

Examining the Degradation of Depleted Uranium Layered Hohlräume

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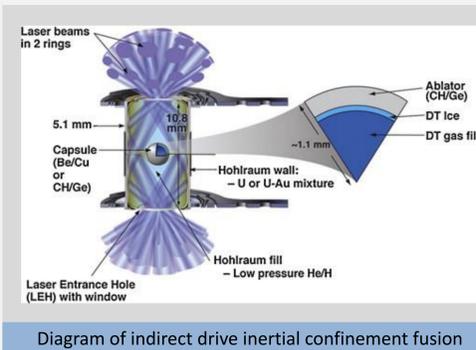
Abstract

- Depleted uranium (DU) hohlraums are used to convert laser energy into X-rays in Inertial Confinement Fusion (ICF) experiments at NIF
- New failure mode with slivers from the DU layer
 - Failure is mostly found in certain cutout sections of the hohlraum (starbursts) where the DU is exposed to air to form sliver-like features
 - Slivers-like features are made up of uranium oxide
- The slivers could flake off onto the capsule
 - The High Z particle contamination caused several targets to get rejected
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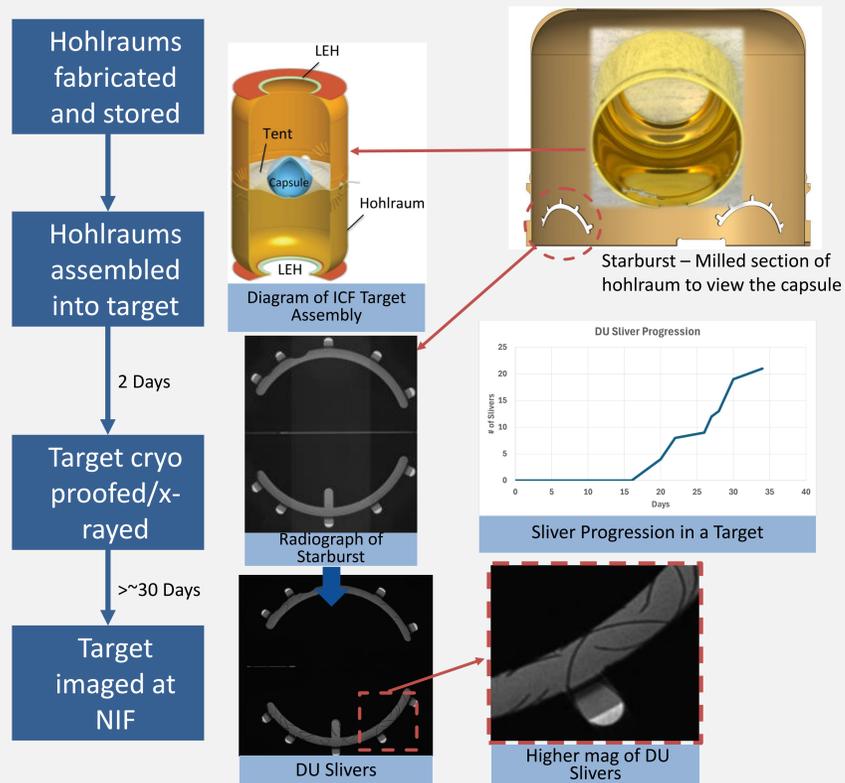
Introduction

Particles on capsule made of high atomic number (High Z) are unacceptable

- Hohlraums are used for indirect drive inertial confinement fusion
- Hohlraums are made up of layered DU-Au and are in close proximity to the capsule
 - If hohlraum sheds particles it goes onto the capsule, affecting the implosion symmetry
- Over the last year, several targets have failed due hohlraum failures

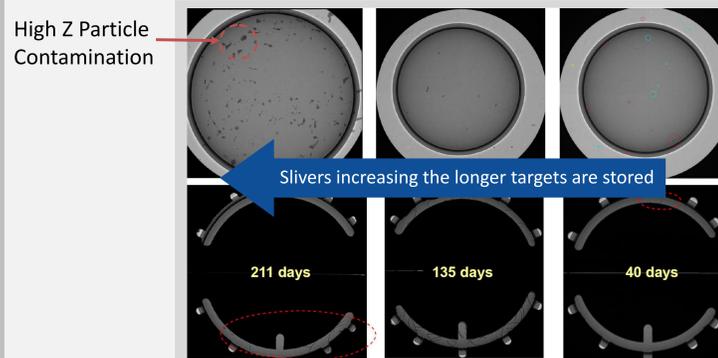


New Mode of Failure – Hohlraum Starburst Degrades Over Time



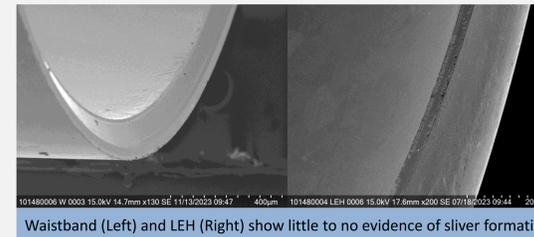
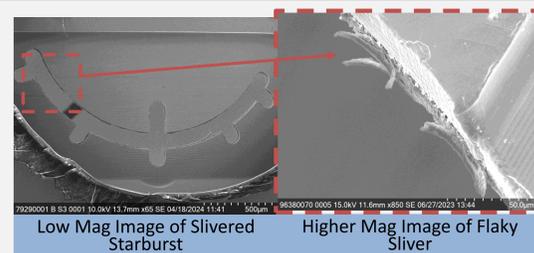
Defining Slivers

Slivers Can Cause High Z Particle Contamination on Capsule



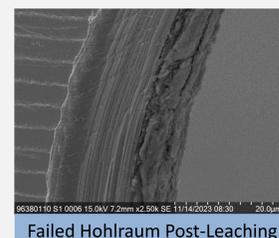
- Mostly form in the starburst, sometimes in the waistband and never in the LEH
- Slivers are always curved

Surface Oxide Layer was Hypothesized to Cause Slivers



“Early-Stage” Slivers form Immediately After Leaching

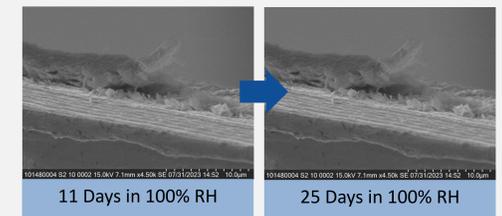
- DU sometimes develops corroded layer immediately after leaching
 - Corroded layer shows flaky and slightly curled features like the slivers in the target assembly
 - SEM shows that they have “crocodile” like flaky features



DU Sliver Studies

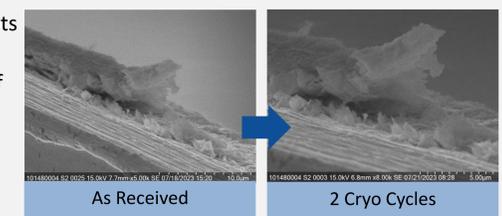
Effect of Moisture on DU Hohlräume Based on Common Cause Mentioned in Literature

- Moisture is known to be an aggravating factor for corrosion layer of DU
- Stored hohlraums in various conditions in attempt to recreate slivers
 - 100% relative humidity (RH)
 - Dry nitrogen
 - Ambient air
- Unable to recreate slivers or cause existing slivers to flake off



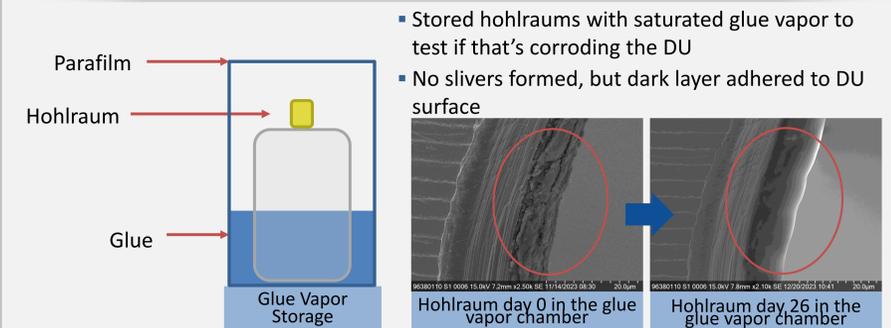
Effect of Cryogenic Cycling Based on Thermal Stress Arguments

- Target is in cryogenic state before shots
- Tested flaky hohlraums through cryogenic cycles to see if flakes fall off due to difference CTE
- No changes to the DU 2 cryo cycles



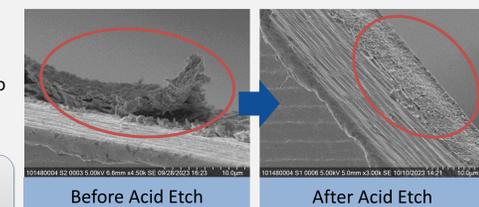
Cryo cycling does not affect DU corrosion

Effect of Glue Vapors Based on Sliver Growth Acceleration Inside Target

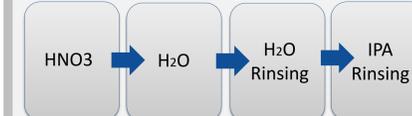


Acid Etching Removes the Flaky Early-Stage Sliver Layer

- Nitric acid etching removes flaky corroded layer quickly
- Dipped hohlraum in acid with custom design basket
- Use acid for 3 hohlraums then dispose it
- Low concentration acid to minimize damage to the metallic DU layer



Acid Etching Procedure



Summary

- DU Hohlräume form slivers immediately from leaching or after target is assembled
- Moisture and cryo cycling proved to not influence the oxidation of the DU
- Acid etching quickly removes the corrosive layer
- Glue vapor shown to interact with DU, but inconclusive as to exactly how
- Further studies will concentrate on interaction between glue and DU