APPENDIX G

TARGET LAYERING

BY

DON BITTNER

Infrared heating forms and smoothes HD layers

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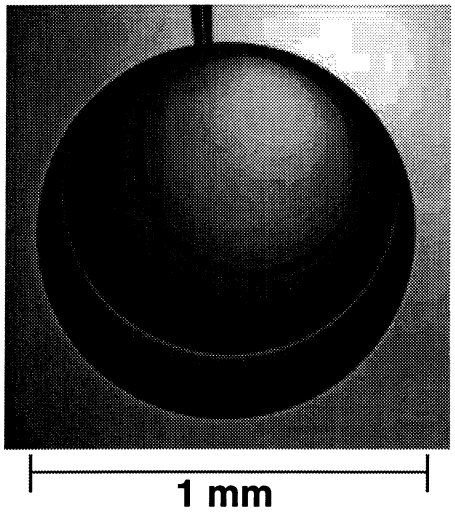
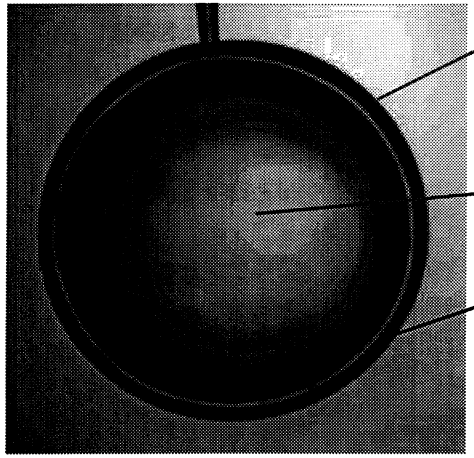
Liquid HD



After solidification



Direct Drive Target Workshop
9/15/99

D. Bittner, J. Burmann, G. Collins, Y. Lee, J. Sater, W. Unites

Cryogenic fuel layers can be enhanced or formed by absorption of infra-red radiation.

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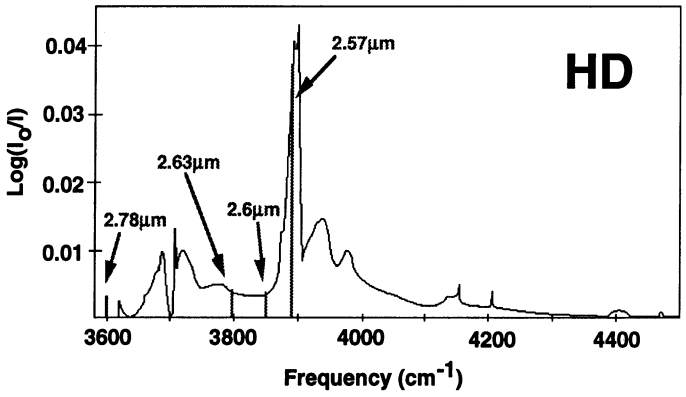
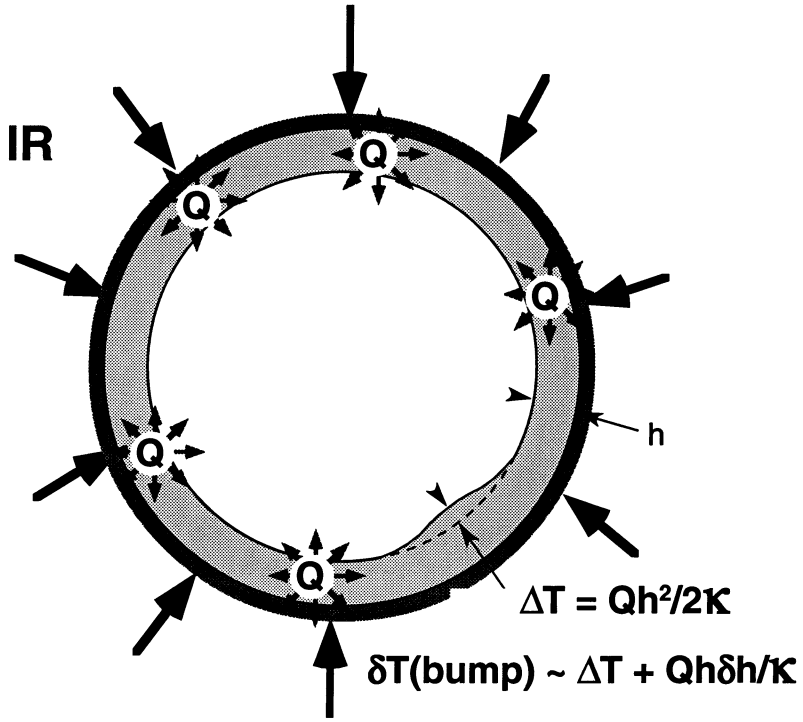
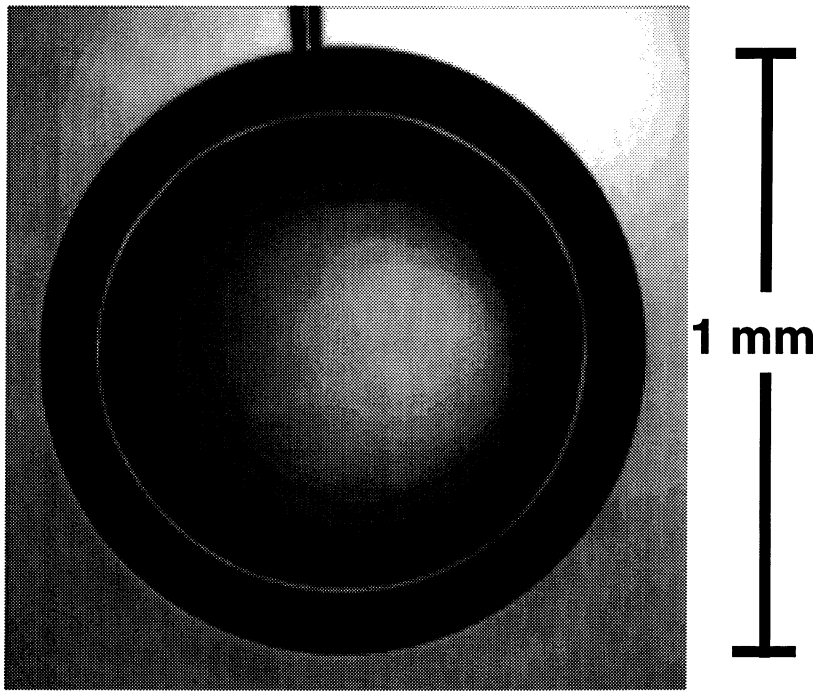




Absorption of IR light generates volumetric heating, Q_{IR} , which adds to or replaces heating from beta layering



150μm thick HD layer formed by uniform infra-red radiation

The capsule material must be chosen to minimize absorption in the shell.

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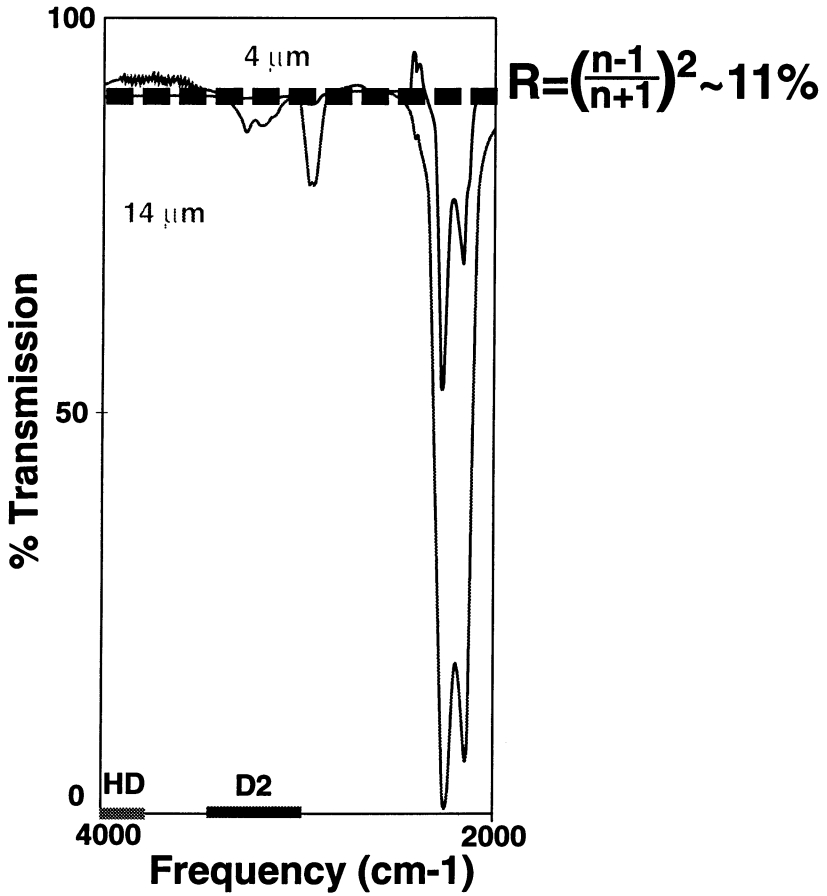

$R=\left(\frac{n-1}{n+1}\right)^2 \sim 11\%$

- Plasma polymer from deuterated p-Xylene
- Using the shift in T_{TP} we have set the maximum baseline absorption at $\alpha < 4\ cm^{-1}$
- Plastic absorption sets the IR uniformity requirements for NIF
- DT does not effect the relevant transmission spectrum of plasma polymer at room temperature

IR illumination can significantly modulate surface structure.

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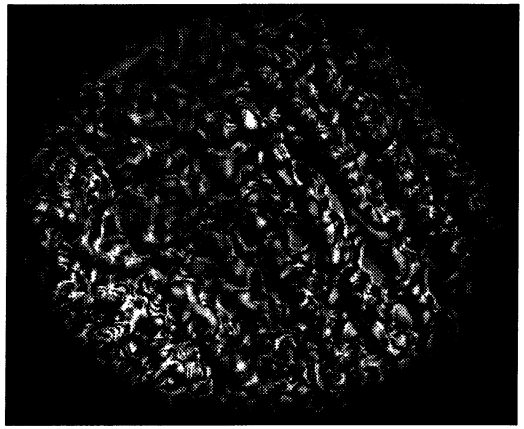
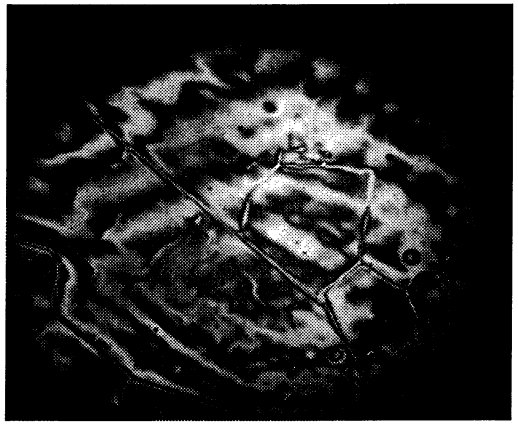
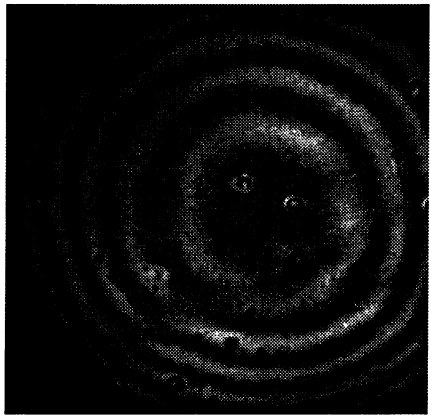
surface with spatially coherent illumination

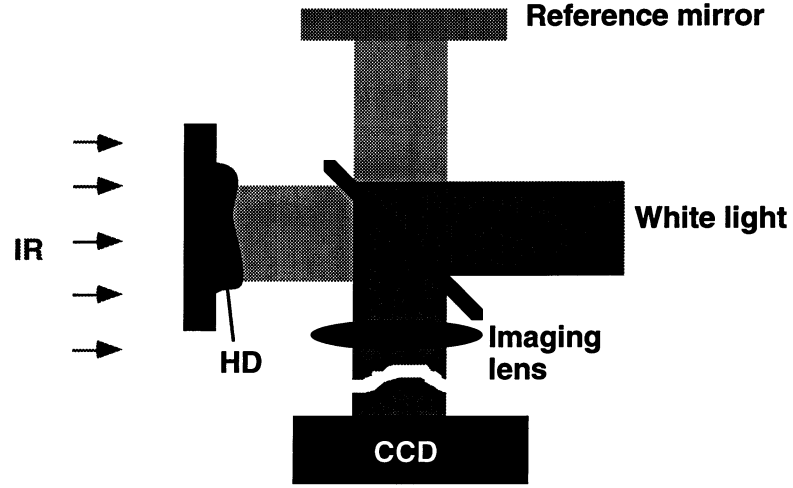
14 % coherent illumination

<3% coherent illumination









The IR now reflects off the bottom of the integrating sphere.

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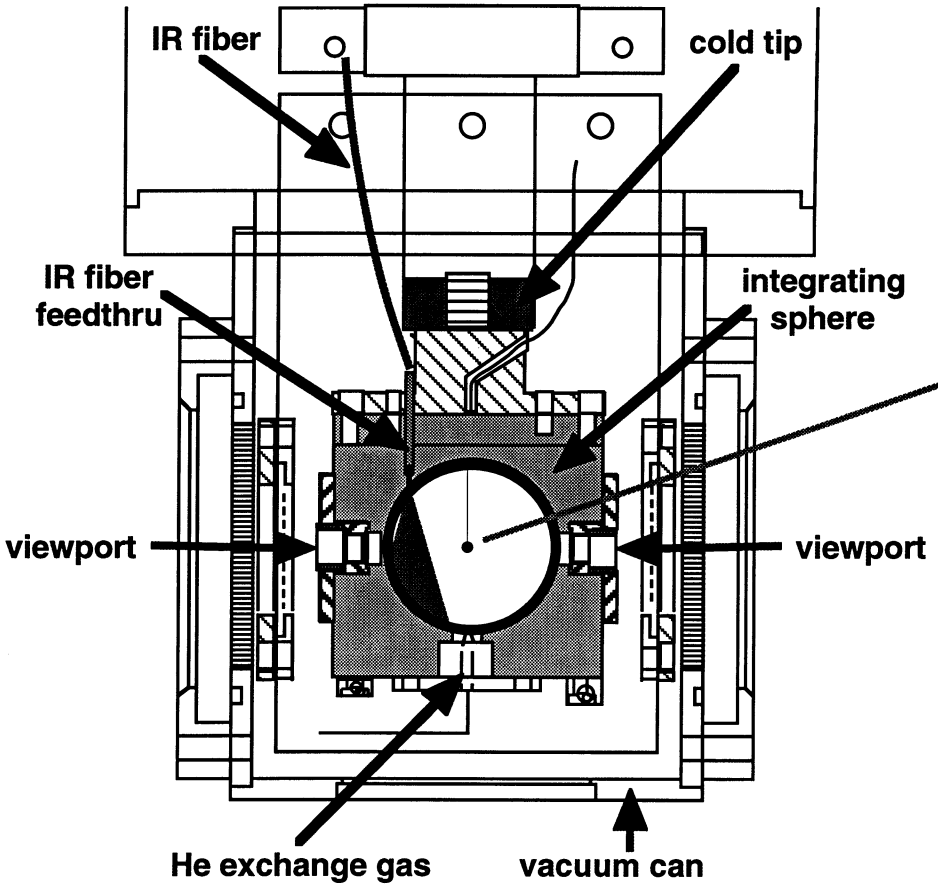
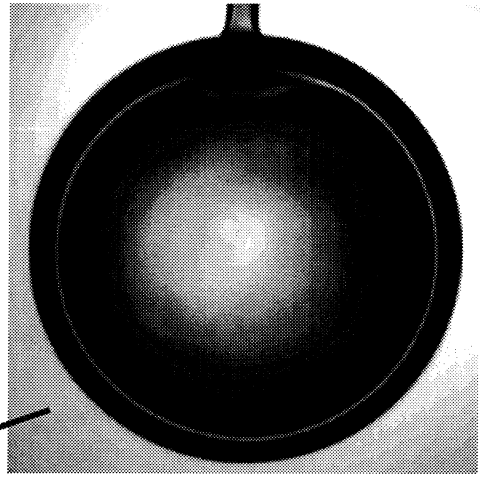
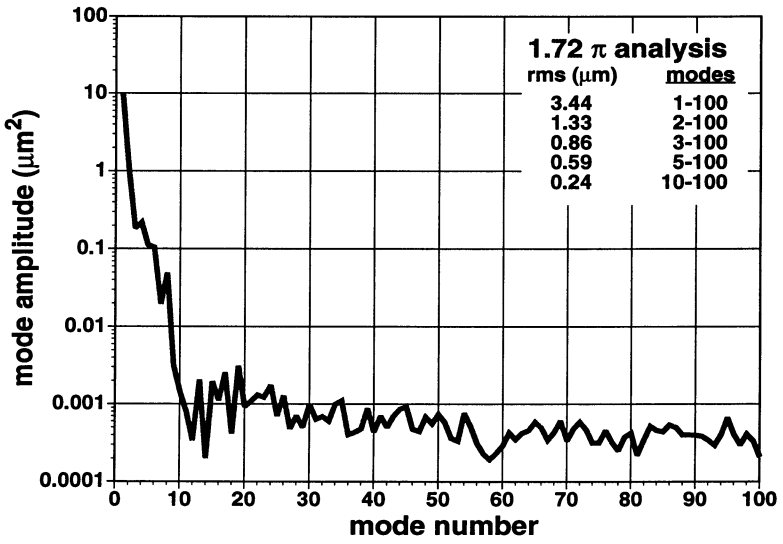




capsule:
870 μm OD
15 μm wall
100 μm HD layer



Layers in shells are characterized using the brightband in the shadowgraph image.

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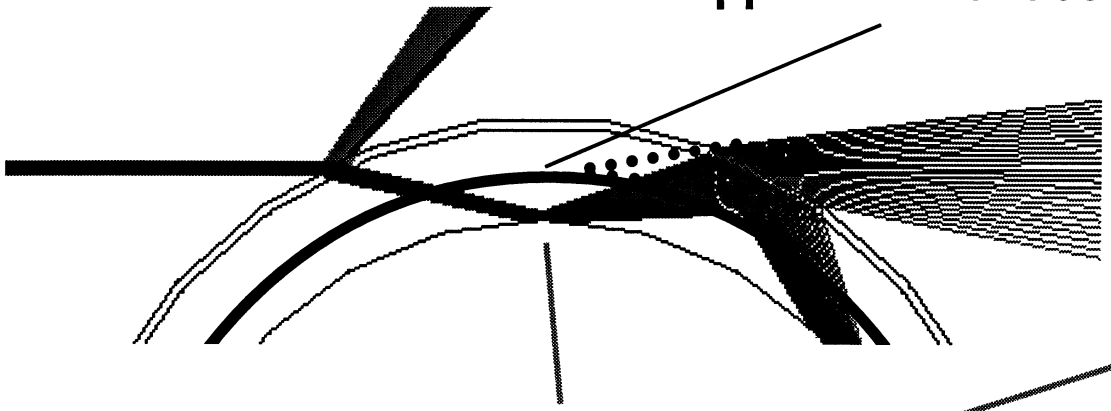
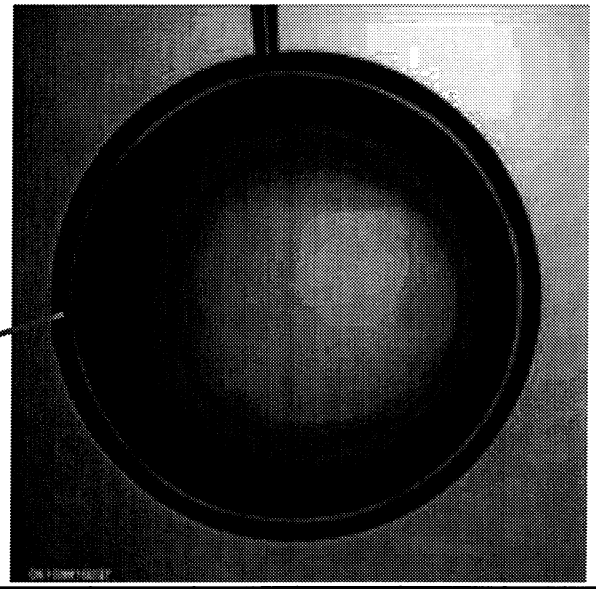
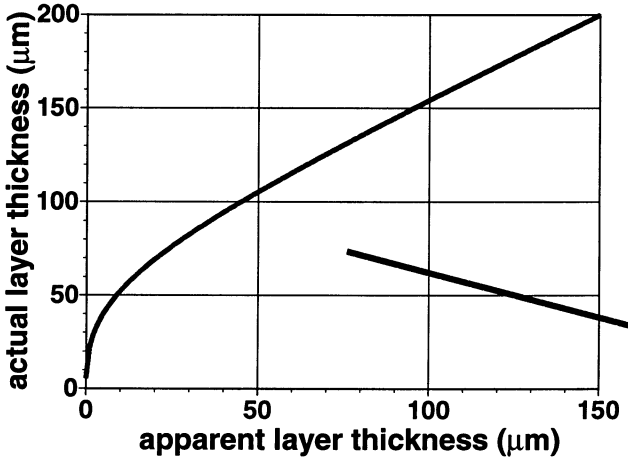
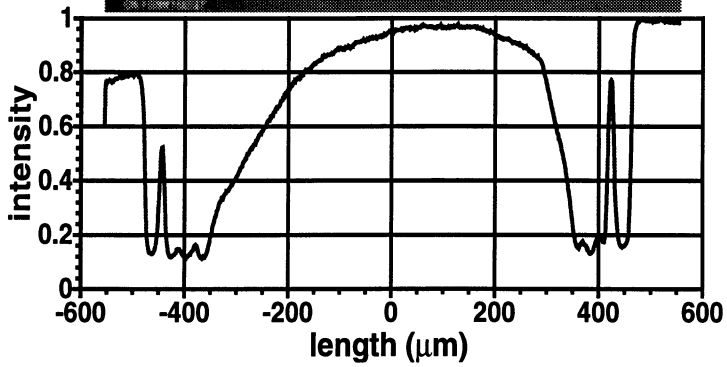




The brightband is due to reflections off the gas/solid interface.





Our characterization technique resolution deceases with decreasing layer thickness.

The aspect ratio of the shell impacts the ice layer characterization.

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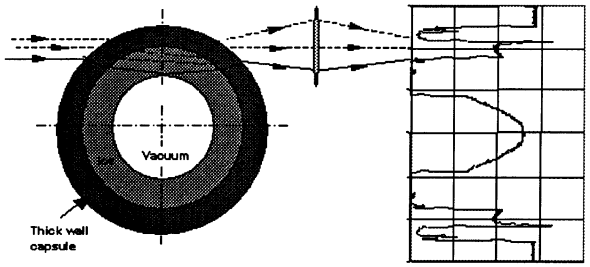
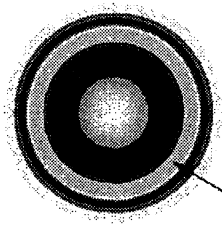
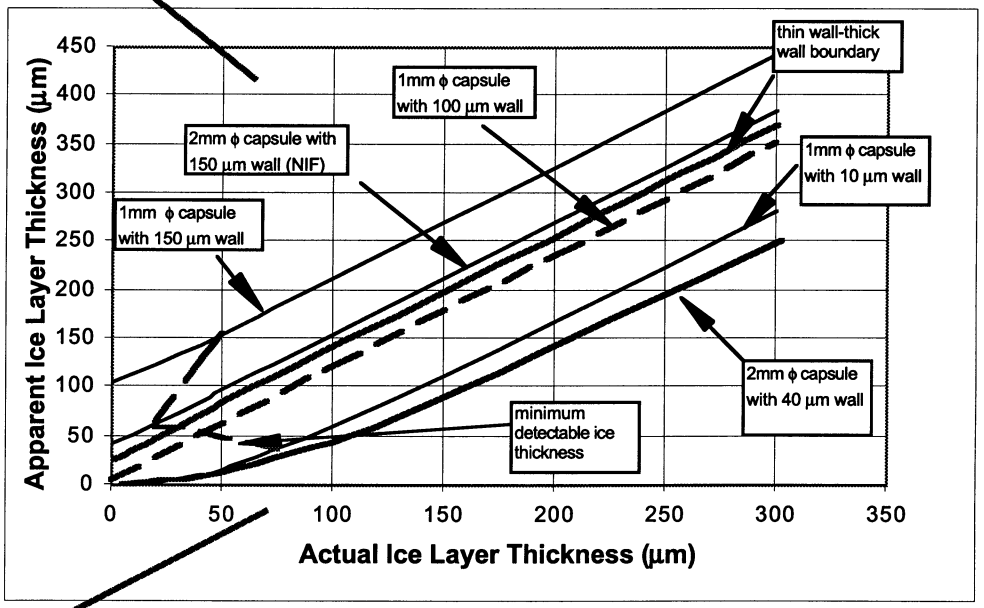


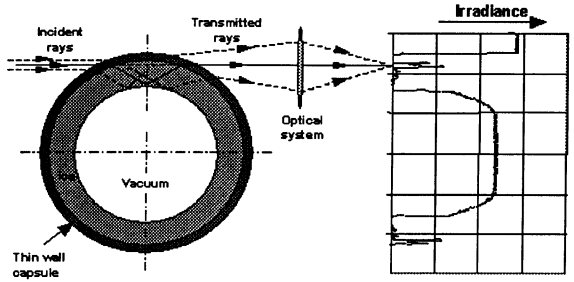


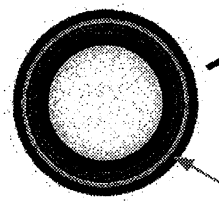
Computer generated images

low aspect ratio

$$\text{aspect ratio} = \frac{\text{wall thickness}}{\text{shell diameter}}$$







high aspect ratio

The layer formation process has a significant impact on the final surface finish.

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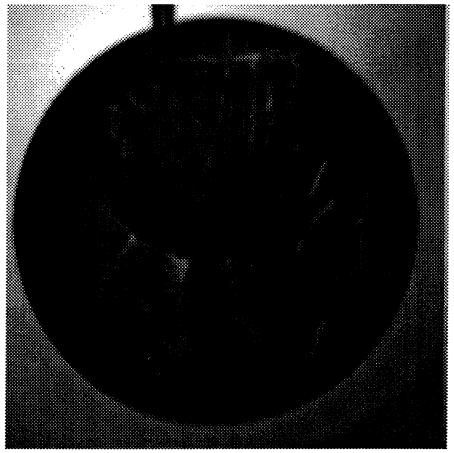
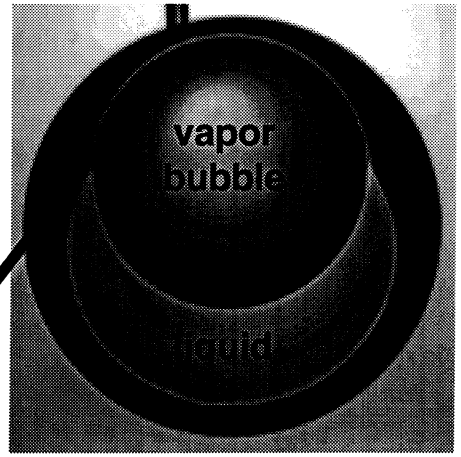
Layer formation from solid.



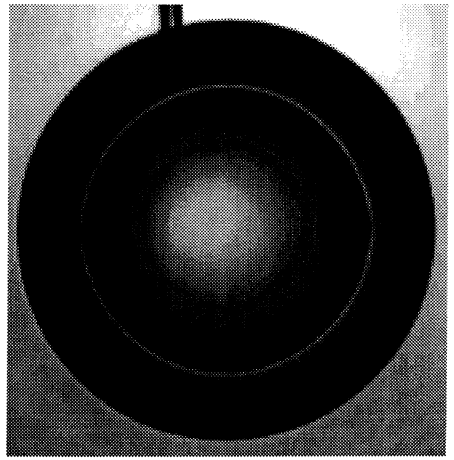
Apply IR ~ 5 Q_{DT}

> 4μm rms

Layer formation from liquid.

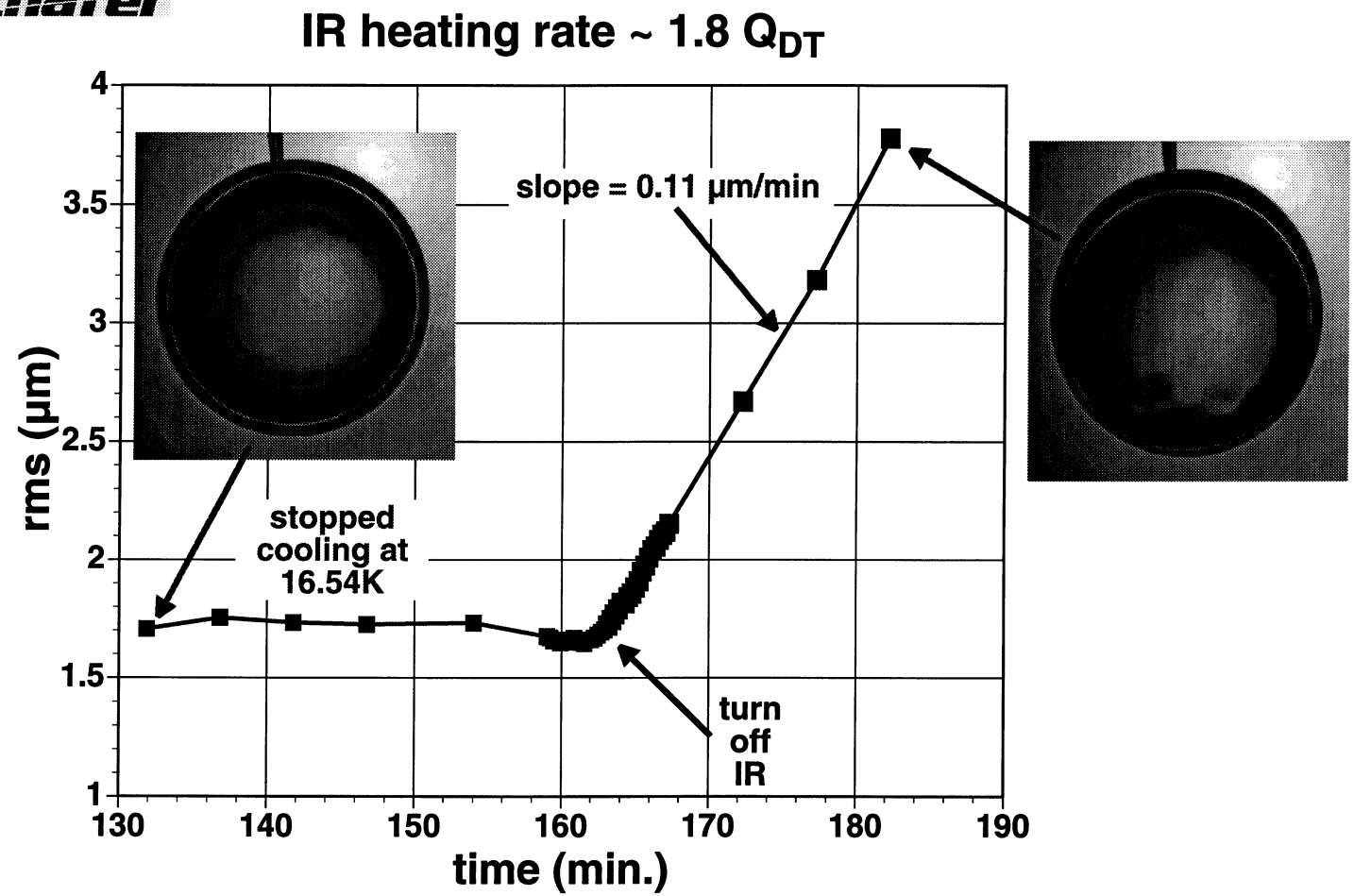


Apply IR ~ 8 Q_{DT}



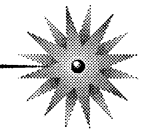
3.0μm rms

Turning off the IR causes the surface to roughen.



- The layer quality is good enough for several minutes.
- The roughening rate is higher for larger $Q_{D\text{-}T}$.

Summary



There are several design issues which must be addressed to implement infrared layering.

- **capsule material - low absorption**
- **coating - non-reflective**
- **illumination - uniform and diffuse**
- **surface degradation - minimize the time between turning off the illumination and the shot.**

- **layering time - minutes to hours**
- **characterization - minimize analysis time (0 to a few seconds)**