University of Saskatchewan

ME324.3 Engineering Materials

d-Term Examination (C

Student N

Instructor: . Odeshi
Time Allowed: 2 h **October 22, 2008.**

1. **Answer ALL questions.**
2. **One formula sheet is allowed but must be turned in with your answer script(s).**

Question 1 - 25 points	**Points**

a. What do you understand by the term *dislocation*? List 2 sources of dislocation in metallic alloys — 3

In order for dislocation to occur, plastic deformation must occur. This results in the breaking and reforming of bonds. There are 3 types of dislocation, line, screw, and edge. Dislocation also compromises the strength of a material.

Two Sources: Edge and Screw dislocation.

1

b. How are strength and dislocation motion in metals related? — 3

The strength of a metal is related to the amount of dislocation motion. The more motion there is, the more ductile and weak the specimen becomes.

3

c. Briefly explain slip systems and state how the mechanical property of a metal is determined by the number of slip systems in its crystal structure. — 3

A slip system is composed of a slip plane and slip directions. Dislocation occurs along a slip systems. the more slip systems there is the more dislocation takes place.

Ductile because extensive plastic deformation is possible when there is a high number of slip systems present.

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Brittle if there are a low number of slip systems present.

d. A zinc single crystal is being pulled in tension with the normal to its slip plane (0001) inclined at 60 ° to the tensile axis and with the slip direction $[11\bar{2}0]$ inclined at 40° to the tensile axis. 4

i. What is the resolved shear stress, τ acting along the slip direction when a tensile stress of 0.5 MPa is applied?

ii. What tensile stress is necessary to reach the critical resolved shear stress (τ_{CRSS}) of 0.90 MPa?

iii. What happens when the resolved shear stress along the slip direction in the single crystal becomes greater than the critical resolved shear stress?

i) $\tau_R = \sigma \cos\phi \cos\lambda = (0.5\text{MPa}) \cos(60) \cos(40)$

$\tau_R = 0.1915\text{MPa}$ $\boxed{\tau_R = 0.19\text{ MPa}}$

ii) $\sigma_y = \dfrac{\tau_{CRSS}}{\cos(60)\cos(40)} = \dfrac{0.90\text{MPa}}{\cos(60)\cos(40)} = 2.34973\text{ MPa}.$

$\boxed{\sigma_y = 2.35\text{MPa}.}$

iii). Yielding will occure when $\tau_R > \tau_{CRSS}$.

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e. Briefly explain why pure metals are usually weaker than their alloys 3

Pure metals are usually weaker than their alloys due to a much higher carbon content. This makes the metals very brittle making them susceptable to fracture.

?

f. Give one reasons why it is more difficult for dislocation to move across grain boundaries than to move within the grains. How is this effect used in strengthening metallic materials? 3

It is more difficult for dislocation to move across a grain boundary because it will be forced to change direction. This

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