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HW#15

10.3 What properties are influenced by the degree of polymerization?

i. Tensile and impact strength

ii. Viscosity

10.11 Discuss the significance of the glass-transition temperature, Tg, in engineering applications.

The glass transition temperature, Tg, is the temperature at which amorphous polymers transition from being hard, brittle and glassy to being softer, more flexible and rubberier, and the mechanical properties are changed significantly.

Because the mechanical properties are changed significantly as this temperature, engineering applications can be developed to exploit this property. For example, below the Tg, amorphous polymers are harder, rigid and brittle. This property can be used to develop polymer parts that require these properties and are only exposed to low temperatures.

This temperature also affects properties like the workability of the polymer, dimensional stability of the material and a few others. These are properties that can be exploited for different suitable engineering applications.

10.27 Review the three curves in Fig. 10.8, and name applications for each type of behavior. Explain your choices.

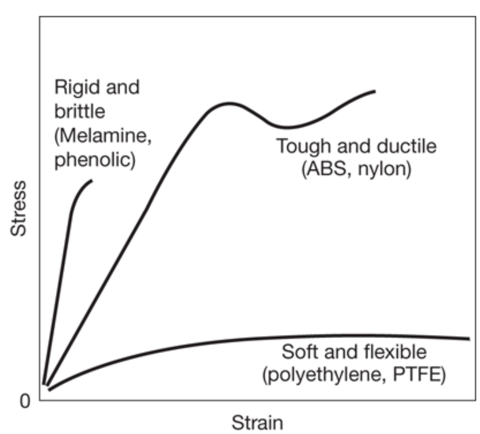


Figure 10.8

Rigid and brittle (Melamine)
Melamine is rigid and brittle and can be applied in the area of furniture making. Melamine is hard, highly durable and can tolerate heat better than other plastics. This makes it a great material in furniture making.

Tough and ductile (ABS)
ABS can be applied in the making of steering wheel covers and dashboards. Toughness and ductility of ABS are great qualities that can absorb and redistribute energy on impact and therefore keep passengers safe.

Soft and flexible (Polyethylene)
Polyethylene can be applied in the making of insulation for wires and cables. Polyethylene is soft and flexible which is a desirable characteristic for insulation for this application. Wires and cables usually have to turn over tight corners and are not usually load bearing.

10.58 What characteristics make polymers attractive for applications such as gears? What characteristics are drawbacks for such applications?

Characteristics make polymers attractive for applications are as follows:

Corrosion resistance - Compared to metals, polymers are very corrosion resistant. This is a favorable property for a gear, especially in an application that is exposed to harsh chemicals.

Light weight - Polymers gears are considerably lighter than metal gears of similar size.

Good shock absorption - Polymer gears can deflect to absorb impact loads more than metal gears.

Noise reduction - The dampening properties of polymers result in more quiet gears compared to metals gears.

Drawbacks are as follows:

Temperature sensitivity - High temperatures may alter the material properties and hence reduce the effectiveness of the gear.

Strength - The strength of polymers is considerably less than the strength of metals.

Wear resistance - Compared to metals, polymer gears may need to be replaced more often.

10.87 Calculate the areas under the stress–strain curve (toughness) for the material in Fig. 10.9, plot them as a function of temperature, and describe your observations.

Approximate areas under each curve:

curve_neg_25 = 0.5*3*10

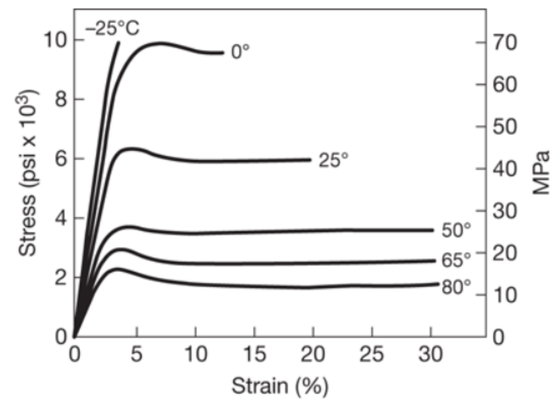
curve_0 = (0.5*4*9.5) + ((13-4) *9.5)

curve_25 = (0.5*3*6) + ((20-3) *6)

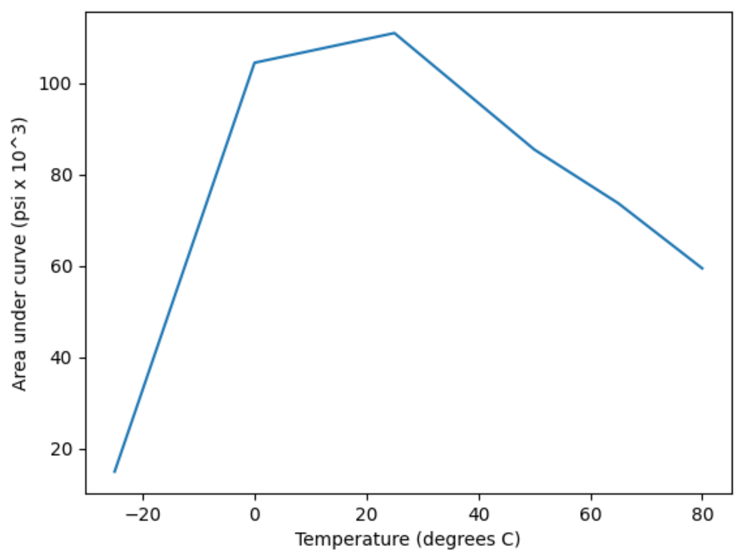
curve_50 = (0.5*3*3) + ((30-3) *3)

curve_65 = (0.5*2.5*2) + ((30.5-2) *2.5)

curve_80 = (0.5*1.5*2) + ((31-2) *2)



	temperature	area
0	-25	15
1	0	104.5
2	25	111
3	50	85.5
4	65	73.75
5	80	59.5



10.88 Note in Fig. 10.9 that, as expected, the elastic modulus of the polymer decreases as temperature increases. Using the stress-strain curves in the figure, make a plot of the modulus of elasticity versus temperature.

Modulus of elasticity = rise/run

curve_neg_25 = 5.2

curve_0 = 4

curve_25 = 3

curve_50 = 2.3

curve_65 = 2

curve_80 = 1.75

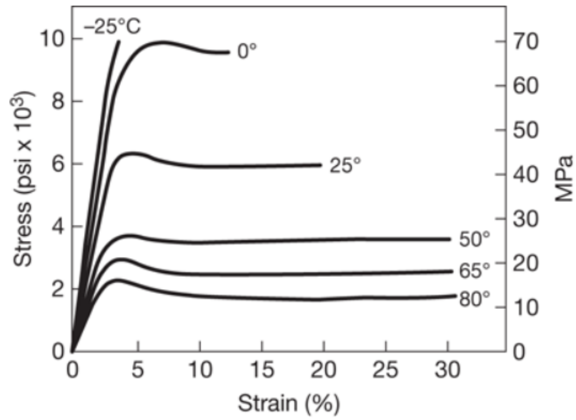


Figure 10.9

	temperature	Modulus of Elasticity
0	-25	5.2
1	0	4
2	25	3
3	50	2.3
4	65	2
5	80	1.75