
SIXTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 15 - 18, 2015
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Session 4
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Session 4
Rafiq Hussain
Session Chair

BiTS Workshop 2015 Schedule

Performance Day

Tuesday March 17 8:00 am

Material Magic

"Reliability and Failure over Time"
Mike Gedeon - Materion

"Using Cold Heading Technology and Deutsch Coat to Produce Test Probes & Spring Contacts "
Jimmy L. Johnson - Tyco Electronics

"APEX Glass for Burn-In and Test Sockets"
Jeb H. Flemming & Tim Foster - 3D Glass Solutions, Inc.

"C3 Coating : Solution for IC Testing"
Bert Brost & Valts Treibergs - Xcerra Corporation
Nakaya Katsura - Kobelco Research Institute, Inc.

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Reliability and Time-Dependent Failure

Mike Gedeon
Materion Performance Alloys

2015 BiTS Workshop
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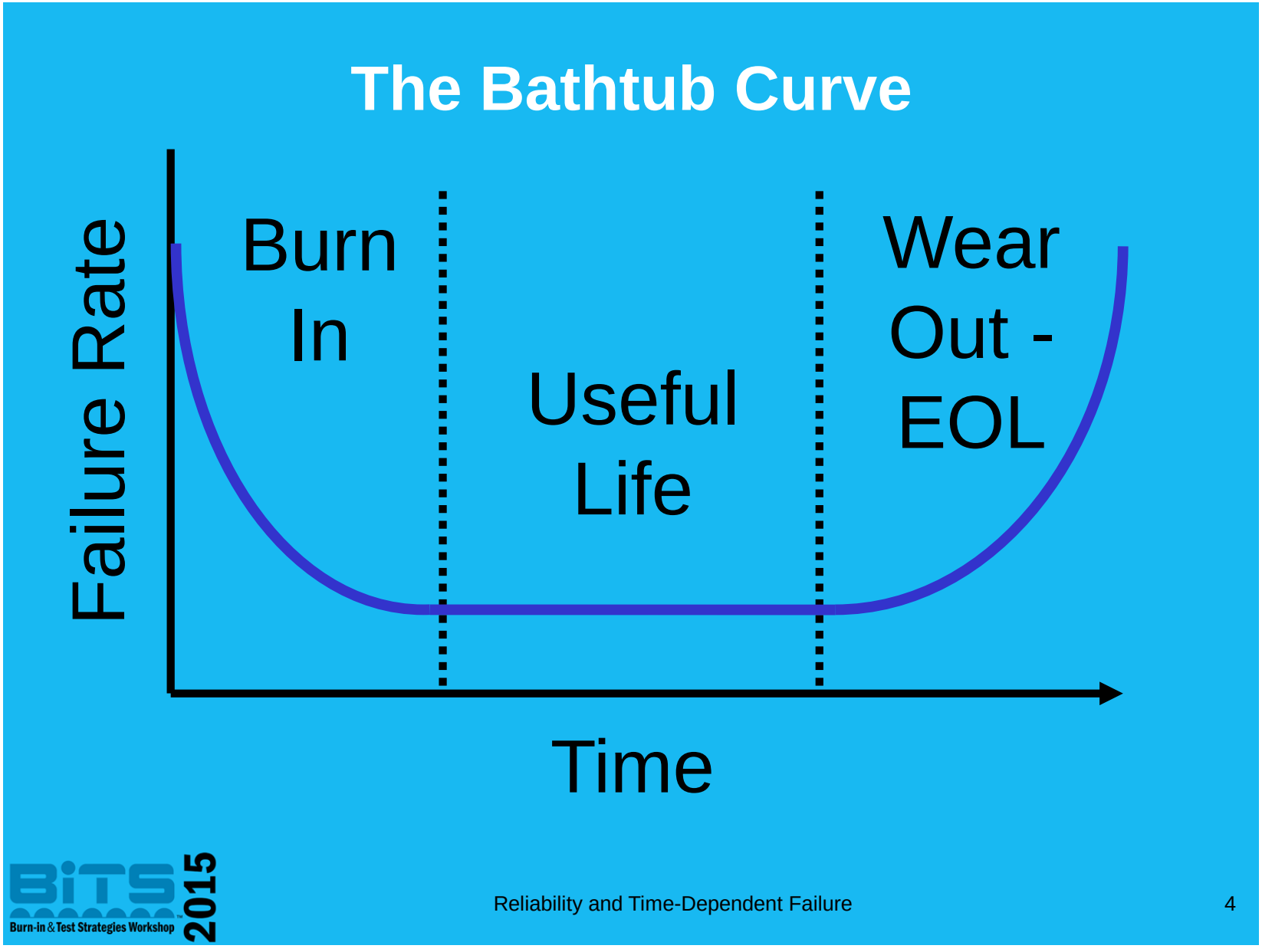
"Riddles in the Dark"

- "This thing all things devours: birds, beasts, trees, flowers;
  Gnaws iron, bites steel;
  Grinds hard stones to meal;
  Slays king, ruins town, and beats high mountain down." - Gollum

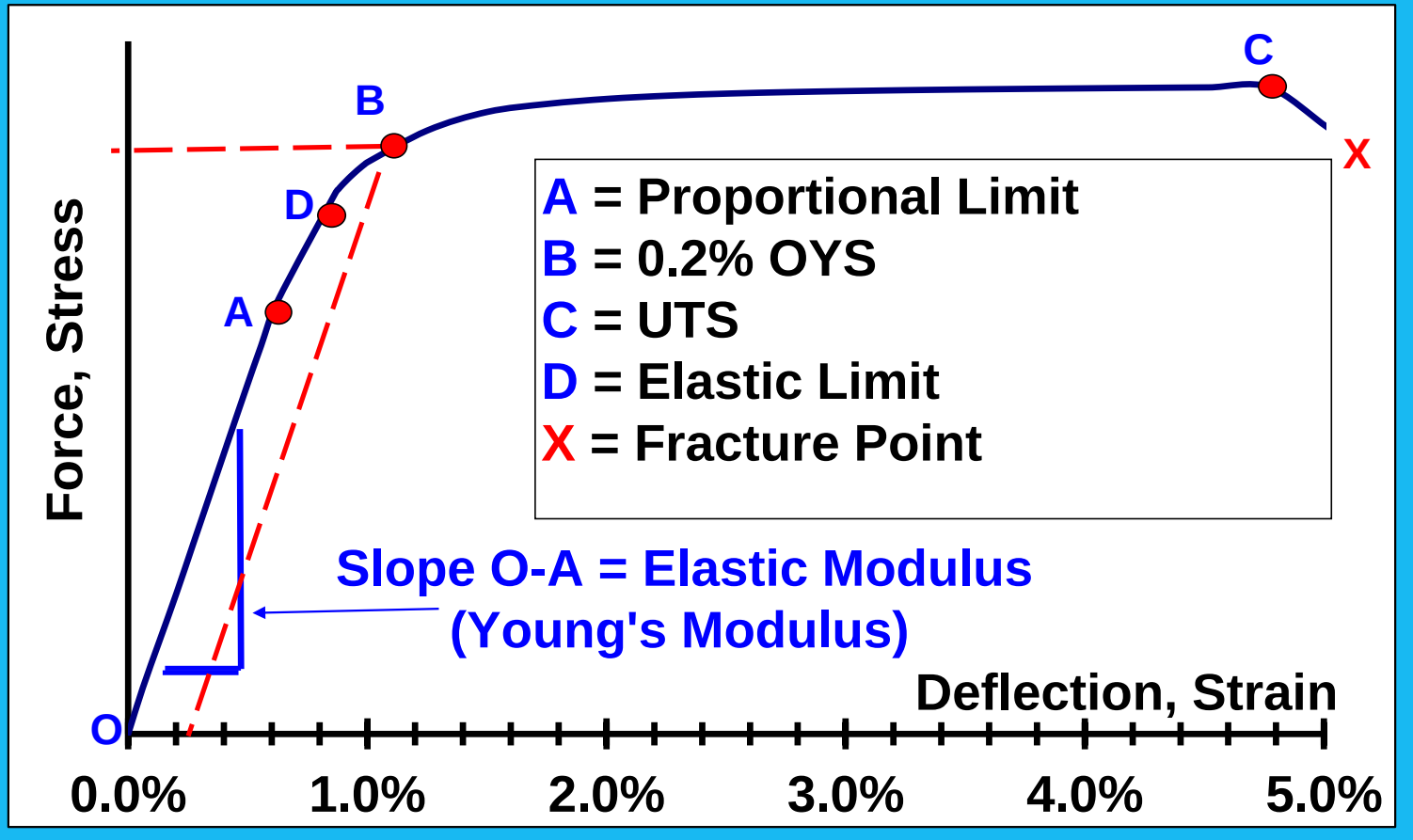
  J.R.R. Tolkien – The Hobbit

The Answer

- Time

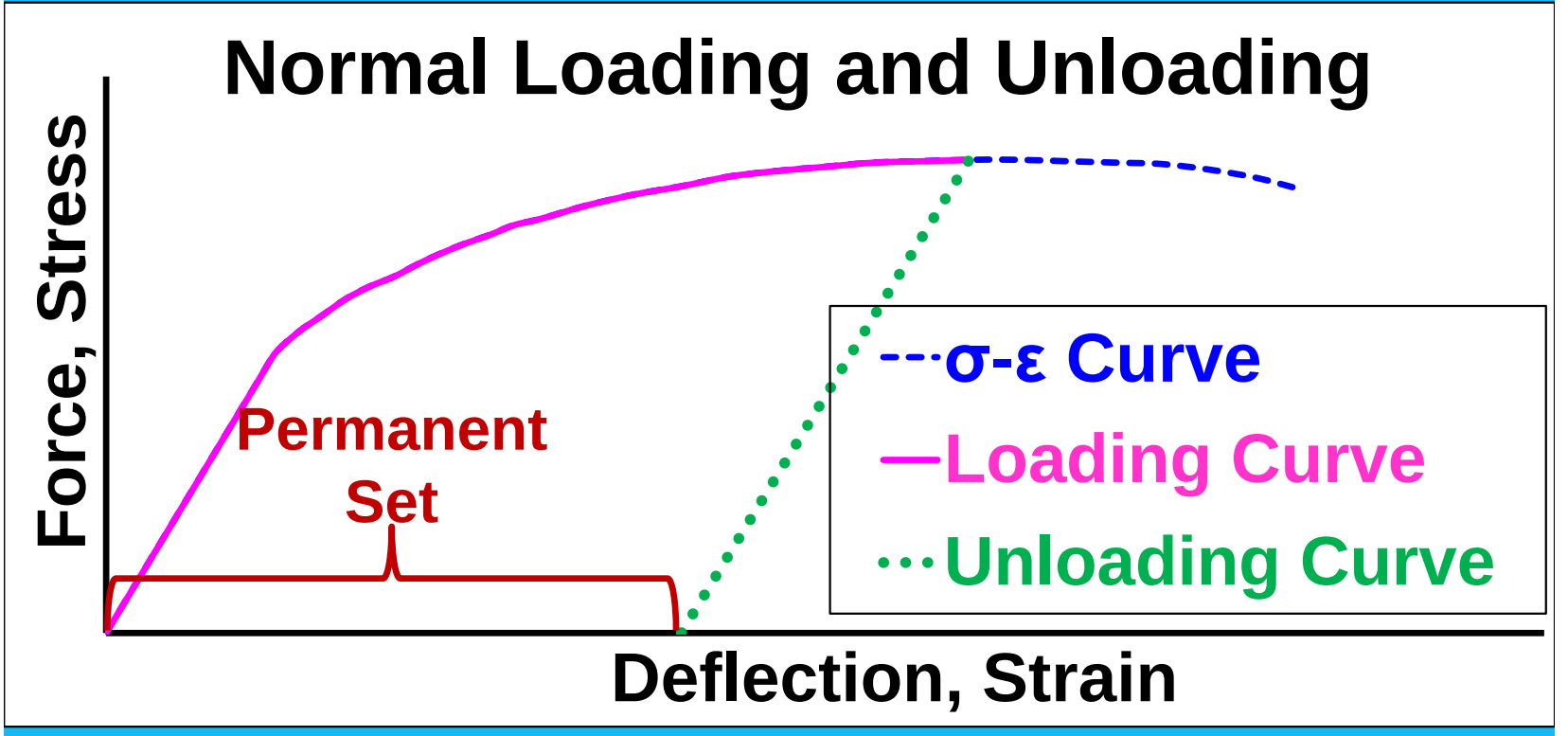

The Bathtub Curve
Failure Rate
Burn In
Useful Life
Wear Out - EOL
Time
BiTS 2015
Burn-in & Test Strategies Workshop
Reliability and Time-Dependent Failure
4

Stress-Strain Curve

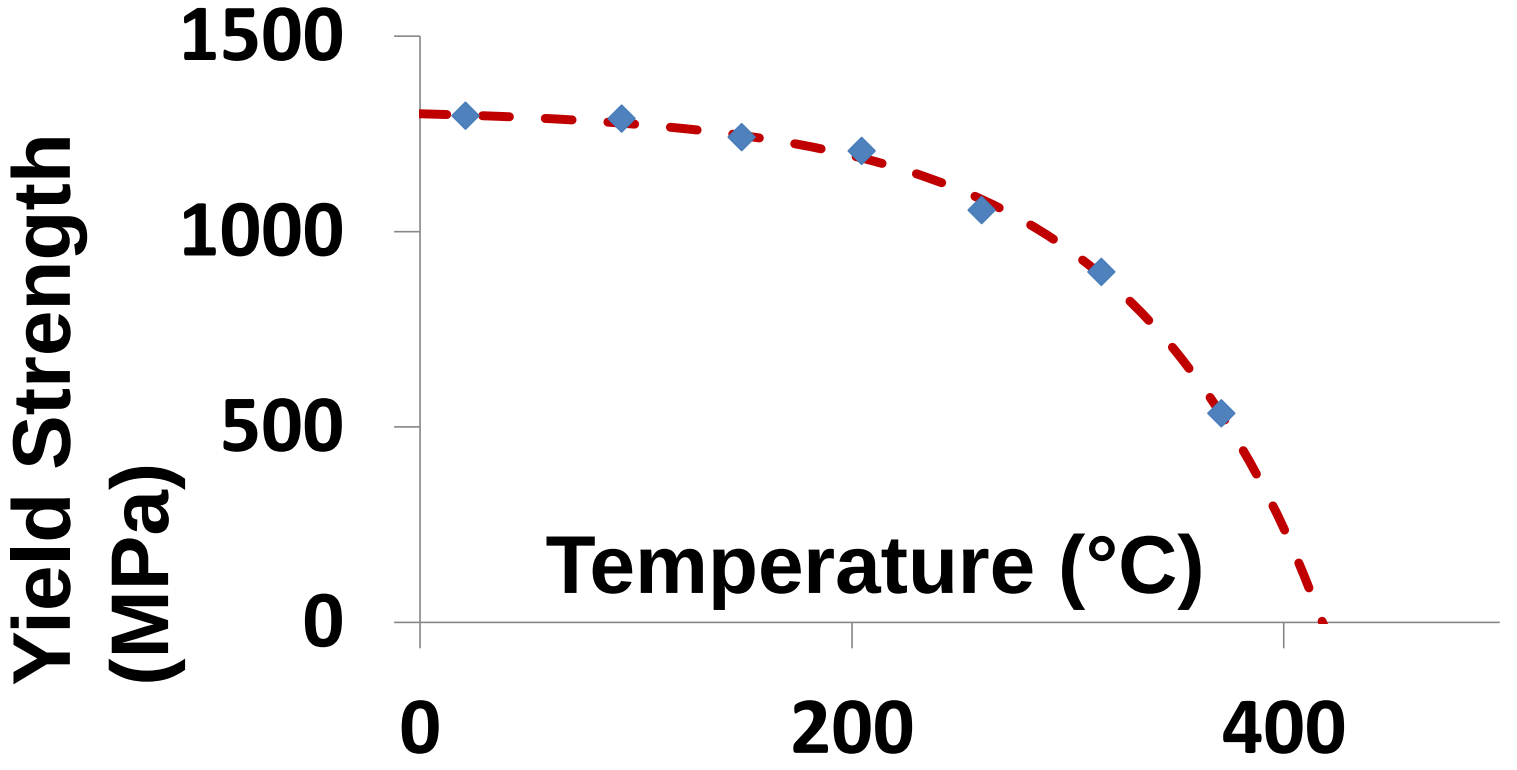


Stress-Strain Curve

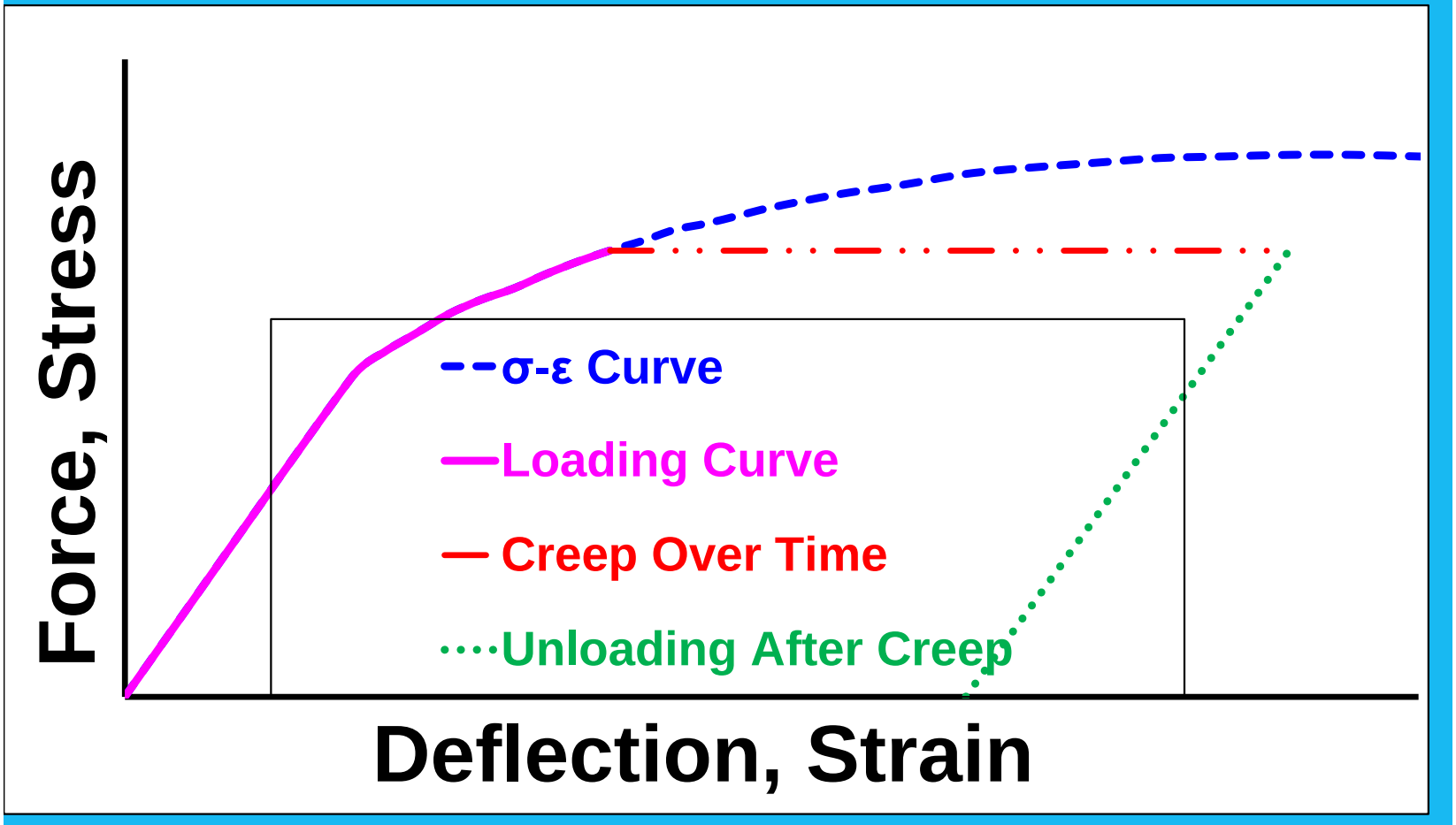
- Plastic Behavior



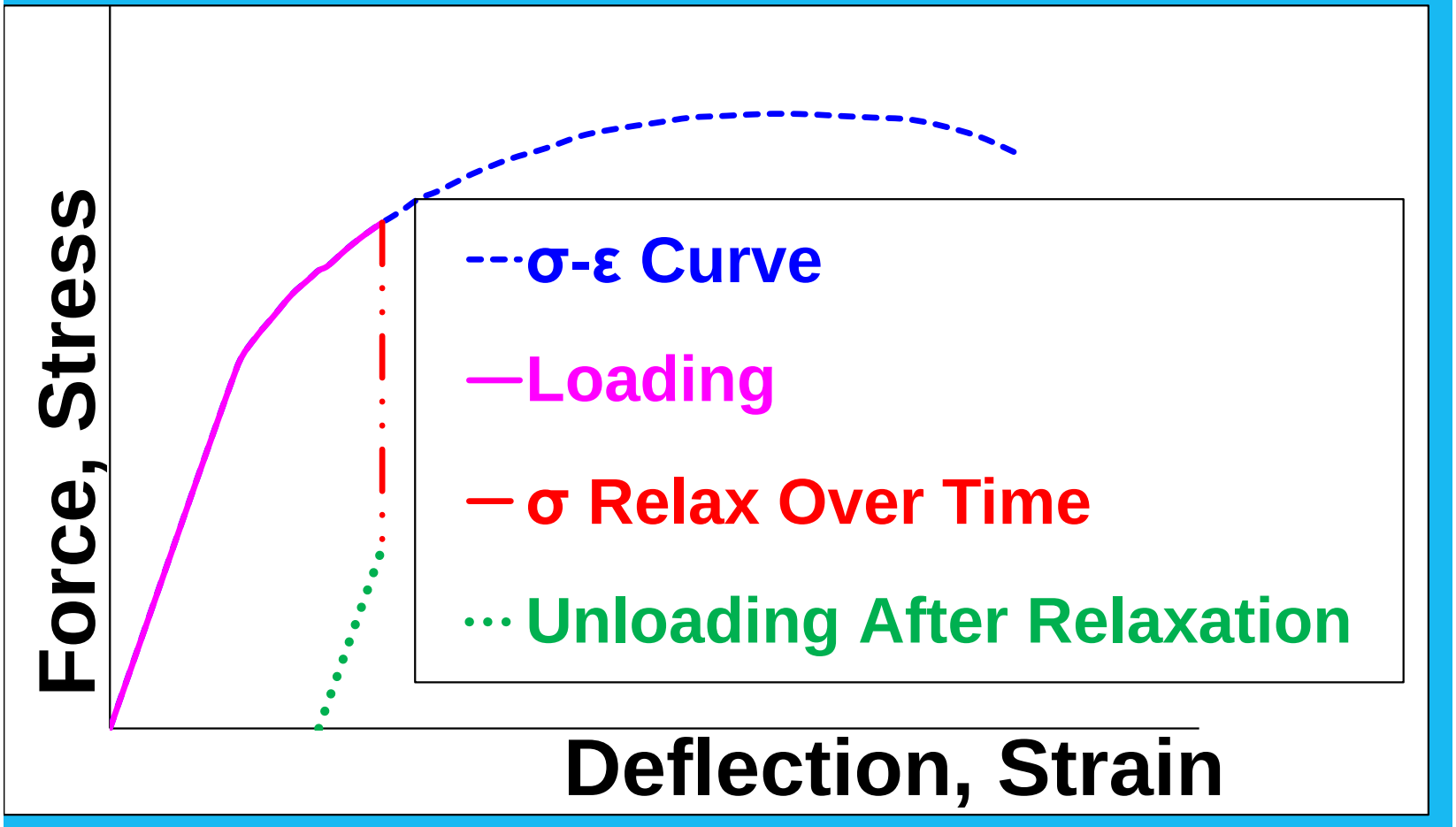
Elevated Temperature Properties



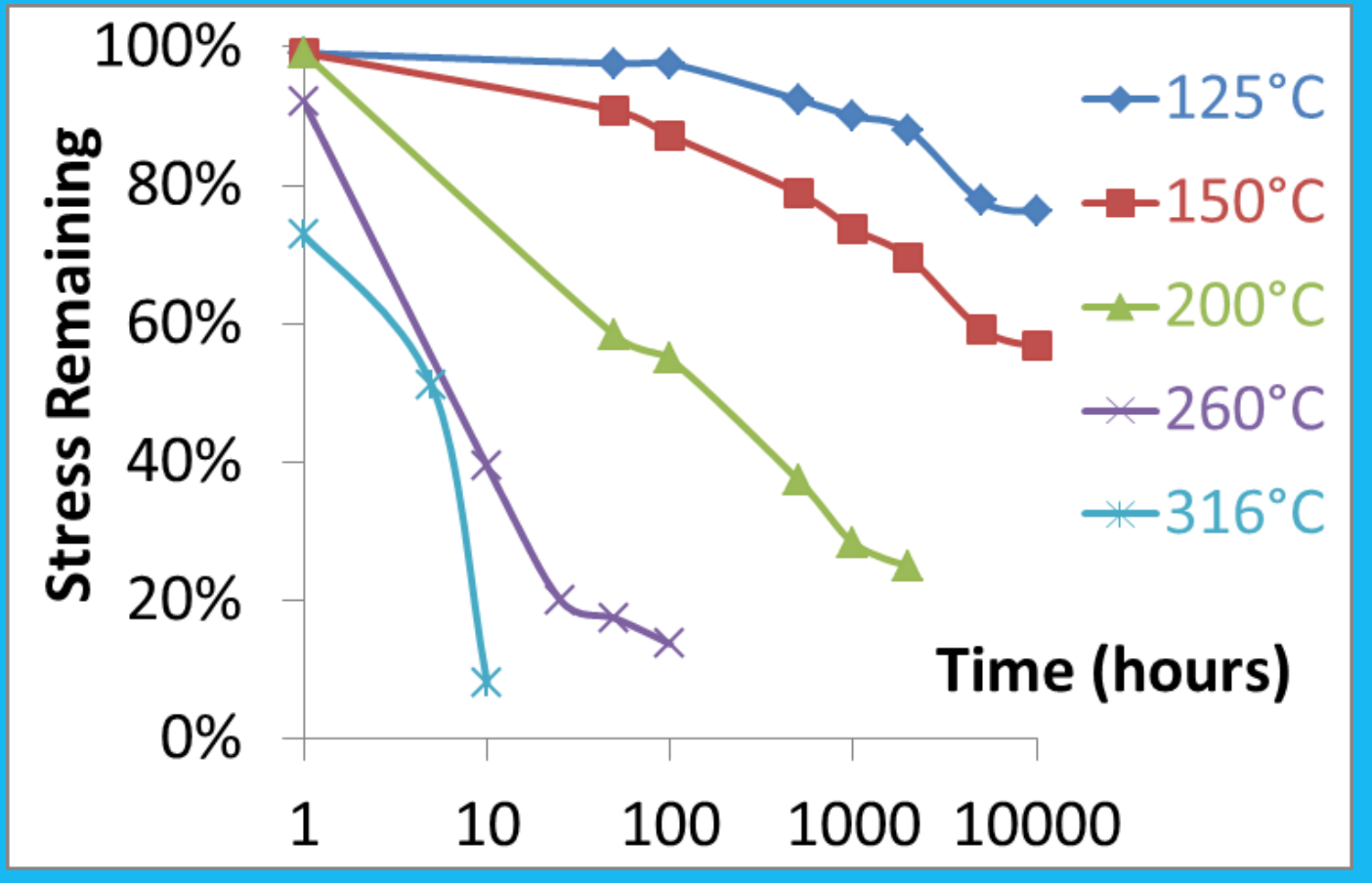
Creep (Heat Deflection)



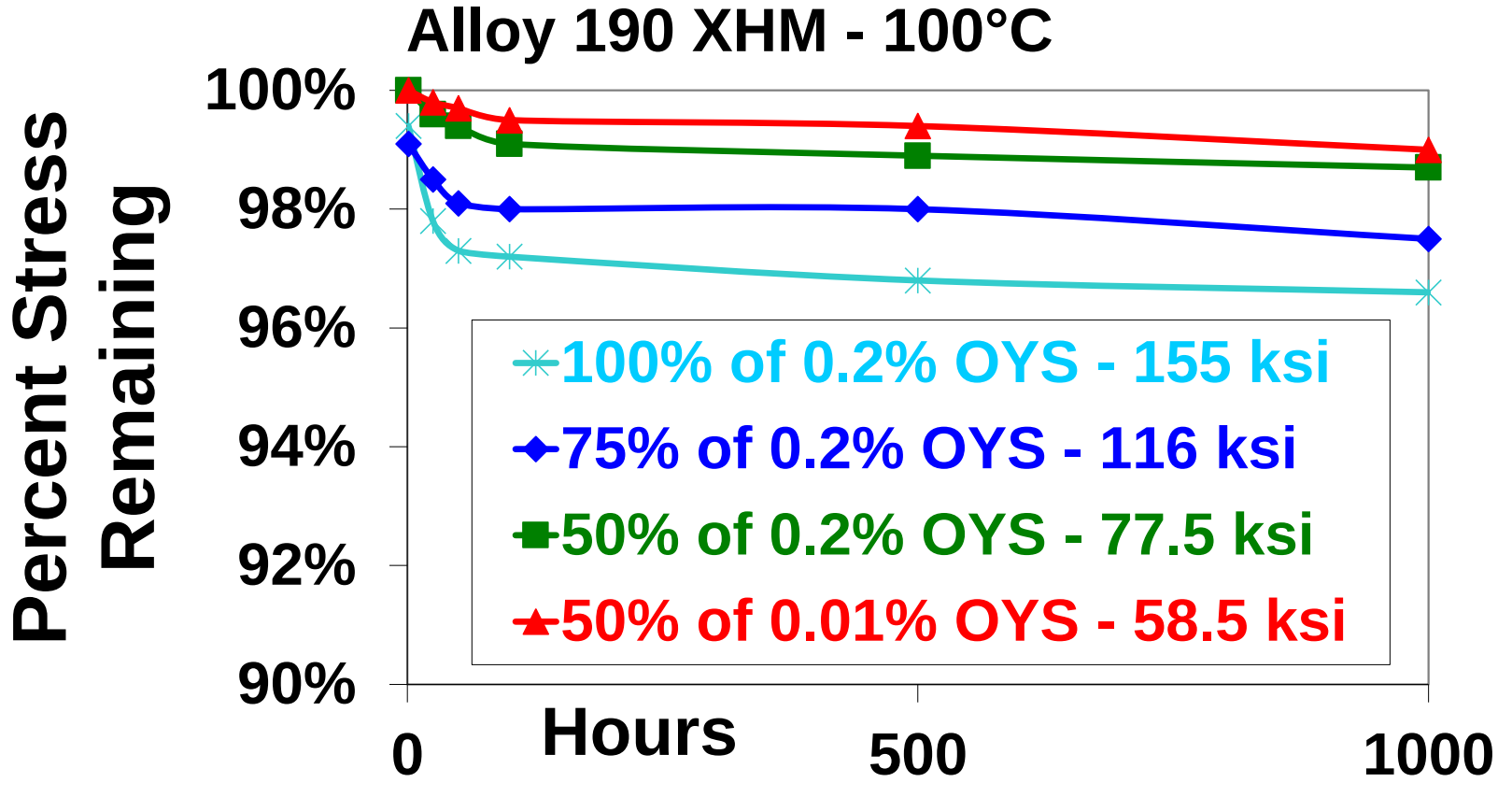
Stress Relaxation



Stress Relaxation Resistance

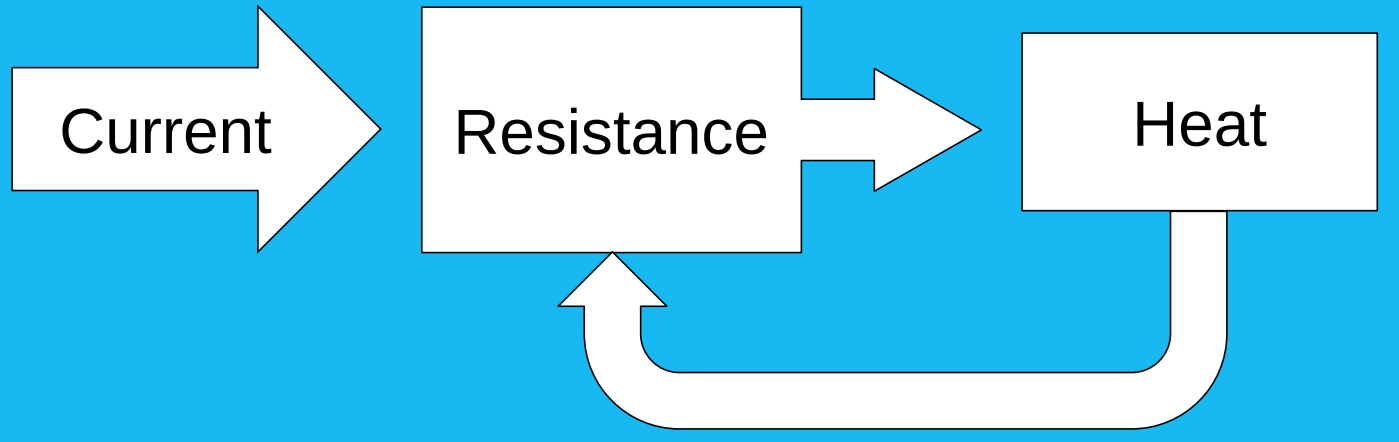


Stress Relaxation Resistance



Thermal Runaway

- Steady state or infinite loop?



- Conductivity dependent

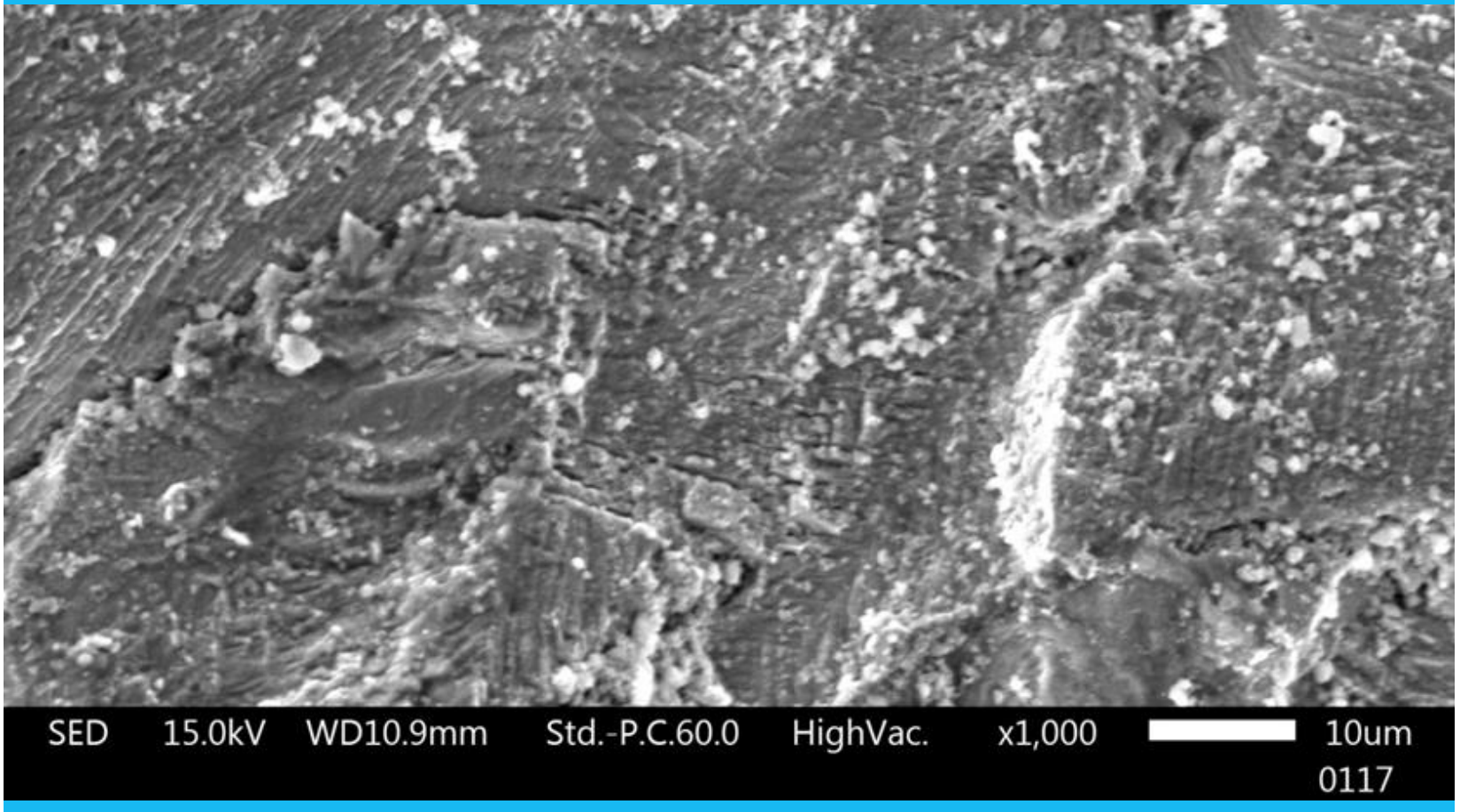
Avoiding Thermal Failures

- Sufficient elevated temperature yield strength/heat deflection temperature
- Stress relaxation resistance
- Sufficient conductivity

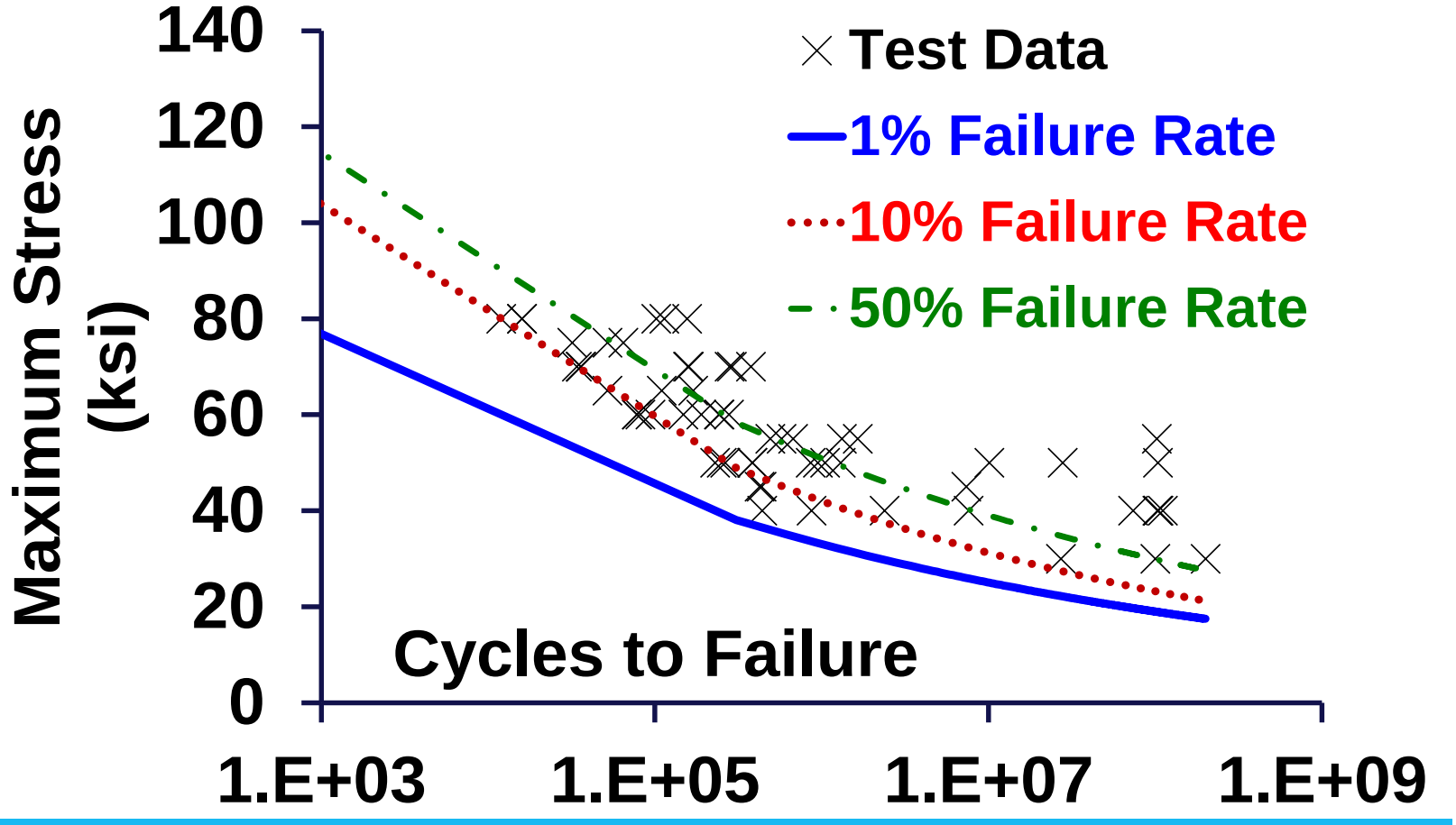
Fatigue

- Accumulated damage over time at low stress
- Slow process, imperceptible each cycle
- Sudden, catastrophic failure

Fatigue Failure – Fracture Surface

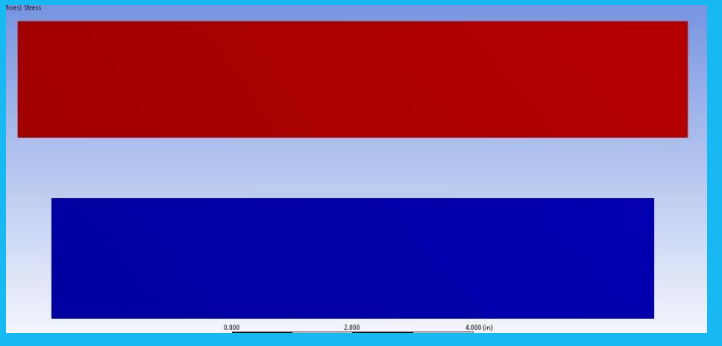


Typical Fatigue Data

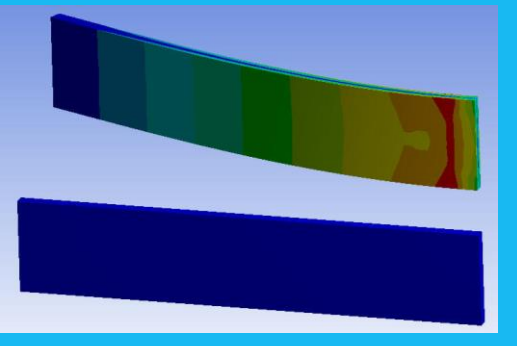


All Cycled Loading Susceptible

- Tension

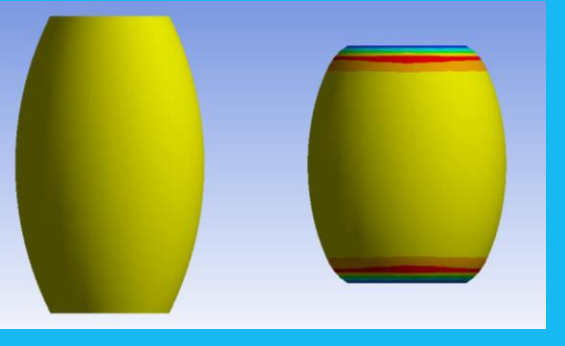


- Bending



- Torsion

- Compression



Avoiding Fatigue Failures

- High fatigue strength material
- Sufficiently ductile, uniform material
- Smooth surface, edges
- Minimize stress concentration
- Avoid corrosion (low stress plating)

Corrosion

- Deterioration caused by chemical or electrochemical reaction of the metal with its environment. – ASM Metals Handbook Desk Edition

- "Corrosion is a natural process that tries to reverse the chemical action of the refining process." – Donald J. Wulpi Understanding how Components Fail

Some Types of Corrosion

- General Corrosion*
- Pore Corrosion*
- Creep Corrosion*
- Galvanic Corrosion
- Fretting Corrosion
- Stress-Corrosion Cracking
- Dealloying
- Crevice Corrosion
- Corrosion Fatigue
- H_2 Embrittlement
- Liquid Metal Embrittlement

*Likely to be found in BiTS World

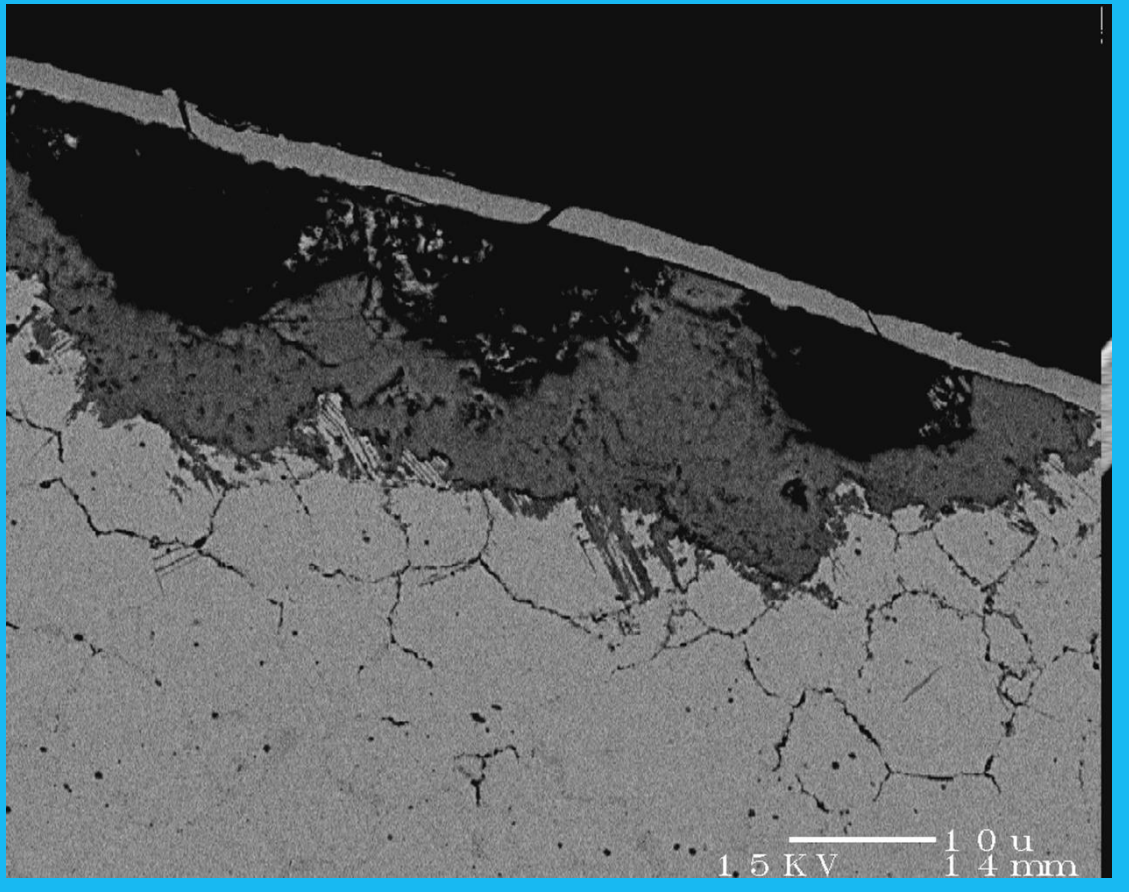
General Corrosion

- Slow, uniform attack of entire surface
- Least prone to catastrophic failure
- Ways to reduce general corrosion:
  - Use a more noble metal
  - Use coating
  - Let the part erode – maybe more economical

Pore Corrosion

- Pores – Defects in plating
  - Exposes base metal
- Ways to reduce:
  - Increase plating thickness
  - Use underplating of less porous metal

Pore Corrosion



Pore and Creep Corrosion Control

Pore Corrosion

creeping corrosion products

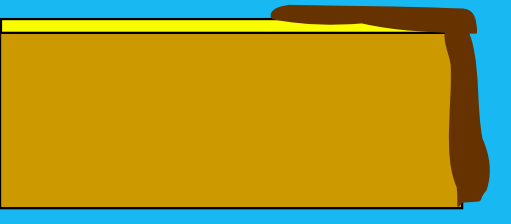
protective **Ni** oxide in pores

Corrosion Migration

creeping corrosion products

protective **Ni** oxide on edge

Au plating
Ni underplate
Cu alloy base metal

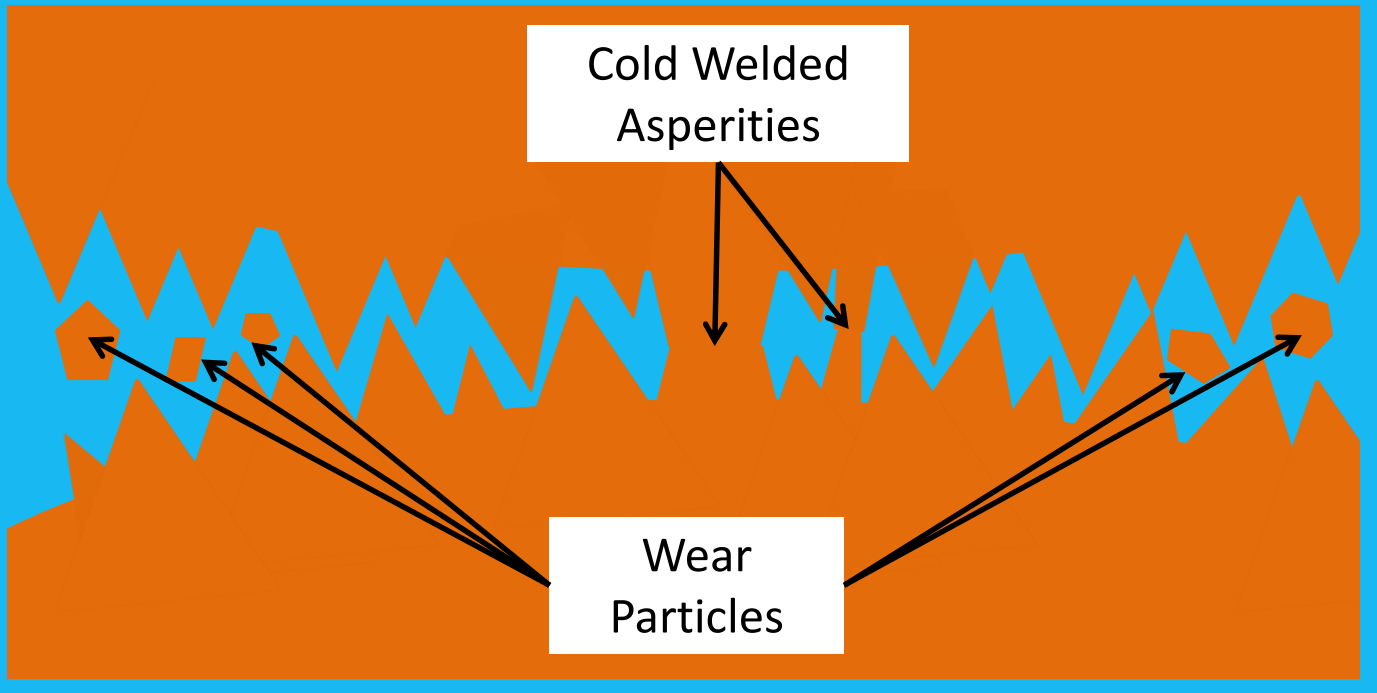


Adhesive & Abrasive Wear

- Adhesive Wear - softer material transfers onto harder surface
  - e.g. solder onto crown
- Abrasive Wear - Hard particles plow across surface and remove volume
  - e.g. oxide particles

Adhesive & Abrasive Wear

- Surfaces in Contact

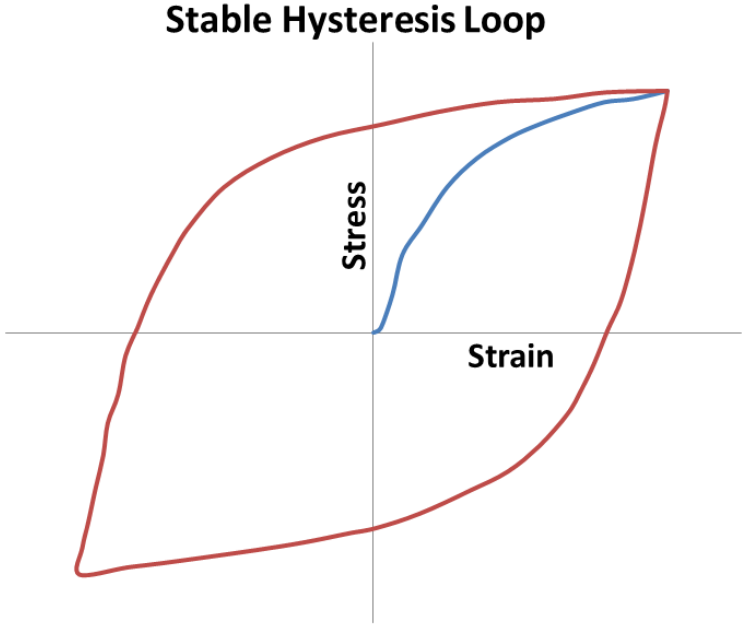


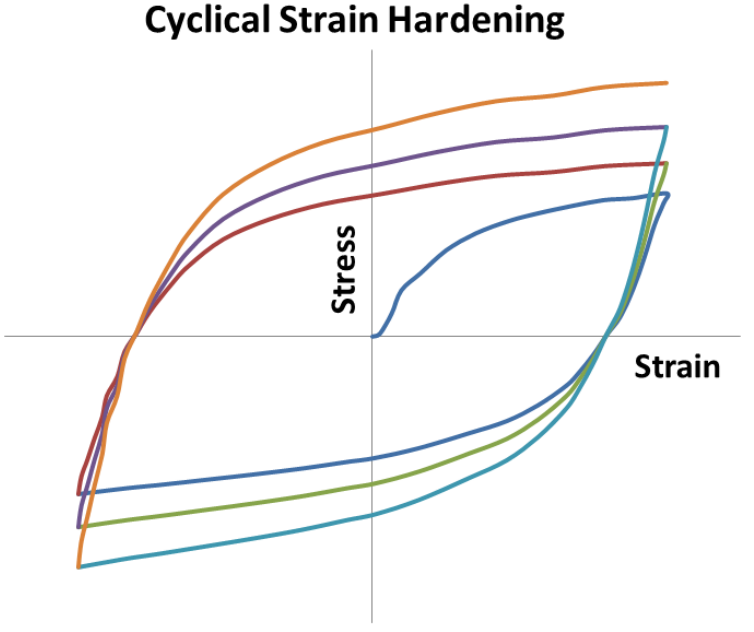
Avoiding Corrosion and Wear Issues

- Plate (sufficiently thick) to avoid corrosion
- Clean to remove corrosion product & wear debris
- Re-plate to enhance service life

Mechanical Hysteresis

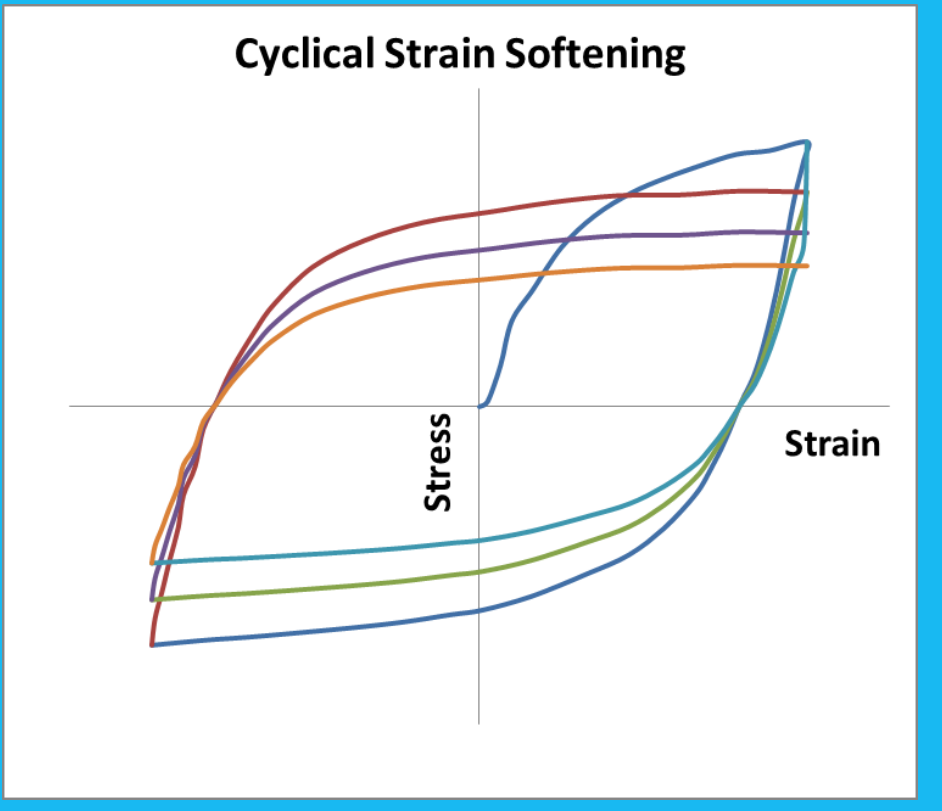
- Stress-strain behavior over time





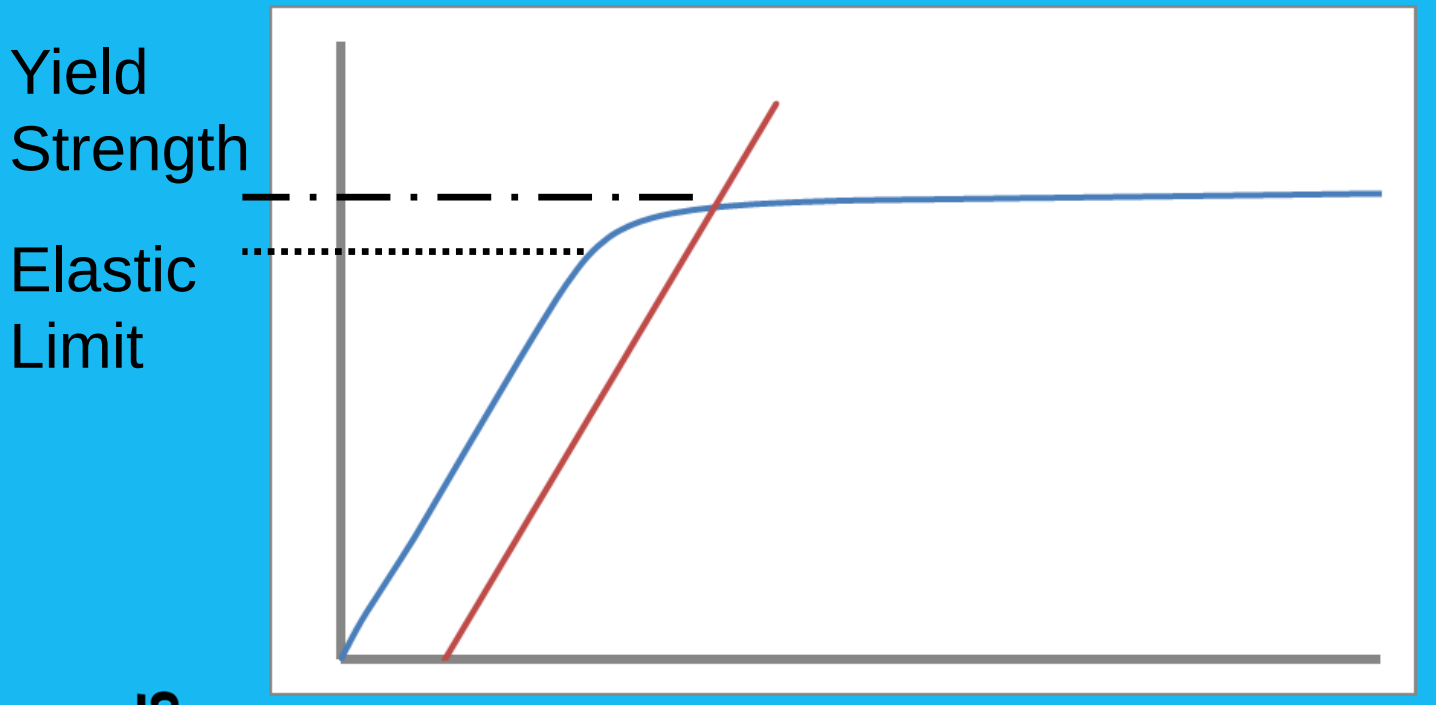
Strain Softening

- Softening behavior over time
  - No cracks
  - No elevated temperature required



Strain Softening

- Usually occurs around knee of stress-strain curve



Avoiding Hysteresis Issues

- Sufficient elastic limit in Material
- Know strain hardening behavior
- Keep stresses in safe zone

Final Thought

- "All we have to do is decide what to do with the time that is given to us." - Gandalf

J.R.R. Tolkien – The Lord of the Rings