

Ph.D. Qualifying Examination

Materials Science

Fall 2008

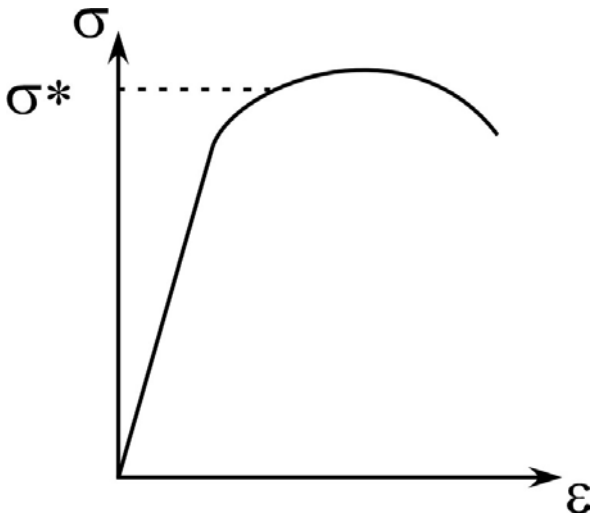
Notes:

- There are a total of 4 problems.
- Time allowed: 2 hours.
- Exam is closed book and closed-notes.
- Problems count 25 points each (total=100 points).
- Show your work on these exam sheets. (Add additional sheets, if needed.)
- You may use a calculator.
- Laptops and cell phones are not allowed.

Problem 1

Using the tensile engineering stress-engineering strain curve shown below, do the following:

- Identify σ_{ult} (ultimate strength)
- Identify E (elastic modulus)
- Overlay a sketch of the true-stress-true strain curve
- If a sample of the material were to be loaded to the stress σ^* , indicate on the figure the amount of elastic strain, ϵ_o , and the amount of plastic strain, ϵ_p
- Indicate the modulus of resilience



Problem 2

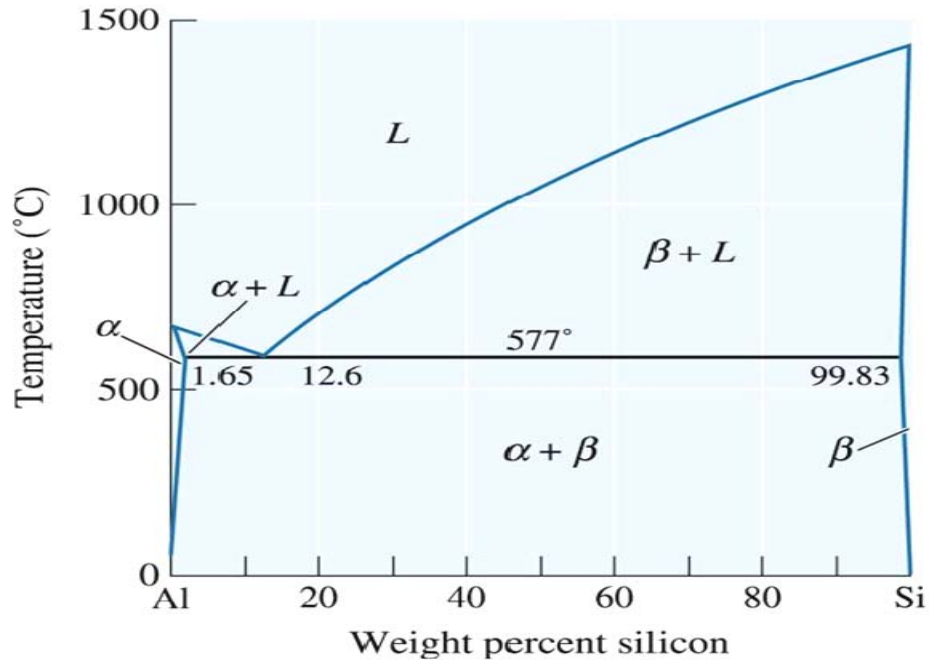
Explain the reason why cold-working makes a metal sample harder, and why annealing would make it go back to the softer state. Do you expect the same kind of effects for typical ceramic materials? Why or why not?

Problem 3

Prove that the maximum possible fiber volume fraction in a unidirectional (long) fiber composite is 0.907 (assuming a perfect circular cross section for each fiber).

Problem 4

Consider an Al-25% Si alloy. The Al-Si phase diagram is shown below.



Determine:

- if the alloy is hypoeutectic or hypereutectic
- the composition of the first solid to form during solidification
- the amounts and compositions of each phase at 578°C
- the amounts and compositions of each phase at 576°C
- the amounts and compositions of each microconstituent at 576°C
- the amounts and compositions of each phase at 25°C