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Siro_Valiu
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Examen 2014-2015 _extra.pdf

Examenes Materiales Aeroespaciales I - Aerospace Materials exams I

2° Materiales Aeroespaciales I

Grado en Ingeniería Aeroespacial

Escuela Politécnica Superior
Universidad Carlos III de Madrid



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Universidad Carlos III de Madrid

EXAM

June 2015

Aerospace Materials I (2nd Year)

Surname: **Name:** **Group:**

Information:

- Read the questions carefully before answering. Use the space given for answering each question.
- You have 2h 30min to complete the exam.
- The marks assigned to each of the questions are given at the beginning of the question.
- To pass the exam you need a minimum mark of 4 over 10.

1. (1 mark) For the following pair of polymers, do the following: (1) state whether it is possible to decide if one polymer has a higher tensile strength than the other; (2) if this is possible, note which has the higher tensile strength and then cite the reasons for your choice; and (3) if it is not possible to decide, then state why not.

a) Syndiotactic polystyrene having a number-average molecular weight of 600,000 g/mol and Isotactic polystyrene having a number-average molecular weight of 500,000 g/mol.

b) Poly(styrene-butadiene) random copolymer having a number-average molecular weight of 100,000 g/mol and 10% of the available sites crosslinked and Poly(styrene-butadiene) random copolymer having a number-average molecular weight of 120,000 g/mol and 15% of the available sites crosslinked.

c) Isotactic polystyrene that has a density of 1.12 g/cm^3 and a weight-average molecular weight of 150,000 g/mol and Syndiotactic polystyrene that has a density of 1.10 g/cm^3 and a weight-average molecular weight of 125,000 g/mol.

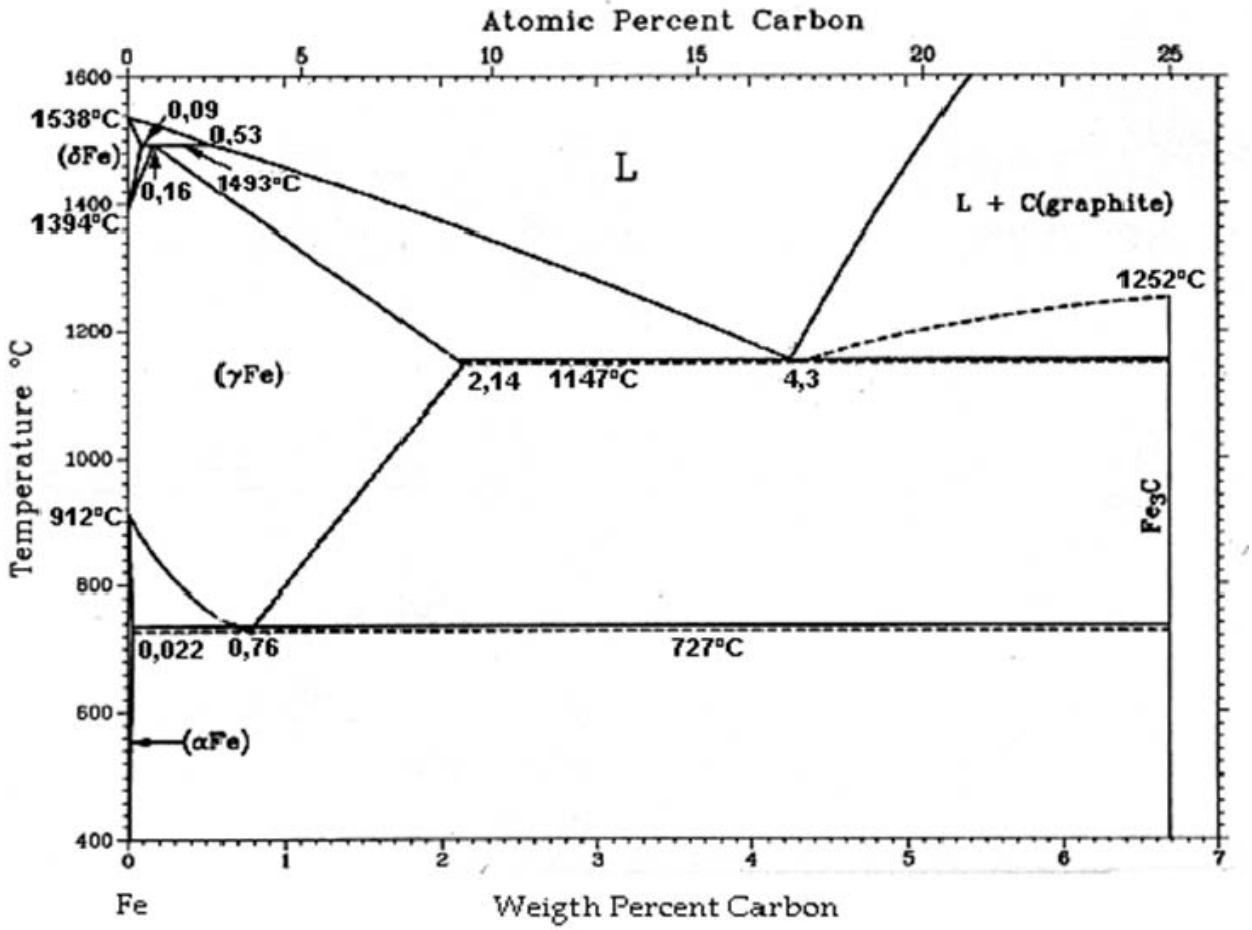
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2. **(2 marks)** Use the Fe-C phase diagram to answer the questions.
   a) **(0.5 marks)** Mark as true (T) or false (F) the following statements:

	Pure Iron has three allotropic modifications
	Cementite melts congruently
	At 1493ºC the reaction is monotectic
	Maximum solubility of C in α phase of Fe at 727ºC is 0.022%
	Microconstituents of an alloy with 3 wt%C at 1000ºC are primary austenite and cementite

   b) **(0.5 marks)** For an alloy with 0.5 (wt.)%C at 727+ΔTºC, indicate the phases present, their mass fraction and their chemical composition
   c) **(0.5 marks)** Consider 250g of an alloy with 1.3 wt% C and calculate the amount of cementite in each microconstituent at 600ºC
   d) **(0.5 marks)** If we add 8% of Mn to the alloy from part c): how will the eutectoid temperature change with respect to the studied alloy? How much carbon will the pearlite have? Justify your answers.



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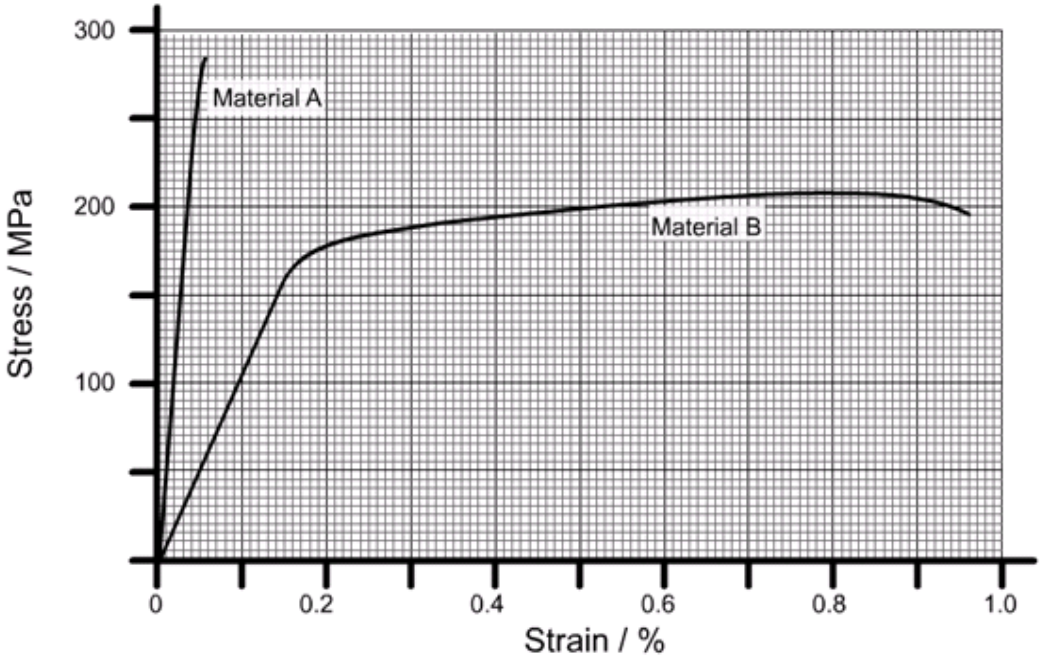
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3. **(2 marks)** A cylindrical rod 3m long and having an initial diameter of 20 mm is subjected to a tensile load of 65000 N and experiences a change in diameter of 0.014 mm, recovering its initial diameter when the load is removed. For this kind of alloy Poisson's ratio is ν= 0.36.
   a) Calculate the length of the cable when it's holding the load mentioned above
   b) Plastic deformation for this alloy begins when it is holding a weight of 26608 kg. Calculate the tensile strength of this alloy. Assuming a safety factor of 2, can it be considered that the rod is working under safe conditions?
   c) Calculate the elastic modulus and the modulus of resilience of this alloy
   d) Calculate the elastic modulus and yield stress for the Materials A and B that have the stress-strain curves represented below. Can Material B replace the alloy rod? Explain why.
   e) If the alloy rod is substituted by Material B and is subjected to the same load calculate the final length of the rod

DATA: g_o=9.8 m/s^2



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4. **(1 mark**) Answer the following question and explain briefly:
   a) What are Bravais lattices and how many are there?
   b) What are the 3 most common structures of metallic materials and which one has the smallest packing factor?
   c) For closed packed structures, what is the relation between number of possible interstitial sites (n) and number of atoms in the cell (N) for both types of interstitials?
   d) Is the solubility of Carbon higher in ferrite or austenite? Why?

5. **(1 mark)** Answer the following question and explain briefly:
   a) What are typical materials used as matrices in ceramic matrix composites (CMC)?
   b) What are the advantages of CMCs?
   c) What is the role of the reinforcements in CMCs?
   d) Name and describe a manufacturing method applicable only to CMCs?

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6. **(1 marks) a)** Define a ceramic material. What structural defects are the main causes of failure of polycrystalline ceramic materials? Distinguish between traditional and engineering ceramics and give an example of each. **b)** What is the sintering process of ceramic materials? What occurs to the ceramic particles during sintering?

7. **(1 mark)** Lattice energy for binary ionic compounds depends on the values of some fundamental constants and other parameters that are a function of the nature of the ions.
   a) Enumerate at least two parameters and briefly explain their influence.
   b) In the following table you may find the values of the melting point (ºC), lattice energy (Kcal/mol), hardness (Moh's scale) as well as the formula of several binary compounds. Match each compound with the correct values of T_m, lattice energy and hardness.
   Data r(Na) > r (K), r(Mg) > r(Ba)

Compound	T_m	Lattice energy	Hardness
NaCl	776	747	6.5
KCl	1923	164	2.5
MgO	801	183	3.3
BaO	2800	940	2.25

Compound	T_m	Lattice energy	Hardness
NaCl			
KCl			
MgO			
BaO			

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8. **a) (0.5 marks)** For a metallic conductor explain how is electrical resistivity affected by (i) increasing temperature and (ii) impurities, alloying additions, dislocations and grain boundaries

b) (0.5 marks) Explain the relationship between superconducting materials and magnetism. Define the T_c (critical temperature in a superconductor). What is the Meissner effect?

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