

Team 2– Biaxial Tensile Tester

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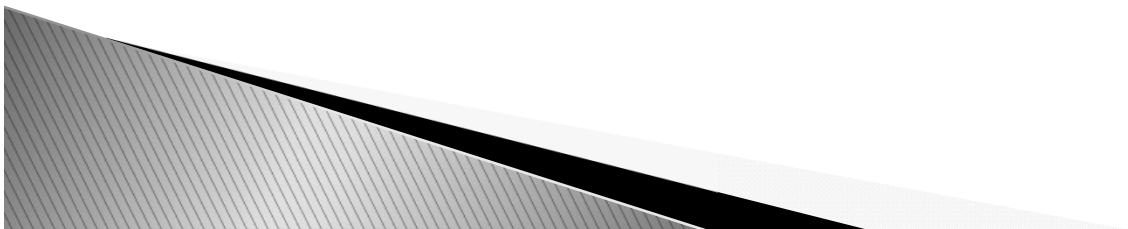


Agenda

- Background/ Project Scope
- Specimen Geometry
- Material Testing
- Device Modifications
- Assembly
- Cable Testing
- Budget and Procurement
- Future Plans

Nomenclature

- Carriers
- Grips
- Specimen Design
- Baseplate
- Linear Rods
- Bushings
- Wire End Fittings



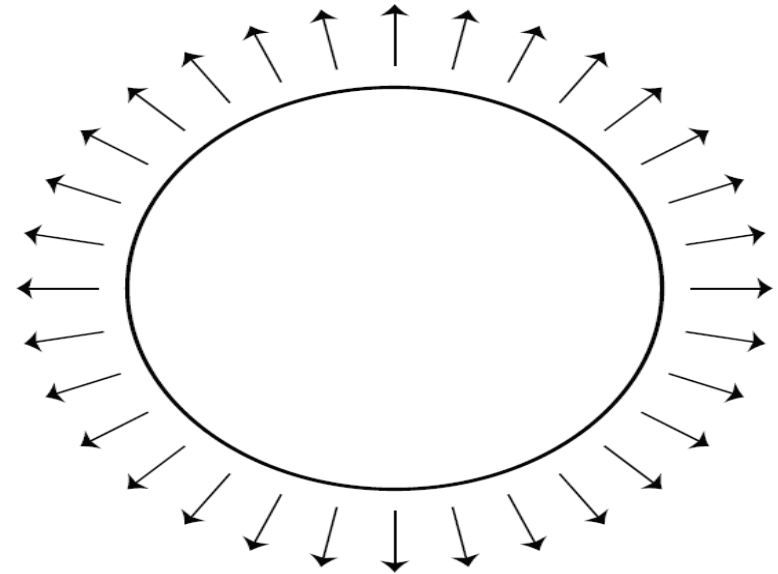
Material Characterization

- In order to model materials, accurate predictions of properties are needed
 - **Uniaxial tension**
 - Standard tensile test
 - **Pure shear**
 - Planar tension test
 - **Uniaxial Compression**
 - Inaccurate due to the friction
 - Causes a mixed state of compression, shear, and tensile strain¹

1. Callister, W.D. (2007). *Material Science and Engineering, An Introduction*; 7th ED. York, PA: John Wiley & Sons, Inc.

Why Equal Biaxial Tension?

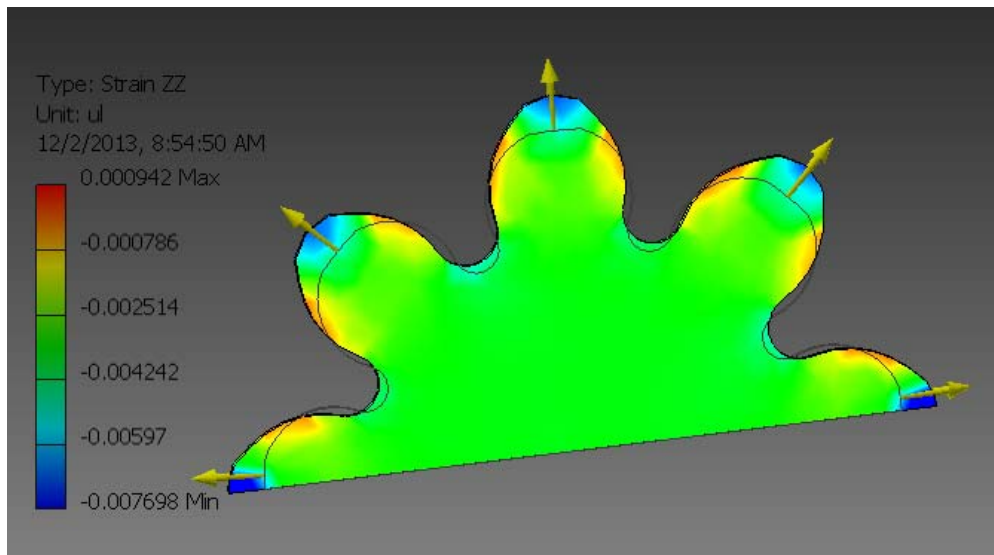
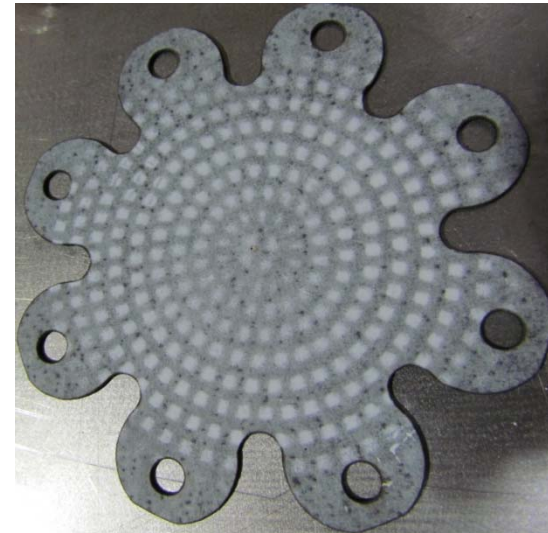
- Biaxial tensile strain is equivalent to uniaxial compressive strain¹
- Poisson's Ratio nearly 0.5
 - Means a process of constant volume
- Free of external frictional effects²



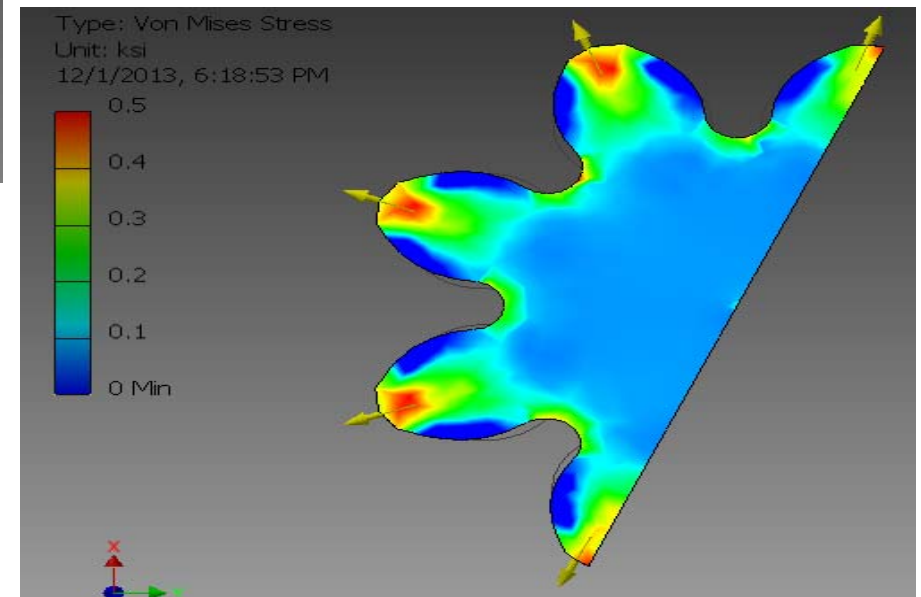
Ideal Equal Biaxial Stress State¹

1. Callister, W.D. (2007). *Material Science and Engineering, An Introduction*; 7th ED. York, PA: John Wiley & Sons, Inc.

Final Specimen Geometry



The strain profile in the ZZ plane after load is applied



The resulting Von Mises Stresses as force was applied radially

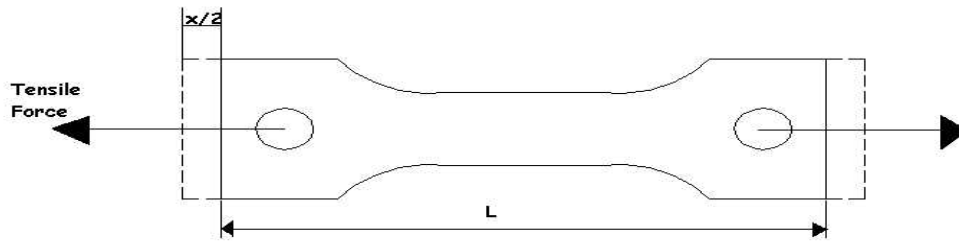
Manufacturing Specimen Geometry

- Gasket and rubber material cut with laser CNC
- Rule Die
 - Total cost ~\$200



Material Testing

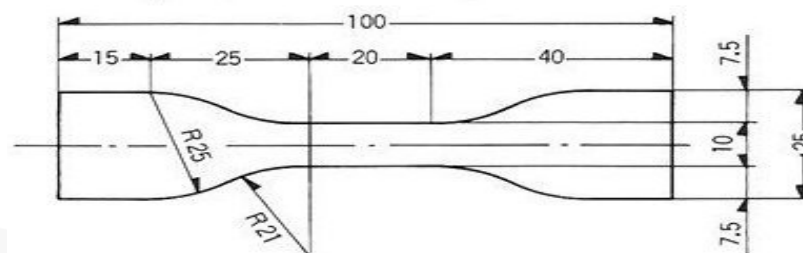
- Dogbone Samples
 - Red Rubber
 - Gasket Materials
 - Width Ratio of 1.27



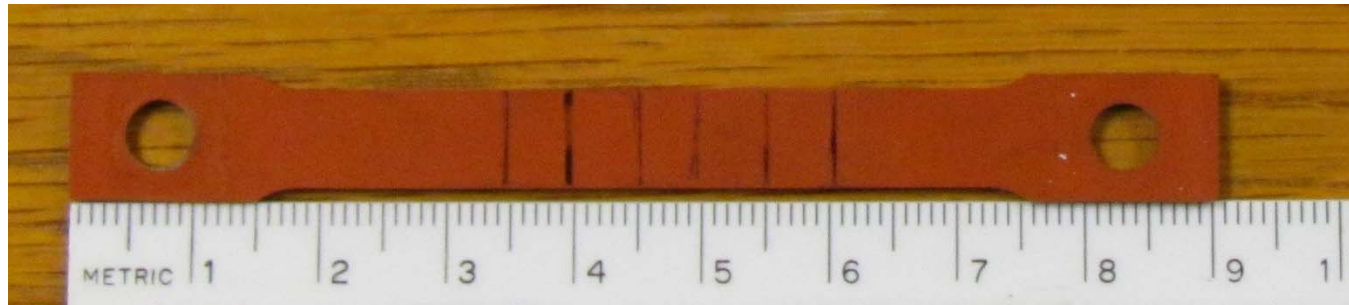
- Dumbbell Samples
 - Black Rubber
 - Width Ratio of 2.2



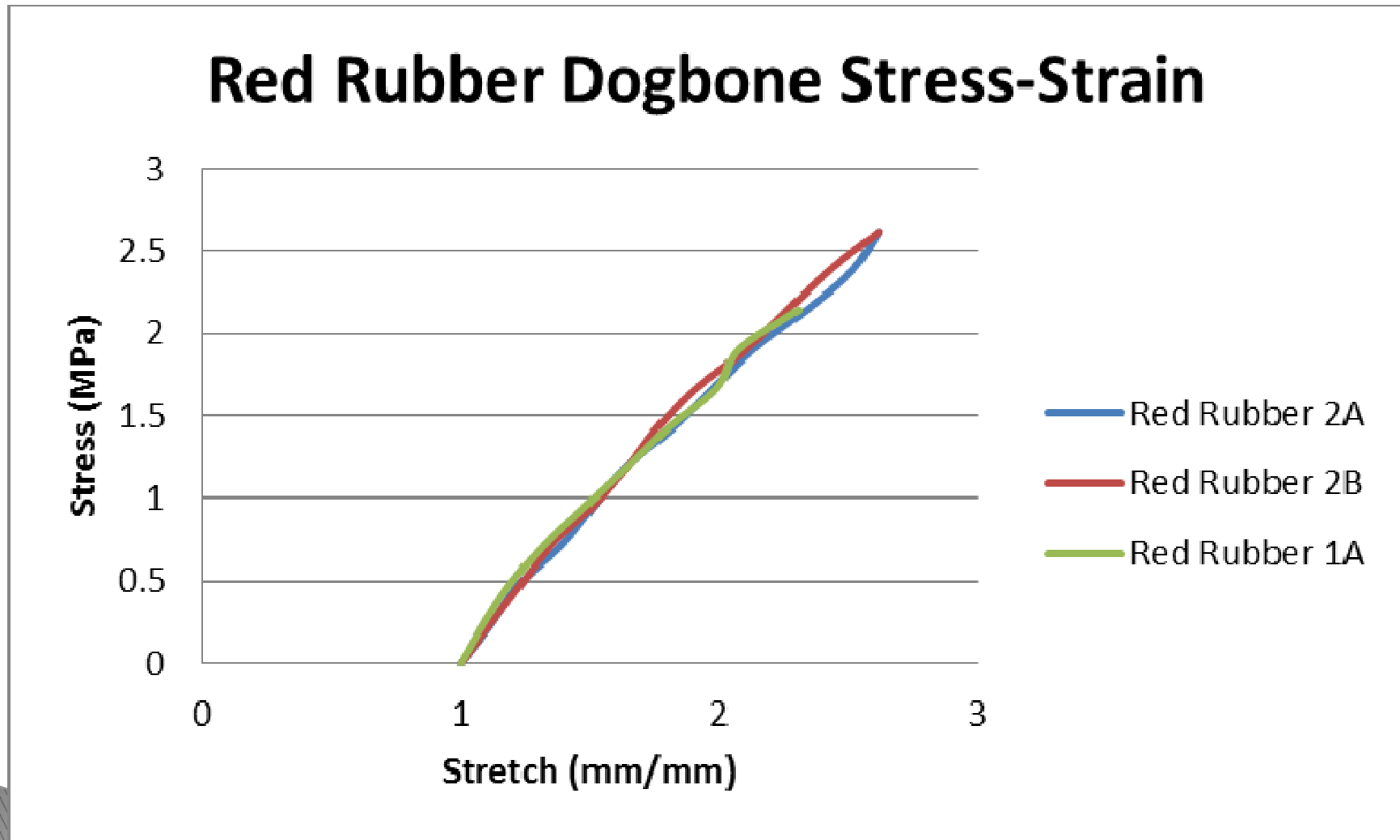
JIS K6251-2, JIS 6301-2



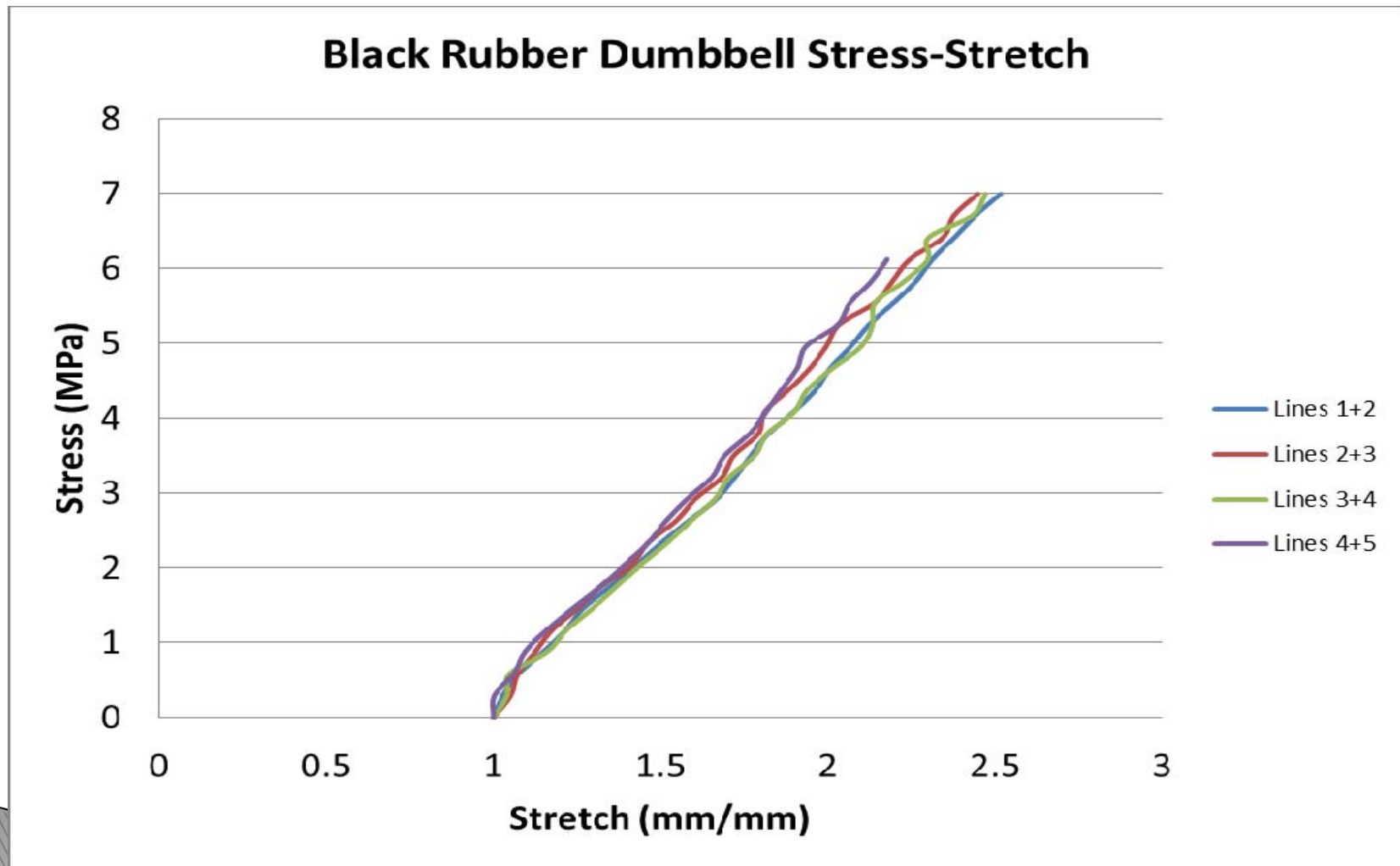
Material Testing (Cont.)



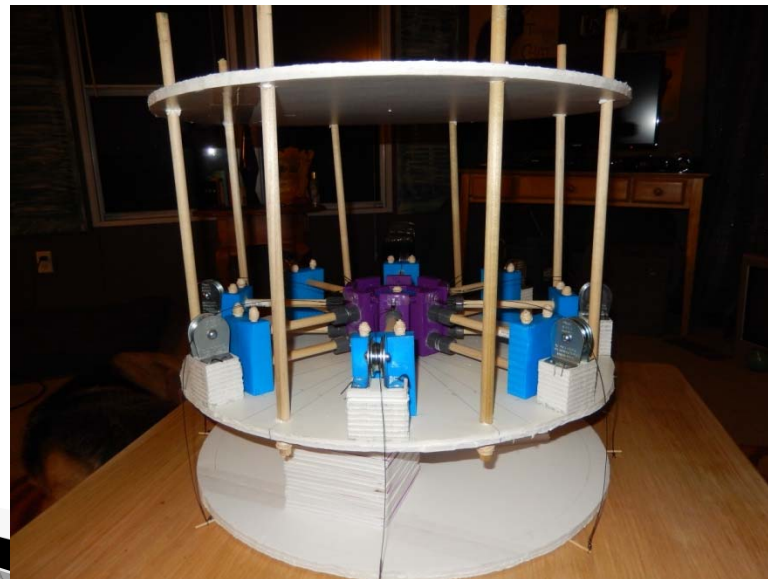
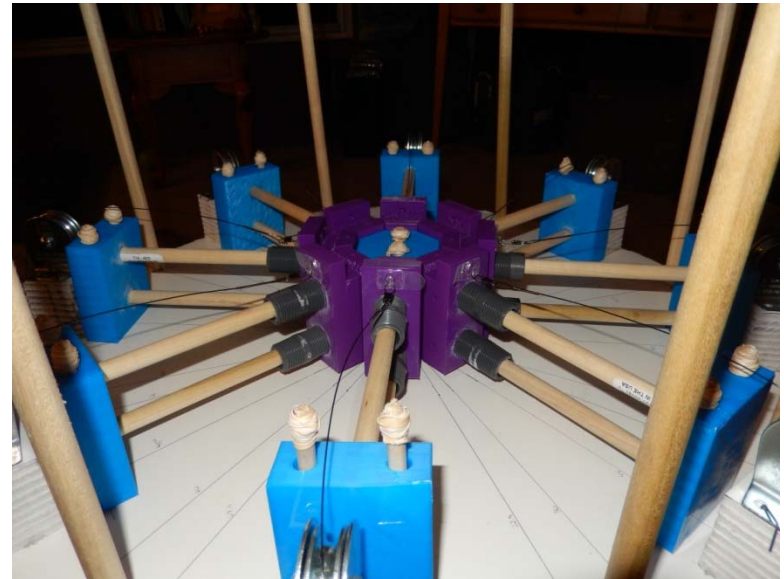
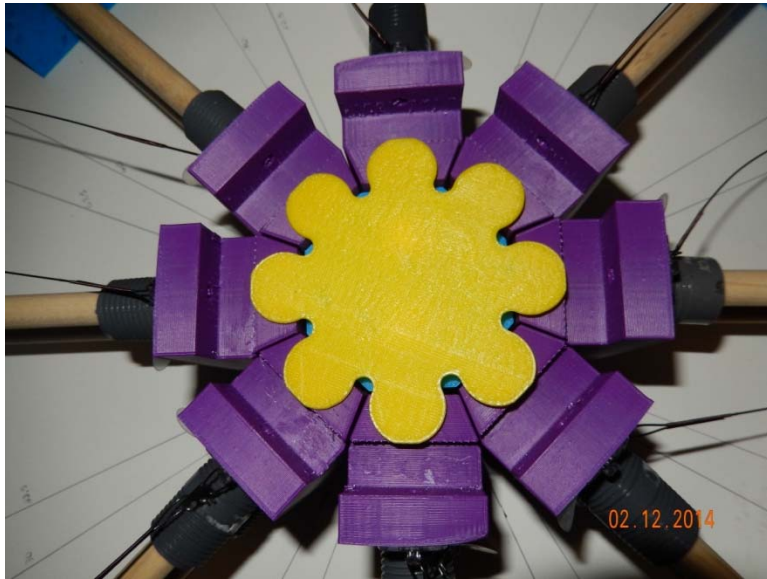
Material Testing (Cont.)



Material Testing (Cont.)



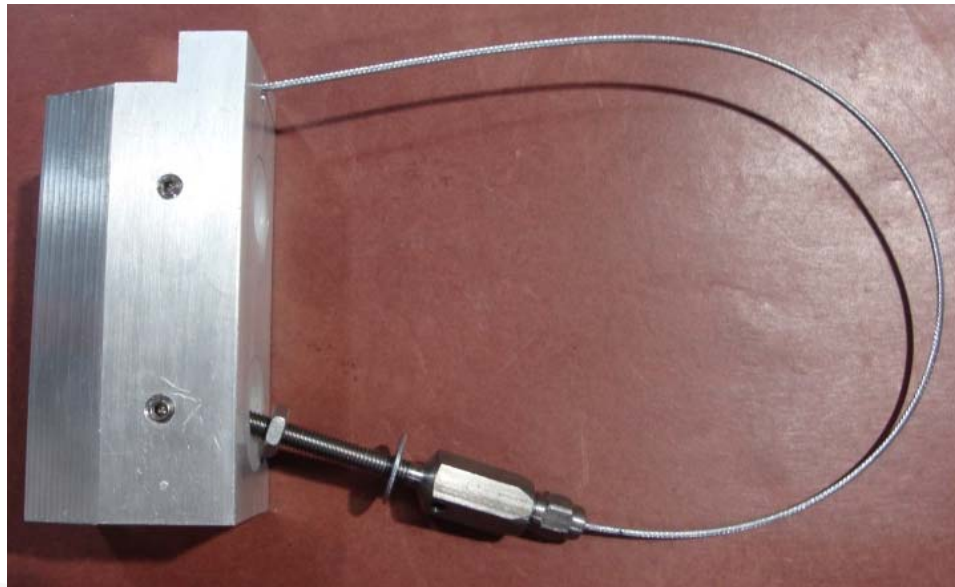
Model



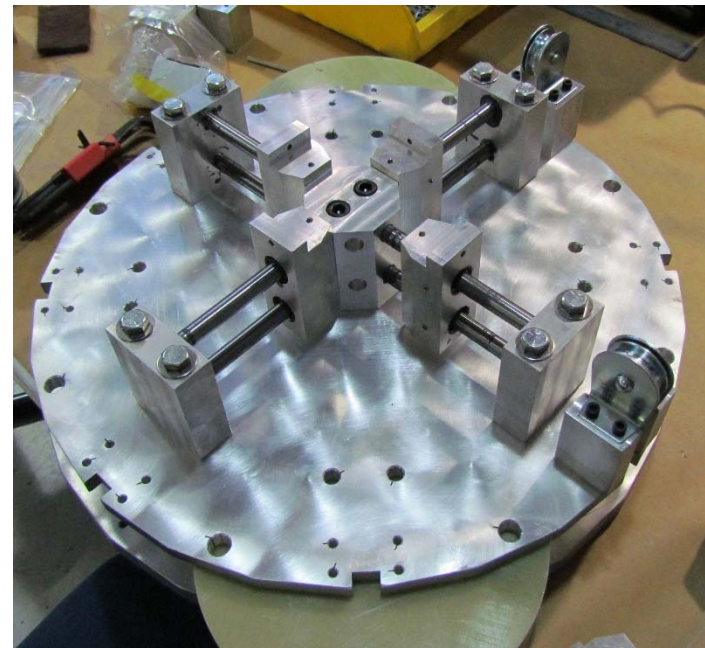
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Device Modifications

- Cut down diameter of all plates by 5 inches
 - Reduces weight by ~50 lb
- Carriers were modified for cable attachment

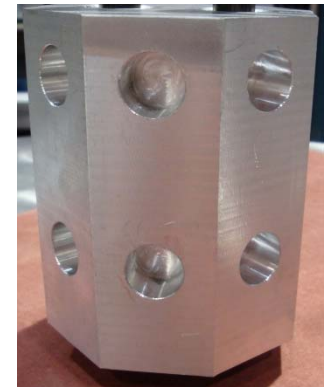
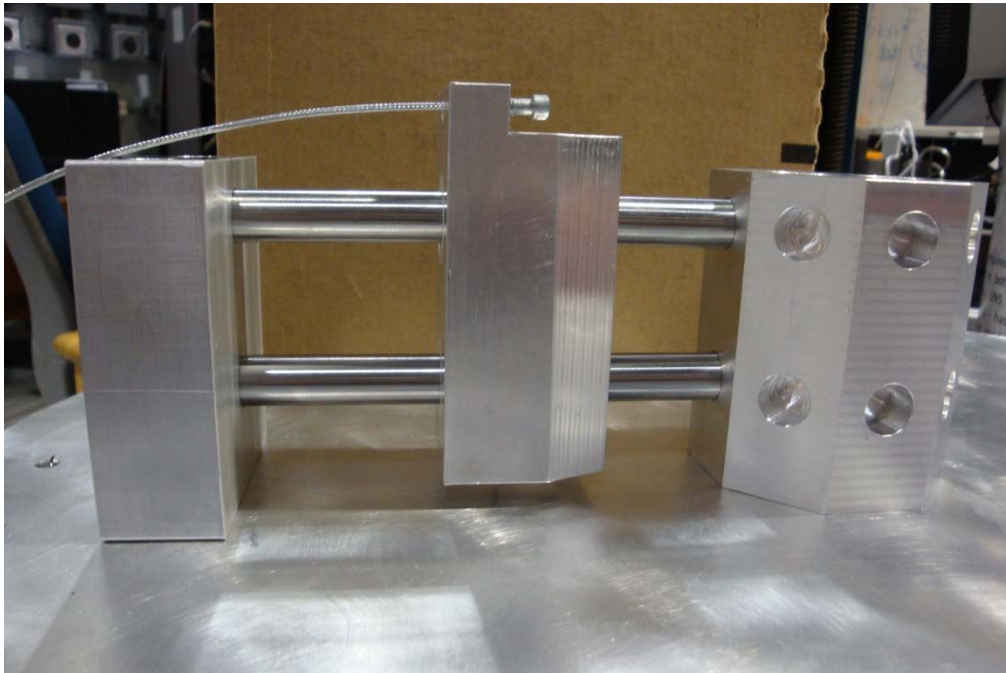


Assembly

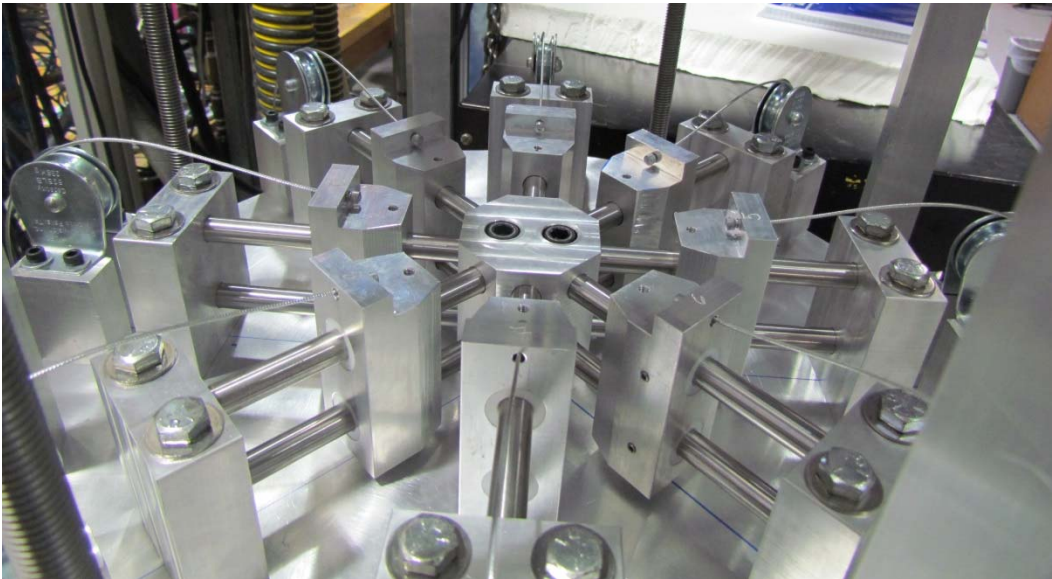


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Prototype Components

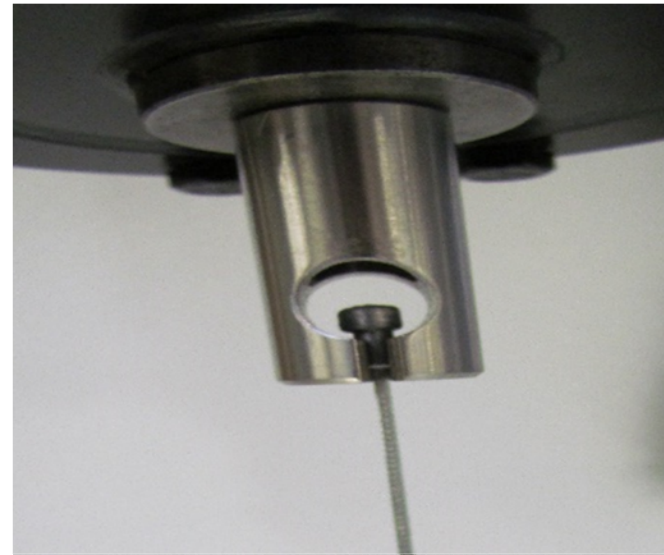
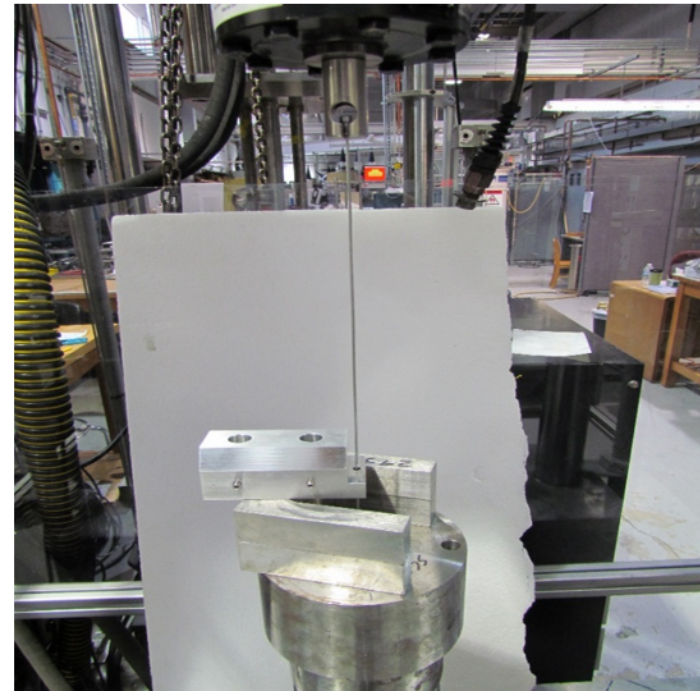
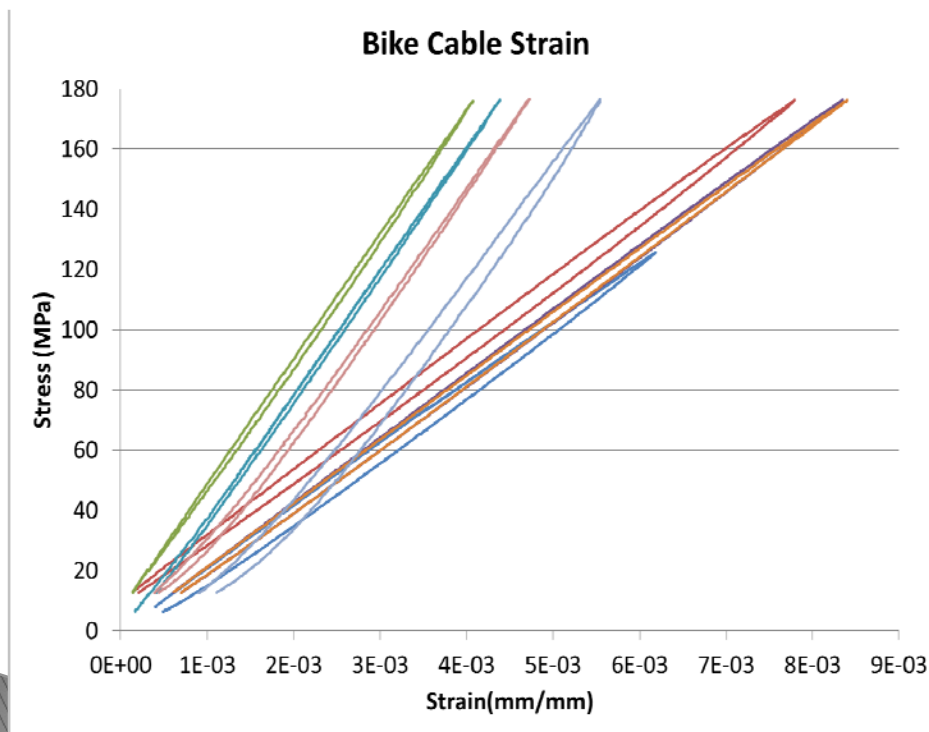


Prototype



Cable Testing

- Tested actual cables to be used
- Performance of the passing cables was excellent
 - Max. Stretch: 2.45mm over entire length of cable

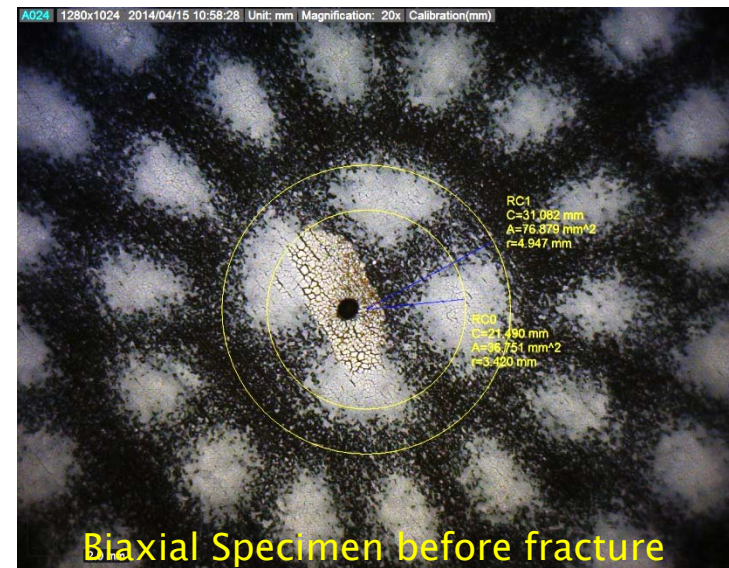
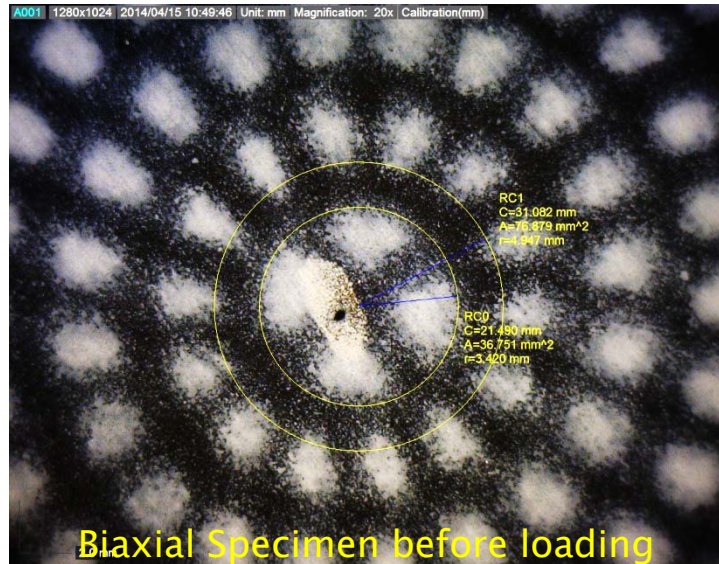
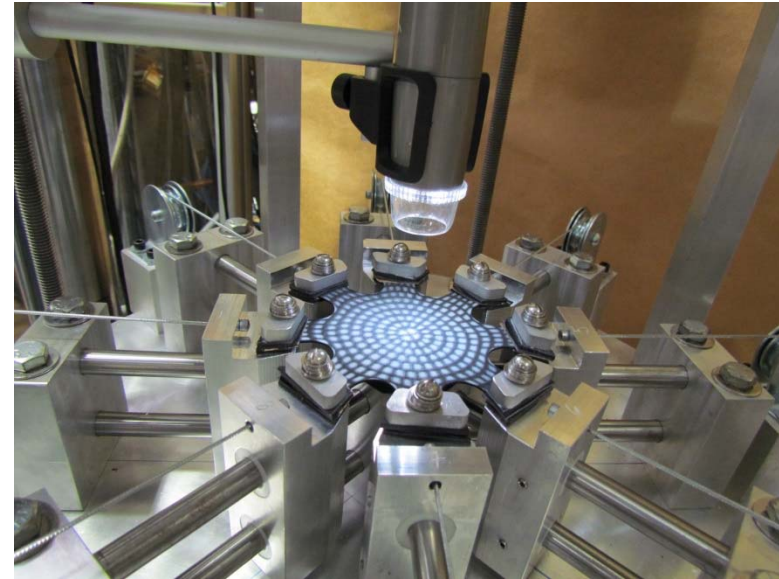


Strain Measurement

- Dino-lite microscope used to take pictures
- Distance measurements done by snapshots
- Stretch ratio then calculated

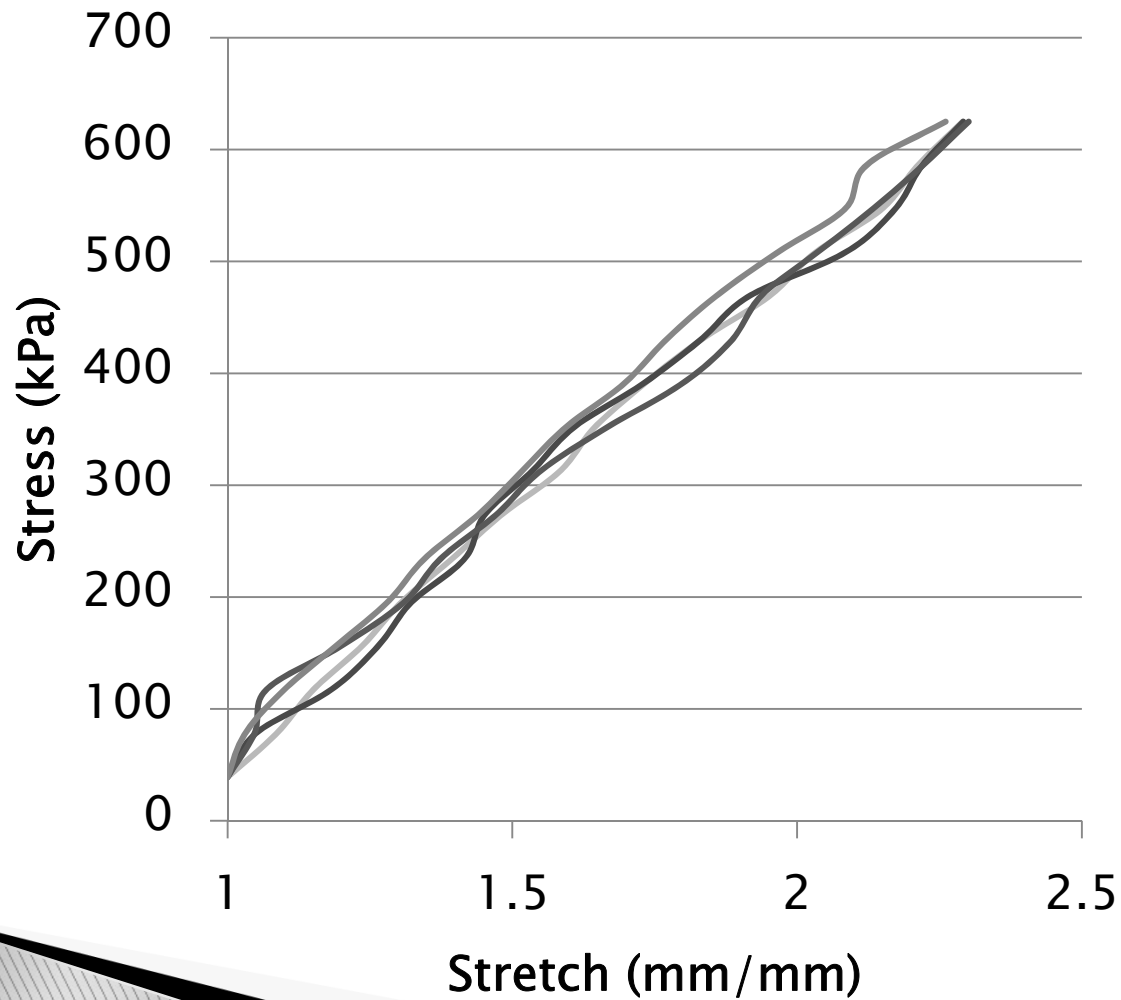


Strain Measurement (Cont.)



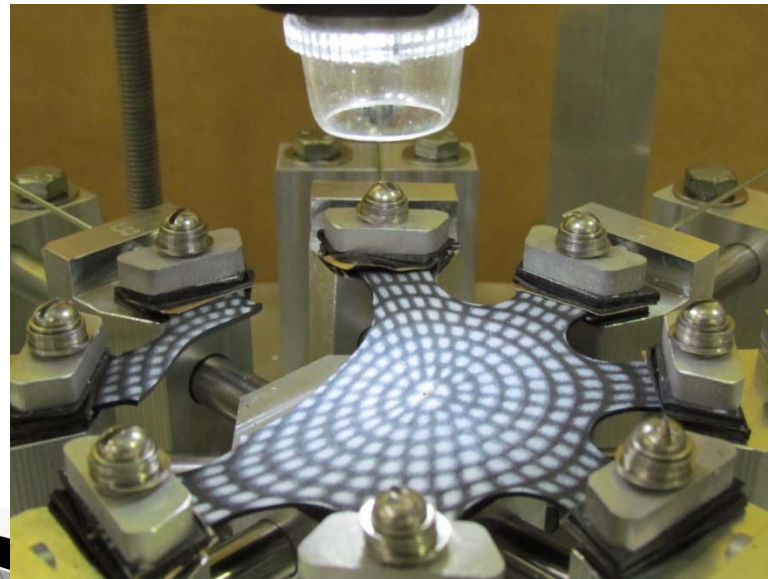
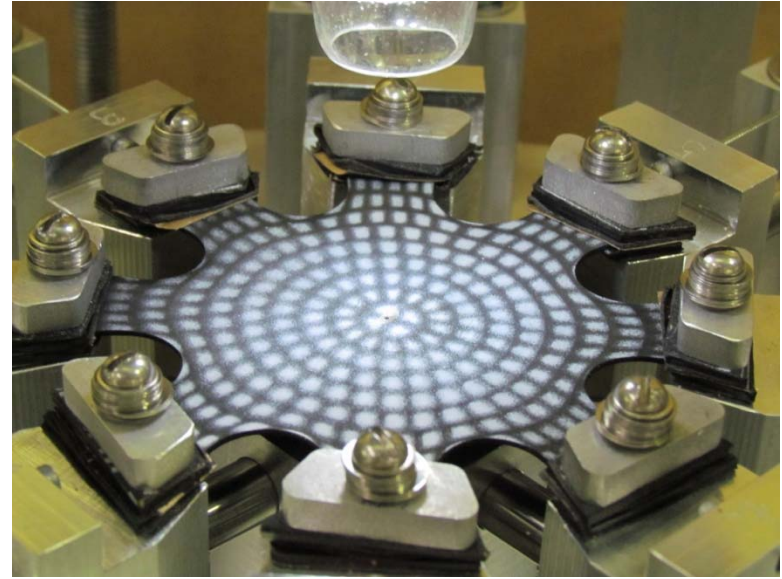
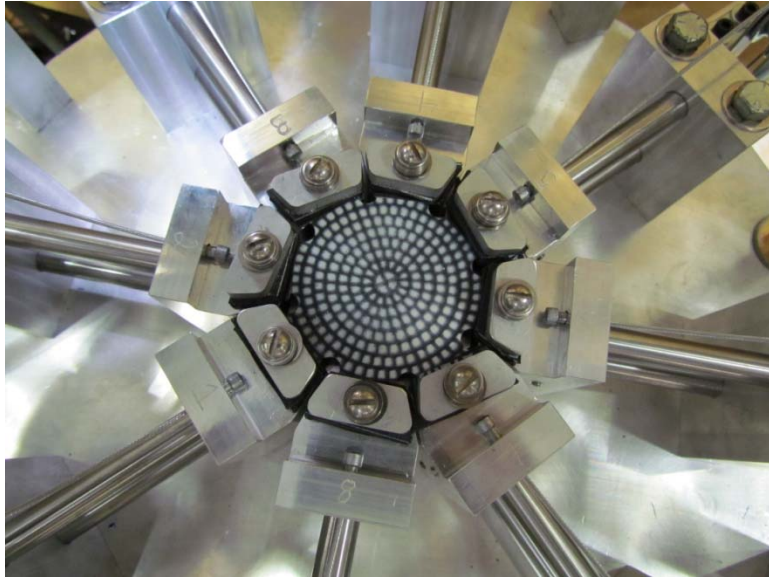
Uniaxial Validation

Carrier Calibration

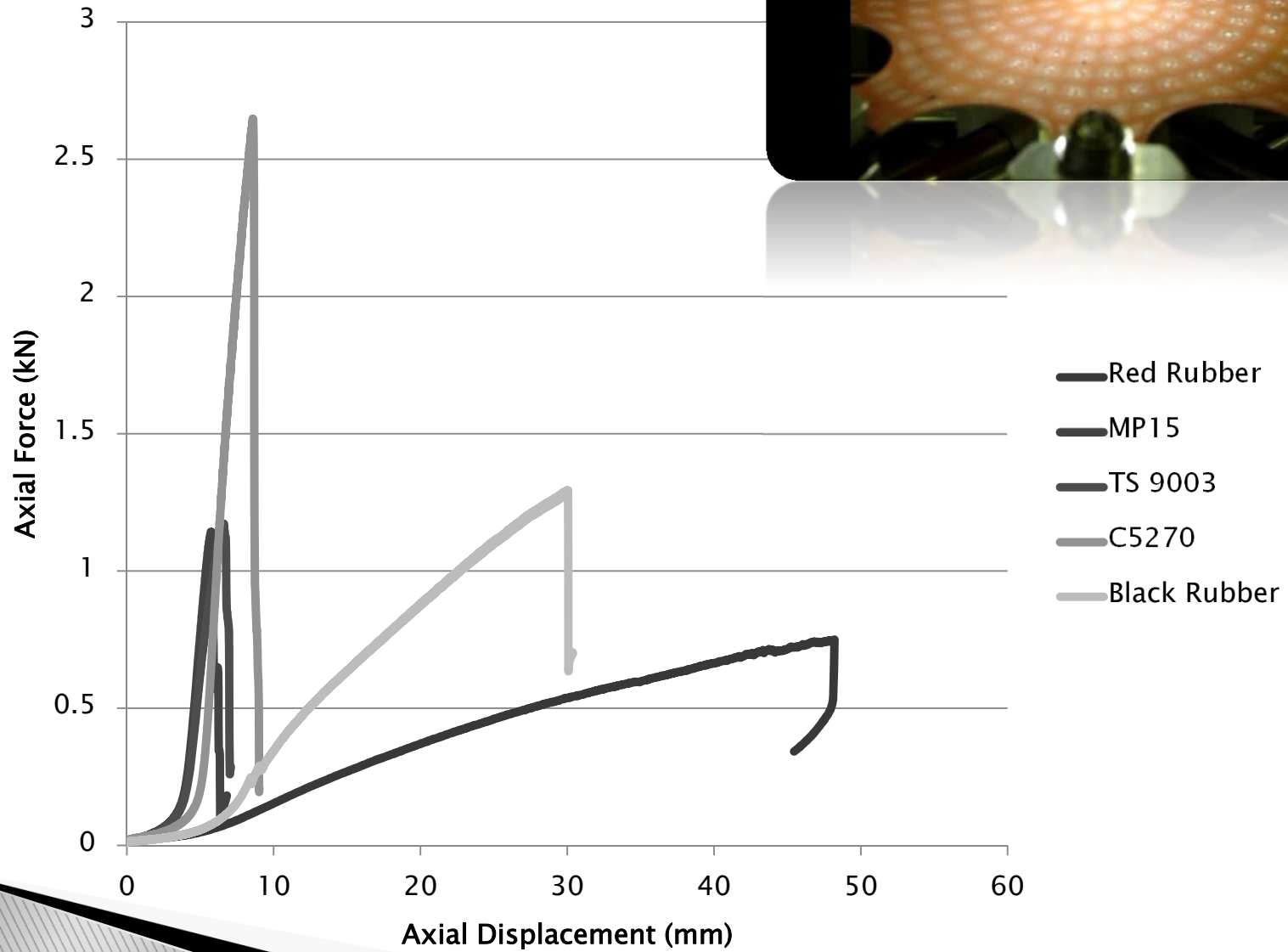
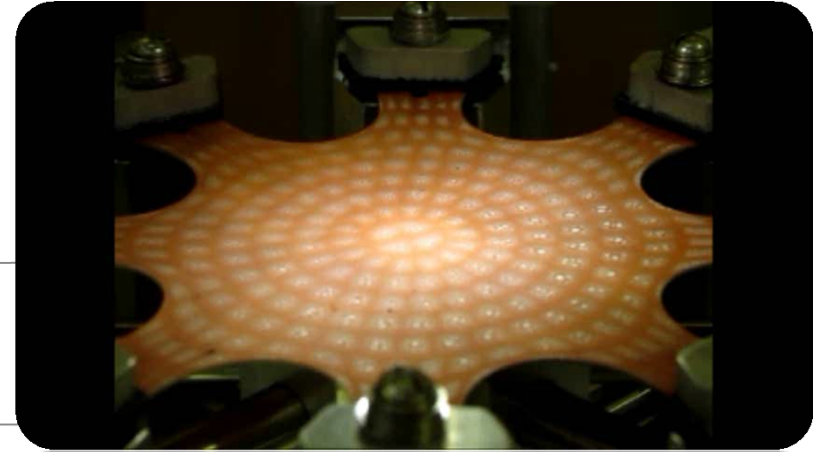


- Carriers 1 and 5
- Carriers 2 and 6
- Carriers 3 and 7
- Carriers 4 and 8

Biaxial Testing



Biaxial Testing



Budget

Suppliers	Item Type	Cost
McMaster-Carr	Hardware	\$733.80
Midwest Steel	Stock Materials	\$598.00
Ebay/Folger	Linear Bearings	\$28.56
West Marine	Dyneema Rope	\$17.74
Grainger	Wire Rope, Pulleys	\$56.93
	Total:	\$1,435.03

Budget (Cont.)

Item Cost	Cost
Original Design	\$1,435.03
Load Cells	~ \$6,400.00
Guide Pins	~ \$200.00
Ball Bearings	~ \$960.00
Labor	~ \$37,800.00
Total:	~ \$45,795.03

Future Plans

- Guide pin
- Rule die
- New gripping method
- Fixed rod in carrier
- New wire rope
- Better strain measurement
- Better bushings
- Load cells on each direction

Conclusions

- Designed and manufactured specimen geometry
- Built working model
- Performed cable testing
- Gathered uniaxial tensile data for given gasket material
- Fabricated prototype
- Calibrated prototype
- Biaxial tensile test performed

Questions?
Comments?
Suggestions?