

# ENGR 240 – Science of Materials Laboratory

## LAB J TENSILE TESTING OF POLYMERS

### Background

While a vast number of standardized tests are available for the measurement of mechanical properties, perhaps the most versatile and widely used procedure is the tensile test. The tensile test examines a material's response to a tensile force. In this experiment, you will gain familiarity with the standard tensile test and the important physical property information that can be obtained from such an experiment. You will also observe the wide range of properties that can be exhibited by plastics.

The mechanical properties and stress-strain response of polymers are largely a result of the chemical structure of the polymer. Polymers exhibit three basic types of stress-strain behavior: (i) “brittle” stress-strain behavior, described by high strength but very low strain to failure (generally observed in glassy or amorphous polymers), (ii) “plastic” stress-strain behavior, described by moderate strengths and relatively high elongations to failure (generally observed in semicrystalline polymers), and (iii) “elastomeric” stress-strain behavior, described by extremely high strains and very low stresses at failure (generally observed in rubbers).

### Procedure

The instructor will provide standard plastic samples ready for tensile testing. The samples were machined from flat sheets and have a standard “dogbone” geometry which corresponds to an ASTM standard shape for plastic testing. Before testing, measure the dimensions of the narrow region of each sample. You'll need to know the cross sectional area (in order to calculate engineering stress) and the initial length of the narrow region (in order to calculate engineering strain).

Consult with the instructor or TA regarding operation and computer control of the tensile testing machine. For each run, the computer will save extension vs. load data in a file that may be opened in Excel. Test each sample to fracture, or to the maximum suggested extension.

### Report

Construct a computer generated engineering stress-engineering strain curve for each specimen tested. Put all stress-strain curves on the same graph for easy comparison (if their elastic regions are difficult to distinguish from each other, you can prepare a second plot showing an expanded view of this region). For each material determine and tabulate:

- a. Initial elastic modulus (psi)
- b. Tensile strength (psi)
- c. Yield strength (psi) – estimate the yield strength from the stress at which significant plastic deformation begins
- d. Percent elongation at fracture

Briefly comment on the combination of properties exhibited by each material.

### Reference:

Callister sections 6.2, 6.3, 6.6, 15.1-15.11, and 16.1-16.9

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Use the following machine settings for the tensile tests:

Polymers	Load Range, lbf	Extension Range, in.	Extension Speed, in./min	Save Time, sec
Polyethylene (PE)	500	25	1.5	0.5
Nylon	500	5	1.5	0.5
Polypropylene (PP)	500	25	1.5	0.5
Polystyrene (PS)	500	5	1.5	0.05
Polymethyl methacrylate (PMMA)	500	5	1.5	0.05
High Impact Polystyrene (HIPS)	500	5	1.5	0.1
Polycarbonate (PC)	500	5	1.5	0.3
Polyvinyl chloride (PVC)	500	5	1.5	0.1