

**Torsional Property of Nano
Structured Titanium for Use in
Biomedical Application**

TEAM

Background

**Project
Architecture**

**ECAP
PROCESS**

Machining

Testing

**Results and
Discussions**

**Future
Recommendations :**

Conclusions

The background features a soft-focus bokeh effect with blue and red light spots. On the right side, there is a detailed, metallic-looking structure that resembles a nano-structured surface or a complex mechanical part, rendered in shades of blue and silver.

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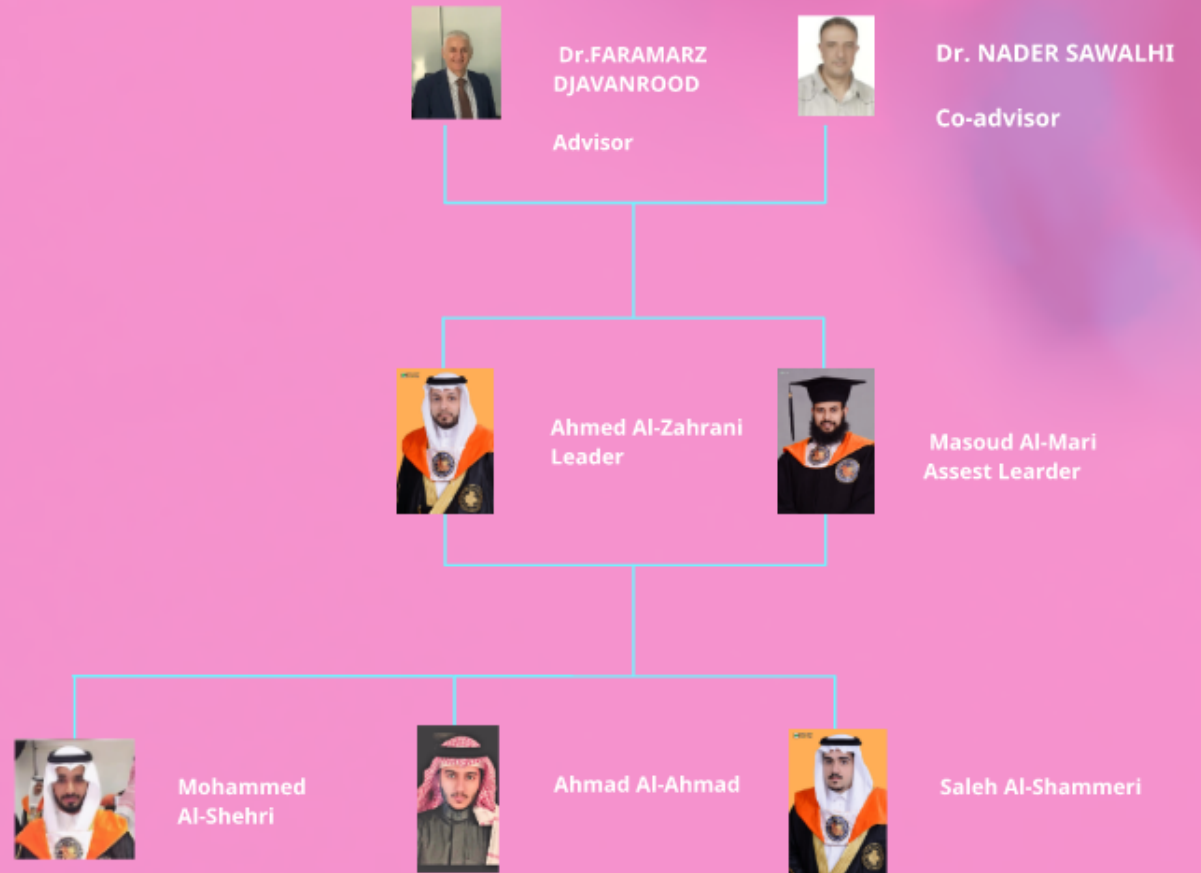
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Organizational chart



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- Biomaterials are important to quality and longevity of life.
- Biomaterials used: Stainless steel, Titanium alloys, Pure Titanium and Copper Alloy.
- Different processes and treatments enhances the properties of biomaterials.

Project objectives:

motivation:

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- Production of commercially pure titanium (cp-ti) using ECAP.
- Machining of the nano-structured Titanium.
- Simulation of ECAP cp-ti for the torsion test.
- Verification of Finite Element Module (F.E.M.) analysis through test.
- Torsion test using standards.
- Comparison of F.E.M. and tests.

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motivation:

- Big business after 10 years



- Aging population

- Support Disabled persons



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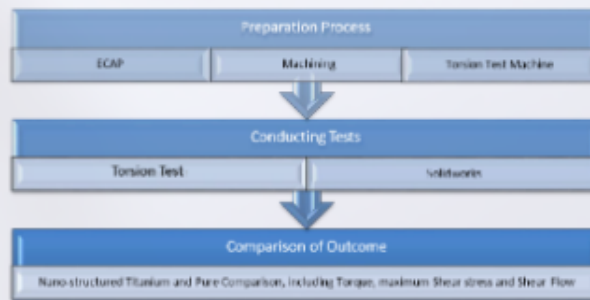
Testing

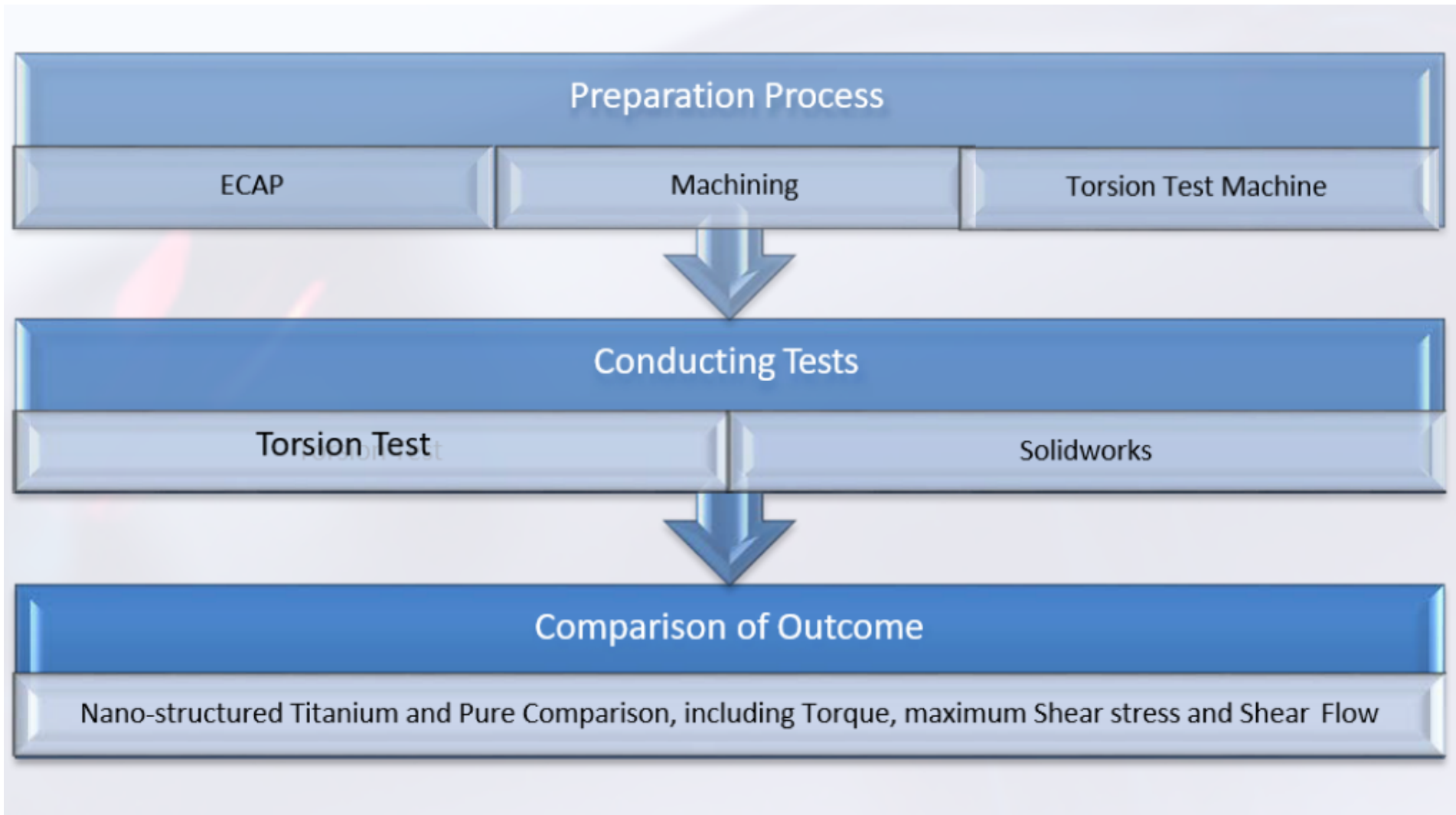
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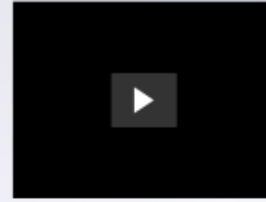
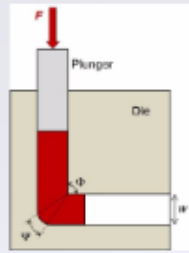
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ECAP PROCESS

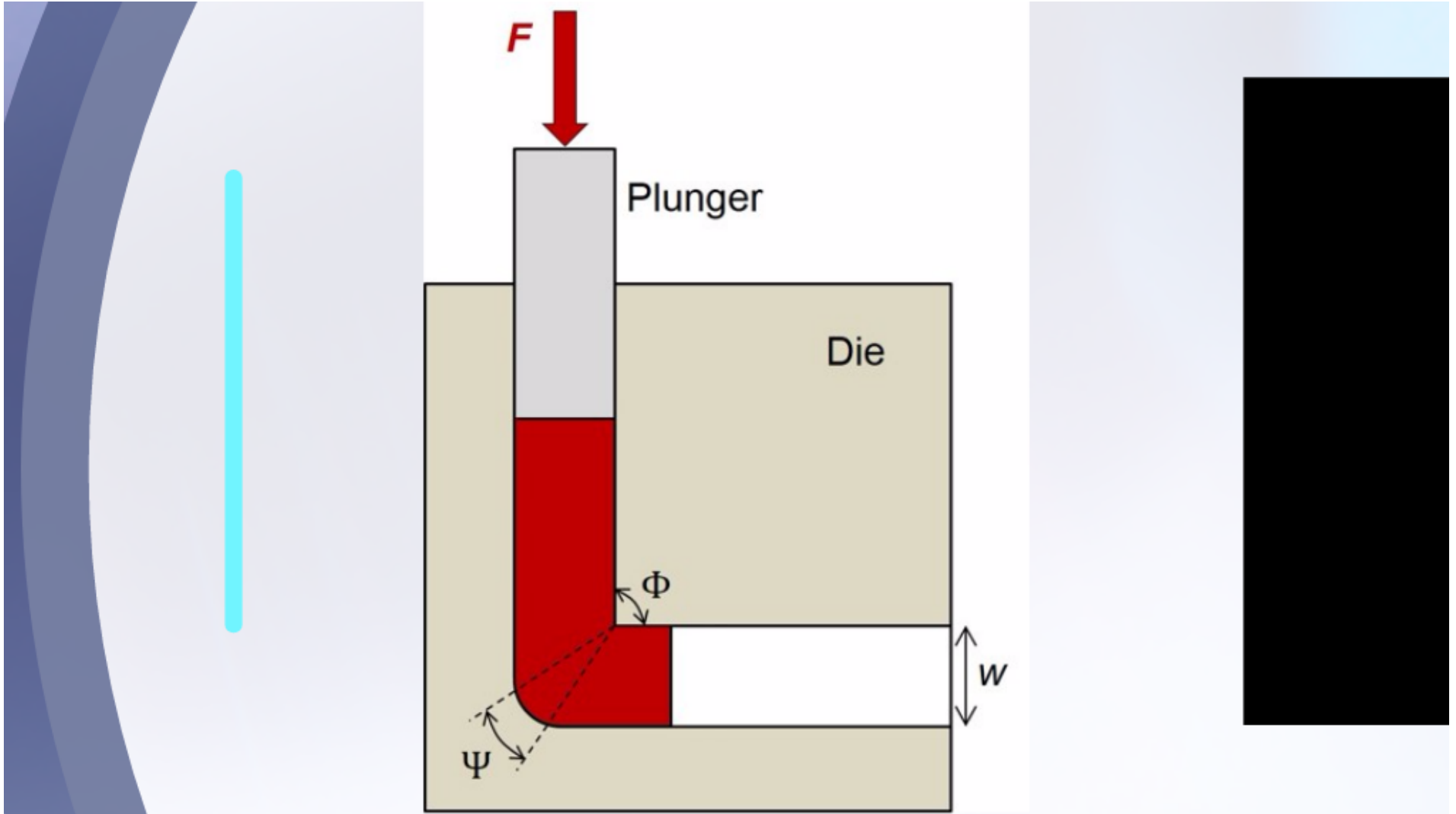
Two passes:

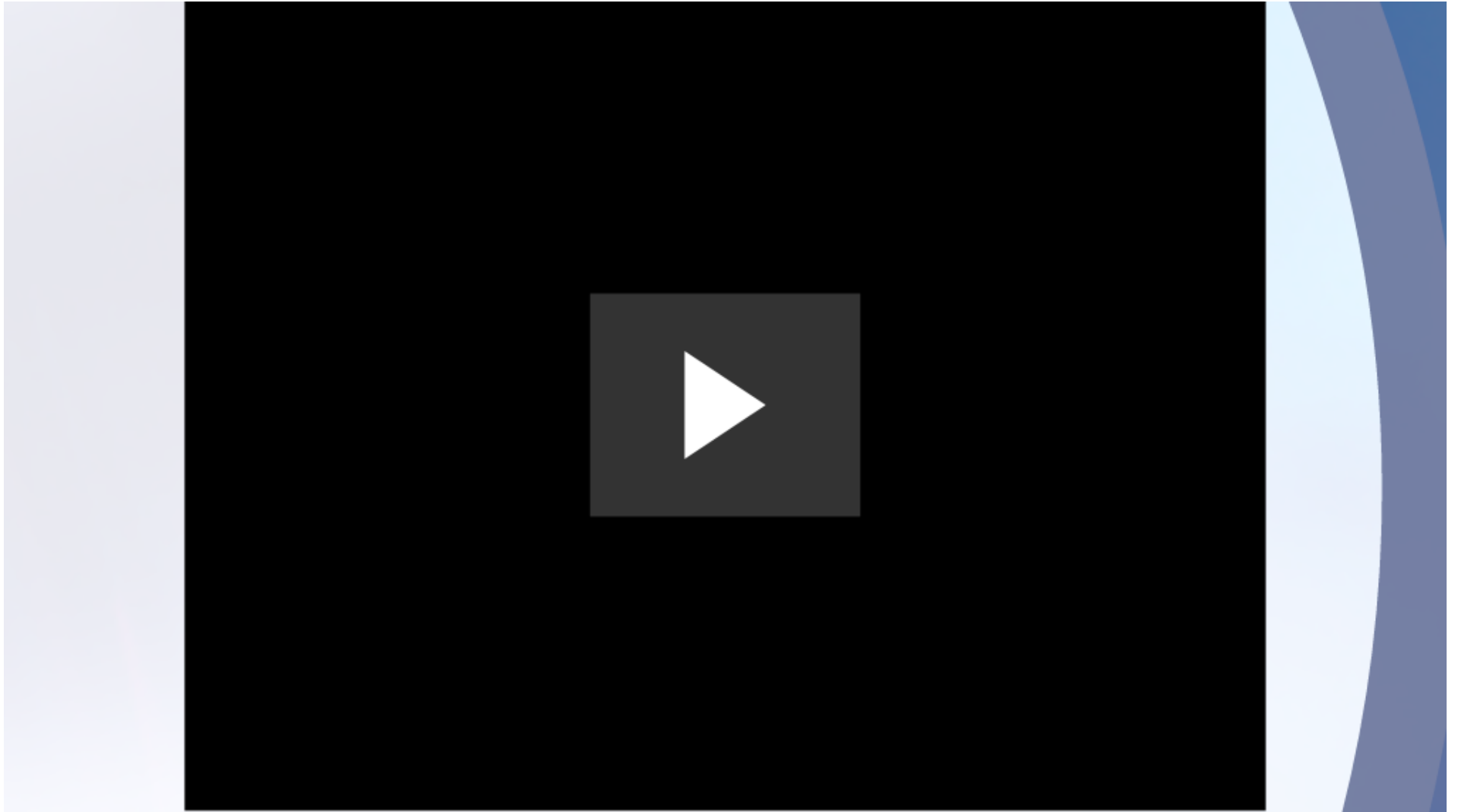


Four Passes:



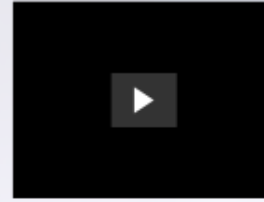
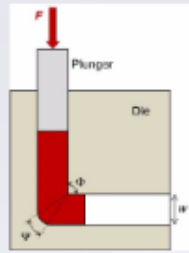
Process:





ECAP PROCESS

Two passes:



Four Passes:



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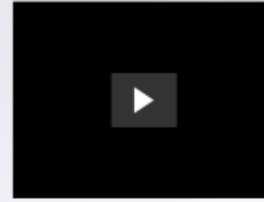
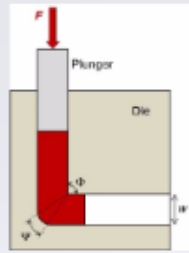


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ECAP PROCESS

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Four Passes:

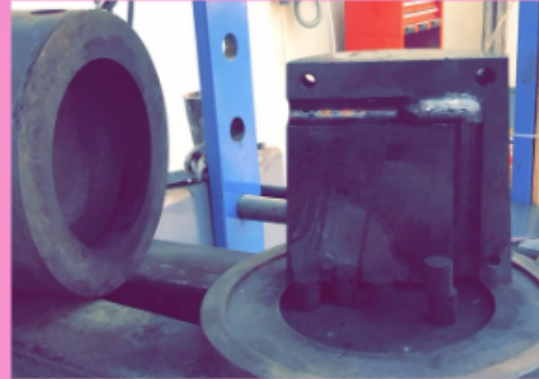


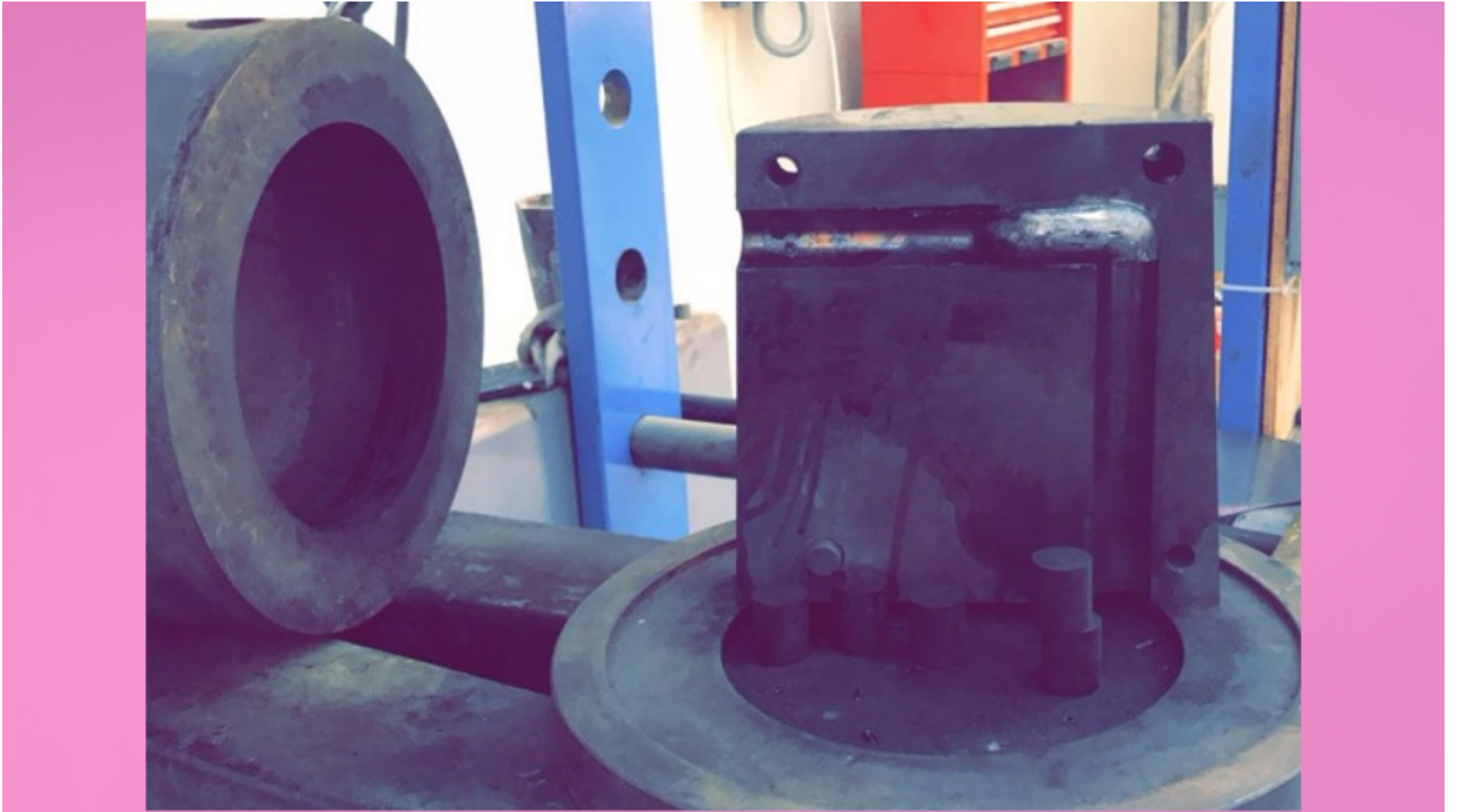
Process:



Process:

- Annealing .
- Than heat up 324 C.
- Lubricant.
- Die and plunger steel H 13 .
- Dimeter 22 mm.





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Machining

Copper

Pure
Titanium:

Machining

Copper



Pure Titanium:



Machining

CNC Milling machine



CNC Lathe machine



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Testing

Torsion test machine:
Testing has been done by
using ASTM standards.



ASTM Standards:
A938 - 13.
E83 - 16.
E4 - 16.
A668/A668M - 16.

Mesh
information:

stress

Strain

Displacement

Mesh
Sensitivity

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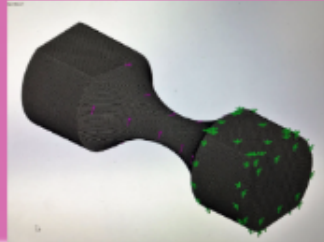
E83 – 16.

E4 – 16.

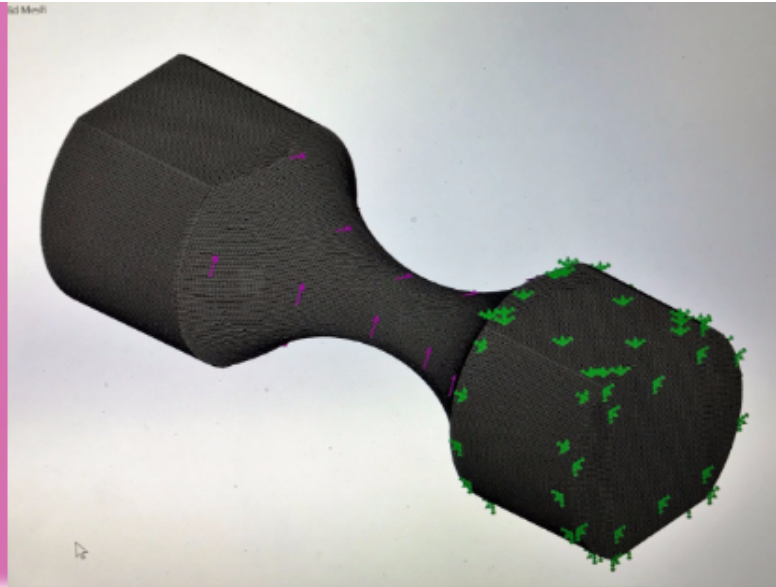
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Mesh information:



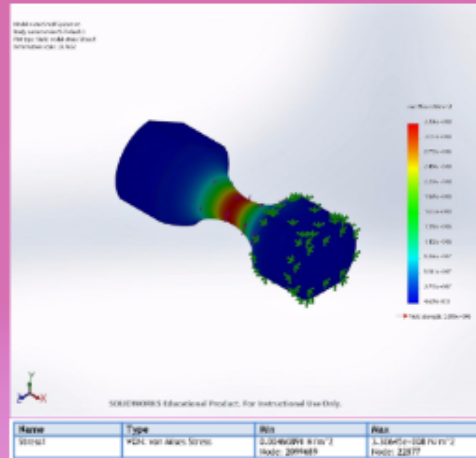
Mesh information	
Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Jacobian points	4 Points
Element Size	0.167 mm
Mesh Quality	High



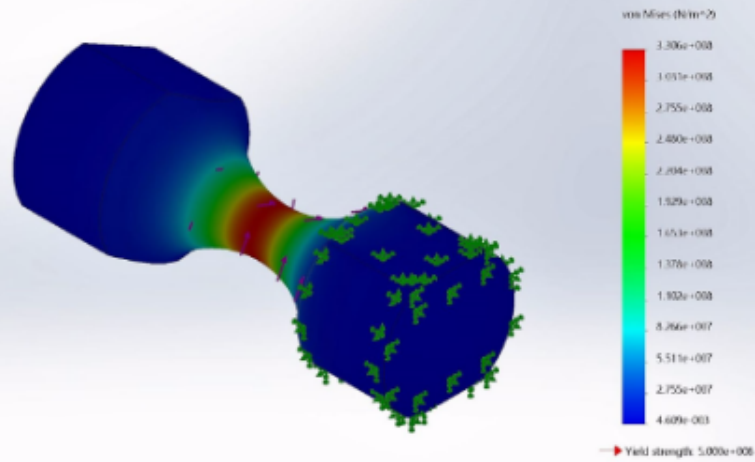
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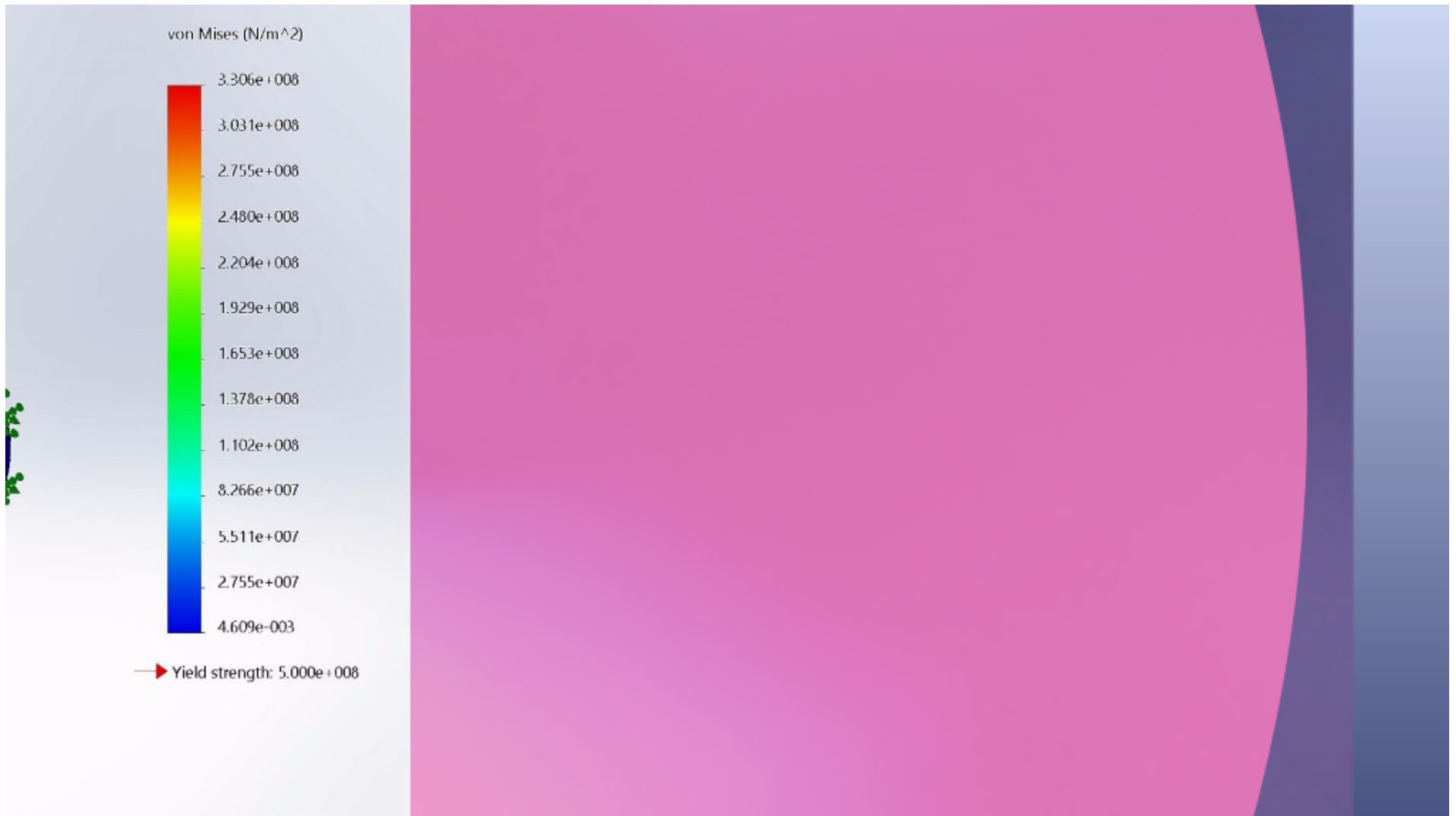


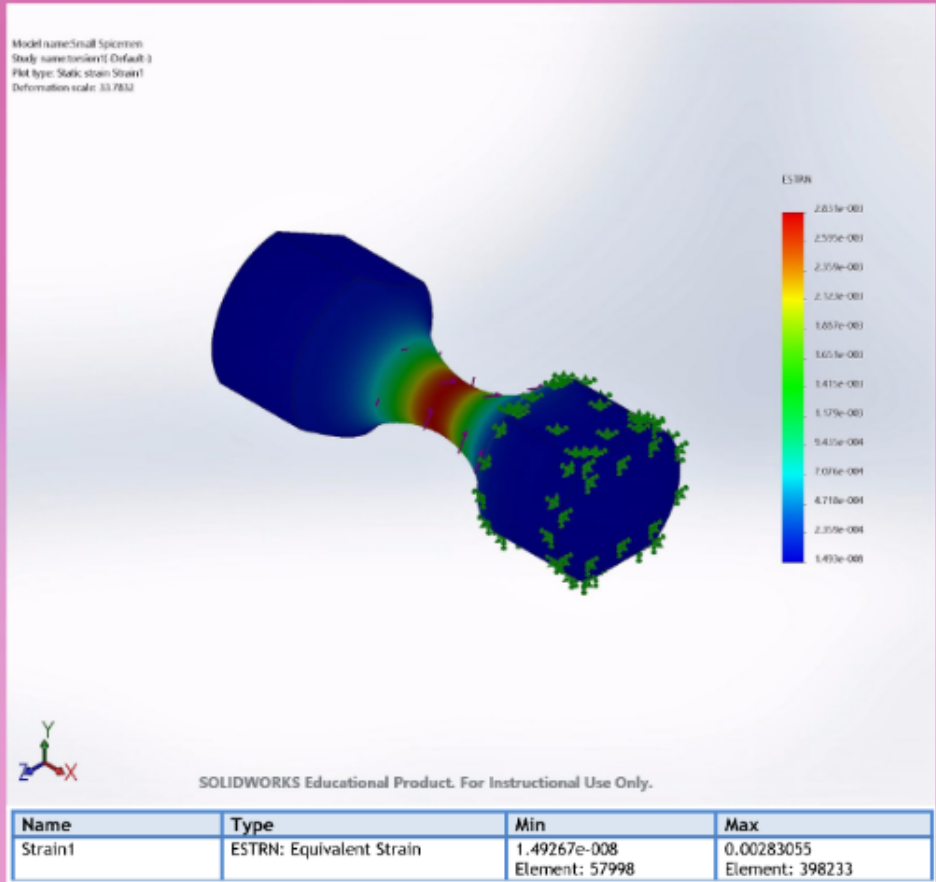
Model name: Small Specimen
Study name: (oskin) (Default)
Plot type: Static, nodal stress Stress1
Deformation scale: 33.7832

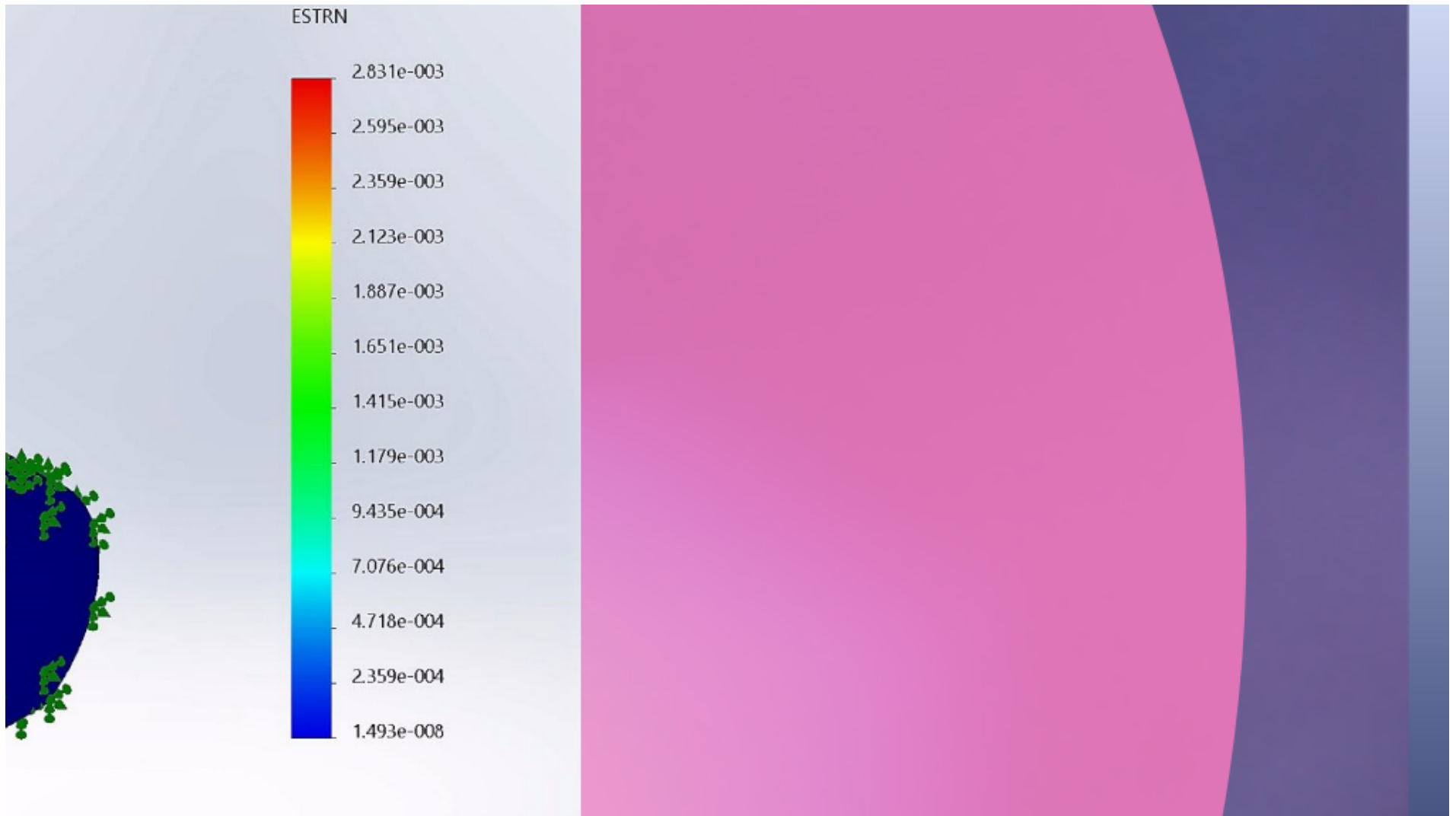


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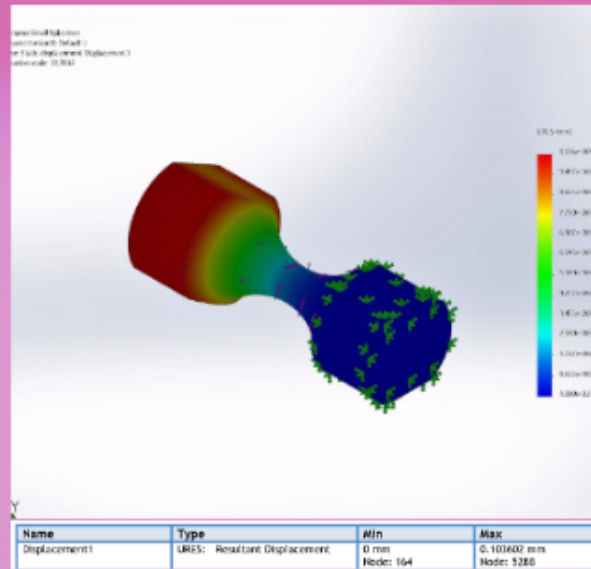
Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.00460891 N/m ² Node: 2099689	3.30645e+008 N/m ² Node: 22877



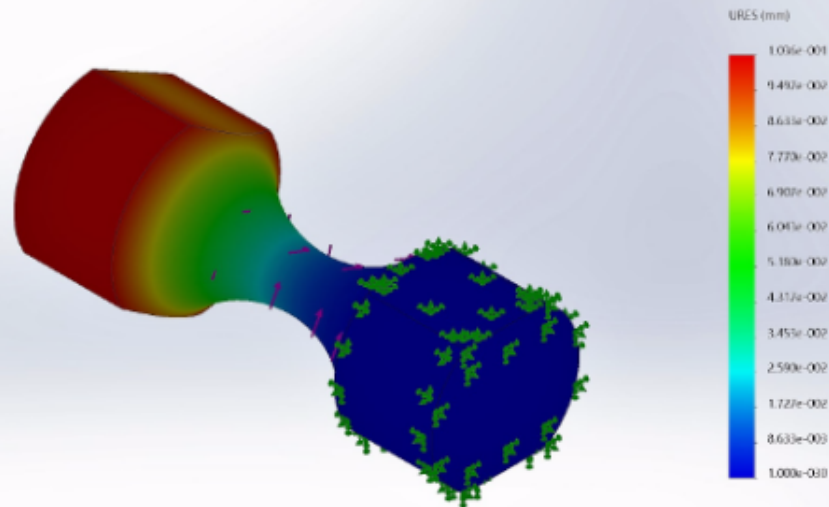




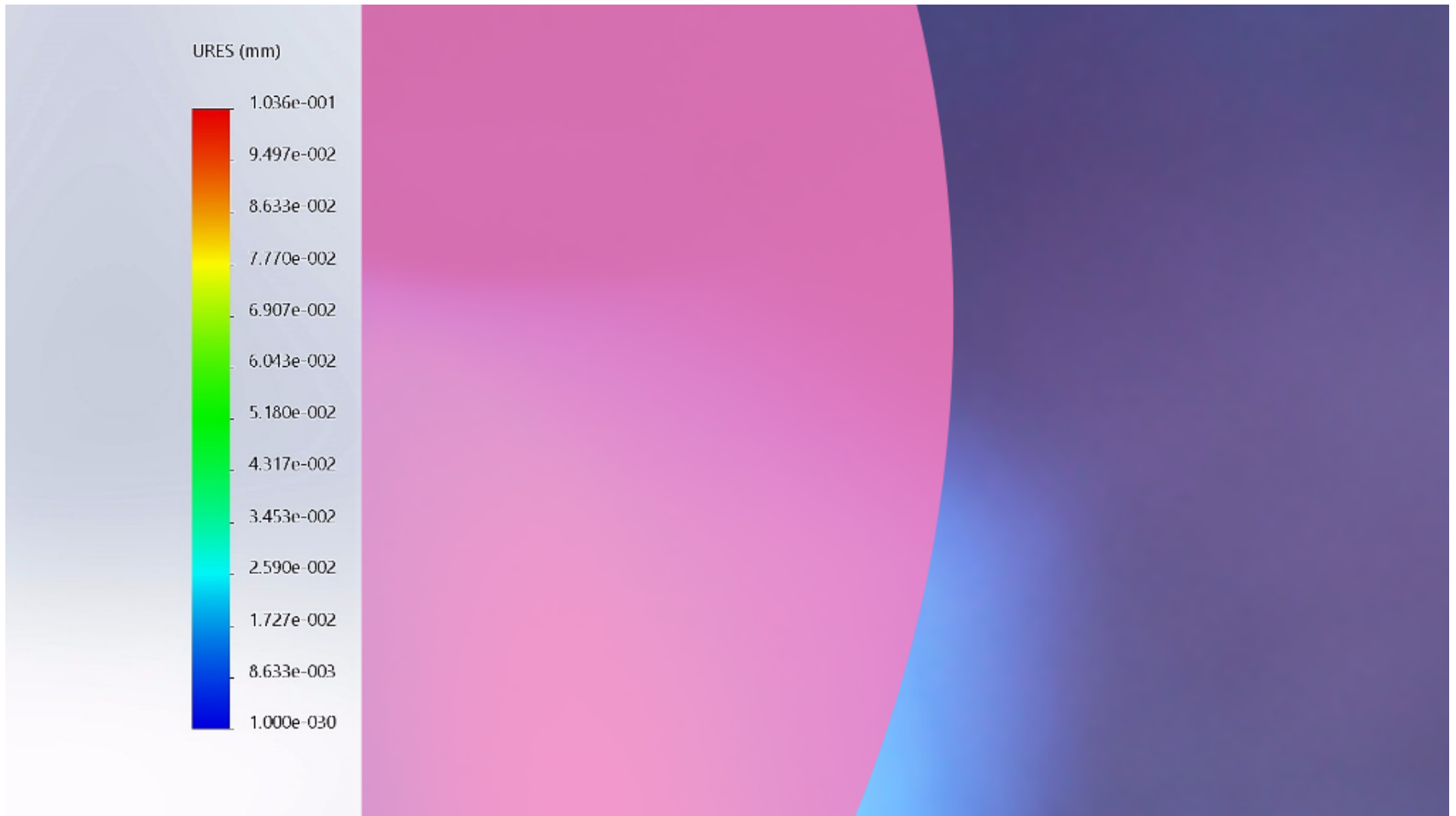
Displacement



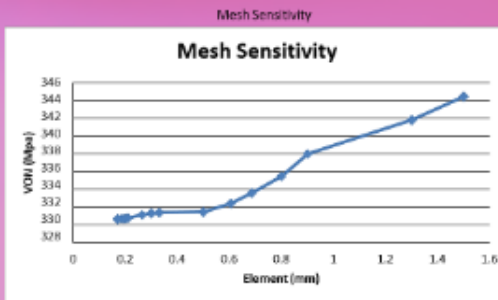
name: Small Specimen
name: Torion I (Default)
type: Static displacement Displacement1
rotation scale: 33.7832



Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 164	0.103602 mm Node: 5288

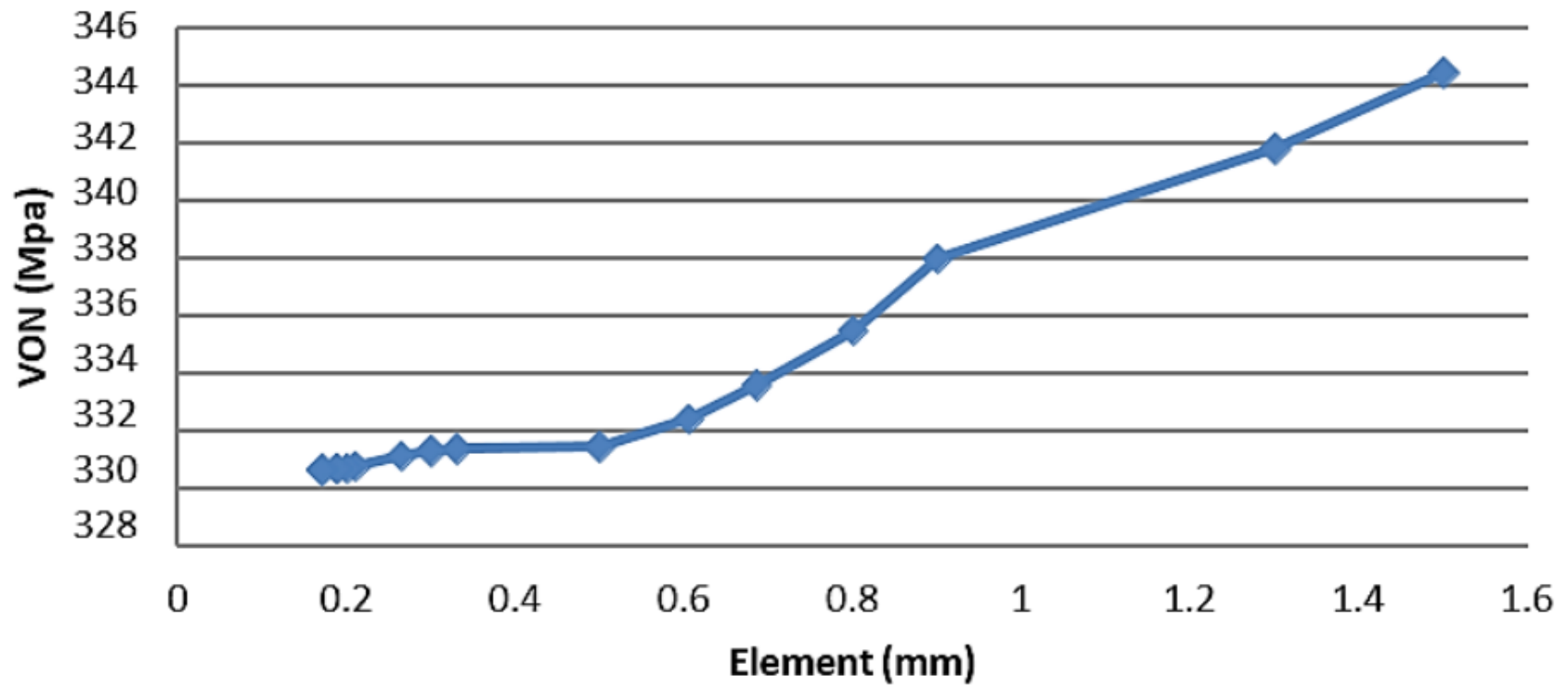


Mesh Sensitivity



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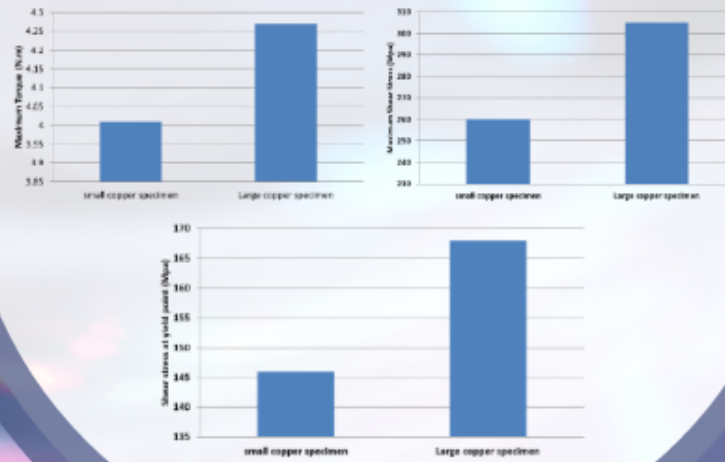
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Results and Discussions

Size Effect:
We tested two copper specimens that differ in size.



Causes of Errors

Stress-Strain Curve for Normal test

Stress-Strain Curve for the test with slippage

Titanium Specimens Results

Torque at Fracture

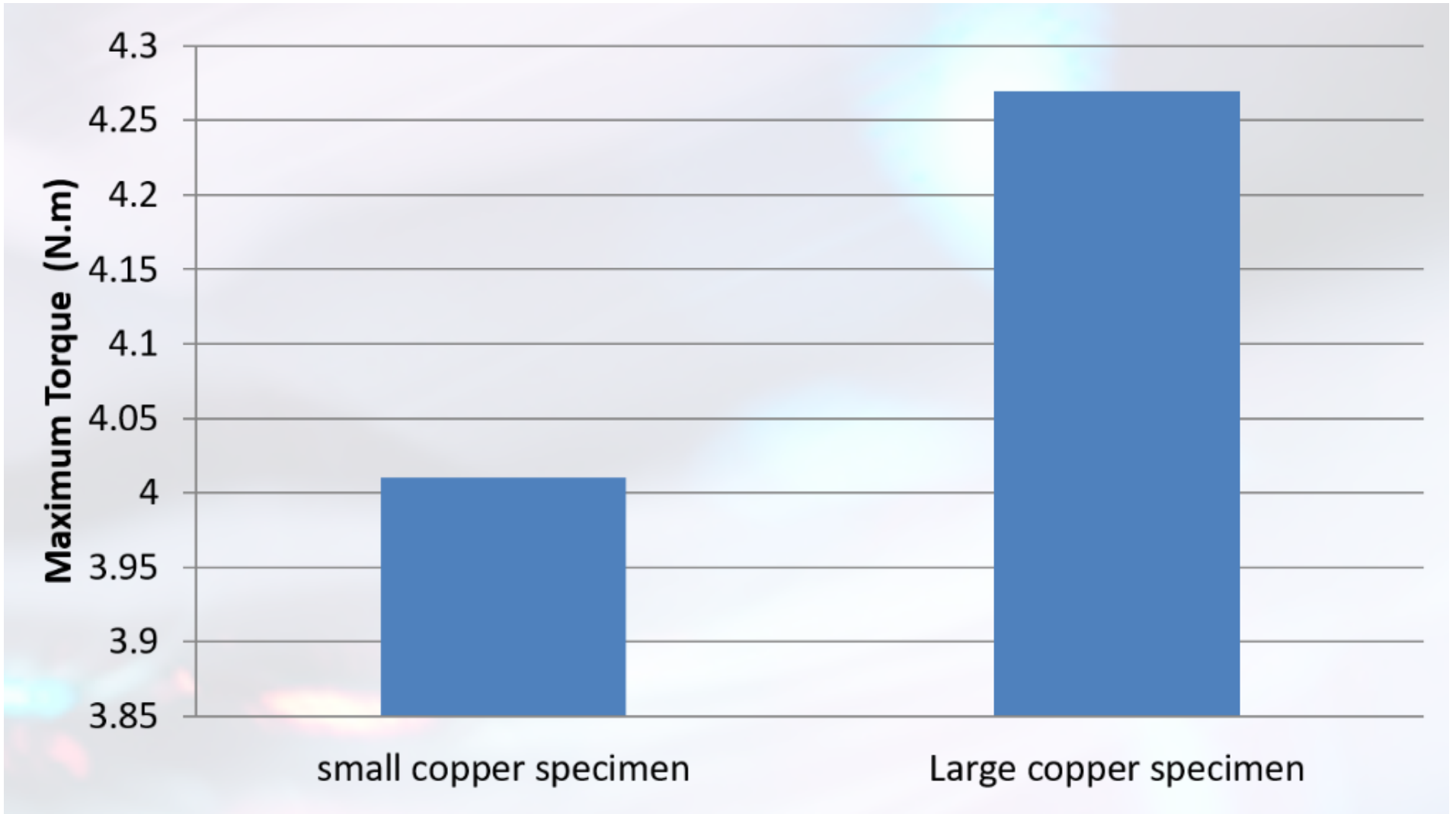
Rotation Until Fracture

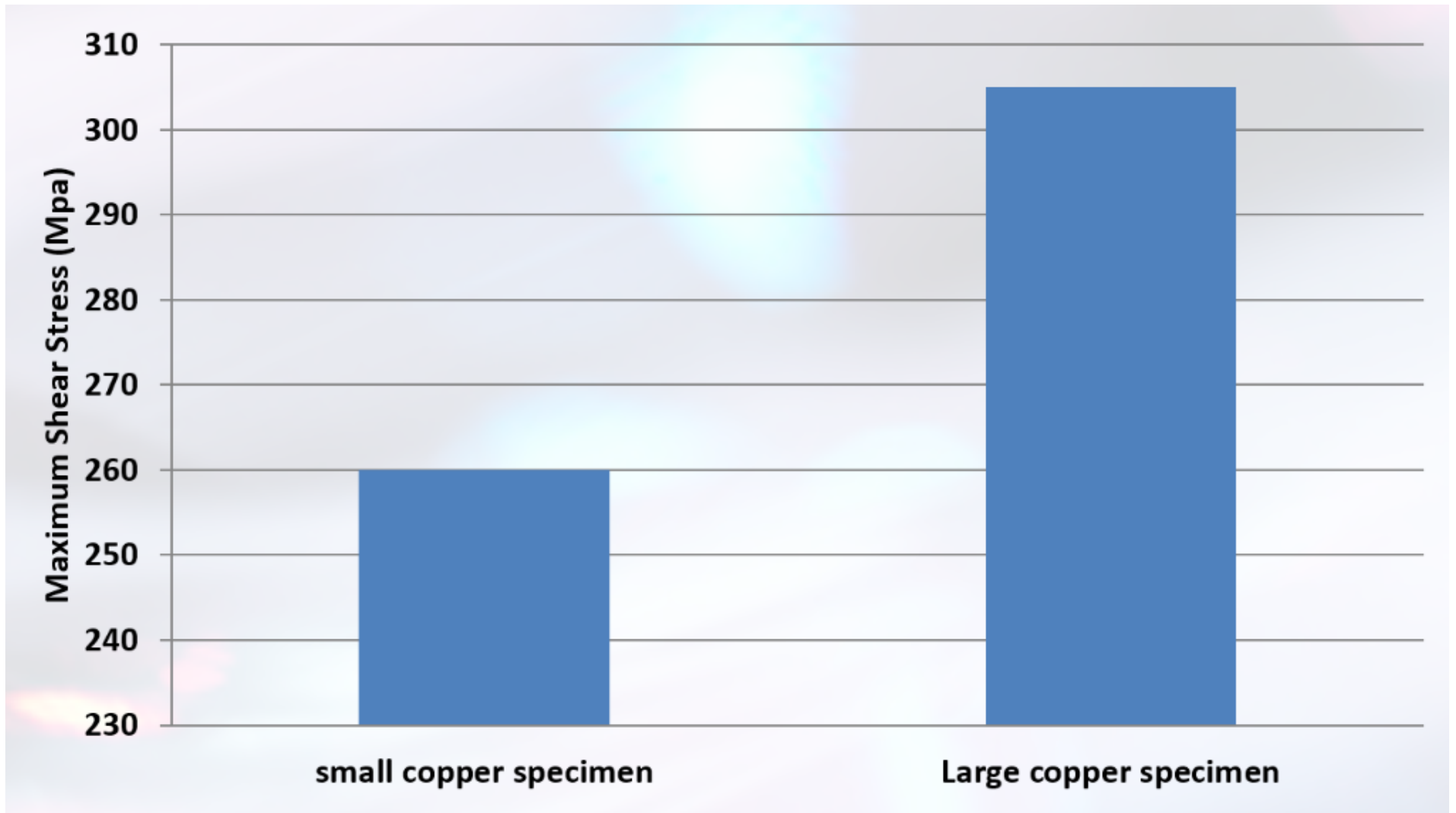
Maximum Shear stress

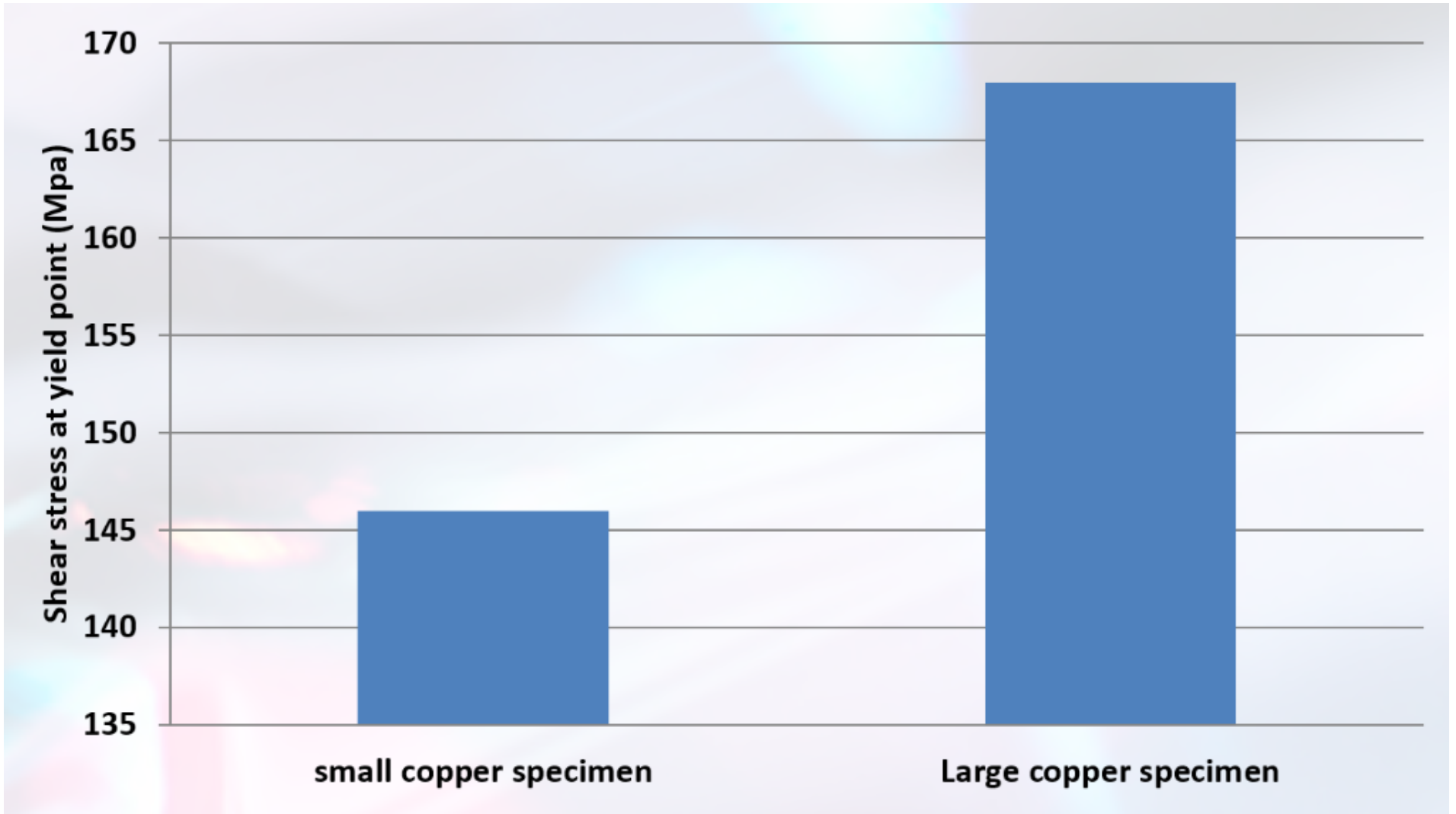
Shear stress at Yield point

Shear stress at Proportionality point

Findings

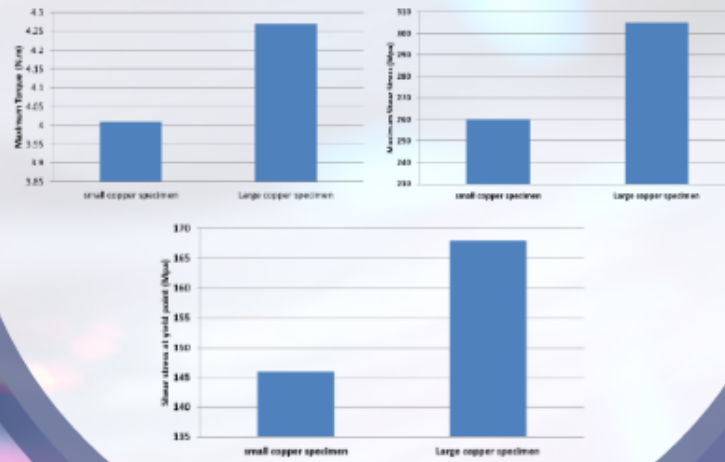






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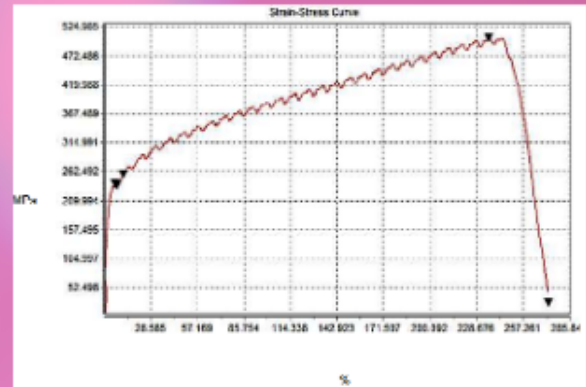
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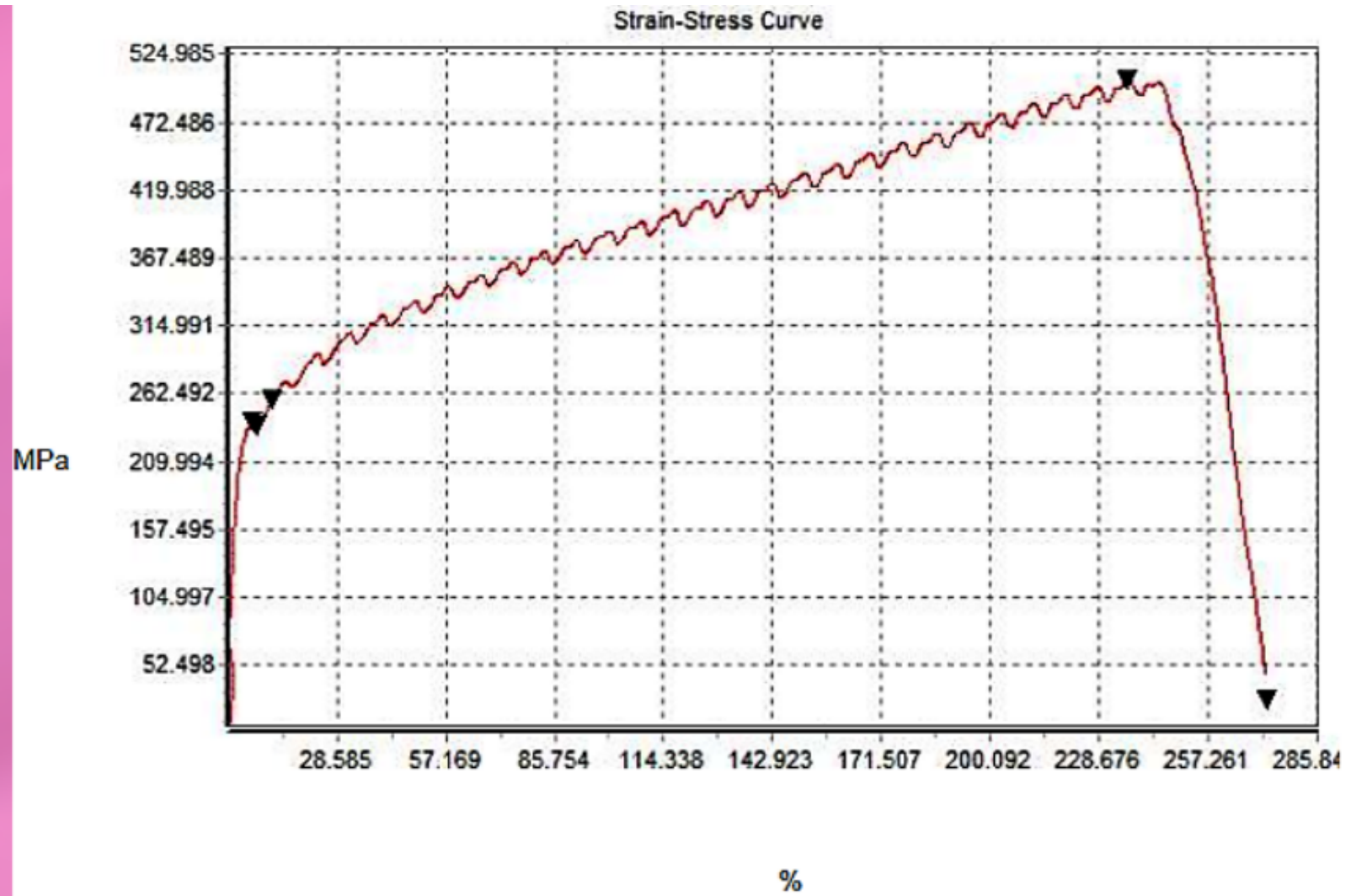
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- Vender issues.
- Slippage in the 4 passes specimen test.

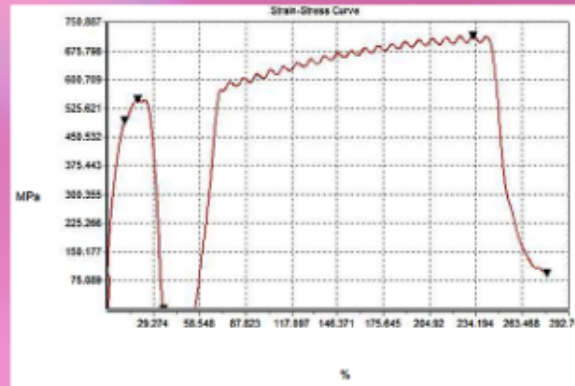
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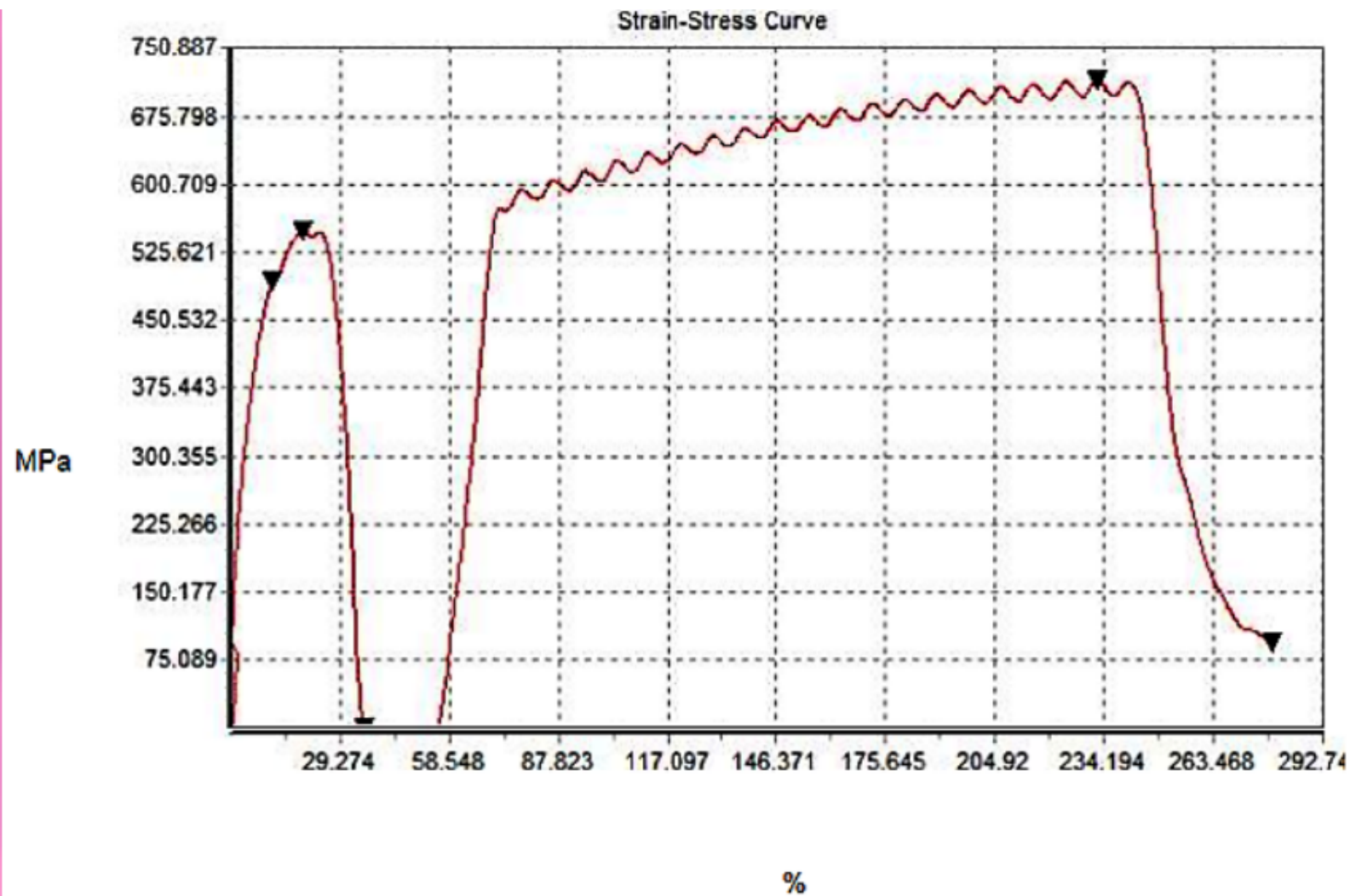
Stress-Strain Curve for Normal test





Stress-Strain Curve for the test with slippage





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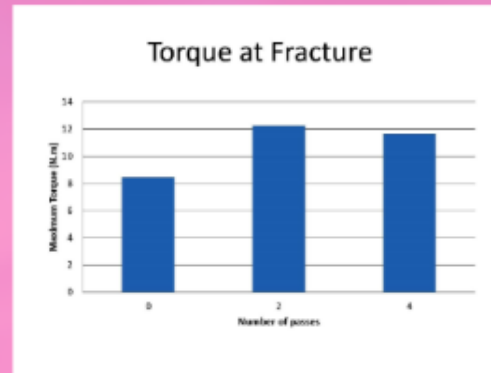
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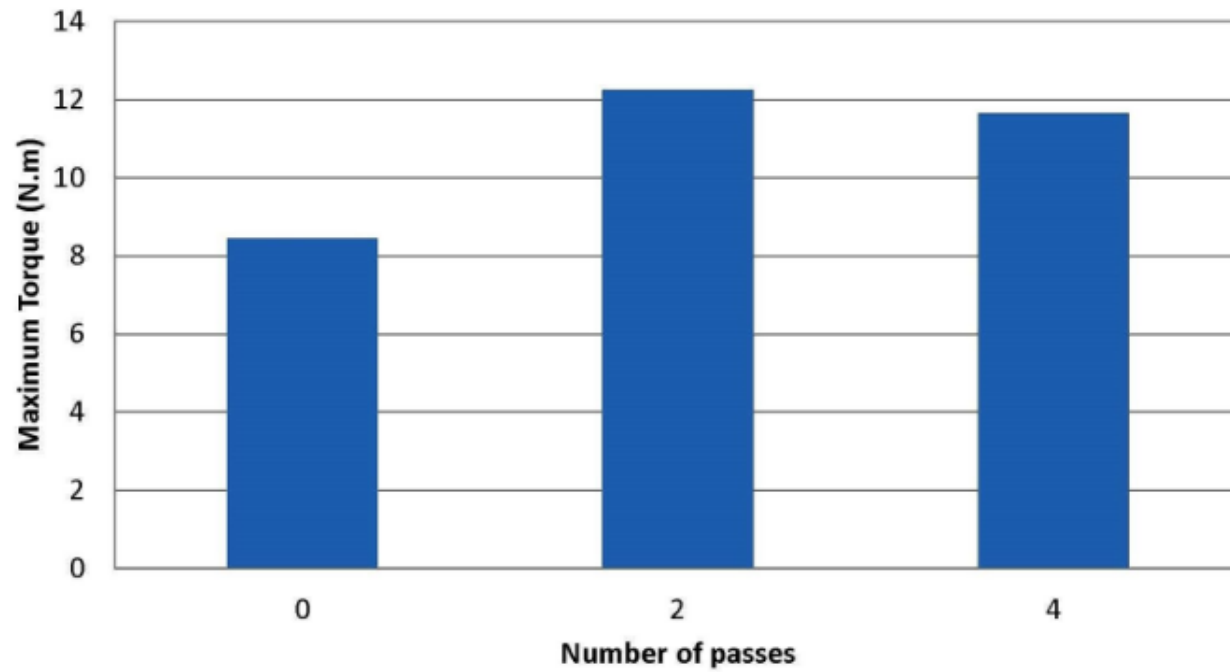
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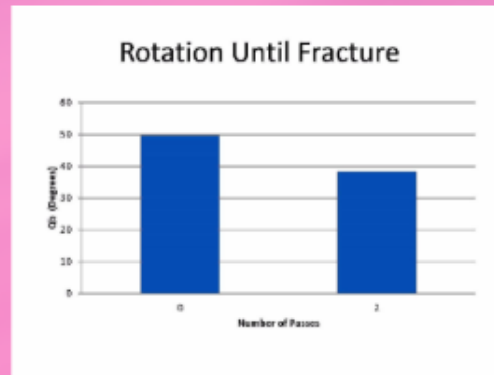
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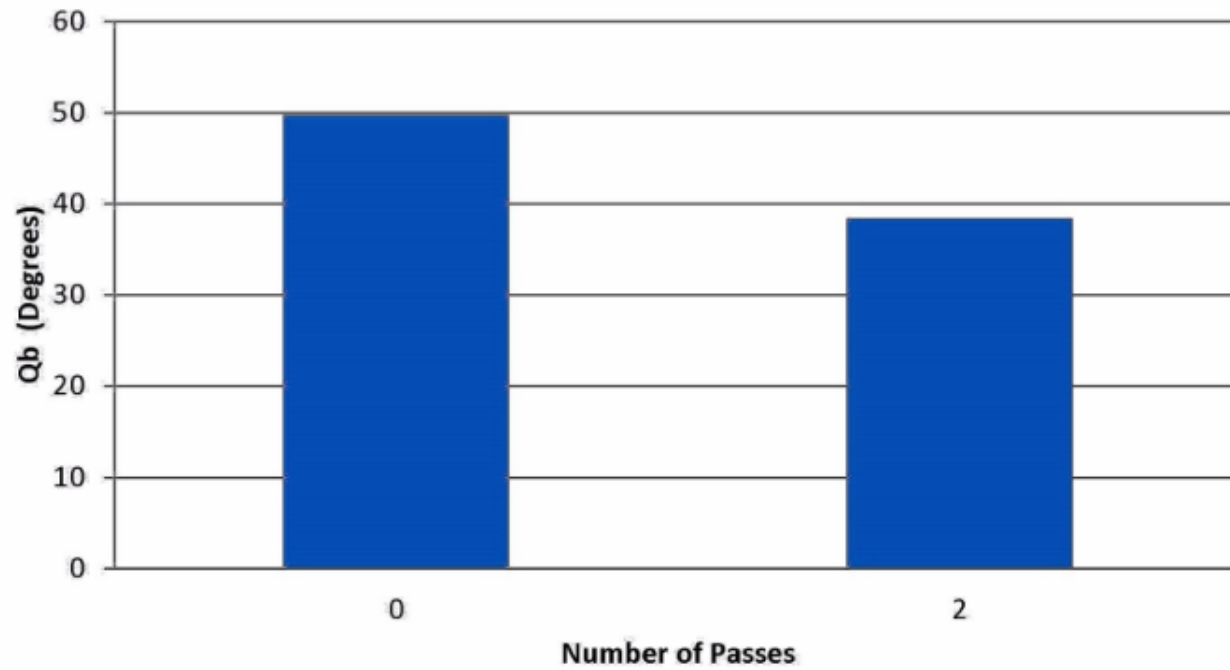
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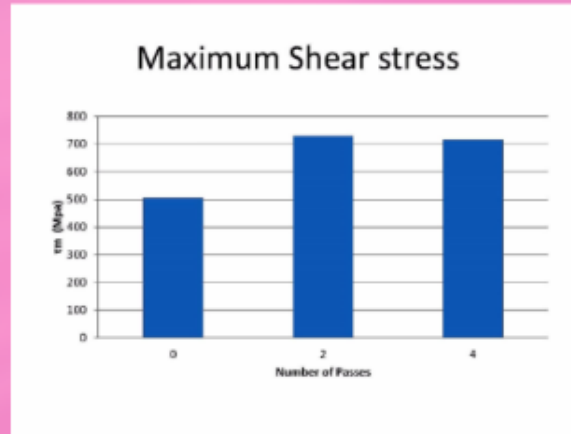
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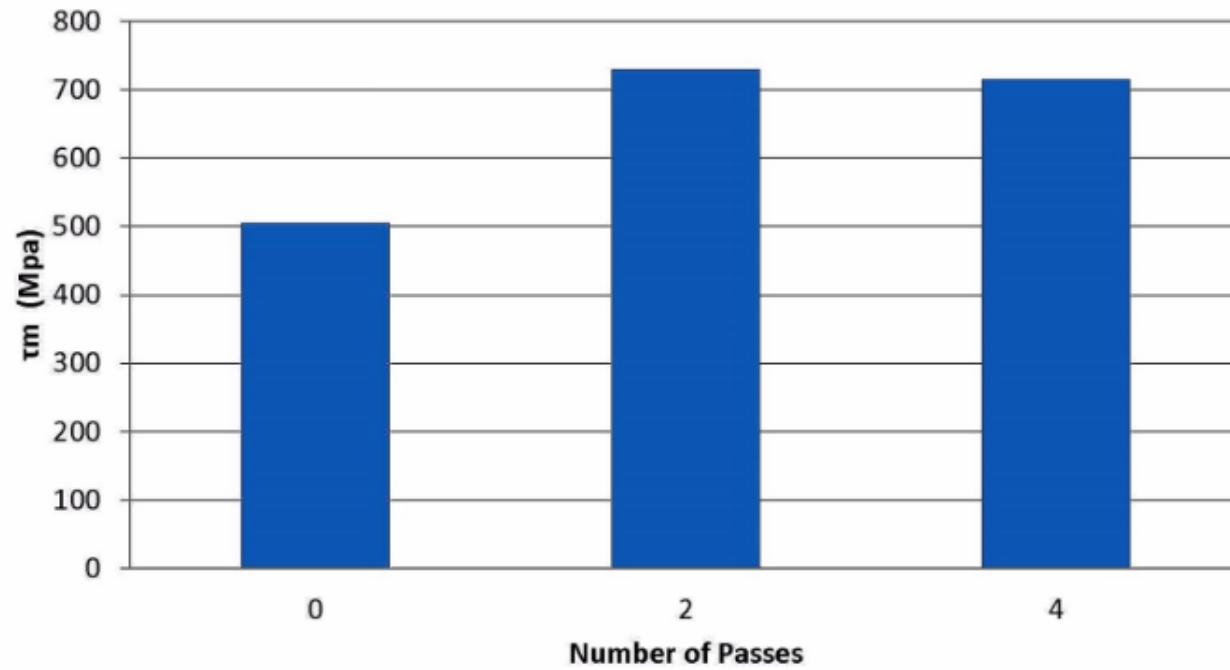
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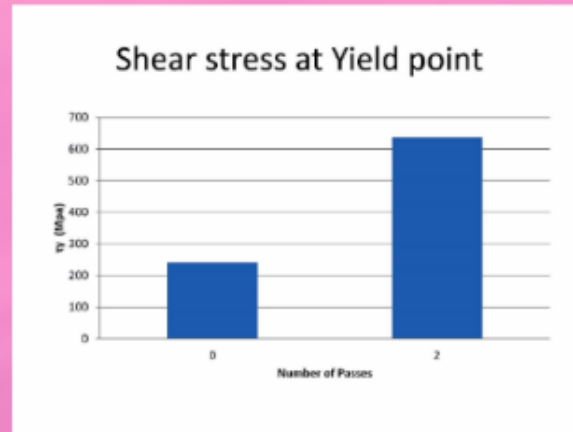
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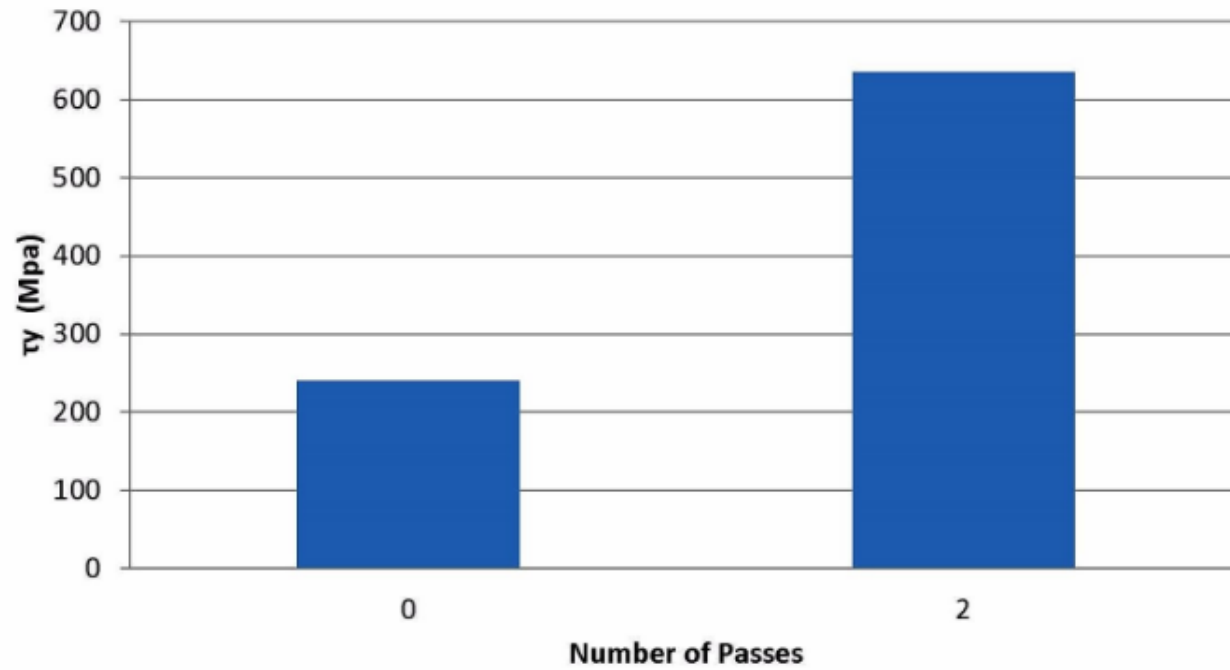
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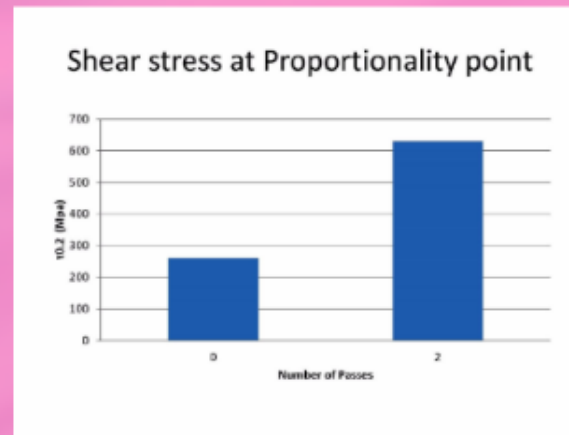
Shear stress at Yield point



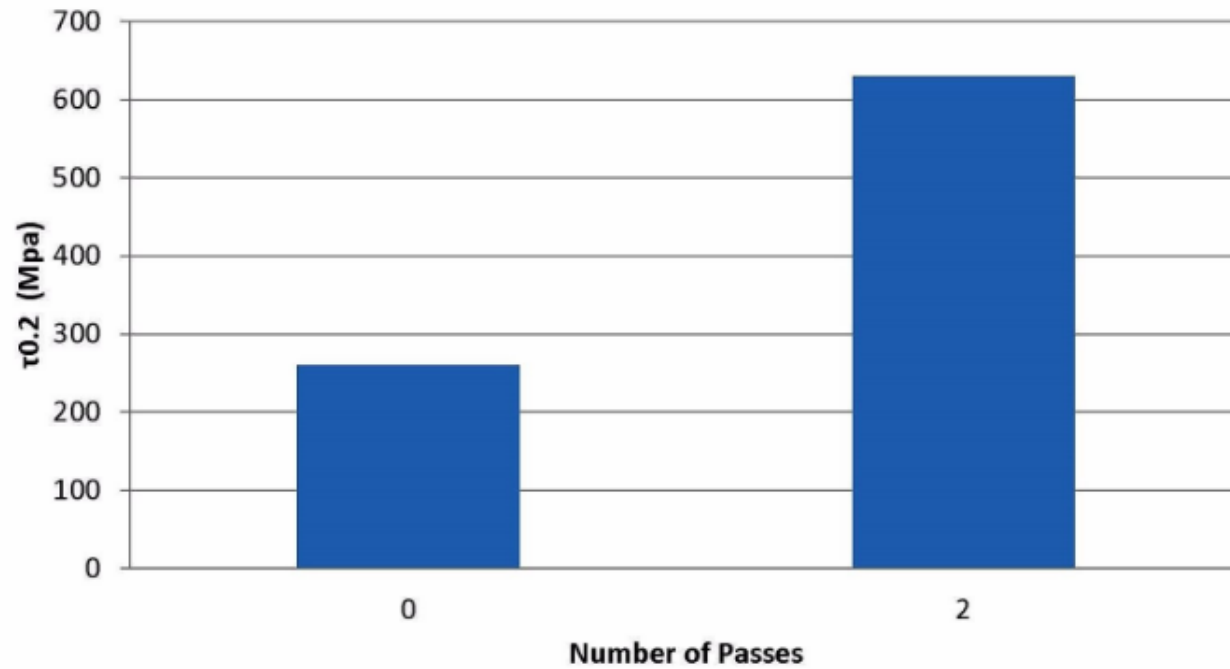
Shear stress at Yield point



Shear stress at Proportionality point



Shear stress at Proportionality point



Findings

- ECAP process enhances the strength of the pure titanium:
 - Maximum Shear stress increased by 44.6%.
 - Shear stress at yield point increased by 164%.
- ECAP process lowered the ductility of the pure titanium by 62.4%.

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- The material should be tested using live stock.
- Material's bio- compatibility property need to be investigated in details.
- Mechanical properties like (strength, harden) needs to be investigated in details.
- Micro structured investigation should be performed on the material to measure the size grain.

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- Nano structure Method.
 - ECAP.
- Assessing the torsional properties of the Nanostructure Pure Titanium.
- The mechanical strength and behavior of pure titanium are improved by ECAP process .
- In this study, we use One fundamental method which is surface modification.
 - Torsional behavior was investigated.
- In this study, three were the constraints of our system design are the sustainability of the results, economical side of the experiment and machining.
- Finally, this study shows the possibility of enhancing the pure titanium mechanical properties and make them compareble to the titanium alloys superior properties.

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