

# [Materials and technology 112](https://assignbuster.com/materials-technology-112/)

Question For each of the following pairs of polymers, decide which is more likely to have the greater tensile strength, and then give reasons foryour choice:   
(a) Lightly cross-linked polyethylene; network Bakelite   
A network Bakelite has a greater tensile strength than a lightly cross-linked polyethylene. 1 Crosslinking hinder the re-organization of molecules during crystallization; hence, a lightly cross-linked polyethylene has a lower degree of crystallinity as compared to its linear form. A decreased in crystallinity makes crosslinked polymers less rigid and weaker. On the other hand, a network of Bakelite, though has a highly crosslinked structure, often produce hard, impervious, black, and tough solids2.   
(b) High density polyethylene; low density polyethylene   
High density polyethylene has high levels of crystallization. 3 The crystallization process is less likely to hinder because of low level branching in its structure. Crystallization markedly enhances strength, rigidity, and opacity of a polymer. High density polyethylene, then, is the stiffest of all types of polyethylene due to its high degree of crystallinity. Thereby, high density polyethylene has a greater tensile strength than low density polyethylene.   
(c) 95% crystalline and linear PTFE; 95% crystalline and branched PTFE   
Branching tend to impede crystallization, making a polymer less rigid, more easily to deform, and weaker4. Thus, a 95% crystalline and linear polytetrafluoroethylene (PTFE) has a greater tensile strength than a 95% crystalline and branched PTFE.   
Question 2:   
Molecular weight data for some polymer are tabulated below. Compute (a) the number-average molecular weight, and (b) the weight-average molecular weight. (c) If it is known that this material’s degree of polymerisation is 477, which one of the polymers listed in Table 14. 3 of the lecture notes is this polymer? Why?   
Number-Average Molecular Weight (Mn)   
Mass per molecule, Mi (g/mol)   
Number fraction, Xi   
XiMi (g/mol)   
14, 000   
0. 05   
700   
26, 000   
0. 15   
3, 900   
38, 000   
0. 21   
7, 980   
50, 000   
0. 28   
14, 000   
62, 000   
0. 18   
11, 160   
74, 000   
0. 10   
7, 400   
86, 000   
0. 03   
2, 580   
Mn   
47, 720   
Mn = ∑ XiMi   
= 47, 720 g/mol   
Weight-Average Molecular Weight   
Mass per molecule, Mi (g/mol)   
Weight fraction, Wi   
WiMi (g/mol)   
14, 000   
0. 02   
280   
26, 000   
0. 08   
2, 080   
38, 000   
0. 17   
6, 460   
50, 000   
0. 29   
14, 500   
62, 000   
0. 23   
14, 260   
74, 000   
0. 16   
11, 840   
86, 000   
0. 05   
4, 300   
Mw   
53, 720   
Mw = ∑ WiMi   
= 53, 720 g/mol   
nn = number-average degree of polymerization   
m = molecular weight of a mer unit   
nn = Mn / m   
nn = 477 Mn = 47, 720 g/mol   
nn = 47, 720 g/mol   
477   
nn = 100. 042 g/mol   
This value is closer to the molecular weight of the mer unit of PTFE/Teflon.   
Question 3:   
The density and associated % crystallinity for two polypropylene materials are as follows:   
 (g/cm3)   
Crystallinity (%)   
0. 904   
62. 8   
0. 895   
54. 4   
(a) Compute the densities of totally crystalline and totally amorphous polypropylene.   
Crystallinity = C ρ = density   
C = % crystallinity / 100   
= ρc (ρs – ρa)   
ρs (ρc – ρa)   
by rearrangement:   
ρc ( C ρs- ρs) + ρc ρa - C ρs ρa = 0   
where:   
ρc and ρa are unknown   
Since ρc and C are specified in the problem, two equations can further be derived:   
ρc ( C1 ρs1- ρs1) + ρc ρa – C1 ρs1 ρa = 0   
ρc ( C2 ρs2- ρs2) + ρc ρa – C2 ρs2 ρa = 0   
where:   
ρs1 = 0. 904 g/cm3ρs2 = 0. 895 g/cm3   
C1 = 0. 628C2 = 0. 544   
ρa = ρs1 ρs2 (C1 – C2)   
C1 ρs1 – C2 ρs2   
= (0. 904 g/cm3) (0. 895 g/cm3) (0. 628- 0. 544)­­\_\_   
(0. 628) (0. 904 g/cm3) – (0. 544) (0. 895 g/cm3)   
ρa = 0. 841 g/cm3   
ρc = \_\_\_ρs1 ρs2 (C2 – C1)\_\_\_   
ρs2 (C2 – 1) - ρs1 (C1-1)   
= ­\_\_\_\_\_(0. 904 g/cm3) (0. 895 g/cm3) (0. 544 - 0. 628)­­\_\_\_\_\_   
0. 895 g/cm3 (0. 544 – 1. 0) – (0. 904 g/cm3) (0. 628 – 1. 0)   
ρc = 0. 946 g/cm3   
(b) Determine the density of a specimen having 74. 6% crystallinity.   
ρs = density of specimen   
ρs = \_\_\_\_- ρc ρa\_\_\_\_\_\_   
C (ρc – ρa) – ρc   
= \_\_\_\_\_\_\_\_\_\_- (0. 946 g/cm3) (0. 841 g/cm3)\_\_\_\_\_\_\_\_   
(0. 746) (0. 946 g/cm3 - 0. 841 g/cm3) - 0. 946 g/cm3   
ρs = 0. 917 g/cm3   
Question 4:   
Carbon dioxide diffuses through a high density polyethylene (HDPE) sheet 50 mm thick at a rate of 2. 2  10-8 (cm3 STP)/cm2-s at 325 K. The pressures of carbon dioxide at the two faces are 4000 kPa and 2500 kPa, which are maintained constant. Assuming conditions of steady state, what is the permeability coefficient at 325 K?   
50 mm = 5 cm   
Q / t = PA (P1-P2) / l   
Q – quantity of permeantP – permeabilityA - area   
t – timeP1 – P2 – drop in pressure   
2. 21 x 10-8 cm3/ cm2-s = P (14. 8038 atm)   
5 cm   
P = 7. 4643 x 10-9 \_cm3-cm\_   
cm2-s-atm   
Bibliography   
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Sperling, Leslie Howard. Introduction to Physical Polymer Science. Hoboken, NJ: Wiley, 2006.