Thermal Control Techniques for Improved DT Layering of Indirect Drive IFE Targets

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Fuel layering is an essential step for any of the target designs under consideration for Inertial Fusion Energy (IFE), both direct drive and indirect drive. The uniformity of the DT layer has a profound effect on the gain of the target. Currently demonstrated layering methods require placement of bare capsules in a "layering sphere" to control DT surface temperature uniformity to less than ~100 μK for times up to several hours. Staging individual capsules in layering spheres would require a prohibitively large number of spheres to produce targets at IFE rates (~500,000 per day). In addition, an additional step to rapidly assemble the capsule and hohlraum after layering would be required.

Layering indirect drive targets with the capsule already assembled in the hohlraum would be an advantage. One way to accomplish this is to layer targets in controlled temperature tubes while they are being staged for feeding to the injection system. Successful layering requires maintaining a specially tailored temperature profile on the hohlraum surface. Tritium decay heat removal from the filled capsule depends upon the thermal properties of the tube material, the capsule material, and the other materials filling the hohlraum.

In this work we evaluate various techniques for achieving adequate thermal control during the in-hohlraum layering process. Anisotropic material properties have been studied as a potential method for tailoring the profiles. This is especially important for high-conductivity materials such as gold, which interfere with external control techniques. The effectiveness of hohlraum surface temperature variations and the effect of contact resistance with the surrounding cryogenic staging tubes were also explored. Results provide feedback to target designers on design techniques which will be important in order to make in-hohlraum layering possible.

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