Glossary of Materials Engineering Terminology

Adapted from:

- Callister, W. D.; Rethwisch, D. G. *Materials Science and Engineering: An Introduction*, 8th ed.; John Wiley & Sons, Inc.: Hoboken, NJ, 2010.
- McCrum, N. G.; Buckley, C. P.; Bucknall, C. B. *Principles of Polymer Engineering*, 2nd ed.; Oxford University Press: New York, NY, 1997.

Brittle fracture: fracture that occurs by rapid crack formation and propagation through the material, without any appreciable deformation prior to failure.

Crazing: a common response of plastics to an applied load, typically involving the formation of an opaque banded region within transparent plastic; at the microscale, the craze region is a collection of nanoscale, stress-induced voids and load-bearing fibrils within the material's structure; craze regions commonly occur at or near a propagating crack in the material.

Ductile fracture: a mode of material failure that is accompanied by extensive permanent deformation of the material.

Ductility: a measure of a material's ability to undergo appreciable permanent deformation before fracture; ductile materials (including many metals and plastics) typically display a greater amount of strain or total elongation before fracture compared to non-ductile materials (such as most ceramics).

Elastic modulus: a measure of a material's stiffness; quantified as a ratio of stress to strain prior to the yield point and reported in units of Pascals (Pa); for a material deformed in tension, this is referred to as a Young's modulus.

Engineering strain: the change in gauge length of a specimen in the direction of the applied load divided by its original gauge length; strain is typically unit-less and frequently reported as a percentage.

Engineering stress: the instantaneous load (or force, typically in units of Newtons, N) applied to a specimen divided by its cross-sectional area before any deformation (in units of m^2); stress is typically reported in units of Pascals (Pa), which is equivalent to $N\ m^{-2}$.

Extrusion: a material forming technique whereby the material (*e.g.*, molten plastic film) is forced by compression through a die orifice, typically forming cords or sheets.

Glass transition temperature (of plastic), T_g: the temperature at which the mechanical properties of plastic transform from a glassy, brittle response (for $T < T_g$) to a rubbery, ductile response (for $T > T_g$); different chemical compositions of plastic have different T_g values.

Mechanical anisotropy: when a material exhibits different mechanical properties in different directions.

Necking: a condition that occurs during deformation of a specimen in response to an applied load in which localized deformation occurs within the gauge of the specimen, forming a region with reduced dimensions compared to the original gauge dimensions.

Plastic: a solid material composed of polymer molecules that has some structural rigidity under applied load; typically used in many general purpose applications (*e.g.*, milk jugs, trash bags, disposable utensils, bike helmets).

Polymer: an organic compound of high molecular weight with a molecular structure composed of small repeating units (*e.g.*, polyethylene is composed of repeat units of C_2H_4); polymer molecules are sometimes referred to as polymer "chains", due to their predominantly linear physical dimensions.

Strain stiffening: region in a stress-strain curve of a material where the value of stress is continuously increasing with strain, which effectively corresponds to a stiffening of the material during deformation; opposite of strain softening behavior.

Stress plateau: region in a stress-strain curve of a material where the value of stress is approximately constant and independent of the value of strain; for plastics, this value of stress is sometimes called a "draw stress" and corresponds with continuous elongation (or "drawing") of the plastic specimen from its original gauge dimensions (*e.g.*, this is how polymer fibers are made, including polyester fibers used in clothing).

Stress-strain curve: a standard graphical representation of a material's mechanical response to an applied load, plotted as strain on the x-axis and stress on the y-axis; the shape of the curve provides information about how strong (or how weak) a specimen is when tensile, compressive, or shear forces are applied.

Thermoforming: a material forming technique whereby the material is forced into a mold cavity, typically by compression from a mechanical punch or by vacuum.

Yield stress: the amount of stress that is required to produce a very slight amount of deformation in a material, reported in units of Pascals (Pa); sometimes referred to as the yield point or yield strength of a material; for plastics, this value of stress typically corresponds to a maximum in the stress-strain curve.