# Tensile Test

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EGR270

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# Overview

- Tensile testing review
- Test procedure
- Materials to be tested

# Tensile Testing

- Uniaxial test (load in one direction)
- Record force ($\sigma = F/A_0$) and strain
- Important mechanical properties
  - Yield strength ($\sigma_{ys}$ or $\sigma_{yp}$)
  - Tensile strength ($\sigma_{UT}$)
  - Modulus of Elasticity (E)
  - Ductility (%EL and %RA)

# Test Standard

- ASTM E8 – *Standard Test Methods of Tension Testing of Metallic Materials*
- Gage length > 4D (uniform stress)
- Grips should be free to rotate
  - uses spherical bearing to allow rotation
  - creates a 2-force member (axial load)
- Temperature between 50 and 100°F

# Procedure

- Mark, measure and record:
  - gage length (close to 2 inches)
  - diameter
- Load into test frame (SATEC)
- Apply load, record force and strain
- After fracture, measure and record:
  - final gage length
  - diameter in necked region

# Materials to be Tested

- 2024-T351 aluminum alloy
- AISI 1045HR (hot rolled)
- UHMW-PE (polyethylene)
- Acrylic
- Already tested: 1018CF, 1045CF, 4140CF

# Aluminum Alloys

- Designation of *wrought aluminum alloys* (by the Aluminum Association) – the first digit of the four digit scheme indicates primary alloying elements:

# *Heat Treatable Wrought aluminum alloys*

- 2xxx – copper
- 4xxx – silicon
- 6xxx – magnesium and silicon
- 7xxx – zinc
- 8xxx – other elements

# *Non-Heat Treatable wrought aluminum alloys*

- 1xxx – commercially pure aluminum
- 3xxx – manganese
- 5xxx – magnesium

# *Cast aluminum alloys*

- 1xx.x – 99.00% pure aluminum
- 2xx.x – copper
- 3xx.x – silicon with copper and/or magnesium
- 4xx.x – silicon
- 5xx.x – magnesium
- 7xx.x – zinc
- 8xx.x – tin
- 9xx.x – other elements

# Temper Designation

- F:  As fabricated
- O:  Annealed
- W:  Solution heat-treated.
- H:  Strain hardened.
- T:  Thermally treated.

- T1 – Cooled from hot working temperature and naturally aged
- T2 – Cooled from hot working temperature, cold worked, naturally aged
- T3 – Solution heat treated, cold worked, naturally aged
- T4 – Solution HT, naturally aged
- T5 – Cooled from elevated temperature and artificially aged
- T6 – Solution HT, artificially aged.
- T7 – Solution heat treated and overaged or stabilized (corrosion resistance).

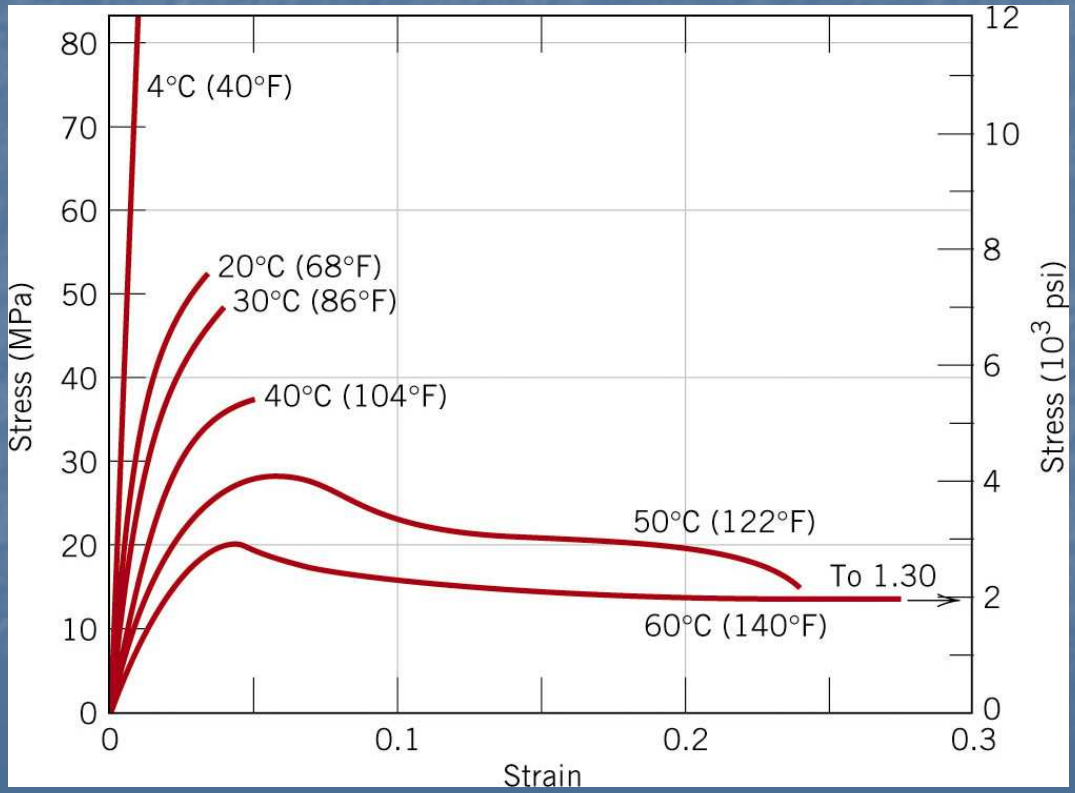
# 2024-T351

- 2xxx = copper main alloy element
  - 2024: 4.4%Cu, 1.5%Mg, 0.6%Mn
- T: Thermally treated
  - T3: sol'n HT, cold worked, nat. aged
  - T351: sol'n HT, cold worked for stress relief, natural aged.

# UHMW-PE

- Ultra-High Molecular Weight, Polyethylene
  - Ultra-High Molecular Weight?
- Thermoplastic
- Thermoplastics are strain rate sensitive
  - Stiffness
  - Strength
- Thermoplastics are temperature sensitive

# Acrylic (Polymethylacrylate)



- Any questions
  - Tensile testing?
  - Stress-strain curves?
  - What we are doing today?
  - What is required?