final temperature but on the cooling rate. Slower cooling rates should allow annealing to take place before layer deformation occurs. Jim Sater of Schafer has done a study at LLNL on the effects of very slow cooling rates on the layer temperature that can be achieved before surface roughening occurs.

DT layers were cooled using a linear temperature ramp between 19.7 K and 18.3 K with rates of 1.0 mK/min and 0.25 mK/min. The total times for the ramps were 1 and 4 days, respectively. These layers began to degrade at temperatures of 19.3 K and 19.1 K, respectively. The slower rate appears to allow a lower temperature to be achieved before roughening occurs, but the statistics are sparse at this time. There is also a single data point from a layer cooled at 0.25 mK/min to 19.3 K and then at 0.1 mK/min to 18.3 K. Degradation of the layer was observed even at the 0.1 mK/min rate. (A 0.1mK/min ramp corresponds to a cooling time of 10 days.)

There are limits to the slowness of the cooling rate. The formation and movement of helium bubbles within some DT layers have been observed. $^3$He is the daughter product from tritium beta decay. The density of these bubbles increases with layer thickness and time. Work is currently being done at Lawrence Livermore National Laboratory to quantify how long this takes at layer thickness' of interest and to put a time limit on the slow cooling technique. For thickness' relevant for indirect drive (~80 µm), bubbles do not appear for at least several days. For thicker layers, however, bubbles appear more quickly as shown in Fig. 1.

The "best" layer made to date was cooled to 19.05 K before beginning to degrade. The RMS roughness of the layer was calculated to be 0.5 µm in modes 3 to 50. Target designers are now beginning to look at using DT gas density corresponding to ~19 K for their ignition targets.

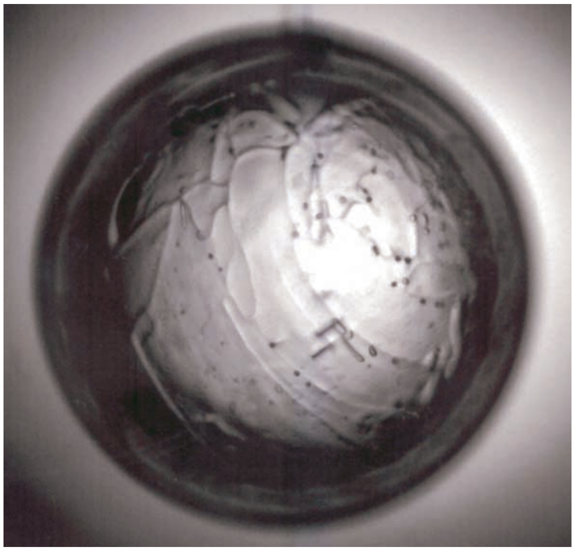

*Fig. 1. Macroscopic $^3$He bubbles and cracks can be seen in this backlit image of a 170 µm layer of DT. The DT has been solid less than 24 hours.*

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