

327 Hw14.pdf

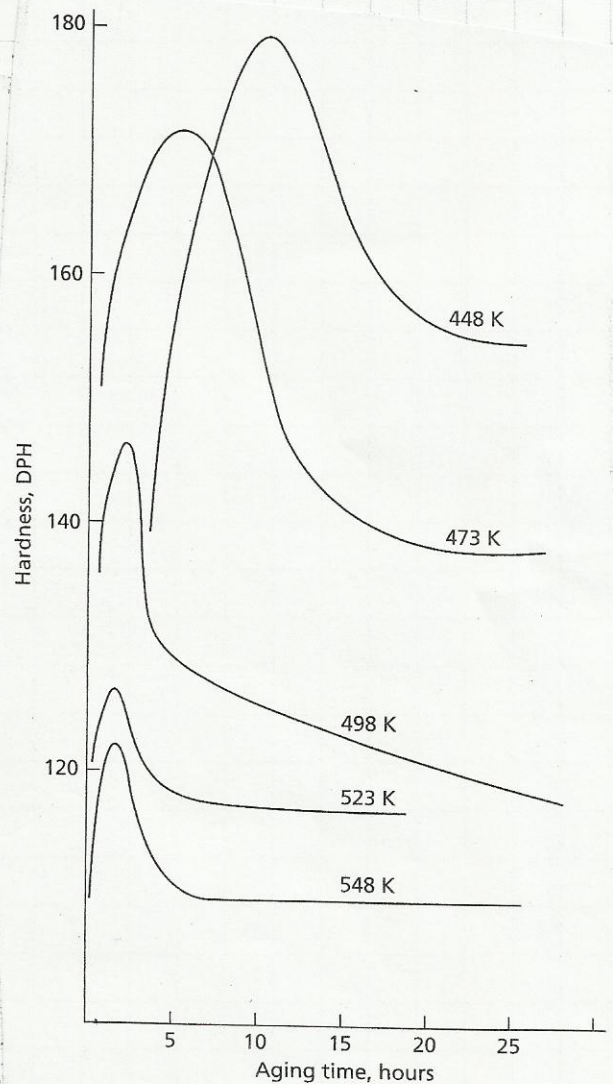
HW # 14
METE 327
due 5-3-2012

20.6

20.6 The hardness of a supersaturated Al-3% Li-5.5% Mg-0.2% Zr as a function of the aging time and temperature is shown in the following figure.

- (a) Describe why at each aging temperature, the hardness goes through a maximum.
- (b) Explain why the maximum hardness and the aging time required for the maximum hardness increase as the aging temperature is decreased.

a) The δ' ppt. nucleate and grow. There is an optimum size and spacing for slowing dislo. motion. As the δ' grow larger, the spacing increased, and they become incoherent, decreasing their ability to impair dislo. motion.



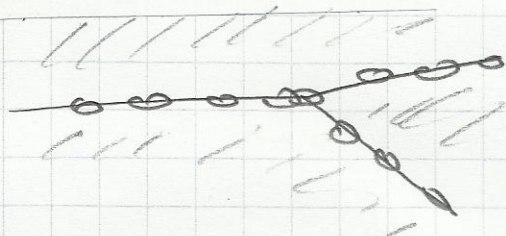
b) At lower temps, the δ' ppt. take longer to grow, but their size and spacing is optimized. The larger undercooling causes more ppt. to nucleate.

PROB. 20.6 Hardness versus aging time and temperature for an Al-Li-Mg-Zr alloy. (S. Abeln and G. J. Abbaschian, *Mechanical Behavior of Rapidly Solidified Materials*, Sastry, S. M. L., and MacDonald, B. A., Eds., p. 167, Minerals, Metals, and Materials Society, Warrendale, Ohio, 1985.)

20.8

20.8 Explain how grain-boundary precipitation can lead to the formation of precipitation-free zones. Prescribe a heat treatment schedule to eliminate or minimize grain-boundary precipitates.

a)



The g.b.'s are preferential sites for precipitation.

The ppt at the gb's soak up the solute causing a depleted zone.

b) You can minimize the gb ppt by providing additional nucleation sites

- 1) 28 cold roll
- 2) 3-step aging

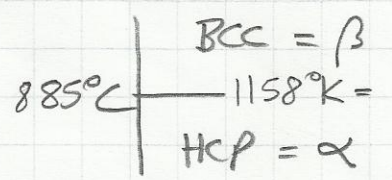


book → 3) solutionize then CWQ

20.13

20.13 How does the addition of an alpha stabilizer strengthen titanium?

Al, Sn



① Alpha Stabilizers (Al, Sn)

provide solid solution strengthening.

② Also grain refining by cold working then annealing (above 885°C) to recrystallize and nucleate small grains.

21.2

21.2 It is possible for zinc crystals to undergo very large plastic strains at temperatures below room temperature. This is not true in polycrystalline zinc, which normally shows a very low ductility at sub-ambient temperatures. Give an explanation for this fact based on the mechanical properties of zinc.

Zinc = HCP

The phenomena is easy glide on the HCP basal plane.

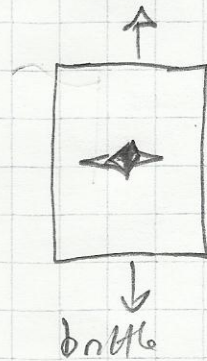
21.4

21.4 (a) It is now believed that inclusions in a metal tend to promote both cleavage and ductile fracture. Explain.

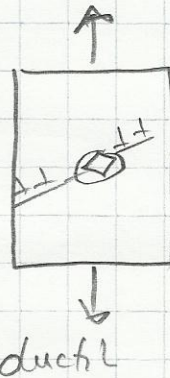
(b) How does the shape of the inclusions affect the fracture in fatigue specimens?

(c) How does the multiaxial state of the stress affect fracture in general?

A) The inclusions initiate both cleavage (brittle) and ductile (dislocation)

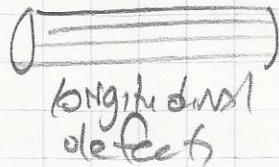


cracks start at sharp corners of inclusion



dislocation pile-up microvoid nucleate

b) Fatigue crack starts at the surface. Defects, inclusions at the surface can initiate the cracks.



longitudinal defects



transverse defects are worse

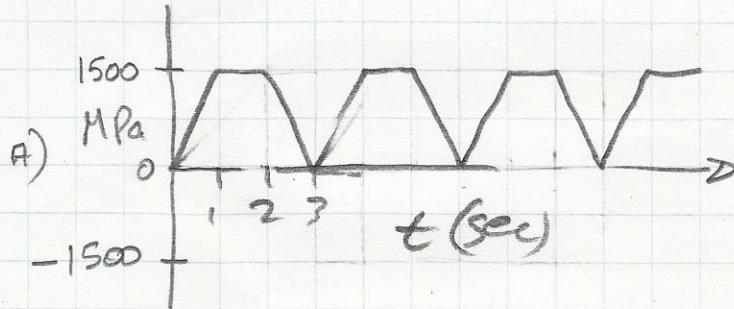
c) Multiaxial stress can increase or decrease the shear stress.

21.6

21.6 A fatigue specimen is cyclic loaded as follows. (1) The specimen is loaded in tension for 1 sec. at 1500 MPa/s, starting from a zero load; (2) it is then held at its maximum load for 1 sec; and (3) it is unloaded for 1 sec. at -1500 MPa/s. This cycle is then repeated over and over.

(a) Draw several cycles showing the cyclic loading pattern.

(b) Determine σ_m , σ_a , R , and A .



$$b) \quad \sigma_m = \text{mean stress} = \frac{1500 + 0}{2} = 750 \text{ MPa}$$

$$\sigma_a = \frac{1500 - 0}{2} = 750 \text{ MPa} \quad \text{Alternating stress}$$

$$\frac{\sigma_{\max} - \sigma_{\min}}{2} \quad \text{Alternation stress}$$

$$R = \frac{\sigma_{\min}}{\sigma_{\max}} = \frac{0}{1500} = 0$$

$$A = \frac{\sigma_a}{\sigma_m} = \frac{750}{750} = 1$$