Fall 2019

**Laboratory 2**

Uniaxial Tensile Testing

**Objectives**

- To understand the basic properties of strength and toughness of materials

- To observe the uniaxial tensile test

- To understand the basic concepts of mechanical stress and strain

- To calculate stress-strain curves

**Reference**

Callister’s Materials Science and Engineering section 6.2 - 6.8, 15.215.3. (Integrated approach – section 7.3, 7.6-7.8, 7.13-7.14)

American Society for Testing and Materials, ASTM Standards, specific references relating to tensile testing.

**Apparatus and Test specimen**

- Equipment

Tensile test machine

Stereomicroscope for fracture surface observation

Testing system consisting of a load unit, an actuator, and a control package. The load unit contains the actuator that applies the loading to the test specimen through mechanical grips. The applied load is monitored through a strain-gage type load cell. The actuator motor supplies the energy for the test. The control package provides precision control for the test program through the principles of closed-loop control. Force, strain, or stroke (displacement) may be used as a control parameter during the test. The output signal, which is used in feedback control can be displayed through digital readout and stored in the computer.

- Materials

1018 CR steel, 2024-T3 aluminum, and plastics flat sub-standard specimen with dimensions recommended by ASTM.

**Lab Report**

Students should hand in a brief laboratory report containing:

1. Data Sheets

2. Data analysis (answers to questions)

3. Conclusions

**Background**

The tensile test is widely used in materials research and quality control to evaluate materials and to monitor standards. As a source of basic design information on the strength of materials, it is used to determine the following mechanical properties

• \_Modulus of Elasticity (psi)

• \_Tensile Strength (psi)

• \_Yield Strength at 0.2% offset (psi)

• \_Percent Elongation (%)

• \_Percent Reduction of Area (%)

• \_Breaking Stress (psi)

**Data Analysis**

Record the pre-test specimen information and machine settings on the data sheet. Measure load vs. displacement of the tensile specimens up to fracture. After fracture, measure the final elongation and cross-sectional area of the specimens. Observe the fracture surface using the stereomicroscope.

From the load-displacement measurements of all materials, construct engineering stress- engineering strain curve. Determine the 0.2% offset yield strength, tensile strength, percent elongation at fracture, percent reduction of area at fracture, and breaking stress of all specimens.

Determine the elastic modulus from the load-strain data for the 1018 CR steel and 2024-T3 aluminum. Also construct a true stress- true strain curve for the 2024-T3 specimen. Prepare a table comparing the measured tensile properties with published values of the tested materials.

1. What are the two types of deformation a material undergoes in a tensile test? Identify where they exist in a stress-strain plot for a ductile material.

2. In testing the polyethylene specimen, did the applied strain rate affect the behavior of the material? Explain.

3. Sketch a tensile stress-strain curve for a brittle material (for example, cast iron).

4. For an aerospace application, it is important to minimize the amount of elastic deformation while minimizing the weight of the aircraft. With the above specific strength and specific modulus, which material would you choose.

**Summary**

This experiment provides the student experience with the use of a standard technique for characterizing the mechanical properties of a metallic alloy and polymer materials. It illustrates the use of stress-strain curves in testing materials. Understanding what occurs to a plastic material as a load is applied is the most important concept to be learned from this experiment.

**Conclusion**

Please submit the Conclusions as a part of the Lab report, along with the Data sheets and Data Analysis.

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Materials Laboratory Section\_\_\_\_\_\_\_\_\_\_\_

Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Tensile Test Datasheet** (use one sheet for each material tested)

Specimen: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Width and thickness: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Neck width and thickness: \_\_\_\_\_\_\_\_\_\_\_

Area of cross-section: \_\_\_\_\_\_\_\_\_\_\_\_\_ Area of neck cross-section: \_\_\_\_\_\_\_\_\_\_

Load range: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Yield point load: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ultimate (maximum) load :\_\_\_\_\_\_\_\_\_\_\_ Breaking load: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Elongation measured after fracture in a \_\_\_\_\_\_\_ inch gage length: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Notes: