Mechanical Properties Module

Outline

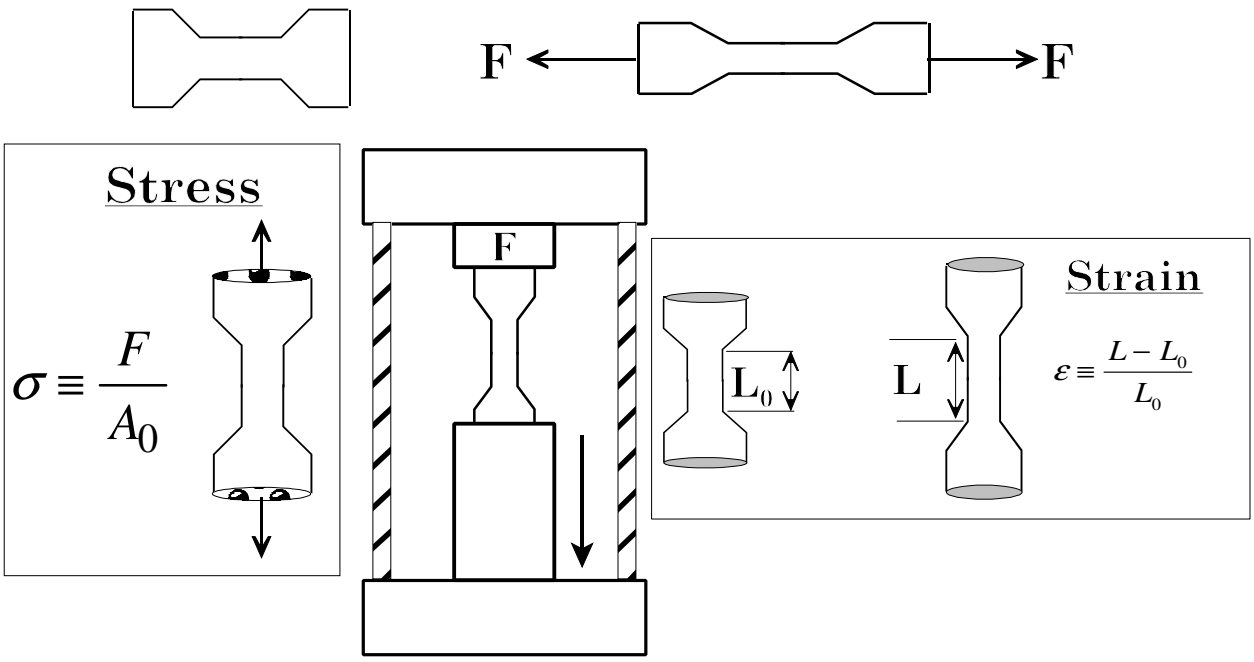
- Mechanical Testing
  - Tensile Test and Mechanical Properties
  - Hardness Test

Mechanical Properties

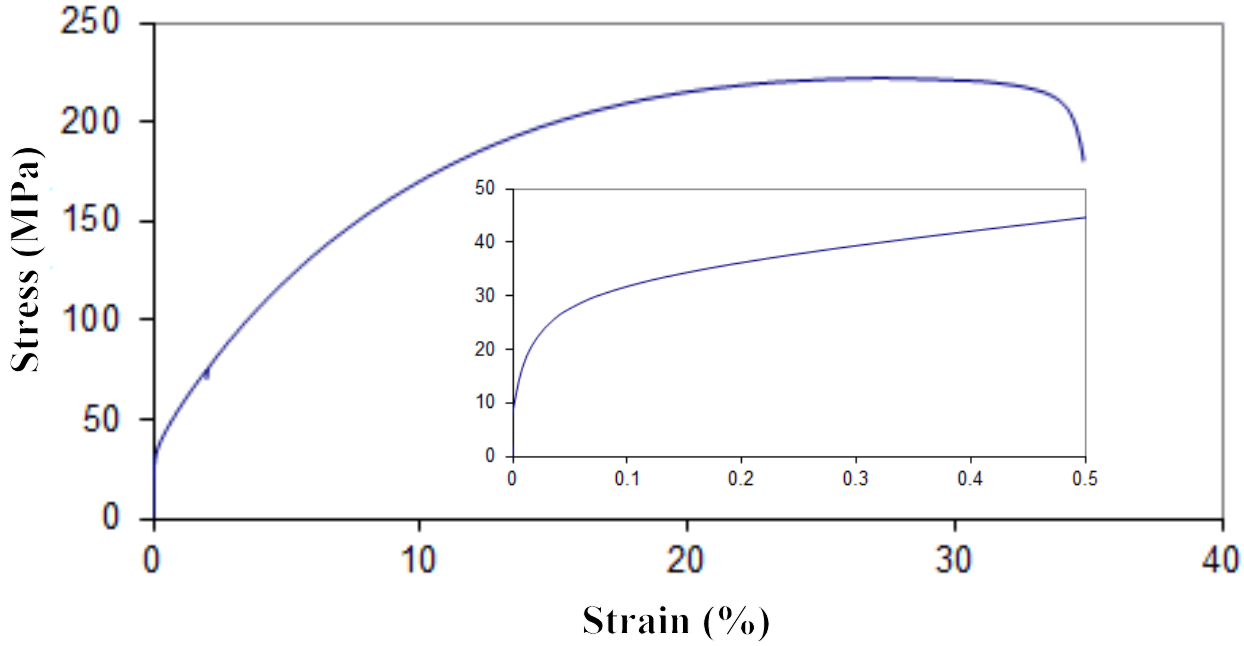
- Effect Both Design and Manufacturing
- Properties of Interest
  - Strength
  - Stiffness
  - Hardness
  - Creep Resistance
  - Fatigue Resistance
  - Fracture Toughness
- Focus On
  - Properties
  - Measurement

Tensile Test Equipment

- Apply a Load to a Material it Elongates



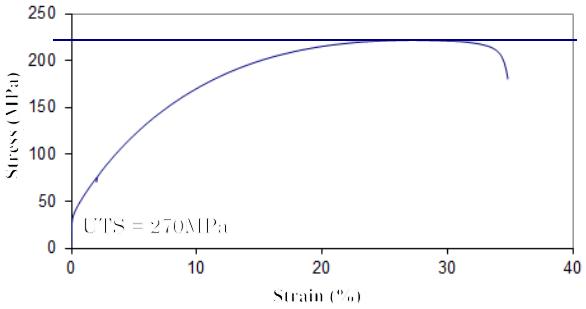
Stress-Strain Curve



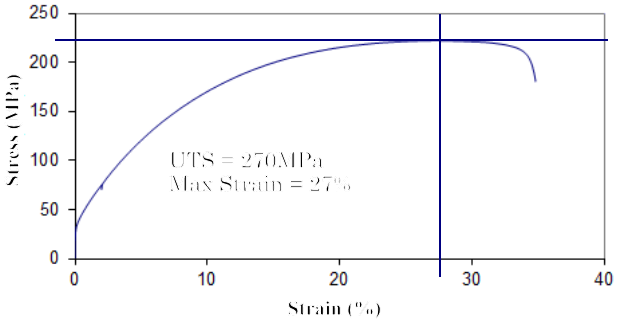
Mechanical Properties

- Ductility, Max Strain, UTS

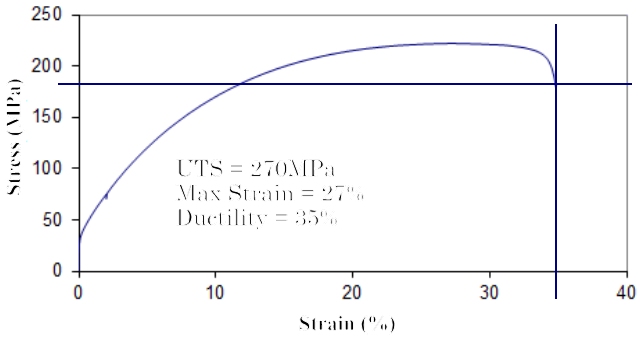
Ultimate Tensile Strength



Max Strain



Ductility

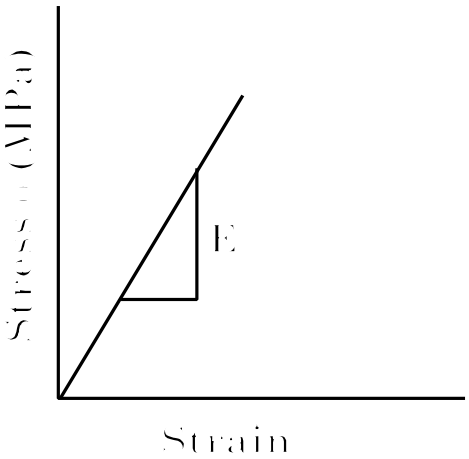


Elastic Modulus

- Energy is Recovered
- Hooke's Law
  - Force is Proportional to Elongation
  - Stress is Proportional to Strain

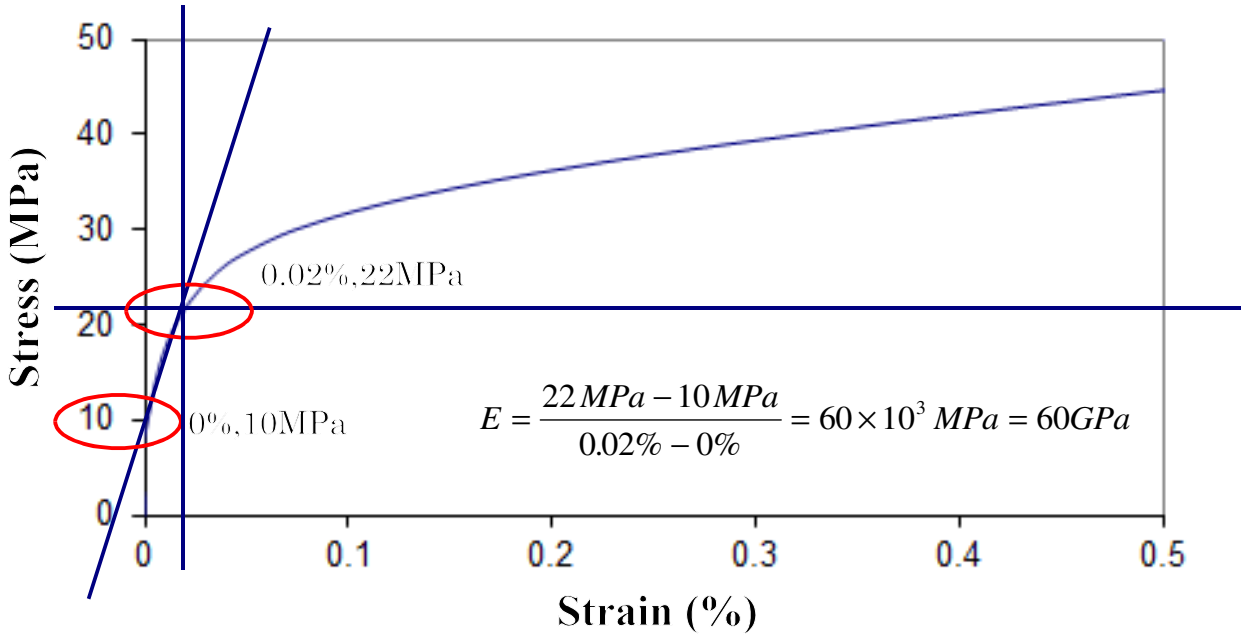
$$\frac{F}{A_0} = E\frac{\Delta L}{L_0}$$

$$\sigma = E\varepsilon$$



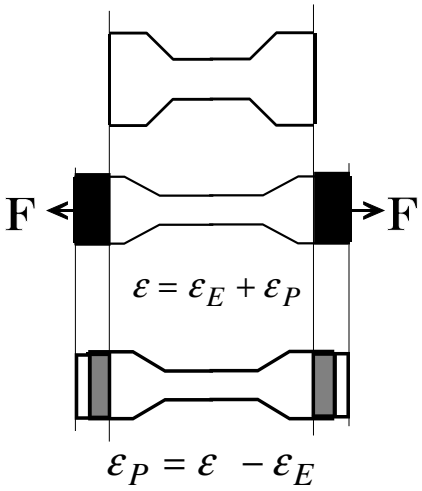
Elastic Modulus

- Slope of σ(ε) When Elastic



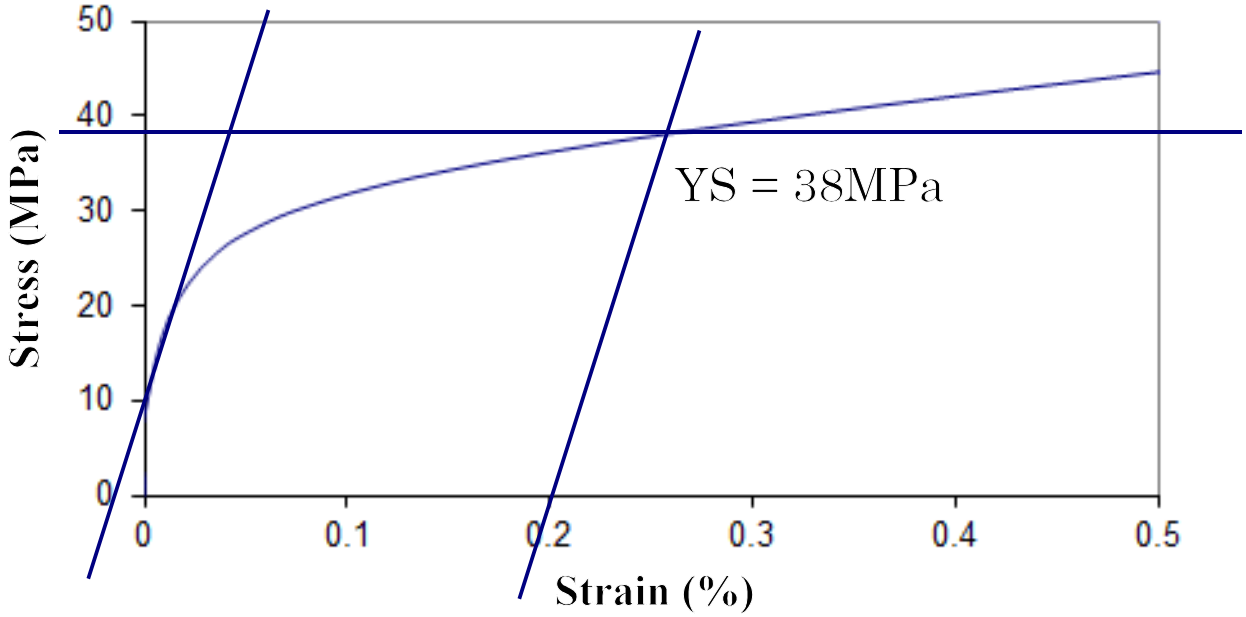
Yield Stress

- Definition
  - Stress Required for Plastic Deformation
- Practical Definition
  - Stress Required for Minimum Observed Plastic Deformation
- Elastic Recovery
  - On UnLoading



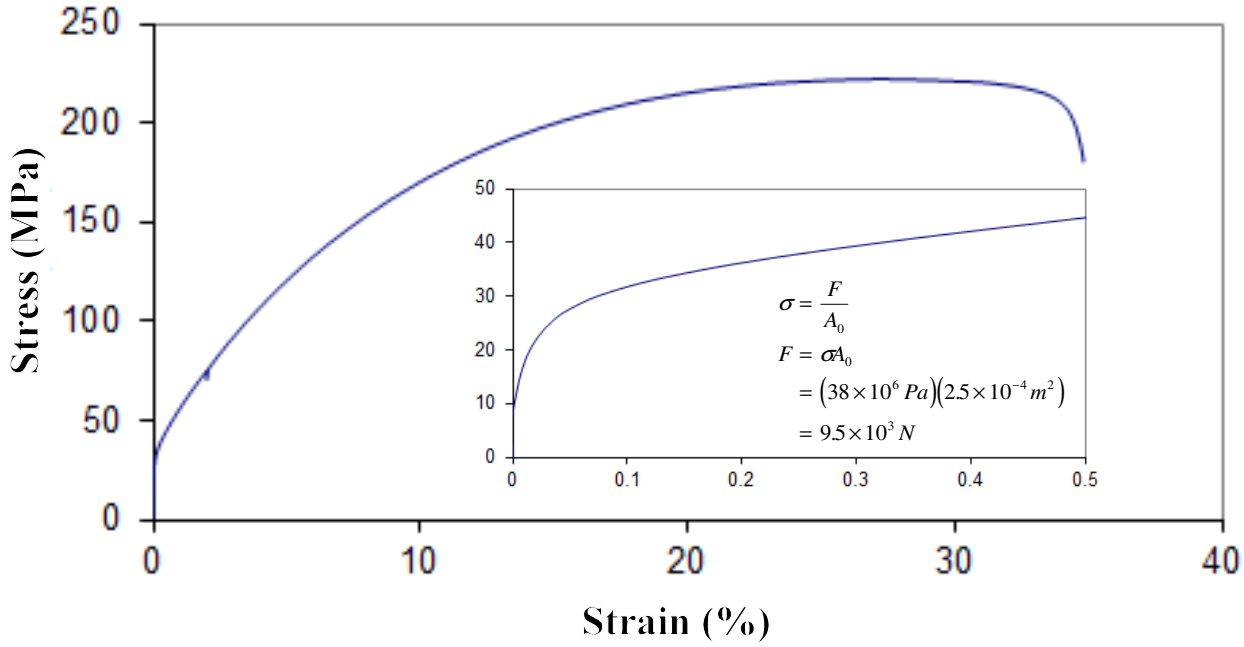
Yield Strength

- 0.2% Permanent Deformation



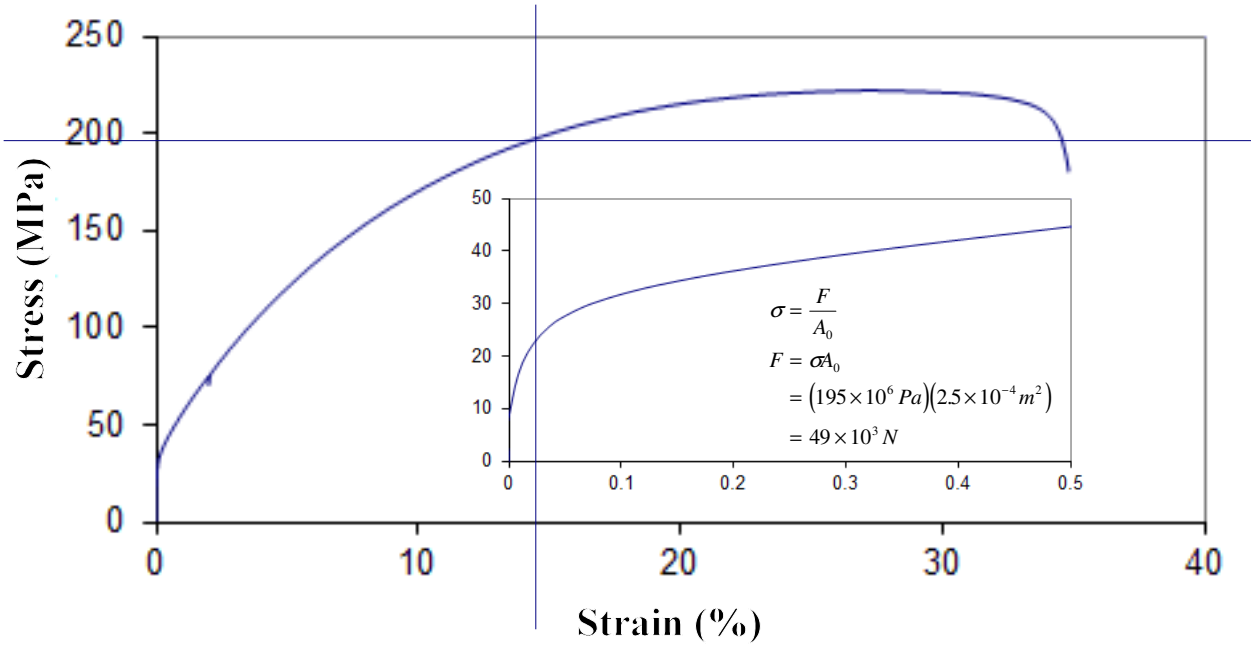
Force Required for Permanent Deformation

- Determine the Minimum Force Required to Cause a 2.5cm^2 Bar to Yield



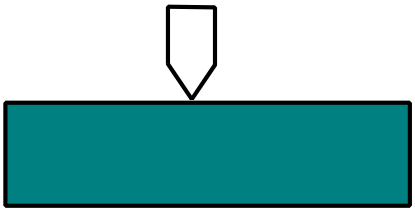
Force for Required Strain

- Determine the Force Required to Strain a 2.5cm^2 Bar to 15%



Hardness

- Defined as Resistance to Penetration
- Measured by
  - Penetrating Material
  - Measuring Resistance
- Empirical Scales
- Correlation With Strength

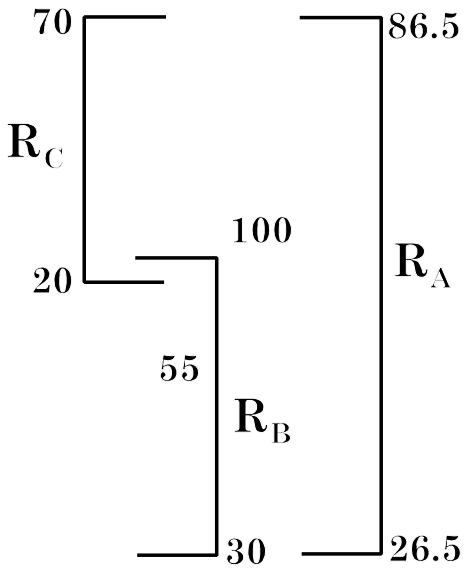


Various Hardness Tests

Brinell	Rockwell C	Rockwell B
3000 kg	150 kg	100 kg
		
10 mm dia.		1/16 in dia.

Relation Between Scales

- Rockwell
  - More Precise
  - C Harder Than B
  - A Overlaps
- Brinell
  - Broad



Hardness and Strength

- Correlations Exist
  - Specific to Alloy Systems
- Hardness Tests
  - Less Expensive than Tensile Tests
  - More Reproducible
- Hardness Often Used as Quality Control Measure