Fabrication and Characterization of Shimmed Capsules for OMEGA Experiment

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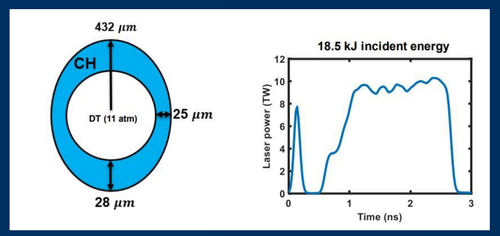
1. Introduction

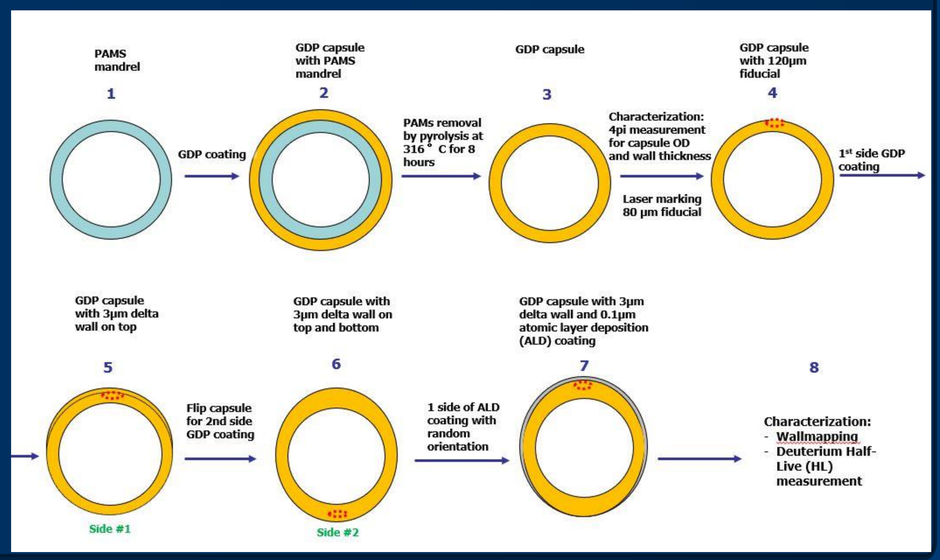
- Shimmed CH capsules were needed in PDD experiments to understand the causes of asymmetric compression and nonuniformity.
- These required inclusion of a 80 μm laser fiducial mark, visible through an SiO2 layer applied via atomic layer deposition (ALD), to ensure accurate capsule orientation during target mounting in the OMEGA system.
- An ALD gas barrier layer was utilized to enhance deuterium gas retention.

2. Approaches to Correcting Implosion Asymmetry Using Shimmed Capsules in OMEGA Experiments

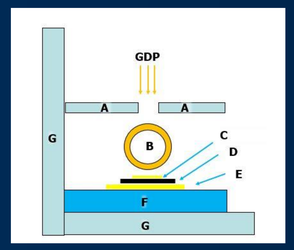


- Laser and target perturbations in OMEGA implosion experiments effectively mitigate low-mode asymmetry at stagnation.
- Uniform laser intensity distribution accelerates thinner walls faster than thicker ones, causing asymmetric compression and implosion nonuniformity.
- Modulating laser energy to increase incidence on thicker capsule regions and decrease it on thinner regions results in symmetric implosion at peak compression.

3. Overview of Fabrication Techniques



4. GDP Coating Configuration



A. Silicon mask with an 800 μm outer diameter (OD) opening
B. GDP Capsule
C. Gel Pak
D. Removable silicon wafer
E. Gel pak
F. X-Y manipulation arm
G. Holder

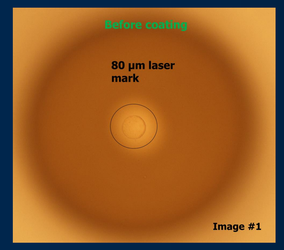
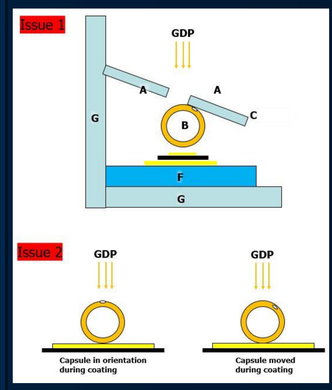


Image #1: A 80 μm fiducial with a step height of approximately 0.4 μm is visible on the top surface of an 860 x 25 μm GDP capsule before coating.

Image #2: A 80 μm fiducial with a gel pak contact ring is observed on the top surface of an 860 x 25 μm GDP capsule after coating.

5. Challenges in Achieving Accurate Coating Profiles

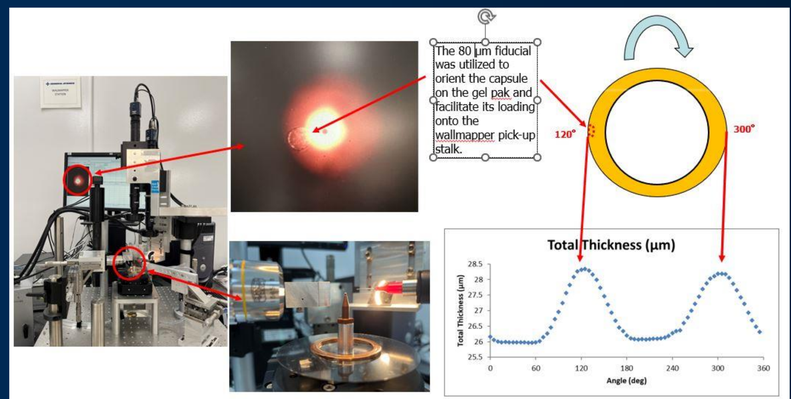


Keeping the 80 μm fiducial at the top/bottom center during coating is crucial. However, two major issues reduced the coating yield of shimmed capsules.

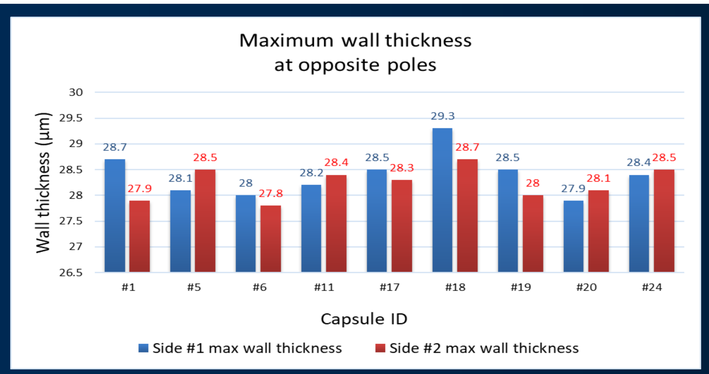
Issue 1: The silicon mask was bent, causing the capsule to move during the pump down phrase. This misaligned the fiducial, resulting in the GDP coating being applied incorrectly.
•Solution: slowing down the pump-down process solved the issue.

Issue 2: The GDP capsule gradually shifted during coating, leading to the GDP coating being applied to the incorrect location.
•Solution: a new fixture will be designed and fabricated to mitigate capsule movement.

6. Characterization: Wallmapping

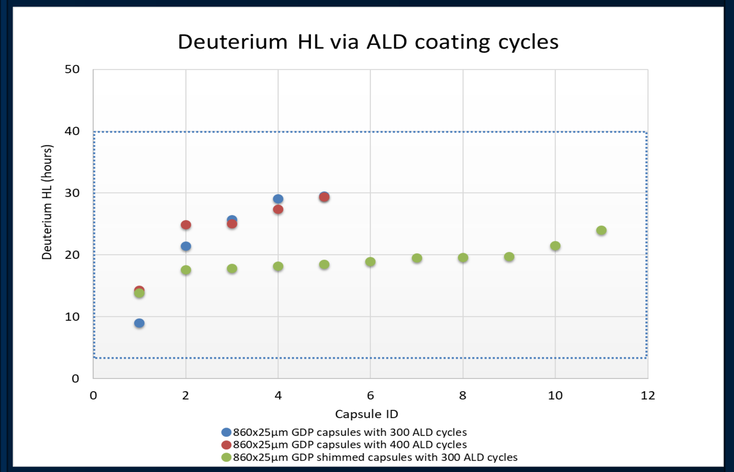


Wallmap profile of DDC5956 B3-17 shimmed capsule



- Maximum wall thickness variation at opposite poles is attributed to slight fluctuations in the coating rate during each coating.

7. Characterization: Deuterium HL Measurement



- **Aluminum (Al) coating**: typical GDP capsules have a 0.1 ± 0.03 μm aluminum (Al) coating to retain gas, providing a deuterium HL of 2.7 to 40 hours. However, the opaque Al coating obstructs the 80 μm fiducial, making alignment and mounting difficult in the OMEGA system. To address this, we explored using a transparent SiO_2 layer by ALD as a gas-retentive barrier for the shimmed capsules.
- **ALD coating**: enables designs that are both gas-retentive and see-through. Keeping capsules transparent for alignment and mounting at LLE.
- **Deuterium HL for Capsules with 300 ALD cycles (~30nm)**: typical GDP capsules from the same batch have deuterium HL of 9 to 30 hours. Shimmed capsules show HL of 14 to 24 hours.

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