

53:086 Civil Engineering Materials
Dept. of Civil & Environmental Engineering
The University of Iowa
Spring Semester 2006, Mid-Term Exam #1
Instructor: C.C. Swan

Answer any five of the following six questions

Question #1: (20 points)

The Griffith micro-crack model suggests that the tensile stress level required to make a void or crack of diameter $2a$ propagate in a linear elastic medium is given by the formula:

$$\sigma_{fract} = \sqrt{\frac{4EG_c}{\pi a}}$$

- a. What is the meaning of G_c in this equation?
- b. Explain how the size of the defect affects material strength.
- c. Explain briefly how this equation was obtained.

Question #2: (20 points)

- a. How is the grain structure of steel or aluminum related to its strength and ductility behavior?
- b. How can the grain structure of steel or aluminum be manipulated to increase the material strength?

Question #3: (20 points)

- a. In a swimming pool, a 316 stainless steel fixture has been attached to the bottom of the pool using 1060 aluminum screws. What do you think about this?
- b. In just a few sentences, what is hot-dip zinc galvanization and what purpose does it serve?

Question #4: (20 points)

In metals, some properties are dependent upon the type of work-hardening and/or the thermal treatments the metal has undergone. These are called structure-dependent properties. Which of the following properties for steel and aluminum are structure-dependent?

- a. mass density
- b. elastic moduli
- c. strength
- d. ductility
- e. thermal and electrical conductivity

Question #5: (20 points)

Calculate the composition of a 0.15% carbon steel alloy in terms of α -ferrite, γ -austenite, and Fe_3C cementite at states A, B, and C shown in Figure 1. Note that cementite has a 6.7% carbon mass content.

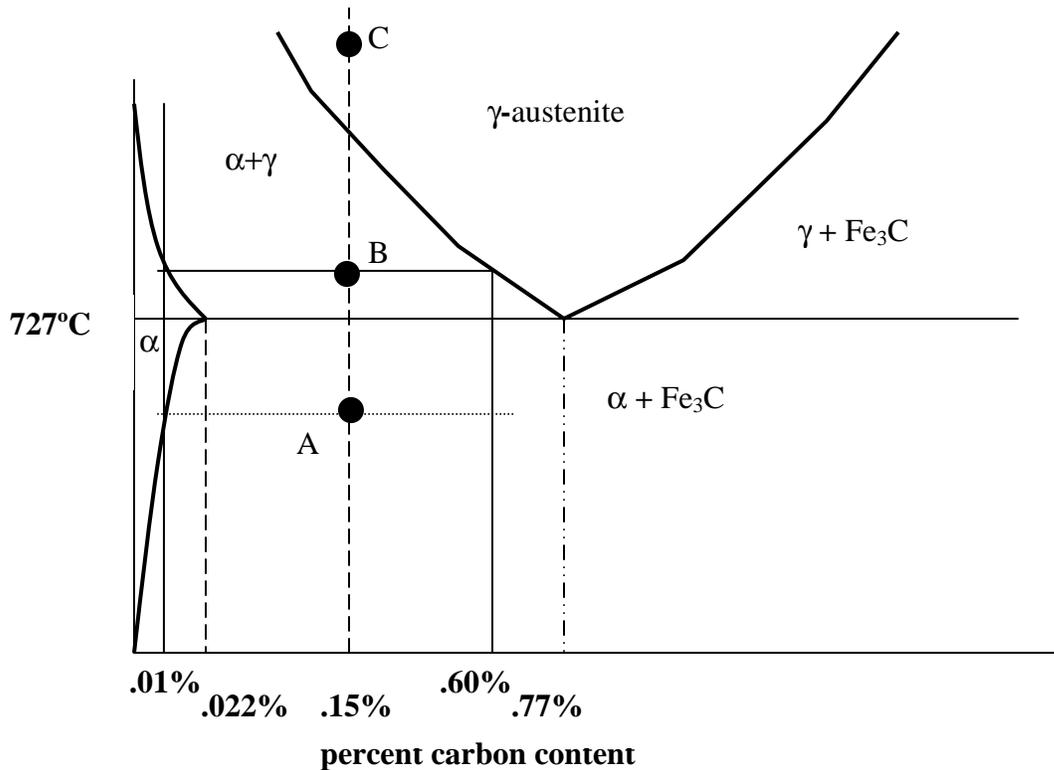


Figure 1. Portion of the iron-carbon phase diagram. (Not drawn to scale)

Question #6: (20 points)

In the lab portion of this course, you measured the tensile strength of 1018 steel and then annealed specimens of the same 1018 steel.

- In general qualitative terms, how were the mechanical properties different between the 1018 steel before and after annealing?
- How did annealing lead to these changes?