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سلول سے میکانیکس / ٹالسے بولیم

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The Brittle-ductile Transition -

The brittle-ductile transition has a great influence on the mechanical properties of metals. For polymers, the situation is more complicated because there are four regions of behavior and not two (glassy - viscoelastic - rubbery - viscous).

The distinction between brittle and ductile failure is manifested in two ways: (1) The energy dissipated in fracture (2) The nature of the fracture surface.

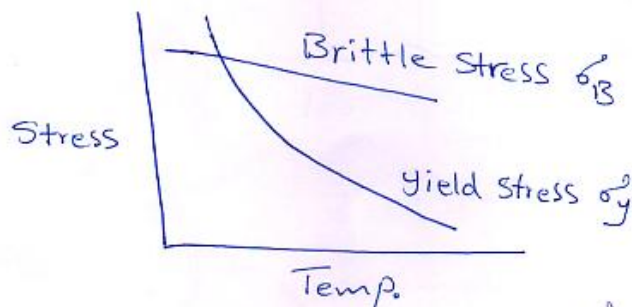


Fig. (1) brittle fracture stress σ_B and the yield stress σ_y as a function of Temp. at const. strain rate.

Changing strain rate will produce a shift in these curves. The intersection of the σ_B/σ_y curves defines the brittle-ductile transition and the material is

ductile at all temperatures above this point.

The brittle stress is not much affected by strain rate and Temp., while the yield stress is greatly affected by strain rate and Temp., increasing with increasing strain rate and decreasing with increasing Temp.

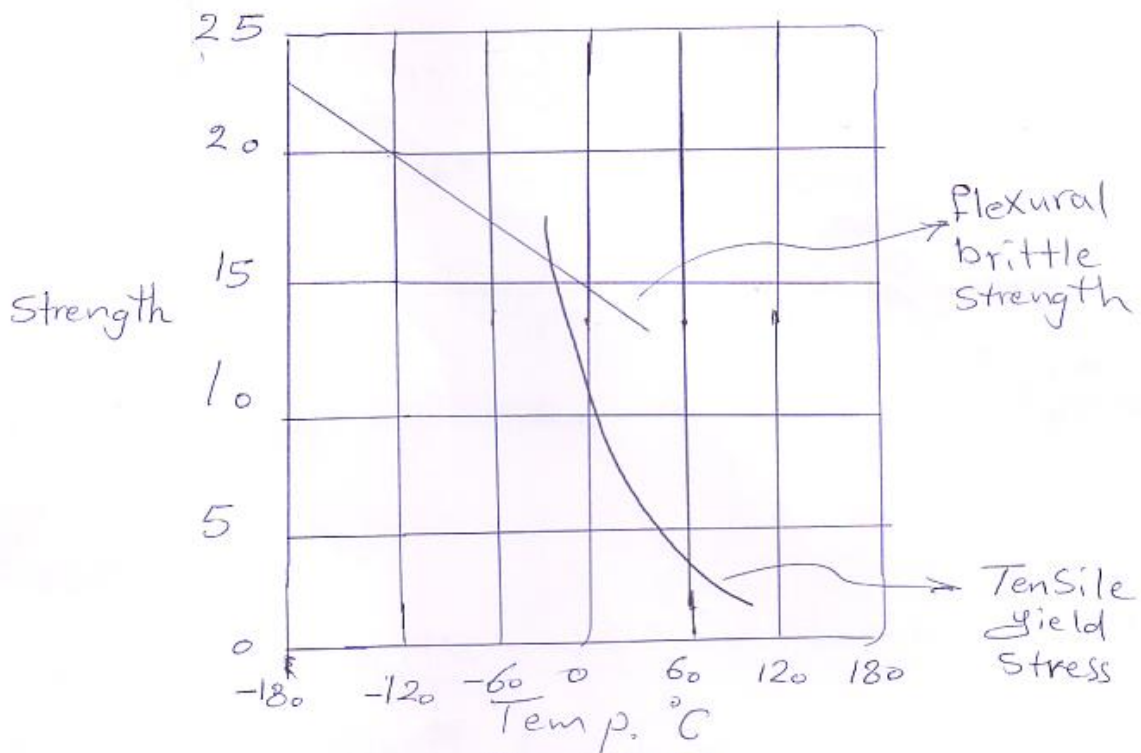


Fig. (2) a)

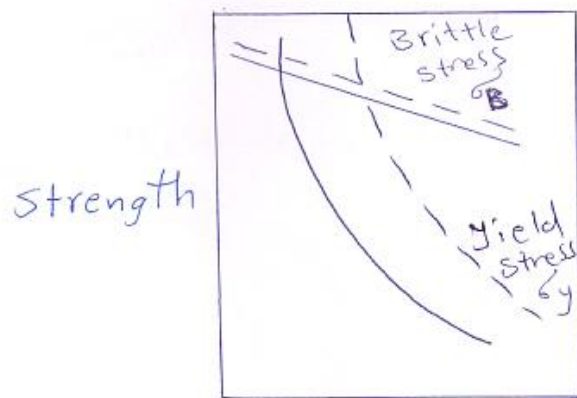


Fig. (2. b) Temp.

Fig. (2-a) gives the effect of Temp. on brittle strength and tensile stress of PMMA (poly methyl methacrylate). The brittle-ductile transition will be expected to move to higher temperatures with increasing strain rate as shown in Fig. (2-b). This is a well known effect with polymers. For example - by applying ~~the~~ various strain rate in a tensile test on a sample of nylon at room temp. At low strain ~~rate~~ rate the sample ^{is} ductile and cold draws where as at ~~high~~ high strain rates ^{the fracture is} in a brittle ~~manner~~ manner.

At low speeds within a certain temp. range cold-drawing occurs while at high speeds the heat is not conducted ~~rapidly~~ rapidly enough; so strain hardening is prevented and the specimen fails in a ductile manner.

Effect of Basic material variables on the brittle - ductile transition :-

1. Side groups :- rigid side groups increase both the yield strength and the brittle strength while flexible side groups reduce the yield strength and the brittle strength. There is no general rule regarding the effect of side groups on the brittle-ductile transition.

2. Cross linking :- crosslinking increases the yield strength but does not increase the brittle strength very much.

The brittle-ductile transition is usually raised in Temp.

3. plasticizers :- ~~plasticizers~~ plasticizers can decrease the chance of brittle failure because they usually reduce the yield stress more than they reduce the brittle strength.

4. Molecular weight :- molecular weight does not have a direct effect on the yield strength but is known to reduce the brittle strength.