Name.....Student I.D.....

Department of Mining and Materials Engineering
Faculty of Engineering
Prince of Songkla University

Final Examination for Semester: 2 Academic Year: 2005
Date: February 22, 2006 Time: 09.00-12.00
Subject: 237-508 Structures and Mechanical Properties of Materials Room: R300

Instruction

1. There are 4 problem sets. Please do all of them and write your answers on the space provided after each problem set. If you need more space, you can write on the back of the paper.
2. Dictionary, calculator, and stationery are allowed.
3. Text books, course notes and other studying materials are not allowed.
4. This final exam is counted for 40% of the total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score (points)	Student's Score (points)
1.	10	
2.	10	
3.	20	
4.	20	
Total	60	

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1. Explain the term "workhardening" and how the microstructure evolves during deformation? Please draw or sketch any diagram, picture to support your answer? (10 points)

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2. The fatigue crack growth equation for a newly developed aluminum metal matrix composite may follow the Paris' law,

$$\frac{da}{dN} = A(\Delta K)^p$$

where, $\frac{da}{dN}$ is the crack growth rate

A is the constant

ΔK is the stress intensity factor range

p is the stress intensity factor range exponent

Please explain how to set up the fatigue experiment in order to obtain the fatigue crack growth equation. Draw or sketch any diagram, picture to support your answer. (10 points)

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3. Suppose you are planning to perform creep experiment on polycrystalline rock salt (NaCl) and you are interested in the power-law creep behavior of this material.

Please use the deformation-mechanism map given below to design the experimental conditions, e.g. what are temperature and stress ranges in which creep experiment will be performed? Show your calculations and explain the reasons to support your answer. (20 points)

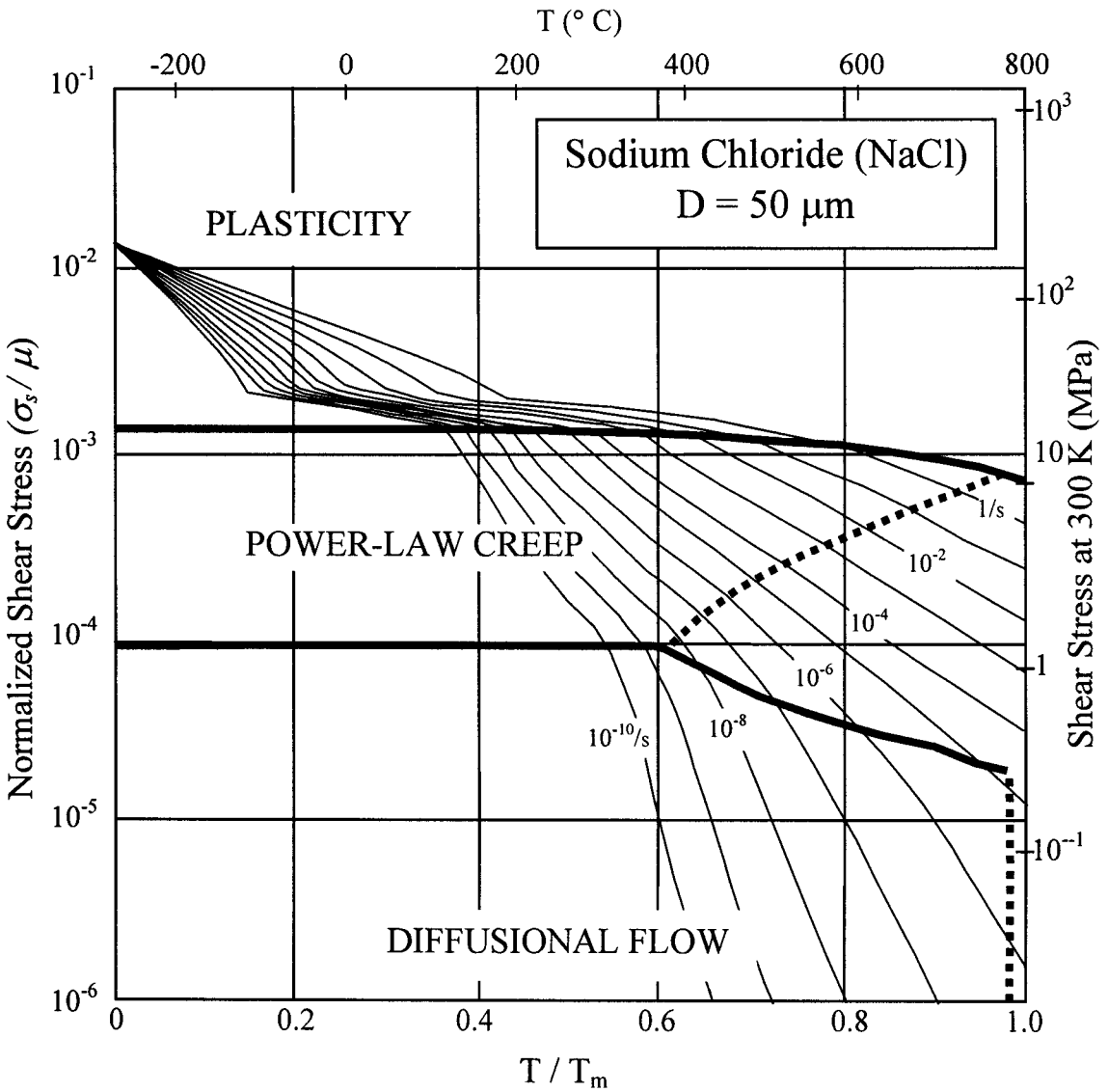

Figure 1 Deformation-mechanism map for sodium chloride (NaCl) of grain size 50 □m. [Redrawn from Frost and Ashby, 1982]

Given:

$$\sigma_s = \frac{\sigma_1}{\sqrt{3}}$$

where σ_s is shear stress, and

σ_1 is normal stress.

T_m = 797 °C

$\mu \cong$ 10,000 MPa

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4. Data from creep tests on 7075-T651 aluminum alloy are shown in the tables below

Data from creep experiments performed at constant temperature, $T = 473$ K.

Creep Stress, σ (MPa)	Minimum Creep Rate, $\dot{\varepsilon}_{ss}$ (1/s)
80	3.5×10^{-8}
100	4.9×10^{-8}
120	1.6×10^{-7}
140	4.5×10^{-7}
160	6.5×10^{-7}

Data from creep experiments performed at constant stress, σ = 100 MPa.

Creep temperature, T (K)	Minimum Creep Rate, $\dot{\varepsilon}_{ss}$ (1/s)
423	3.6×10^{-9}
473	4.9×10^{-8}
523	6.1×10^{-6}

According to the power-law creep equation,

$$\dot{\varepsilon}_{ss} = A\sigma^n \exp(-\frac{Q_c}{RT})$$

where, A is the material constant

σ is the creep stress

n is the creep stress exponent

Q_c is the activation energy for creep

R is the universal gas constant (8.314 J/mole·K), and

T is the absolute temperature.

Please estimate the values of n and Q_c. What kind of creep mechanism is dominant and why? Explain the creep mechanism you suggest. (20 points)