ENGINEERING NOTES:

There are some important "**good engineering practice**" guidelines that should be used when designing engineering plastic parts. Among those are:

- **SAFETY FACTORS** – many properties, especially those with ultimate strength values, should be divided by 4 to arrive at a safe "working stress". For instance, if a material has a compressive strength of 12,000 psi, the part should be designed with 3,000 psi as its "working maximum pressure"
- **TEMPERATURE** – all properties are reported at 70°F-73°F, and are usually tested in a lab environment. Temperature affects all materials, but plastics more than most. As temperatures increase, properties tend to decrease (material softens); chemical resistance declines (chemicals are more aggressive at elevated temperature); materials themselves begin to oxidize from the surface inward, again reducing properties. As temperatures decrease, properties also change, especially impact resistance (cold materials are more brittle)
- **TIME** – the longer a material is exposed to any external stress (thermal, chemical, electrical, mechanical), the more effect it will have on the material. With mechanical forces, a material can permanently deform under loads below the "yield point" (defined as the point where the material will no longer go back to its original size & shape); this is called "creep" or "cold flow" (time dependent deformation), which becomes more severe as temperature increases
- **TEST CRITERIA** – it is critical to know which tests can use different test methods to generate data. For instance, ASTM D-648 allows testing for the Heat Deflection Temperature to be run at either 66 psi, or the "normal" 264 psi. Obviously, the lower load generates a higher HDT
- **READ HOW A VALUE IS REPORTED** – there are "word games" played to try to show how one supplier's material may be superior to another's. Take moisture absorption for cast nylon; a company might can report any of the following:
- **24 hour absorption** (from a "dry" state), usually from 0.3% to 0.7%
  - **"Equilibrium" Content** – the moisture content that, on average, will be absorbed from the material from ambient air in a given location, usually 2% to 4% (this one is usually a "red herring", depends totally on part of the country, storage conditions, time in storage, etc – but it's always LESS moisture reported than full saturation)
  - **Saturation** – the maximum amount of moisture the material can absorb usually 7%.

SUMMARY: So, for the same basic material, you'll see numbers from 0.3% to 7% - are the materials really different? <u>Reputable suppliers usually report 24 hour and full saturation values</u>

- **FILLERS CHANGE PROPERTIES** – ALWAYS report the properties for the specific material being discussed. For instance, as compared to unfilled PEEK, 30% carbon fiber filled PEEK has different stiffness, heat transfer and wear properties – and loses its FDA compliance. (NOTE – colors usually do not affect properties but they can affect food compliance, etc)

ZL engineering plastics

866-957-5278
info@zlplastics.com

ZL Central
10908 Strang Line Rd
Lenexa, KS 66215
P: 913-327-0300
F: 913-327-0302

ZL West
8485 Unit D Artesia Blvd
Buena Park, CA 90621
P: 714-523-0555
F: 714-523-4555

ZL Engineering Plastics proudly stocks the following materials:

Acetal Copolymer & Homopolymer (ZL®900 series)

<u>Benefits</u>: Excellent dimensional stability and ideal for wear applications in wet environments.
<u>Limitations:</u> Excessive wear in dry applications
<u>Applications</u>: Bearing and wear parts, solenoid blocks, hinge pins, scrapers, gears, sprockets, nozzles, pistons, dispensing heads, slide parts, washers, pump parts, guides, handles, fittings
<u>Industries</u>: Transportation, food processing, medical and paper processing.
***Stocked in plate, rod and tube** (up to 20" diameter rod STOCKED)*
Stock colors available: natural, black and blue. (All colors FDA)

PET (ZL®1400 series)

<u>Benefits</u>: Combines the wear resistance of nylon with the dimensional stability of acetal, plus wears well in both wet and dry environments.
<u>Limitations:</u> Inherently brittle and poor resistance to bases
<u>Applications</u>: Bearing and wear parts, scrapers, nozzles, pistons, dispensing heads, guides, slide parts, plungers, cams, tension wheels, fittings, pump parts, washers, valves, cams.
<u>Industries:</u> Transportation, food processing, bottling equipment, medical
Stocked in plate and rod (tube available on special order basis)
Stock colors available: natural and black.
Internally lubricated bearing grade (ZL®1400T) stocked

Nylon (ZL®250~Extruded & ZL®1100~Cast series)

<u>Benefits</u>: Outwears acetal by a factor of 3:1 in dry applications
<u>Limitations:</u> Absorbs moisture resulting in increased wear and potential tolerance issues.
<u>Applications</u>: Bearings, bushings, rollers, guides, slide pads, sprockets, gears, star wheels,washers, chain guides, wear strips, rollers.
<u>Industries</u>: Construction, conveying, transportation, food processing, medical and paper processing.
Stocked in plate and rod
Stock colors available: natural and black.

PEEK (ZL®1500 series)

<u>Benefits</u>: Excellent wear resistance, continuous use temperature up to 480 °F, chemical resistance and stability.
<u>Limitations:</u> Typically much higher cost versus other mechanical plastics.
<u>Applications</u>: Valves, insulators, valve seats, pump wear rings, pump parts, washers, bearings, wafers
<u>Industries</u>: Construction, semiconductor, transportation, chemical processing, food processing, medical.
Stocked in plate and rod
Stock colors available: brown.

"Product material finder" tool available at www.zlplastics.com!!

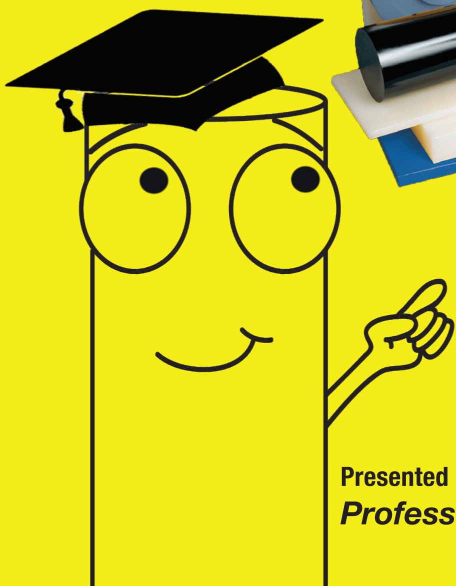
Engineering Plastic Terms & Properties

ZL engineering plastics

for you

Simplified

A Guide for the Rest of Us!



Presented by:
Professor Z

Property	Description	Why??
Specific Gravity (SG) or Density ASTM D-792	Ratio of the weight of a material compared to the weight of same volume of water	Determines the weight of a part. The higher the number, the heavier the material. Materials with a SG < 1.00 will float, as they are lighter than water
Tensile Strength ASTM D-638	Pulling force required to break a material (psi) (Tensile = "in tension" = pulling)	Determines how much load a given cross section of a given material can withstand in tension without breaking
Tensile Modulus ASTM D-638	A measure (psi) of how stiff a material is when in tension	Allows a calculation of how much a material will move (strain) under a given load (stress) when being pulled
Flammability UL 94	A measure of the way a material burns under very specific conditions	Very important safety consideration; ratings are listed by material thickness; generally are obtained by the resin supplier; actual UL testing generates a "Yellow Card" for that resin
Coefficient of Friction (COF)	Measures "slipperiness" of a material against another; with engineering plastics, usually against steel	Determines force required to start a material sliding (static COF) and to keep it moving (dynamic COF); important in designing slide bearings / wear pads; results are comparative only, not absolute values.
Dielectric Constant ASTM D-150	Describes the ability of a material to store electrical energy (act as a capacitor)	Allows a designer to compare materials for their ability to store (inhibit) or "not store" (allow) electrical current to pass through it
Dissipation Factor ASTM D-150	Measures dielectric loss in an AC current	Dielectric loss is measured as heat, and since heat is normally NOT wanted, materials with low dissipation factors are preferred for electrical applications of all types.
Moisture (Water) Absorption ASTM D-570	The percentage increase in the weight of a material based on how much water it absorbs, usually measured by "24 hour" and "saturation"	This property addresses two areas: dimensional stability (the more water a material can absorb, the more it will grow); changes in properties – the more water a material absorbs, it generally becomes softer and less wear resistant

Property	Description	Why??
Elongation ASTM D-638	The percentage (%) increase in a materials length when it breaks	Used in failure prevention analysis (don't overstretch the material!) It is a measure of stiffness more than the actual strength of a material.
Flexural Strength ASTM D-790	A measure of how much bending force a material can take before breaking	Determines the max bending load a material a given cross section can withstand, whether fixed at one end with a load at the other, or suspended at both ends with the load in the middle
Flexural Modulus ASTM D-790	A measure (psi) of how stiff a material is when being flexed.	Allows a calculation of how much a material will move (strain) under a given flexural load (stress). It represents a combination of the tensile strain (one side is stretching) PLUS the compressive strain (the other side is compressed)
Compressive Strength ASTM D-695	A measure of how much weight a material can withstand in compression (being "squeezed")	Determines how much load a given cross section of a given material can withstand in compression before deforming 10% of original cross section
Compressive Modulus ASTM D-695	A measure (psi) of how stiff a material is when being compressed	Allows a calculation of how much a material will move (strain) under a given load (stress) when being compressed
Shear Strength ASTM D-695	A measure of how much shearing force a material can take before breaking	Determines how much load a given cross section of a given material can withstand in shear without breaking
Hardness ASTM D-785	Determines resistance to indentation a given material can withstand	There are various test methods and scales, and except for materials reported in the same scale, there is no direct correlation between any two test methods! Within a scale, higher number = harder; most engineering plastics are reported in Rockwell scales
IZOD Impact Resistance ASTM D-256	*Method "A" (ft.lbs/in)* A measure of the impact resistance, or "toughness", of a material	Allows comparison of materials using a specific impact criteria, it actually measures notch sensitivity; this is usually used in conjunction with other properties to determine best candidate materials in an impact environment

Property	Description	Why??
Coefficient of Linear Thermal Expansion ASTM D-831	(CLTE) Measures how much a material shrinks or grows with changes in temperature	Determines the allowance that must be designed to allow for material movement over a given temperature range (the larger the range, the more important this is); values reported are the "line" (average) in the graph from 30°F through 300°F
Melt Point ASTM D-348 (°F)	Gives the temperature at which a crystalline / semi-crystalline material melts (becomes fluid)	Most important for processing (extrusion) of polymeric materials, in service an engineering plastic will usually fail long before getting to this temperature.
Glass Transition Temperature ASTM D-348 (°F)	The "softening" temperature for amorphous materials	Important to companies doing thermoforming, this is the minimum temperature needed to be able to thermoform PC, PMMA, PET-G, etc
Continuous Use Temperature (CUT) UL 746 or resin data	The maximum temperature at which a material can withstand, in air, for 100,000 hours (`11 years) with no load and still retain at least 50% of its physical properties	This is important for very lightly loaded parts that must withstand long term elevated temperatures; the material oxidizes over time and can become brittle. Few plastic parts see this type of service
Heat Deflection Temperature ASTM D-648 (°F)	The temperature where a ½" thick test bar deflects .010"	This is the "working stress" number, a fair indicator of the maximum operating temperature of a material under load, very important design consideration; **usually reported with a load of 264 psi**
Thermal Conductivity ASTM D-5930	Gives the rate at which heat is conducted through a material	Determines the ability of a material to act as a thermal insulator (the lower the value, the better the thermal insulation)
Dielectric Strength ASTM D-149	The voltage where a 1mm sample fails as an electrical insulator	Basically, a comparative test only between materials, NOT a design criteria by itself
Volume Resistivity ASTM D-257	Another measure of electrical insulation properties	Provides a means to estimate how many amps go through a material with a given application of volts; important when considering static dissipative material performance

Call ZL for expert advice on how to use material properties to offer "best design" assistance!
866-957-5278