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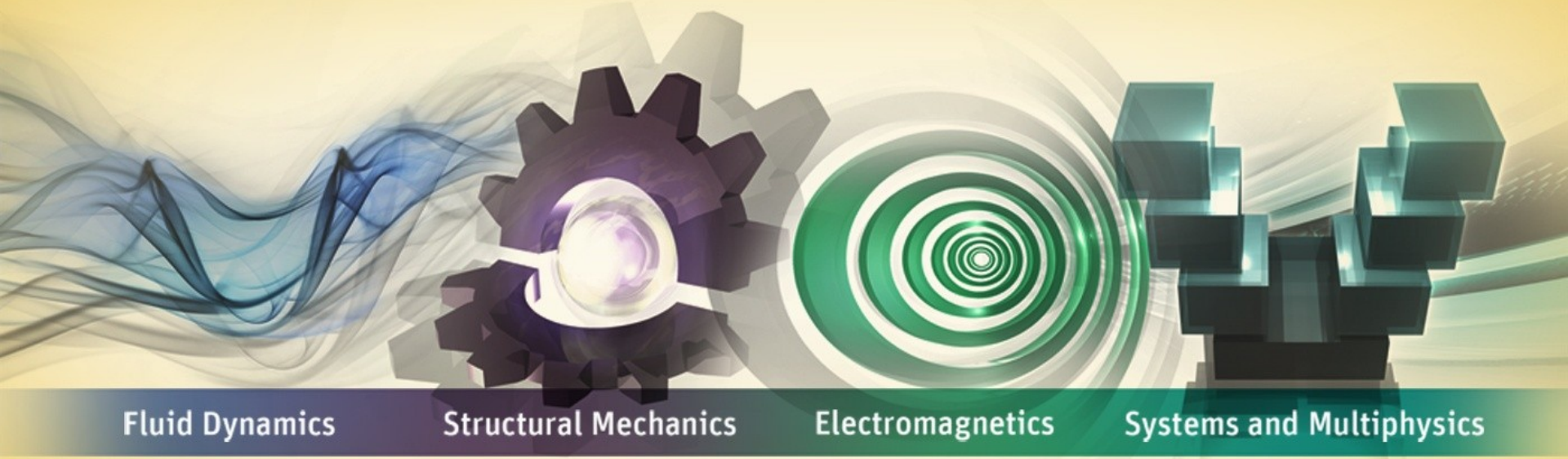
FLUID SHAPE APPLICATIONS FOR THE SILICON VALLEY

Solder Reflow & Hard Drive Media Processing



Chris Cowan, Ozen Engineering Inc.
Shaun Chen, Ph.D., Western Digital Corp.

ANSYS Convergence Conference
Santa Clara, CA
May 30, 2013

OZEN ENGINEERING, INC.

With over 25 years of experience in Finite Elements Simulations and Engineering Consulting, we collaborate with customers to provide the best in class expertise and solutions to their problems, enabling them to succeed.

Introduction: Hard Drive Disk Coating

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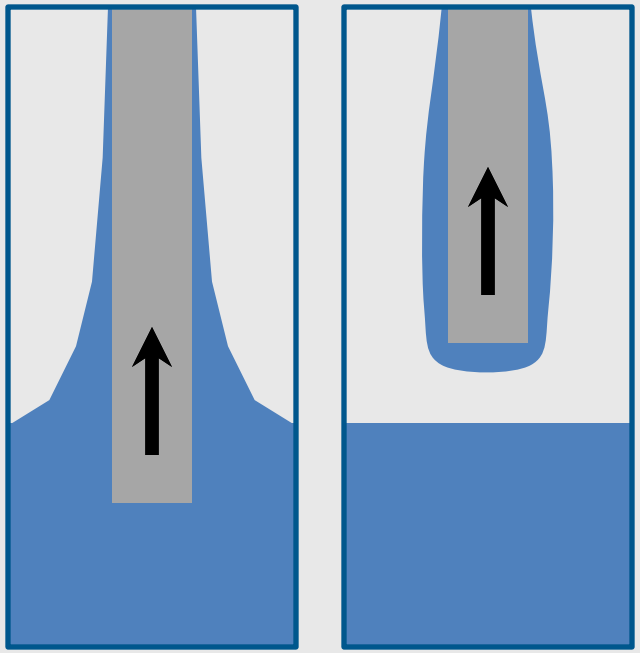
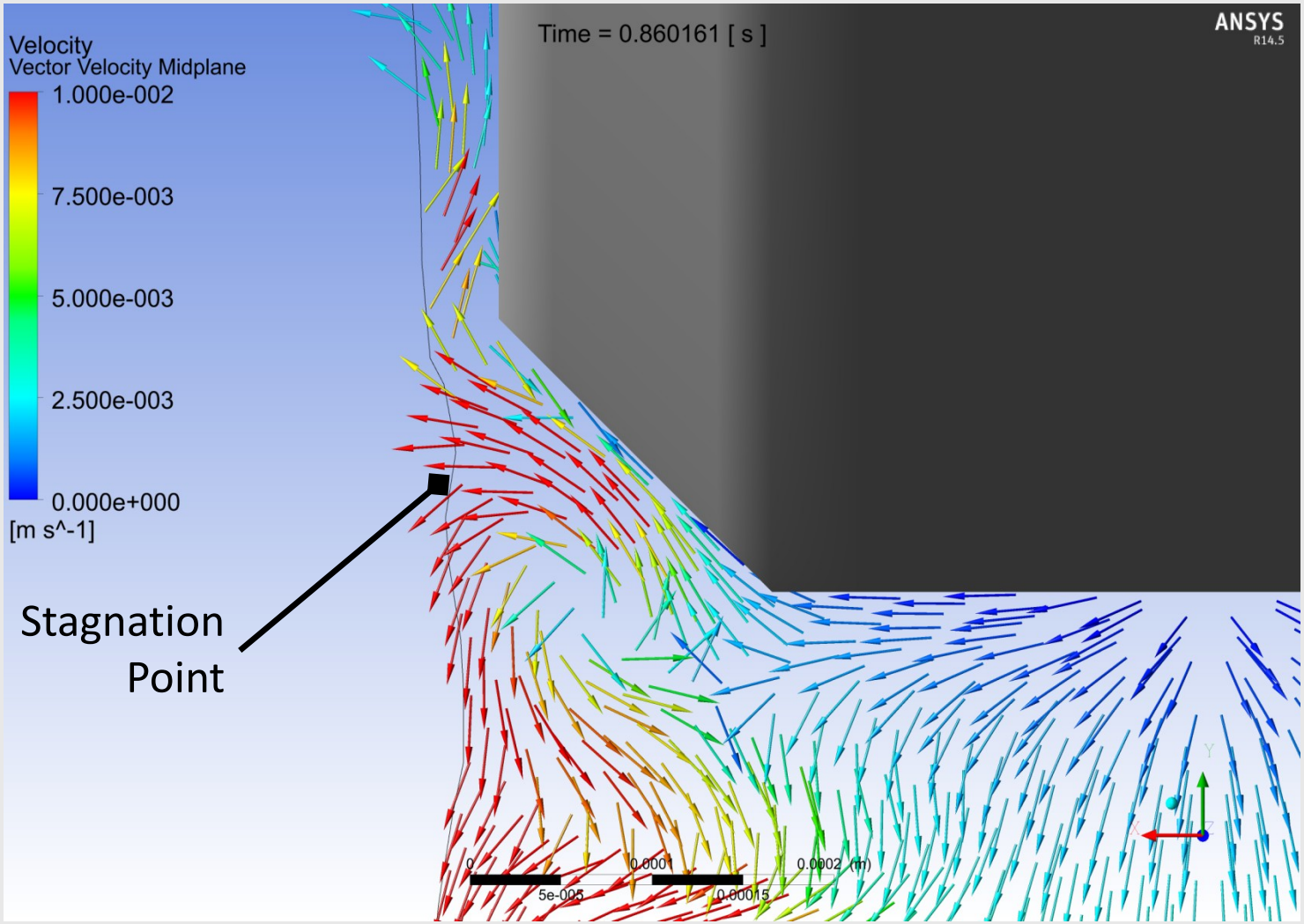
Dip Coating

- Manufacturing Process for Recording Media
- Lubricant film
- Process conditions determine thickness



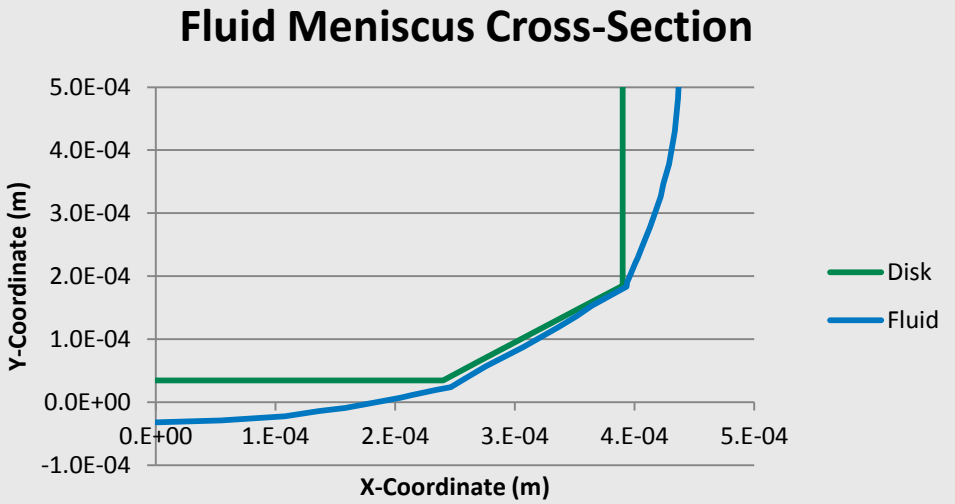
Recording media in a fluid bath is withdrawn & separated.

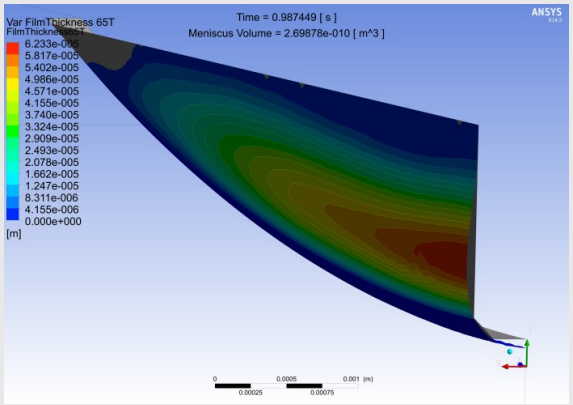
Dip Coating



Manufacturing Challenges

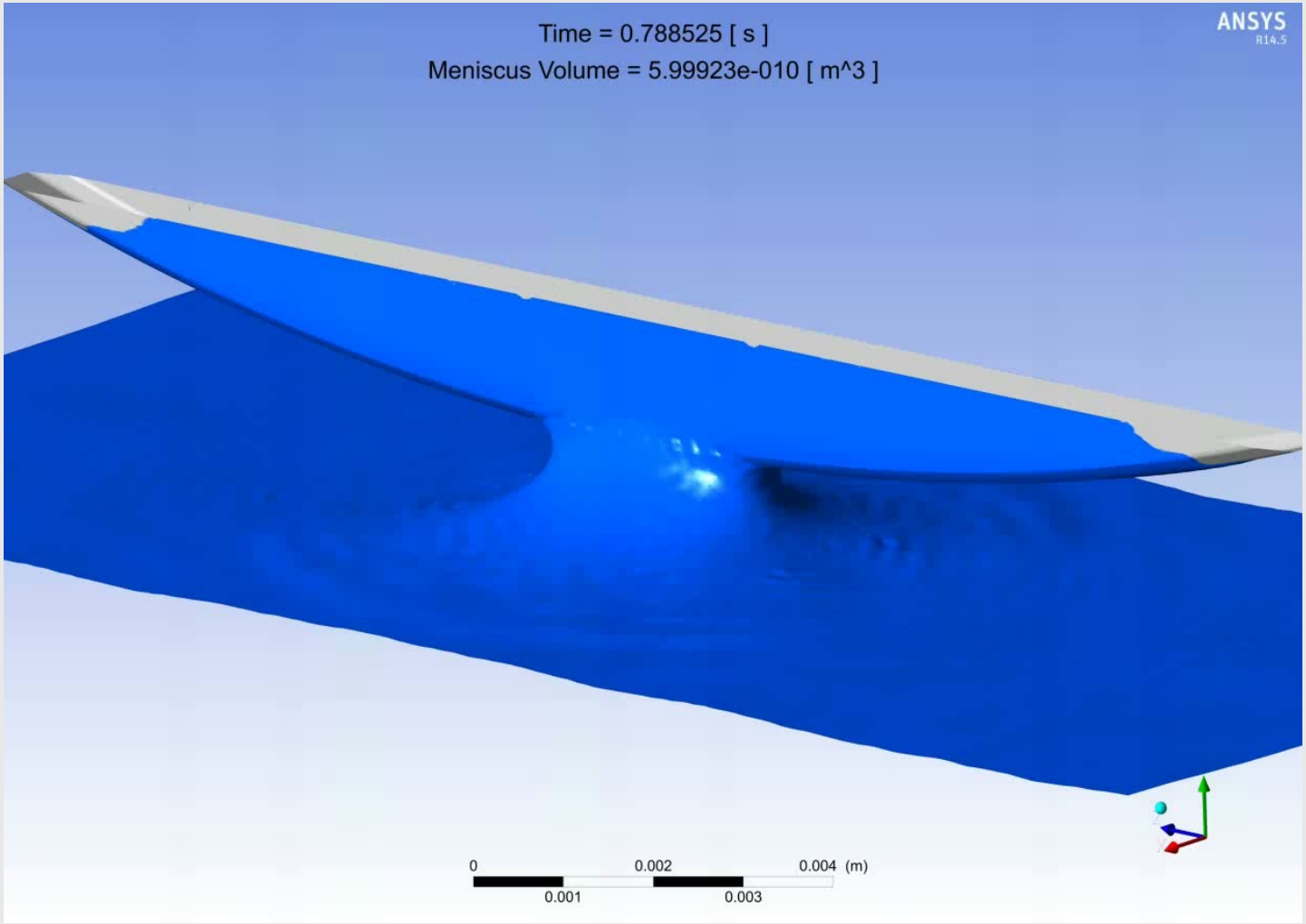
- Non-uniform coating thickness
- Droplet formation during separation from bath
- Reduce effect by tuning process equipment





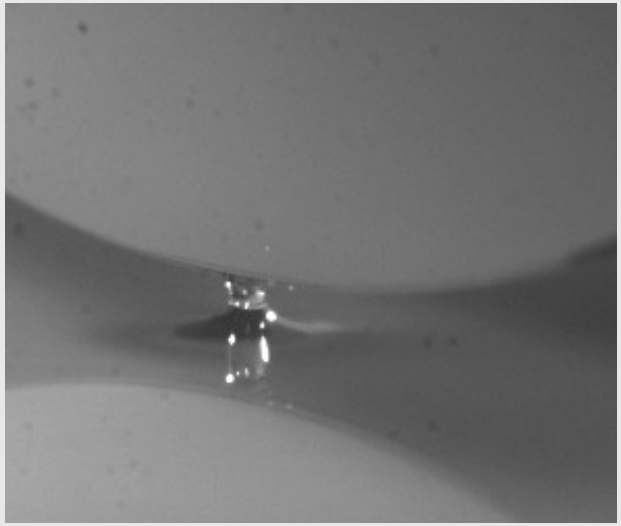
Dip coating equipment

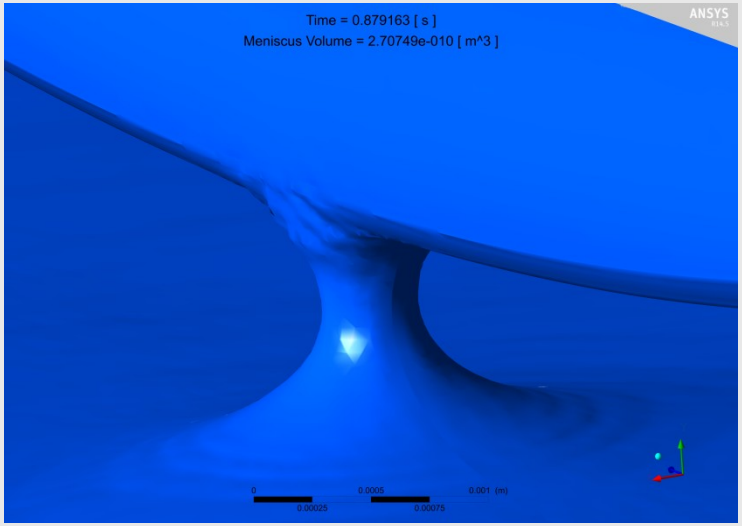
Animation - Disk Withdrawal



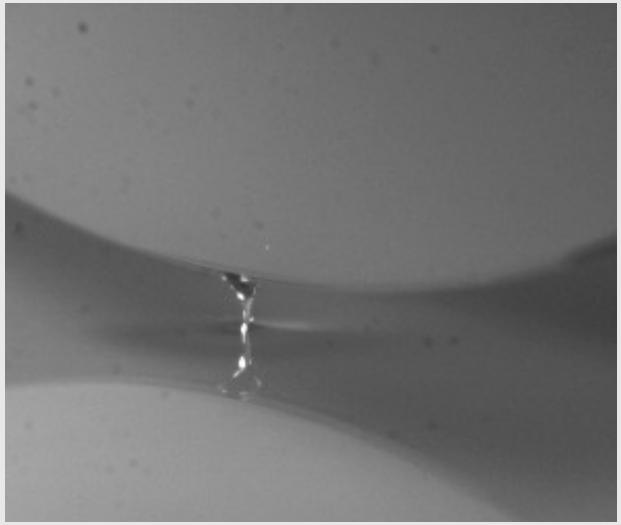
Experimental Comparison

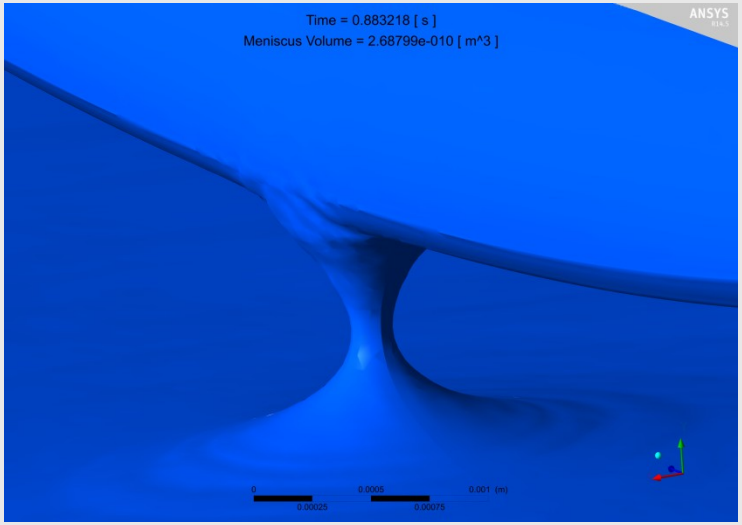
Break Time – 6ms





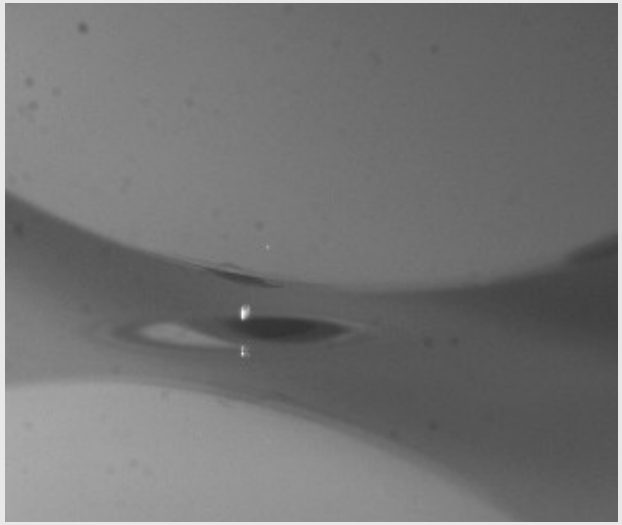
Break Time – 1ms

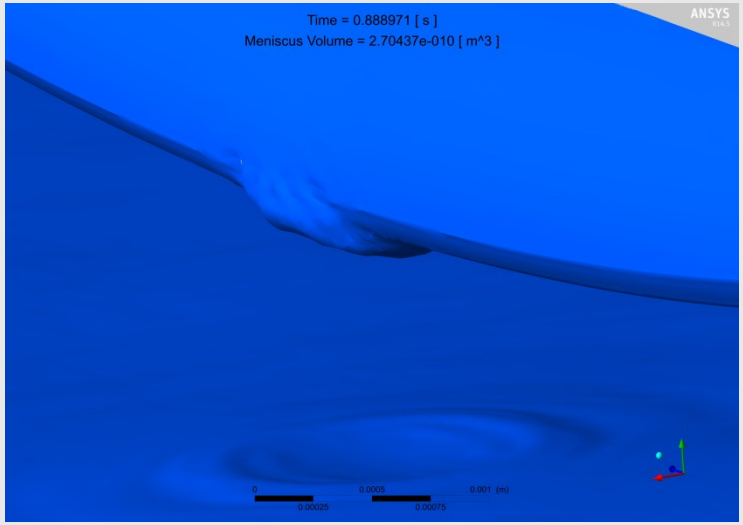




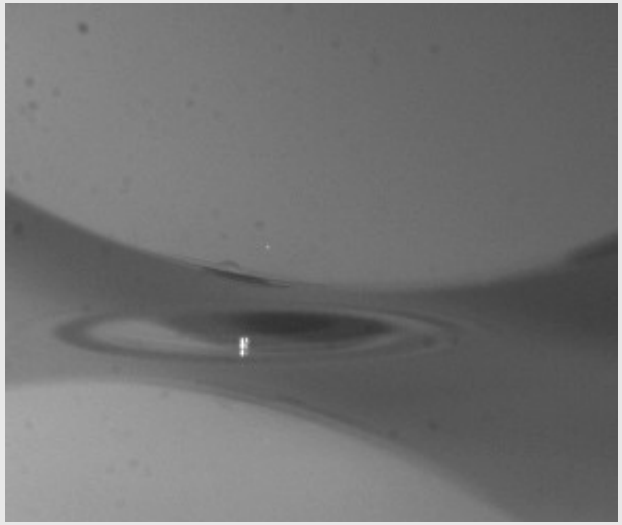
Experimental Comparison

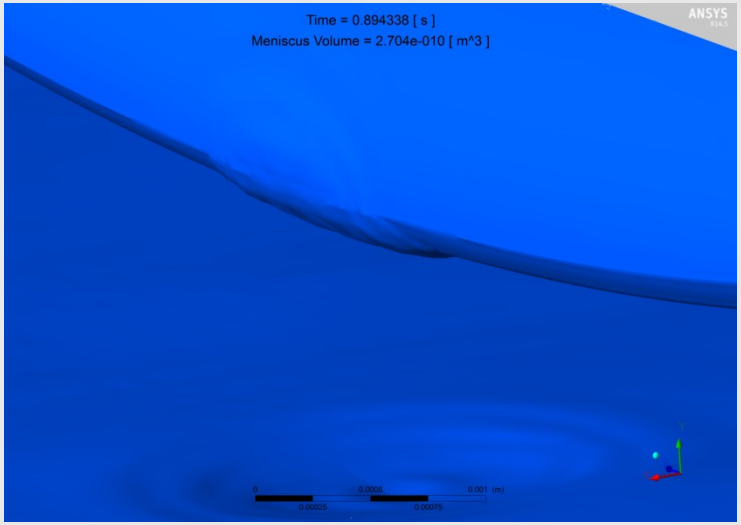
Break Time + 4ms





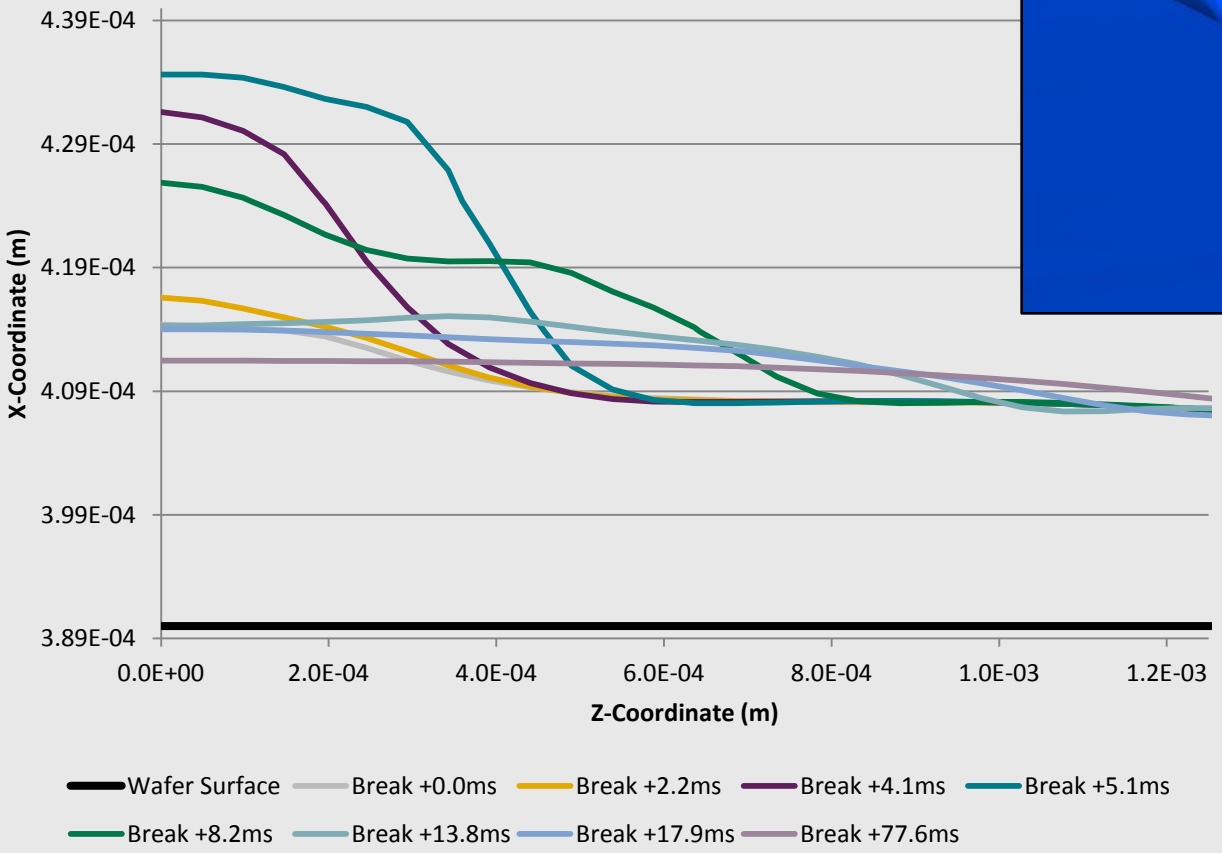
Break Time + 8ms





Transient Profile

Fluid Meniscus at 0.25mm above Disk Bottom



Solution Challenges

- Transient analysis, timesteps vs. end time
- Detailed free surface resolution
  - Thin film on wafer surface
  - Droplet formation
- Starting conditions
  - Viscosity, withdrawal
- Very slow processing velocity relative to VOF interface currents

Introduction: Solder Reflow Shape Prediction

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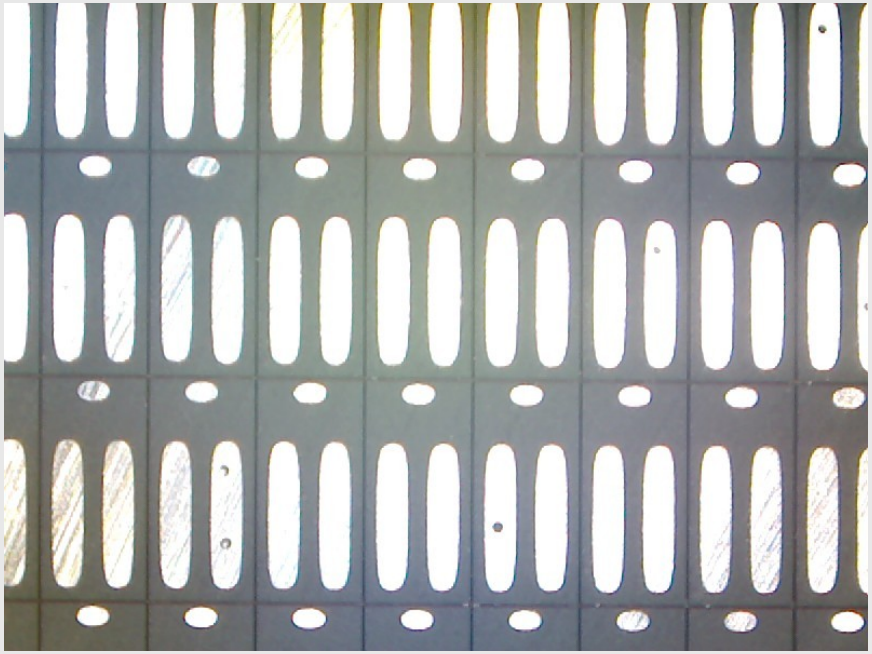
Project Description

Predict the shape of a reflowed solder joint

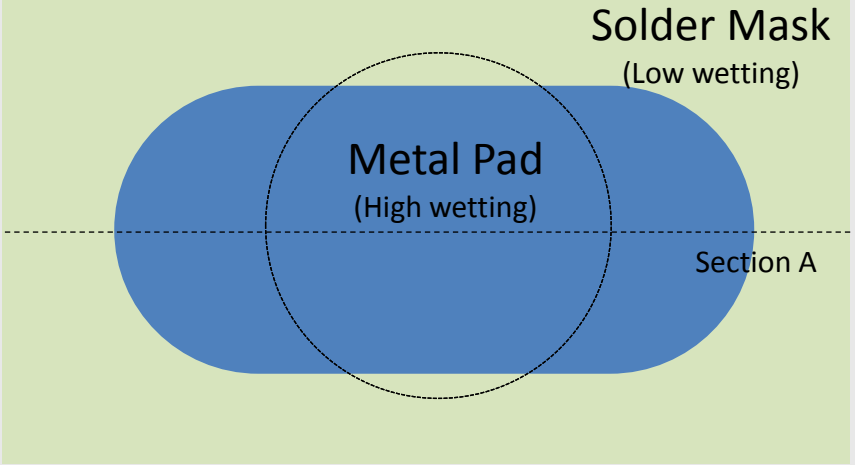
Minimize a process bottleneck resulting from removal of the top layer after encapsulation



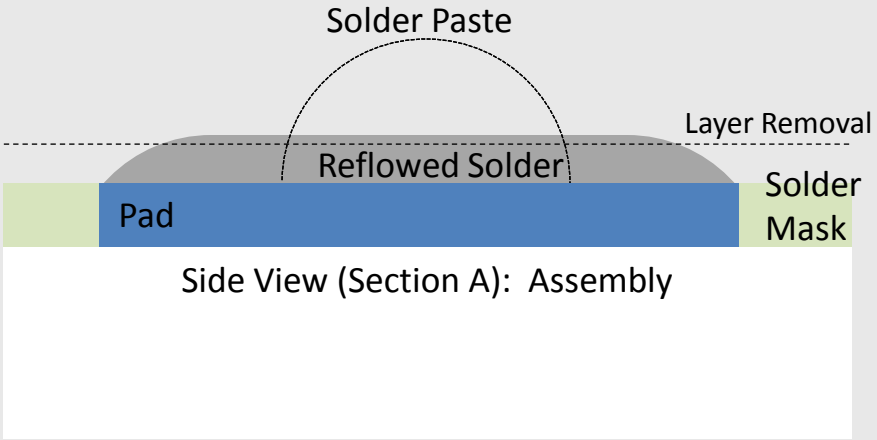
Solder pads exposed following encapsulant layer removal

Solder Reflow and Manufacturing

- Solder is deposited as a paste onto a metallic pad with surrounding passivation.
- During high temperature reflow, liquid solder shape is influenced by surface tension, gravity and wall contact angles.
- Solidified solder is encapsulated then a layer is removed to expose a flat plane for connections.
- Predict the cross-sectional area of exposed solder

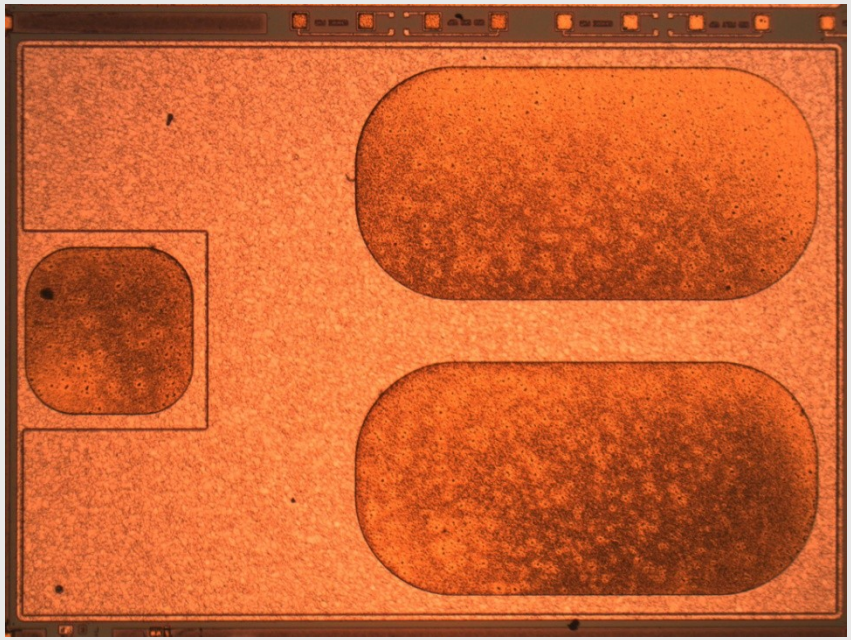


Top View: Pad, Solder Mask, Paste outline

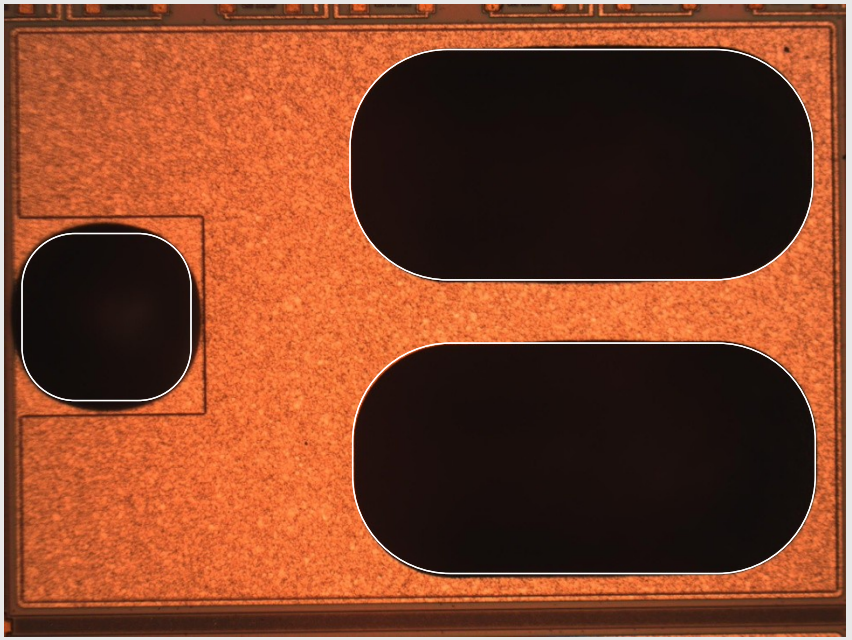


Side View (Section A): Assembly

Images

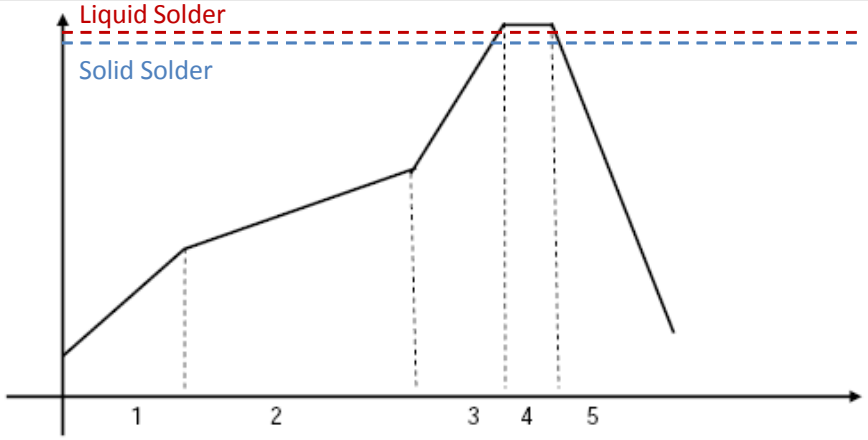


Bare metallic pads before solder reflow.

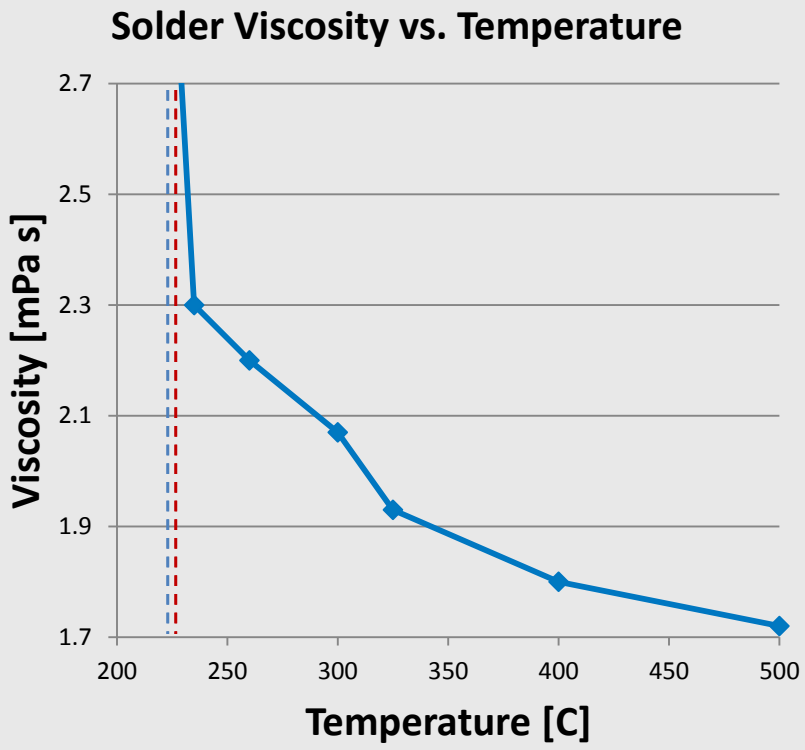


Solder over metallic pads after reflow.

Reflow Properties

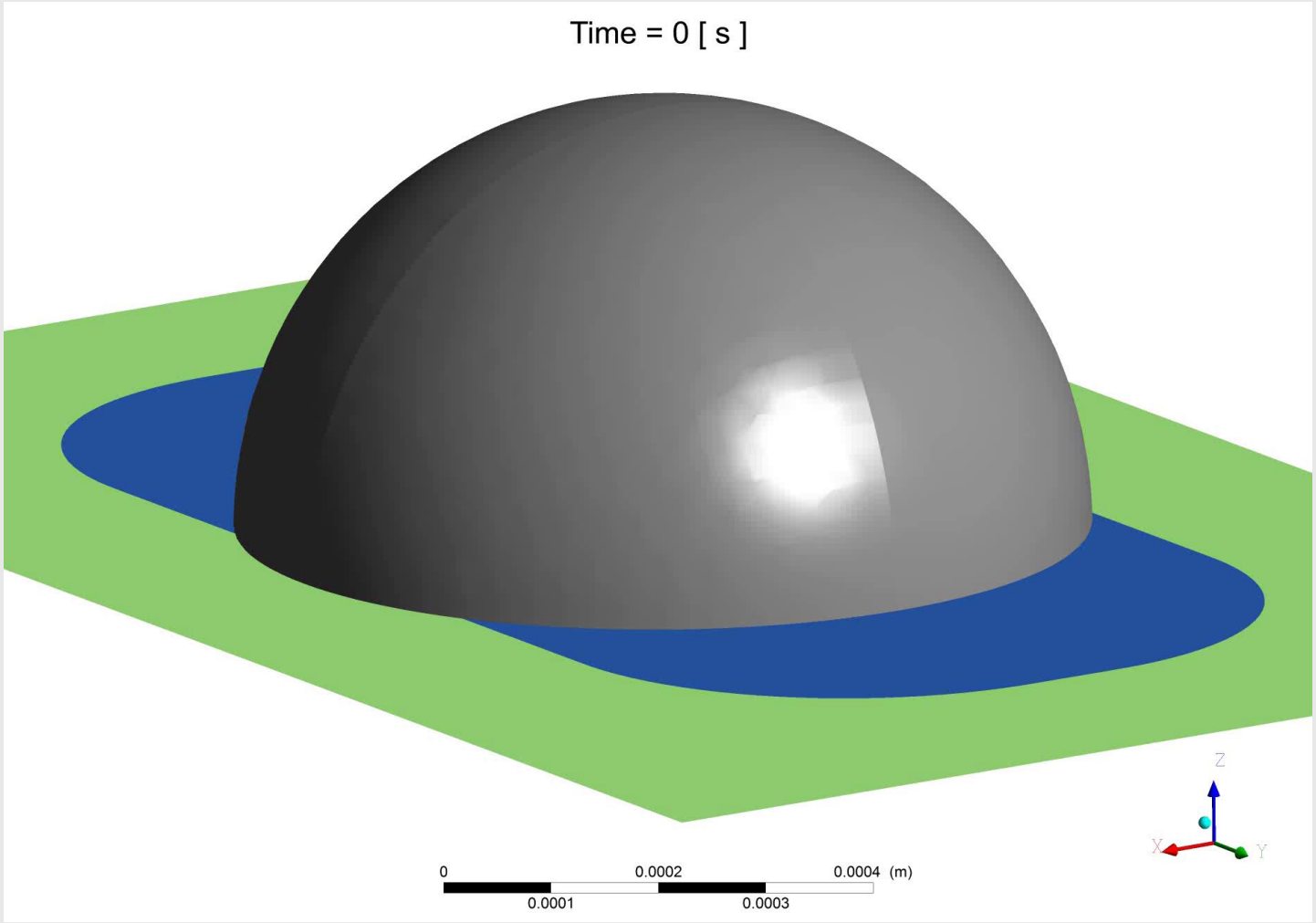


Profile Feature	Requirement
1. Ramp up	1-4°C/second
2. Soak	150°C ~200°C 60-180 seconds
3. Ramp up	1-4°C/second
4. Peak soak	245~260°C 10 seconds max.
5. Ramp-down rate	1~6°C/second max.



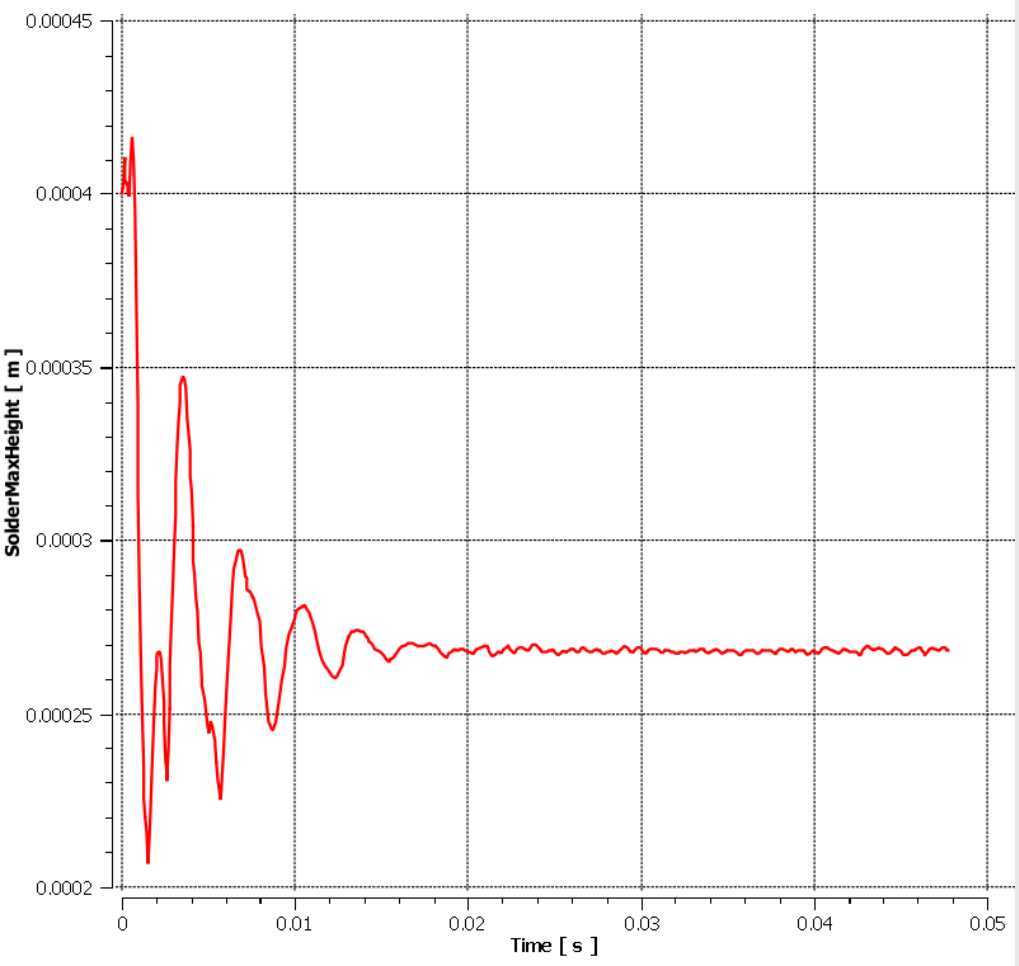
Generic solder reflow manufacturing specifications.
Generic solder viscosity profile from Ning, Viscosities and Wetting Behaviors of Sn-Cu Solders, 2012.

Animation – Solder Reflow



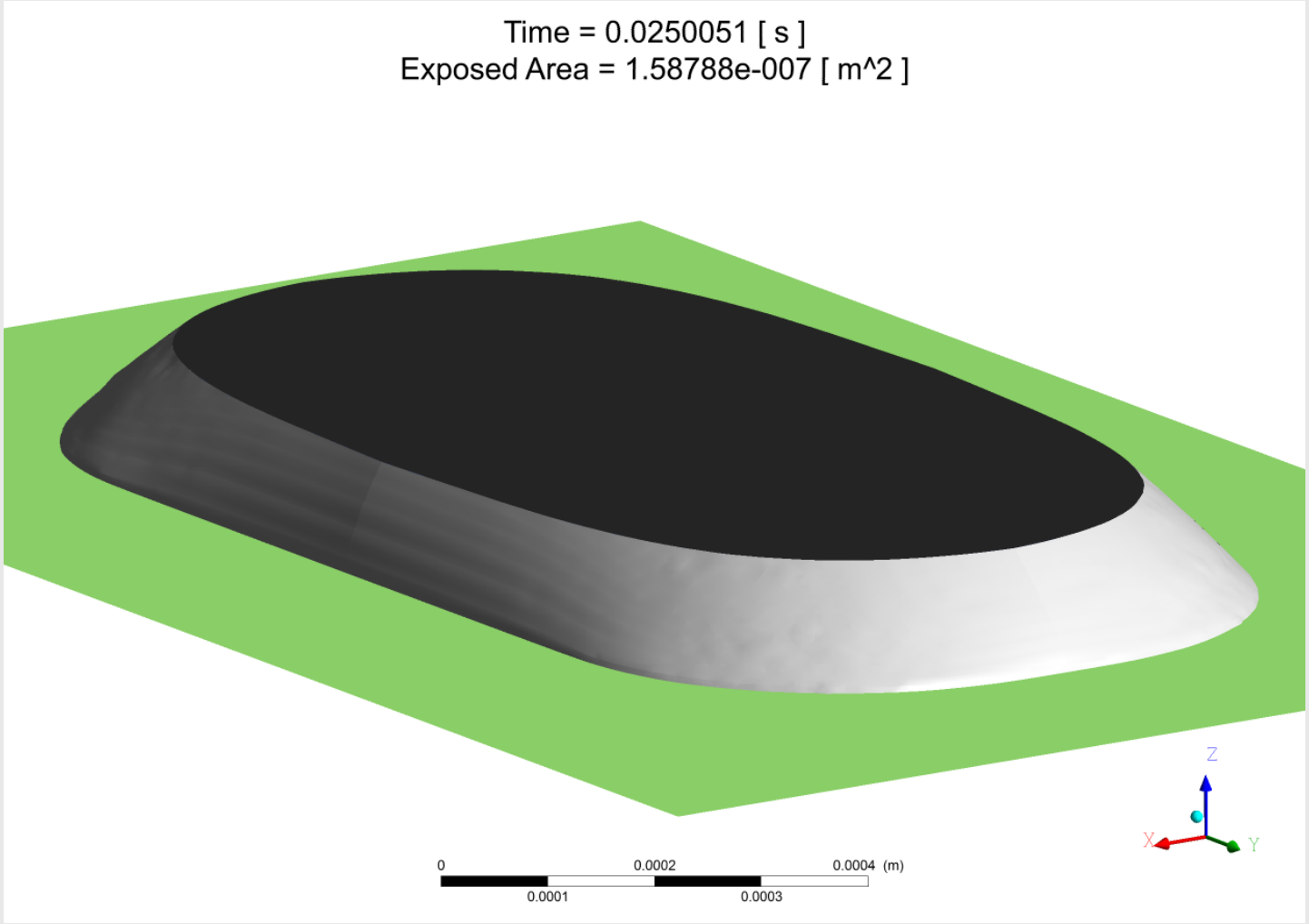
IsoSurface at Solder Boundary

Solution Monitor



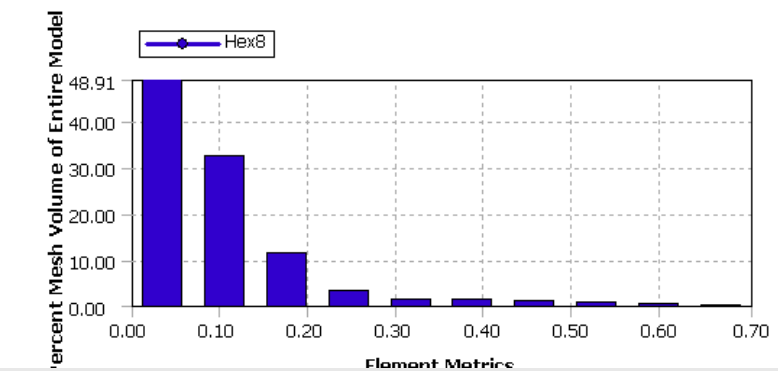
Maximum Solder Height vs. Time

Exposed Solder Area

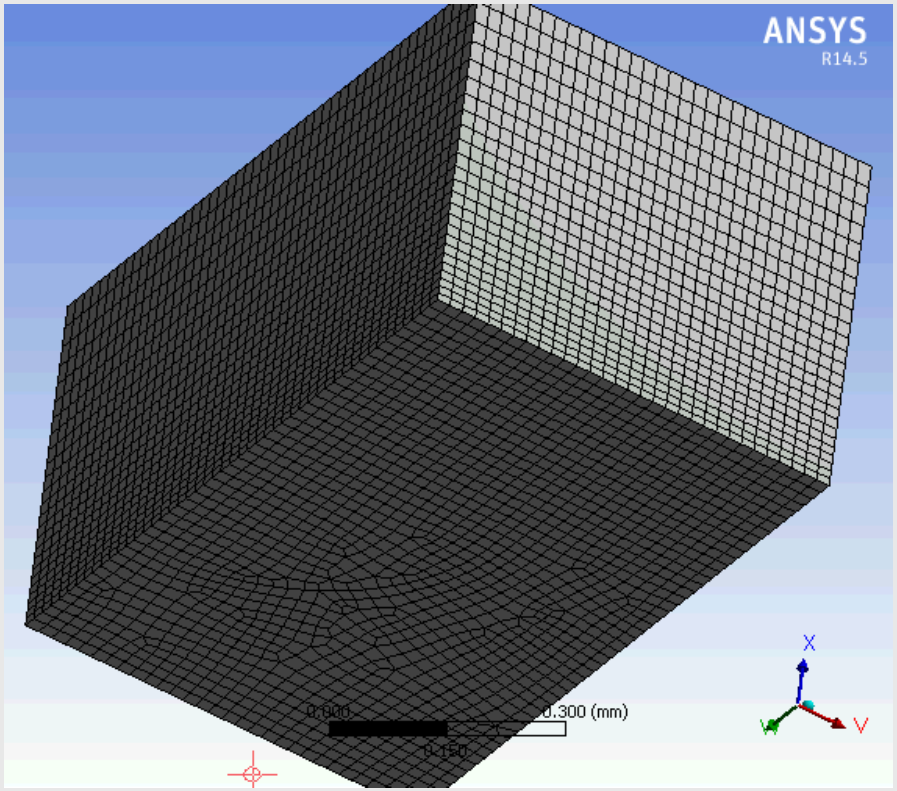


Meshing for VOF

- Uniform sized hex elements
- Gradual transition from refined regions
- Low skewness & aspect ratio

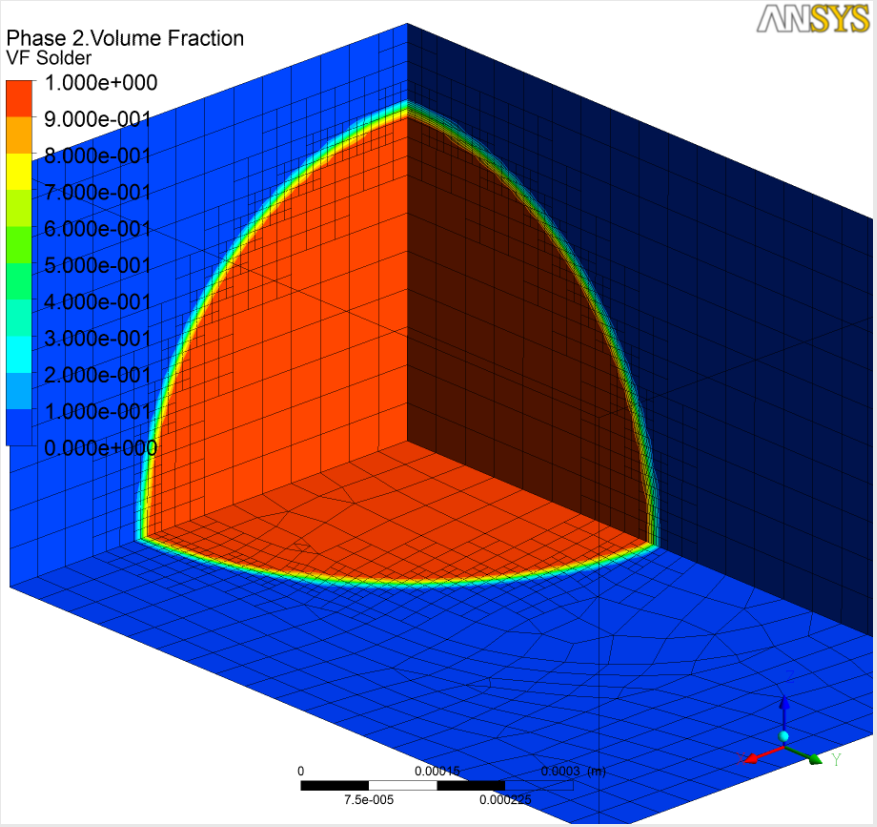


Recommendations from ANSYS Knowledge Resources

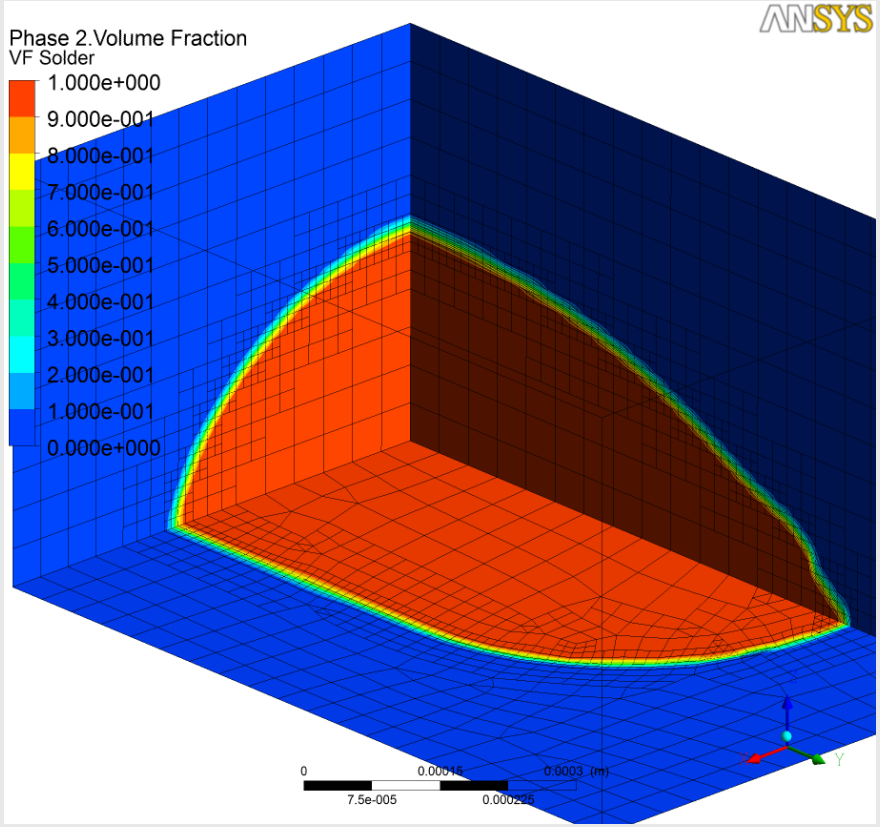


Skewness

Adaptive Meshing

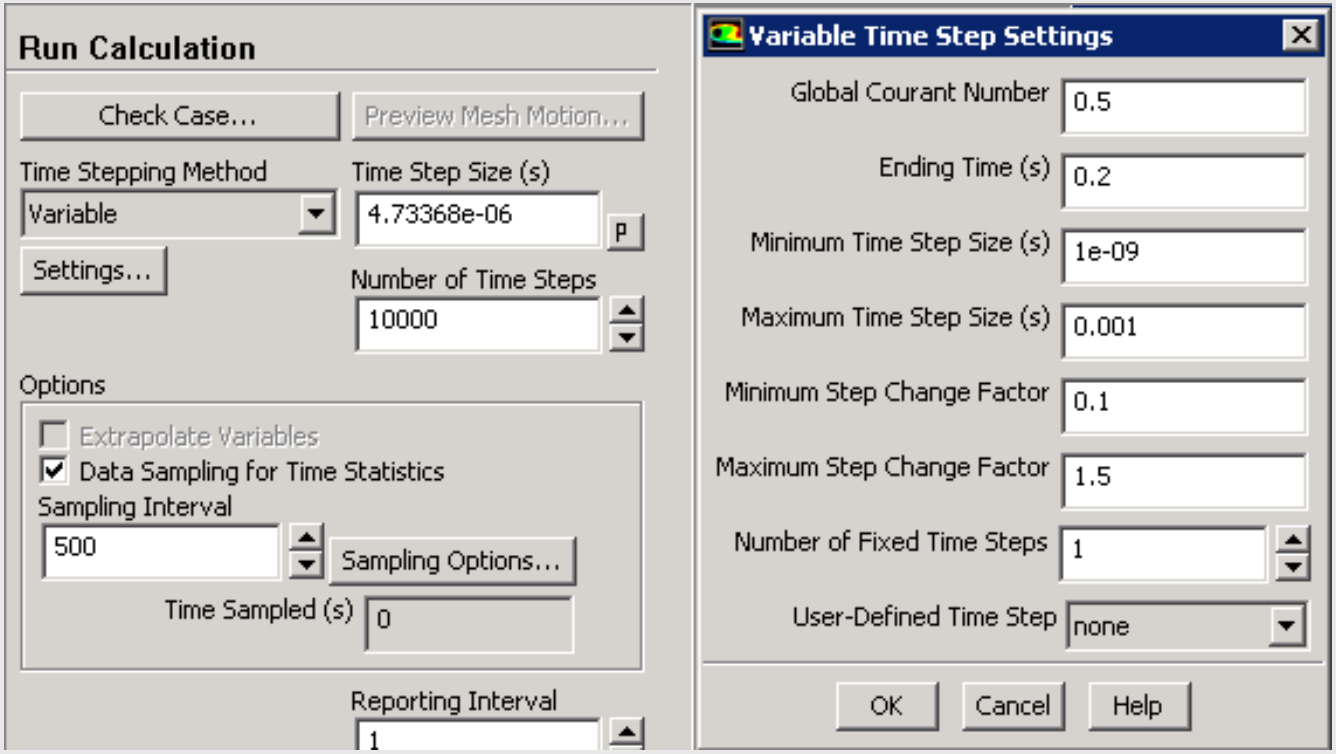


Time = 0 ms



Time = 13 ms

Time Stepping



Variable Time Stepping

Global Courant Number

Data Sampling

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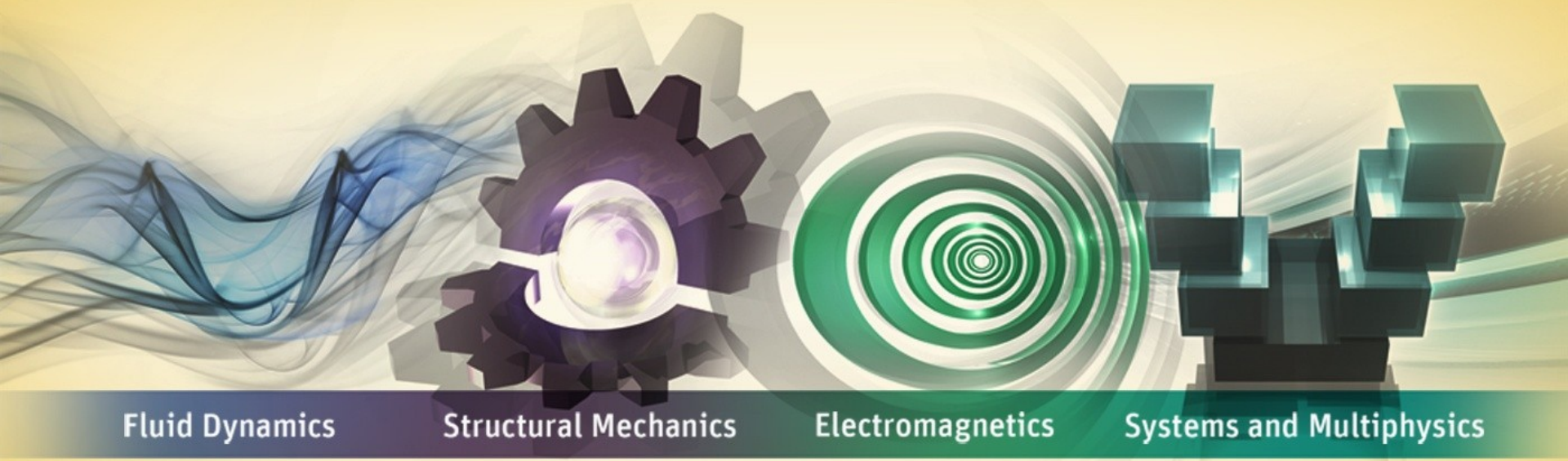
END

Thanks for your attention !!!

Questions ?



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