

Designing for Residual Stress with Glass



PRESENTED BY

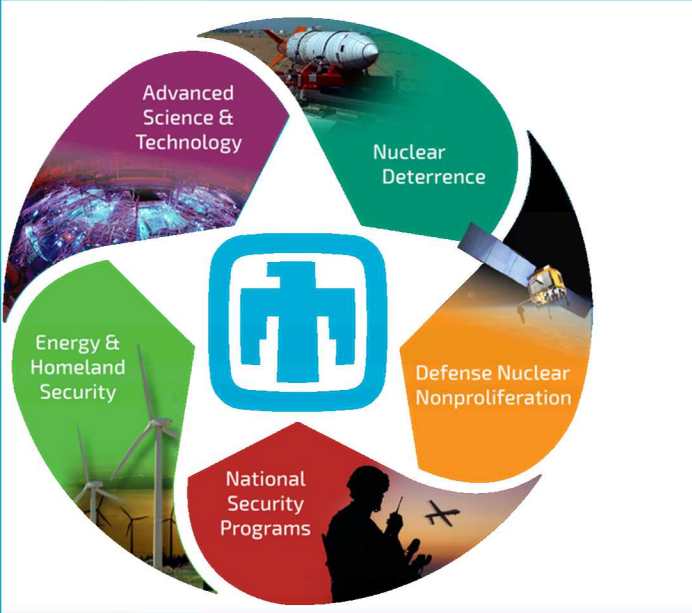
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SAND2018-XXXX



Sandia's Budget Covers a Broad Range of Work



OTHER
 Department of Homeland Security
 Other federal agencies | Nonfederal entities
 CRADAs, licenses, royalties | Inter-entity work



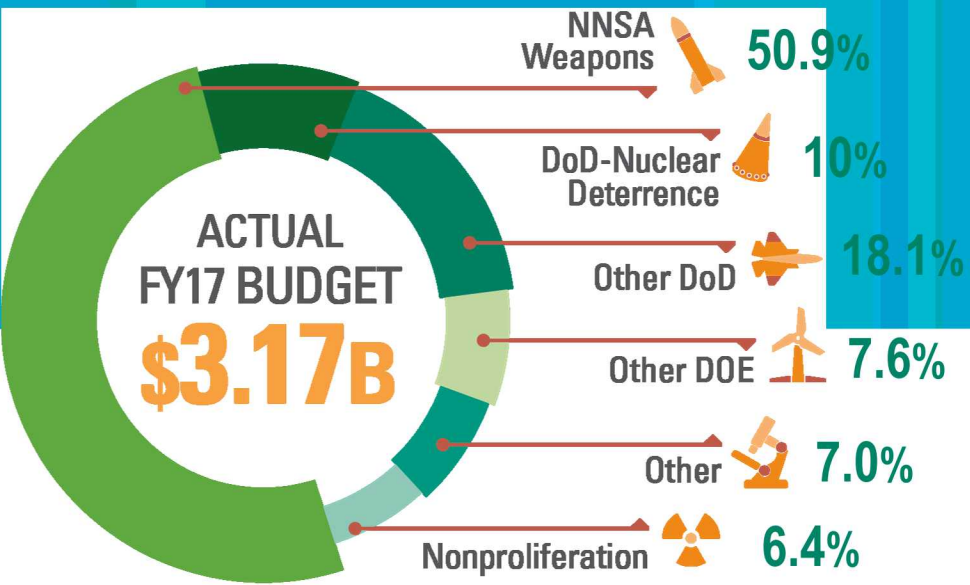
DoD
 Air Force | Army | Navy
 Defense Threat Reduction Agency
 Ballistic Missile Defense Organization
 Office of the Secretary of Defense
 Defense Advanced Research Projects Agency
 Intelligence Community



OTHER DOE
 Science
 Energy Efficiency and Renewable Energy
 Nuclear Energy
 Environmental Management
 Electricity Delivery and Energy Reliability
 Other DOE



NONPROLIFERATION
 NNSA/NA20 | State Department



3 Opportunity Space



Residual Stress is a common concern for additively manufactured components

- Additive manufacturing techniques impart uncontrolled residual stress into parts
- This causes warpage of metals and polymers after they are removed from their print bed
- Significant research and money has been invested to eliminate and reduce residual stress

Computational modeling has begun to predict residual stress in parts

Can residual stress be a benefit instead of a defect?

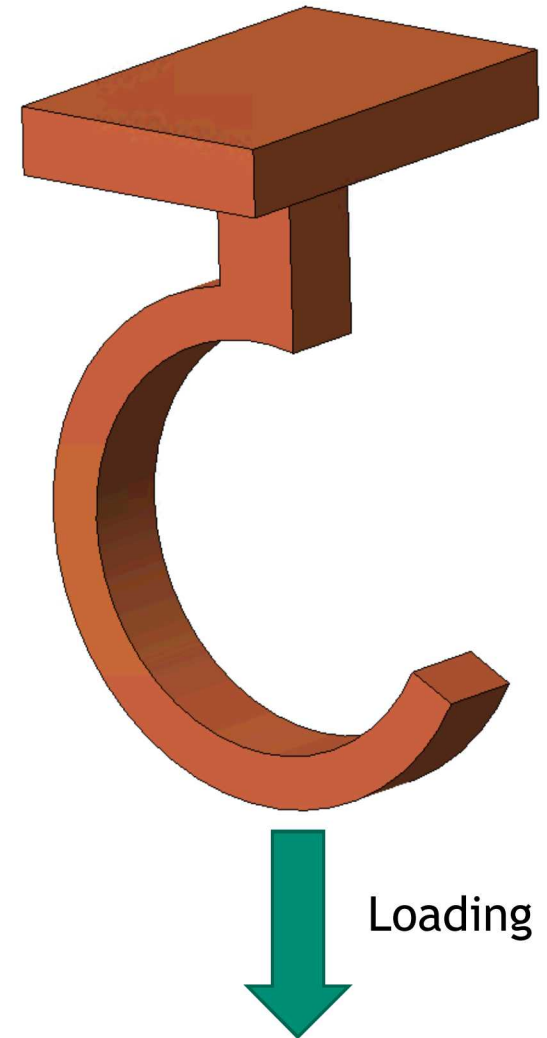
4 Project Goal: Design for Residual Stress

Controlled residual stresses in a design would enable the material to appear “stronger” and provide designers with the option to reduce weight or improve margin

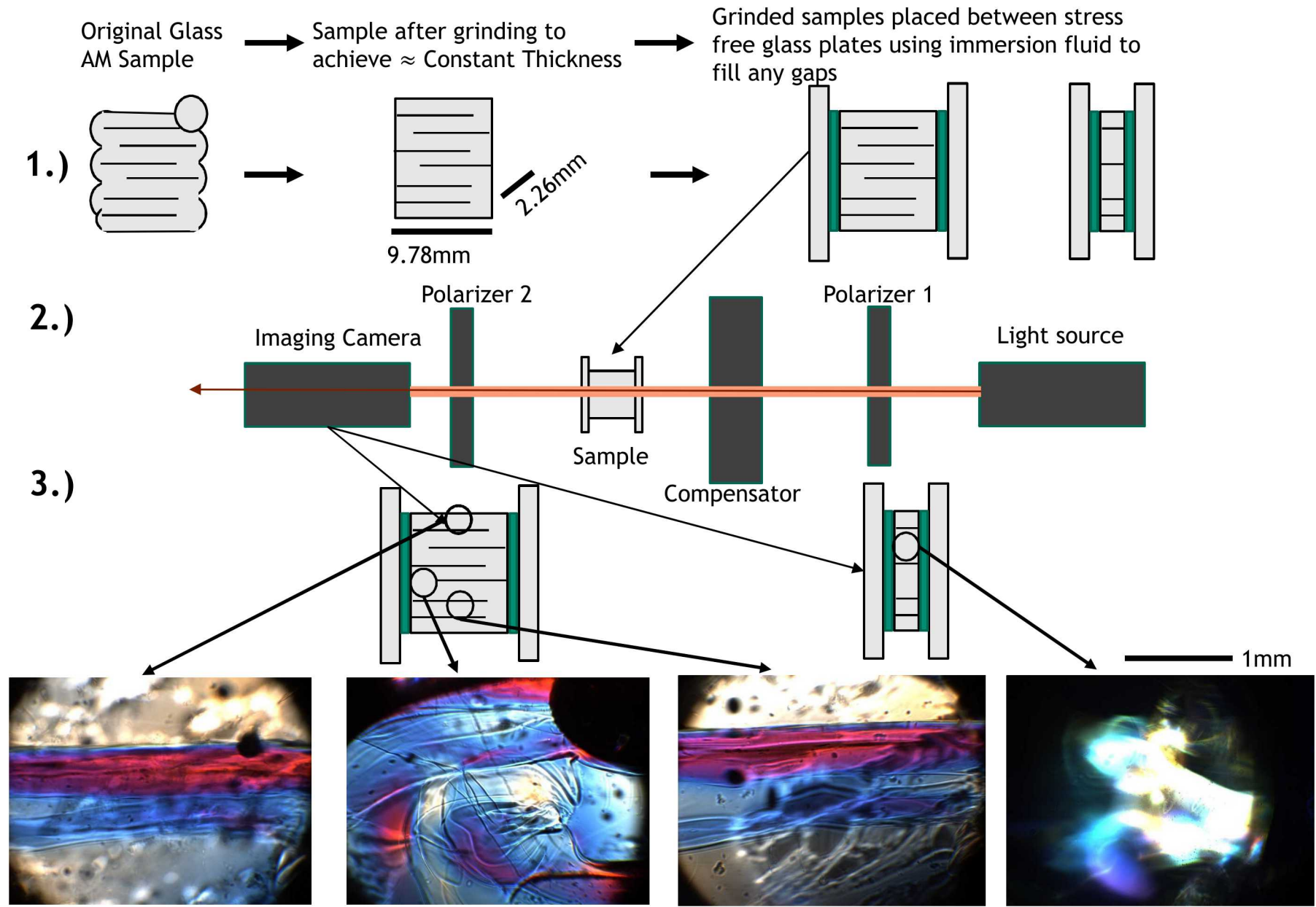
Tailored residual stress would provide a new opportunity for additive manufacturing

Demonstrator Project Steps:

- Identify Simplistic Exemplar
- Identify Materials
- Characterize Materials and Validate Material Models
- Demonstrate Exemplar



Glass Characterization Setup



6 Glass Characterization – Pt. 2



Without Rotation

30 W

45 W

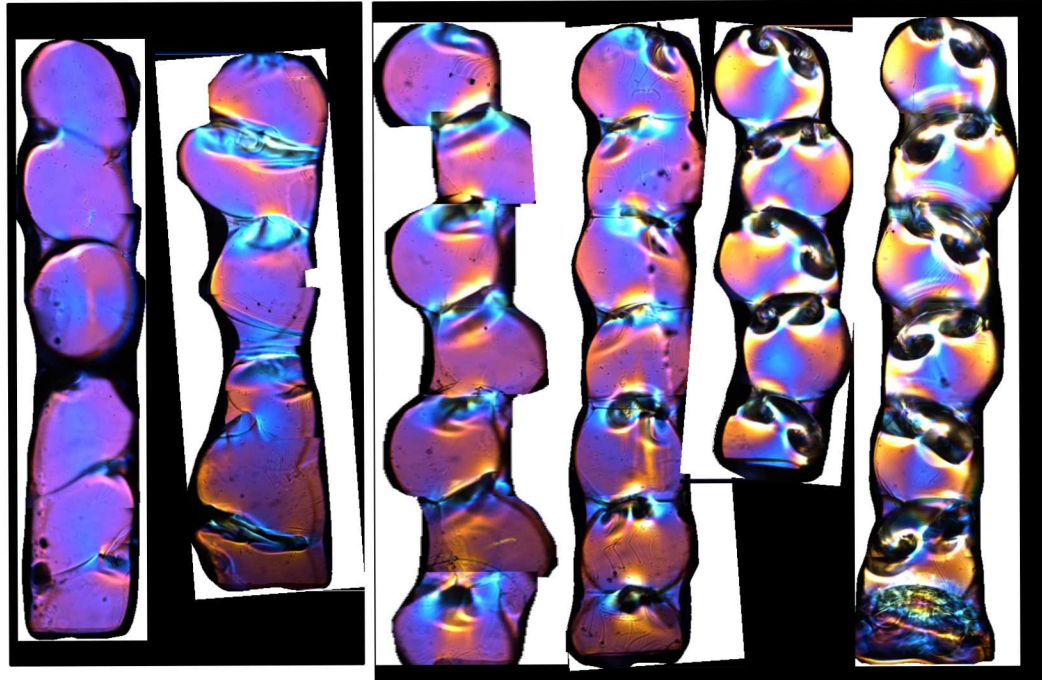
With Rotation used at corners of wall

25 W

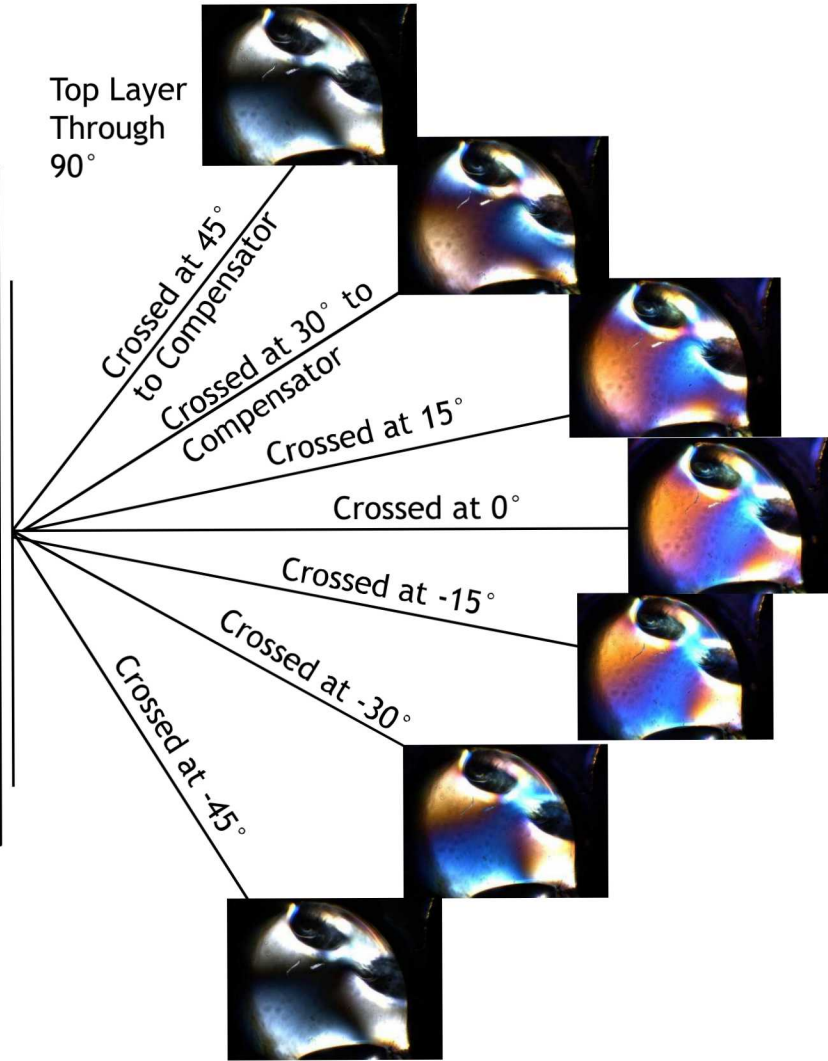
30 W

45 W

55 W



Top Layer
Through
90°



Blue = Tension

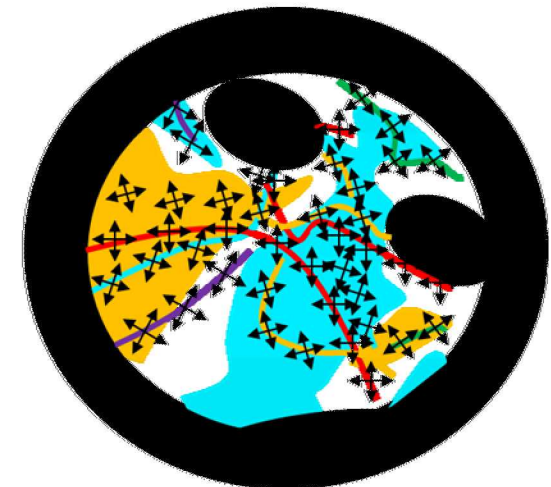
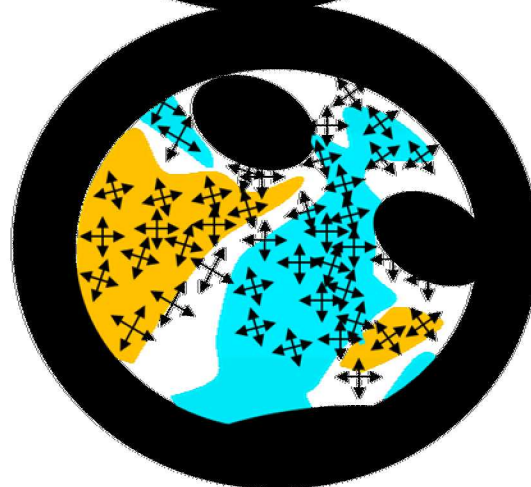
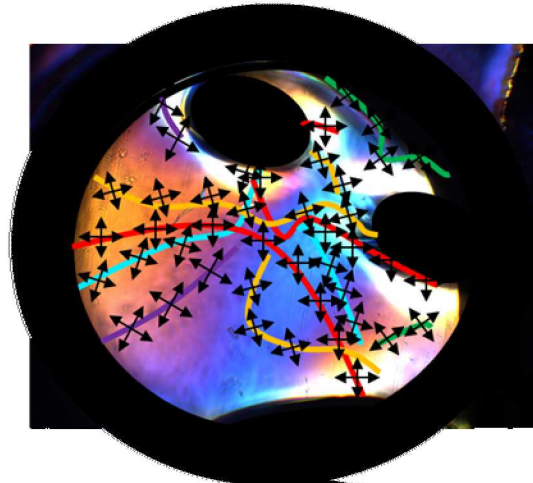
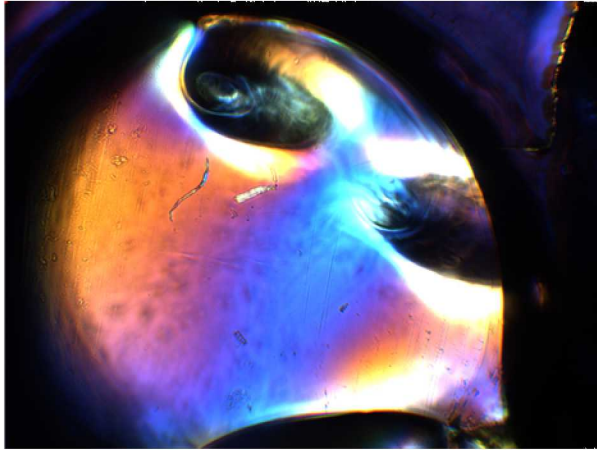
Orange = Compression

Full Sample Image

Top layer imaged through 90° of polarizer rotation

Black lines that move through rotation are lines of stress containing the same direction of principle stresses that are parallel to the polarizers configuration

7 Glass Characterization – Pt. 3



Stress from additively manufactured glass can be mapped via known methods and used to calibrate models

8 Next Steps



Refine models to include higher order effects

Characterize more fabricated glass

Demonstrate design for residual stress with simple exemplar



Questions