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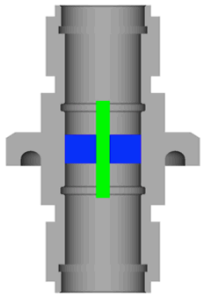

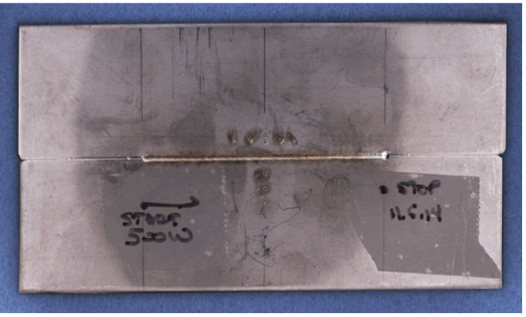

Analysis of Laser Weld Induced Stress in a Hermetic Connector

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D. MacCallum, M. Neidigk, J. Dempsey

June 11, 2015

2015 SEM Conference

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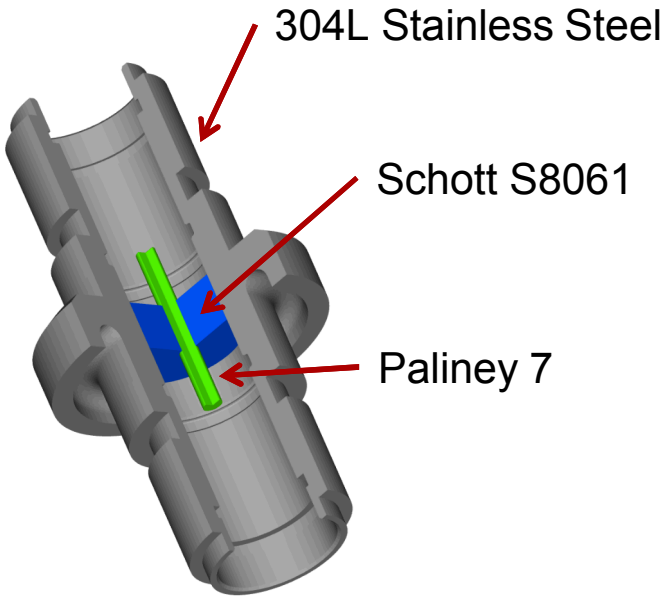
- Introduction
- Laser welding experiments
- Glass sealing cycle
- Laser welding analysis
- Conclusion

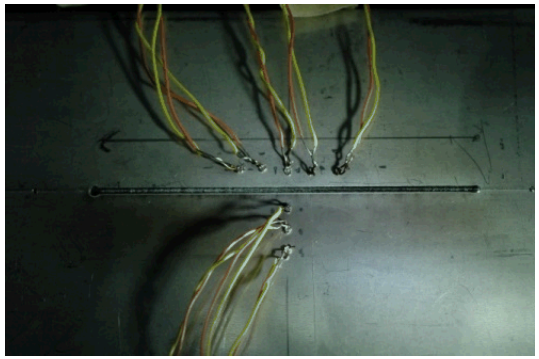
Introduction

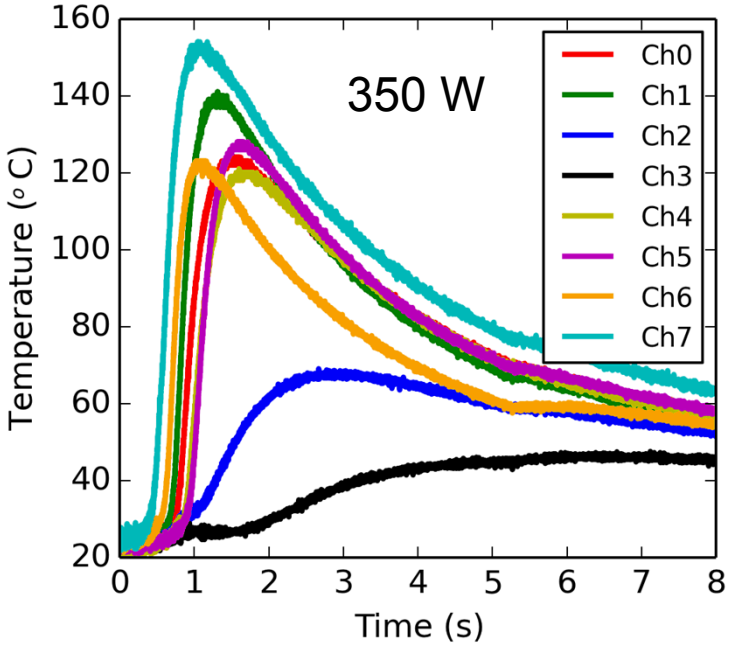
- What is a hermetic connector?
  - Matched seals
  - Mismatched (compression) seals
- Attachment methods
  - Welding
  - Soldering/brazing
  - Mechanical
- Residual stress
  - Sealing cycle
  - Laser welding

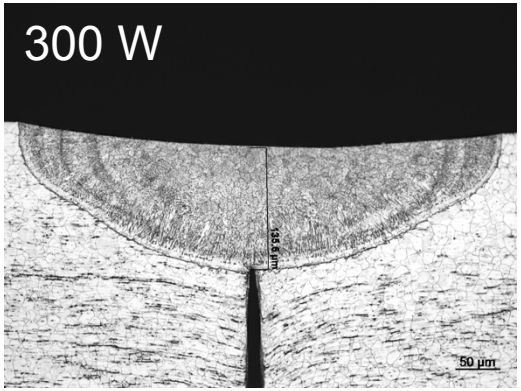


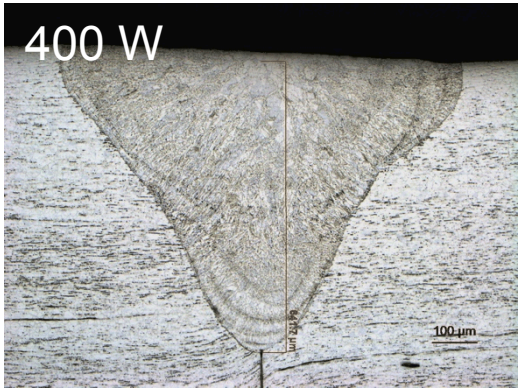
Weld Bead on Sheet Experiments

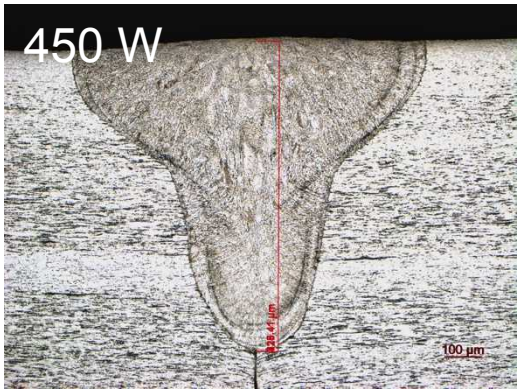
- Power: 300 – 500 W
- Measure temperature and weld penetration depth

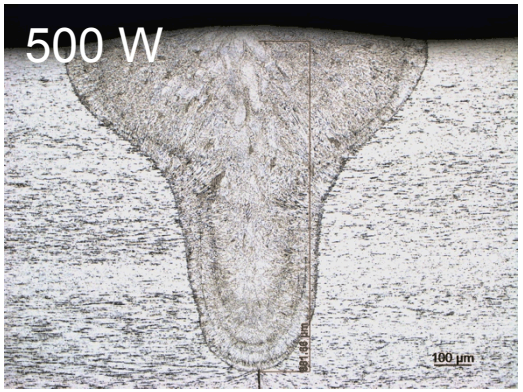






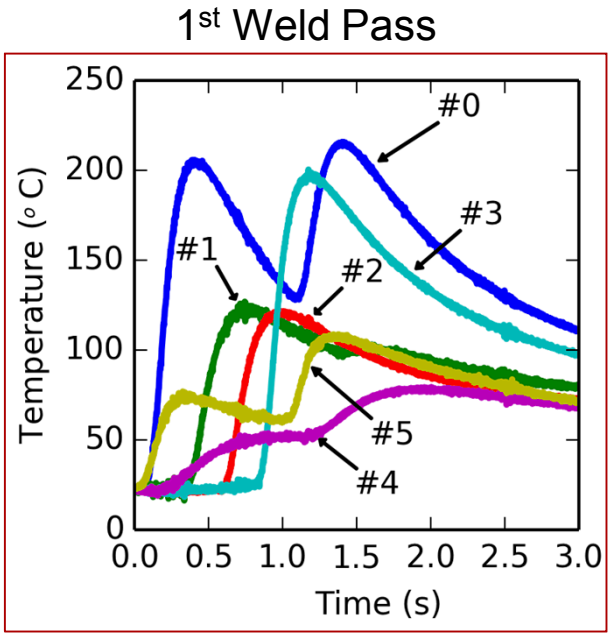


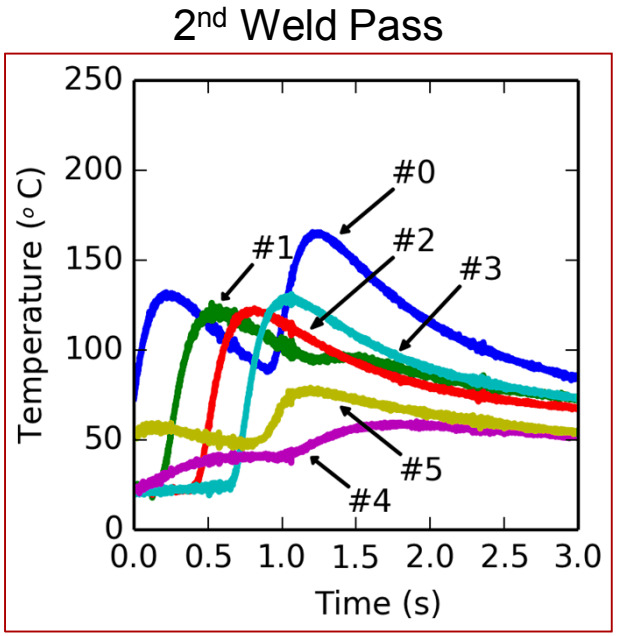


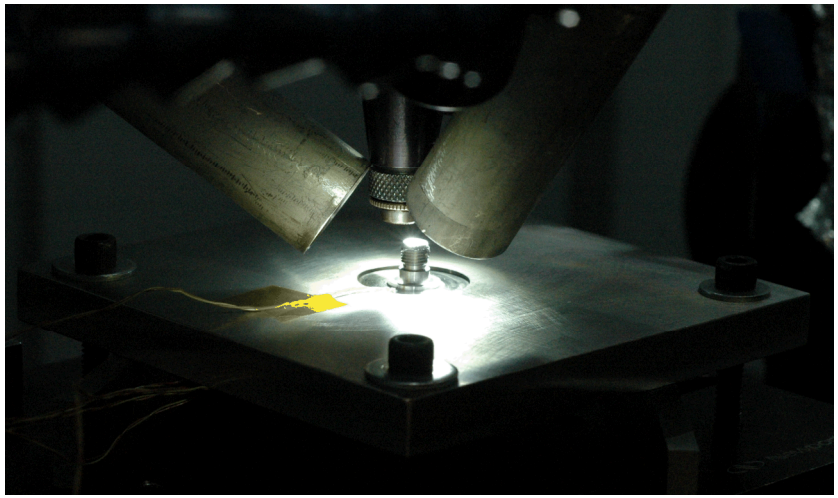


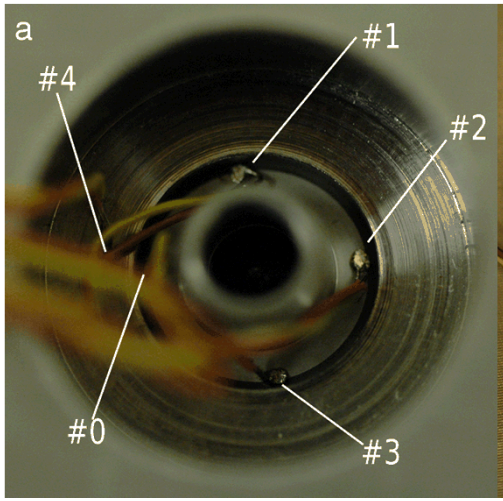
Hermetic Connector Weld

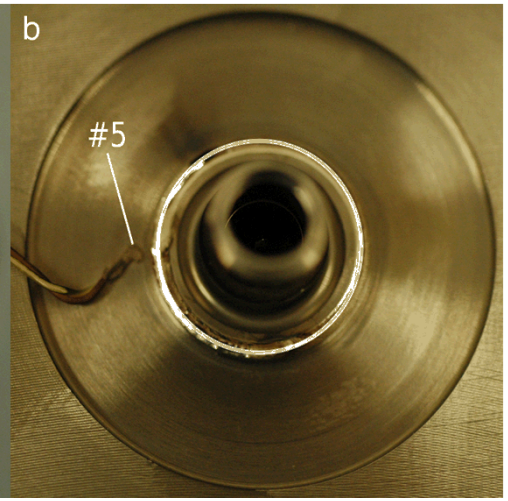
- Power = 338 W
- Transition from Conduction to key hole mode





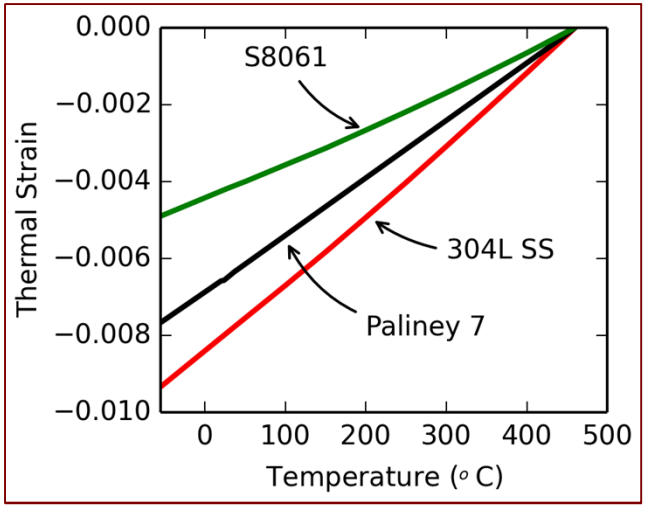


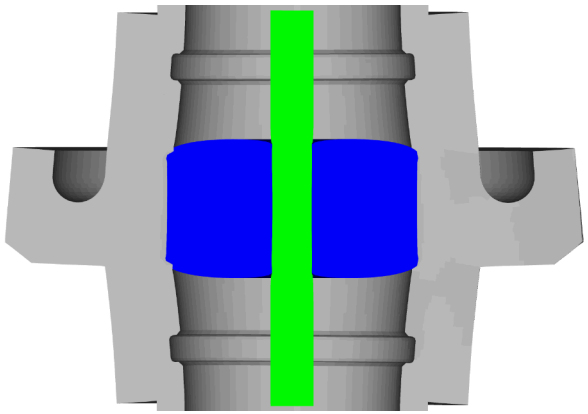




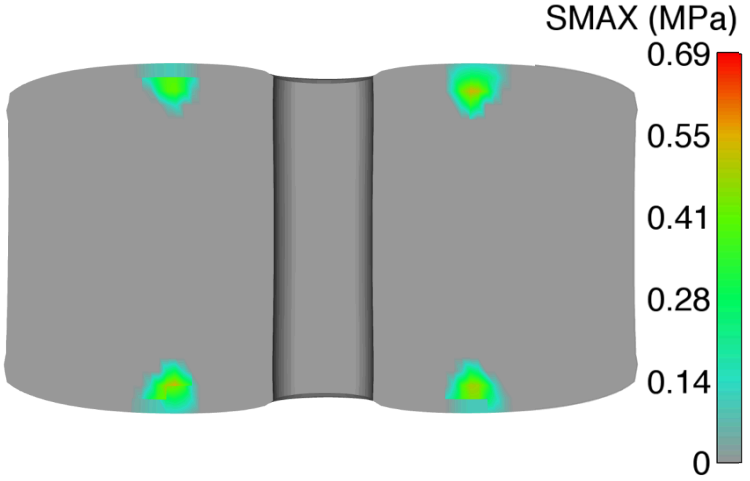
Glass Sealing Cycle

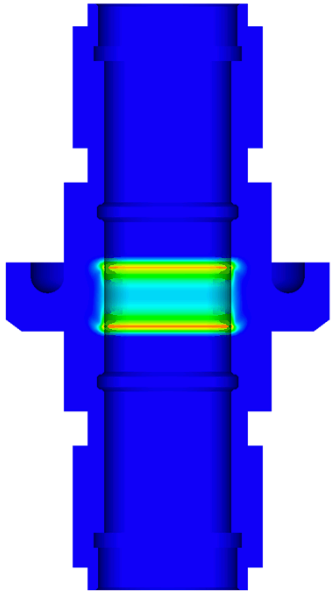
- Cool from 460 ° C to room temperature
- CTE mismatch causes residual stress
- Paliney contact does not yield





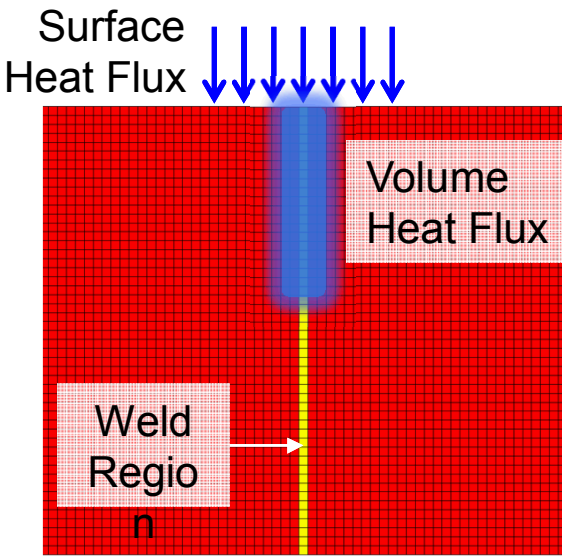
50x Deformation





Max EQPS 0.9 %

Laser Weld Modeling

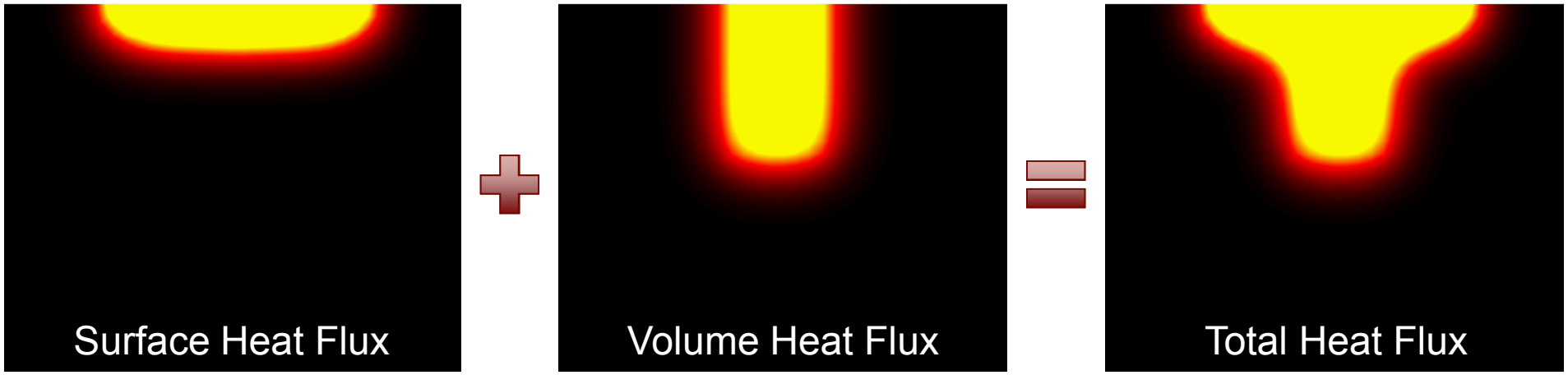


Uncoupled thermal-mechanical analysis

Mechanical

Mechanical response of weld region

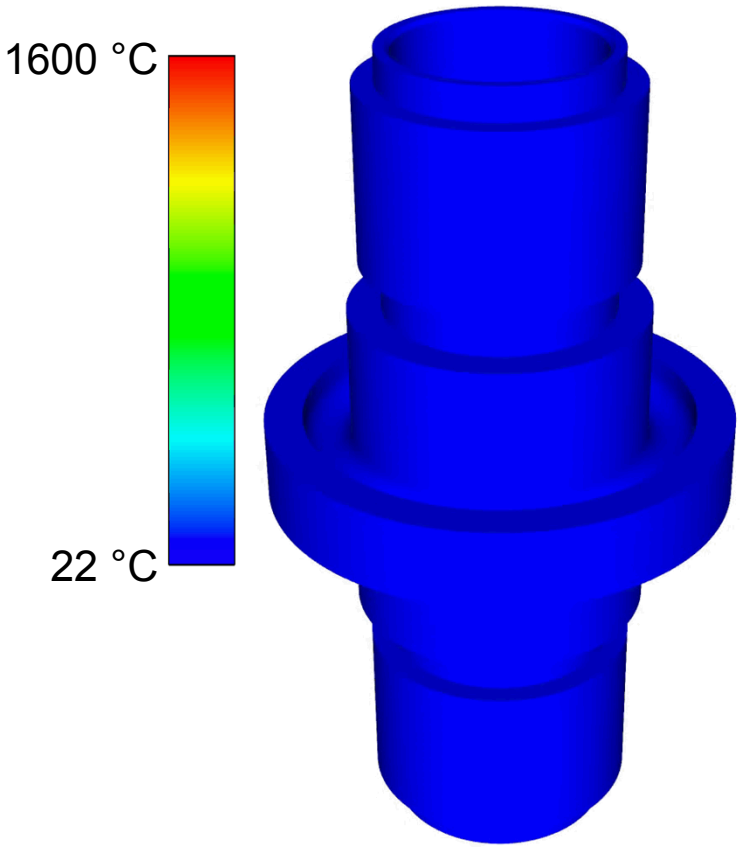
- Power law hardening
- Low stiffness prior to welding
- Melt temperature triggers higher stiffness

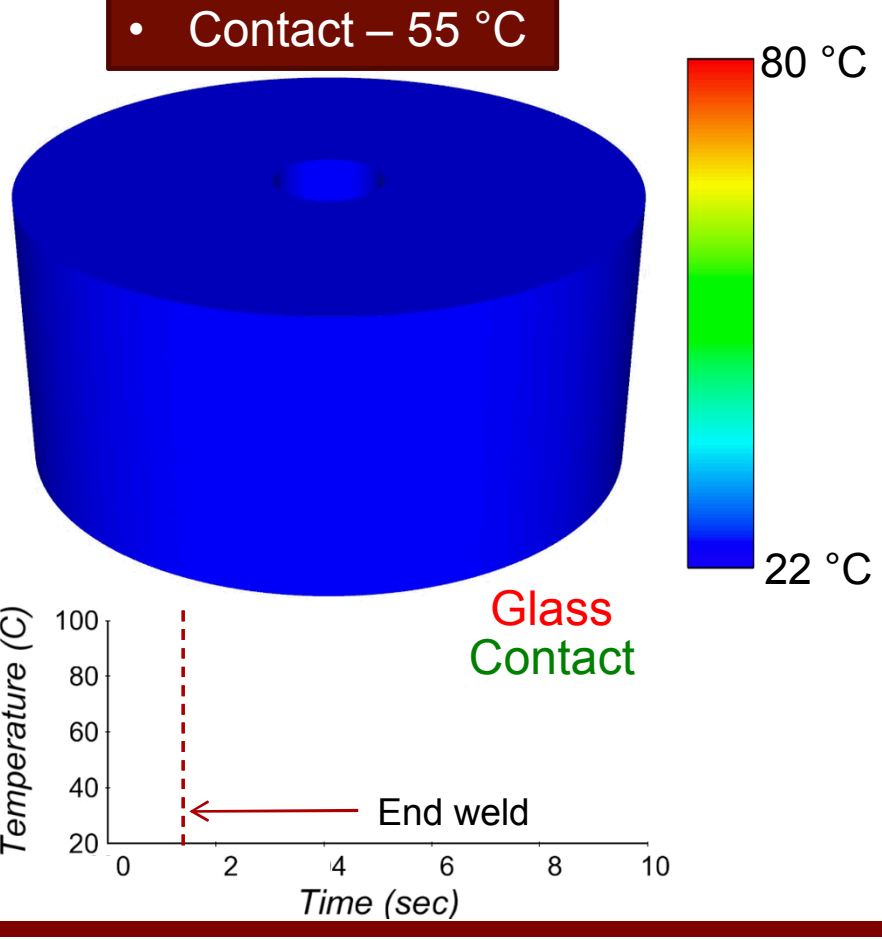


Laser Weld Thermal Results

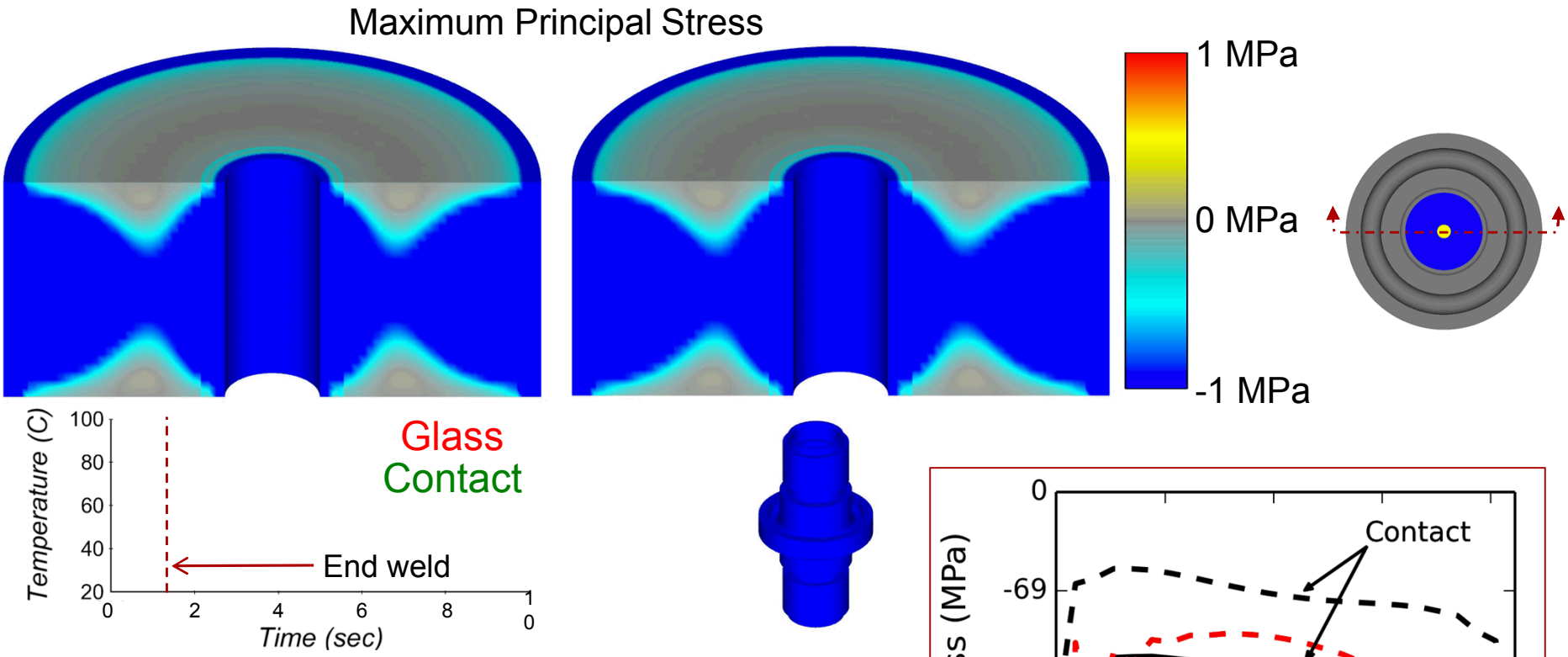
- Power = 350 W & speed = 33.8 mm/sec (80 ipm)
- Overlap = 40˚ , Ramp down = 40˚

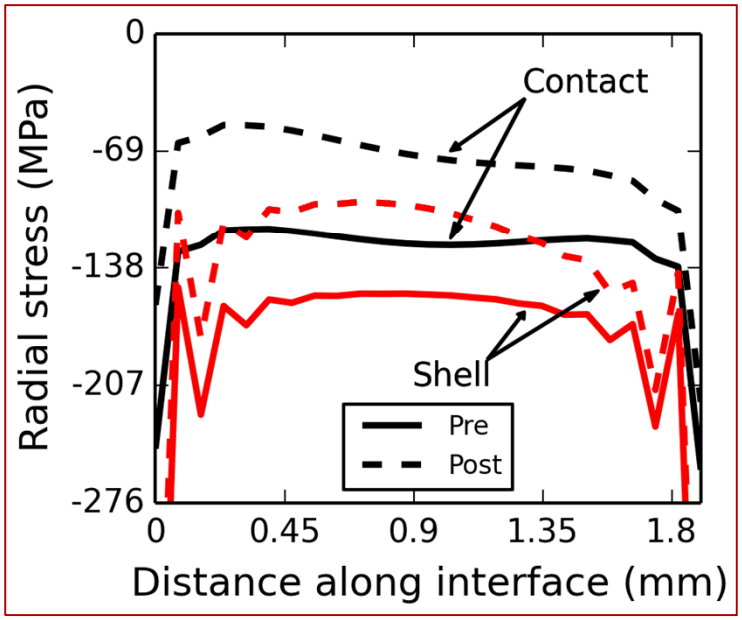
Peak temperatures
- Glass – 80 °C
- Contact – 55 °C





Laser Weld Residual Stress





- Peak stress increases by 1 MPa
- Weld results in a decrease in compression
- Peak stress location relates to weld overlap

Conclusion

- Experimental study of laser welded hermetic seal
- Low residual stress post sealing cycle
- Simple laser weld model applied to hermetic seal
- Temperature increase by 60 ° C resulting in localized changes in residual stress
- Compression in seal decreases by nearly 70 MPa