

MATERIALS SCIENCE AND TECHNOLOGY II

Midterm Examination, Instructor: Selis Önel, PhD

Wednesday, November 18, 2009

Please give brief answers to the following questions. All answers should be in English.

You may use a two-sided information sheet handwritten by yourself. Please put your name on the information sheet and submit with the exam paper. No photocopies or printed copies are allowed.

Question 1. (15 pts)

One way of categorizing materials is done as:

1. Metals and alloys, 2. Ceramics and glasses, 3. Polymers, 4. Semiconductors, 5. Composites

Match the following properties with the appropriate category by putting 1 for Metals, 2 for Ceramics, 3 for Polymers, 4 for Semiconductors, and 5 for Composites next to each property

- a) Strong, ductile.....
- b) Soft, ductile, low strength, low density.....
- c) Brittle, glassy, elastic.....
- d) High thermal & electrical conductivity.....
- e) Thermal & electrical insulators.....
- f) Non-conducting (electrical insulators).....
- g) Opaque, reflective.....
- h) Optically translucent or transparent.....
- i) Compounds of metallic and non-metallic elements.....
- j) Metallic bonding.....
- k) Ionic bonding.....
- l) Covalent bonding by sharing of e's.....
- m) Composed of two or more materials.....
- n) Electrical conductivity between insulator and conductor.....
- o) Exceptionally lightweight and strong.....
- p) Used especially in electronic devices.....

Question 2. (10 pts)

For each property listed below, compare the material types in general. Put them in increasing order for that property and label with the appropriate number using 1 for “Lowest”, 2 for “in between”, 3 for “Highest”

<i>Property</i>	<i>Ceramic</i>	<i>Metal</i>	<i>Polymer</i>
Hardness	_____	_____	_____
Elastic modulus	_____	_____	_____
Thermal expansion	_____	_____	_____
Wear resistance	_____	_____	_____
Corrosion resistance	_____	_____	_____
Ductility	_____	_____	_____
Density	_____	_____	_____
Electrical conductivity	_____	_____	_____
Thermal conductivity	_____	_____	_____
Magnetic	_____	_____	_____

Question 3. (30 pts)

- What is the cause of fatigue and where in the material does it often start? Why?
- What is the typical fatigue mechanism in a metallic material?
- Can a material fail even though the overall applied stress is below the yield stress? Why or why not?
- How does fatigue take place in polymers?
- How does fatigue take place in ceramics?

Question 4. (25 pts)

The following data were obtained when a cold-worked metal was annealed:

Annealing Temperature (°C)	Electrical Conductivity (ohm ⁻¹ · cm ⁻¹)	Yield Strength (MPa)	Grain Size (mm)
400	3.04 × 10 ⁵	86	0.10
500	3.05 × 10 ⁵	85	0.10
600	3.36 × 10 ⁵	84	0.10
700	3.45 × 10 ⁵	83	0.098
800	3.46 × 10 ⁵	52	0.030
900	3.46 × 10 ⁵	47	0.031
1000	3.47 × 10 ⁵	44	0.070
1100	3.47 × 10 ⁵	42	0.120

- Estimate the recovery, recrystallization, and grain growth temperatures and state the reason for each
- Recommend a suitable temperature for a hot-working process and explain why
- Do the mechanical properties of a material change during recovery, why or why not?
- Incandescent light bulbs contain filaments that are made from tungsten (W). What may be one of the main factors that cause the filament to fail?