midterm-1-materiales-1.pdf

zumixdexmanzana

Materiales Aeroespaciales I

2º Grado en Ingeniería Aeroespacial

Escuela Politécnica Superior. Campus de Leganés
Universidad Carlos III de Madrid

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[redacted]

Universidad Carlos III de Madrid
Aerospace Materials I 2022/23
Assessment Test 1B **Grade:** ____ ***Points/10***
Surname Sangrador Cano **Name** Alejandra
Group 47.
Date: September 29th 2022

Important: Please write your first and last name before you start. Neither books nor any other extra material is allowed in the exam but the calculator. Please, mark your answer with an **X in the table**. For the correct answers you will receive **+0.5 point**, for the incorrect answers you will receive **-0.15 points**. Unmarked questions will **NOT** be evaluated either with positive or negative points Good luck!

Part I (**5 points**)

	Answer					Answer			
Question	a	b	c	d	Question	a	b	c	d
1			X		6	X			
2		X			7		X		
3					8			X	
4			X		9				X
5				X	10				

1. Ionic bond strength decreases with increase in the:

a	Valence number
b	Melting temperature
c	Ion size
d	Electronegativity difference

2. In polymeric materials:

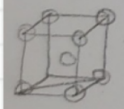
a	the chains are bonded by directional bonds with a fixed angle between them
b	the chains are bonded by van der waals bonds
c	molecules within the chains are primarily bonded by non-directional covalent bonds
d	molecules within the chains are primarily bonded by ionic bonds

3. The lattice energy in (KJ/mol) of the following oxides is:

MgO:	3932	CaO:	3583	SrO:	3311	BaO:	3127

Which of the oxides will most likely have the highest hardness

a	MgO
b	BaO
c	CaO
d	SrO



4. The atomic radius of an atom in a BCC unit cell having lattice parameter of 4.5 Å is:

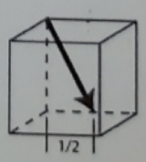
a	2.25 Å
b	1.59 Å
c	1.95 Å
d	1.12 Å

$4R = a\sqrt{3}$

$R =$

5. The direction indices for the crystallographic direction indicated the vector shown are:

a	$[0\bar{1}2]$
b	$[012]$
c	$[\bar{2}01]$
d	$[01\bar{2}]$



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$D = D_0 \exp\left(\frac{-\Delta H}{RT}\right)$

X

6. Diffusivity of an element:	
(a)	Depends exponentially on temperature
b	Does not depend on the temperature, but it depends on error function
c	Depends linearly on temperature
d	Does not depend neither on temperature, nor the error function

$J = -D\frac{\Delta C}{\Delta x}$

X

7. A plate of iron is exposed to a carburizing (C-rich) atmosphere on one side and a decarburizing (C-deficient) atmosphere on the other side at 600 °C. If a condition of steady state is achieved, calculate the diffusion flux of carbon through the plate if the concentrations of carbon at positions of 2 and 7 mm beneath the carburizing surface are 1.8 and 1.3 kg/m^3, respectively. Assume a diffusion coefficient of 2.4×10^{-11} m^2/s at this temperature.

a	3.4×10^{-9} kg/m^{2}s
(b)	2.4×10^{-9} kg/m^{2}s
c	3.9×10^{-9} kg/m^{2}s
d	1.8×10^{-9} kg/m^{2}s

8. Diffusion occurs faster:	
a	In metals with high melting point than in metals with low melting point
b	By vacancy diffusion than by interstitial diffusion
c	In the BCC structure than in the FCC structure
d	Along the volume (crystal lattice) than along the grain boundaries

9. For a screw dislocation it is true that:	
a	The burgers vector is perpendicular to the dislocation line and parallel to the direction of dislocation movement.
b	The movement of the dislocation occurs easier in non-closed-packed directions.
c	Is a lattice imperfection produced when an extra half-plane of atoms is introduced in the lattice.
d	The burgers vector is parallel to the dislocation line and perpendicular to the direction of dislocation movement.

10. With an increase in temperature of a material:	
a	The number of vacancies will not change
b	The number of interstitials will not change
c	The number of grain boundaries will decrease
d	The number of Frenkel defects will decrease

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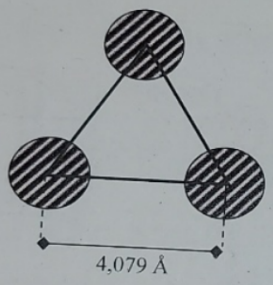
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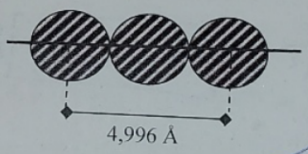
Part II ((5 points)
The plane (111) and direction [111] of a unit cell of a metal are shown below. Circles represent atoms.

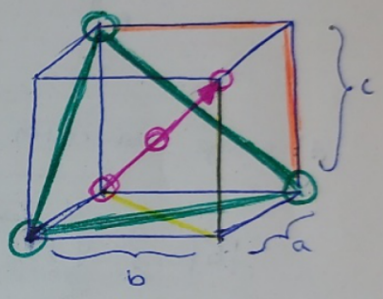
a) Draw the plane, direction and unit cell. Determine the crystalline structure (crystalline system and Bravais lattice).
b) Calculate the planar density for the plane (110) in atoms/ Å²
c) Calculate the molecular mass M of the element
d) Determine the magnitude and the direction of the Burger's vector for an edge dislocation in the plane (111).
e) Calculate distance between $(0\bar{1}3)$ planes.

Data: $N_A = 6.023 \times 10^{23}$ atoms/mol, $\rho = 7.2$ g/cm³

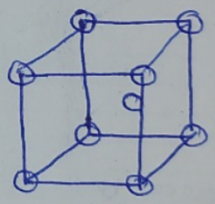


(111)





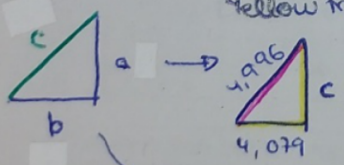
[111]



a) Plane & direction: at the top Unit cell:

The crystalline structure :

Yellow triangle:



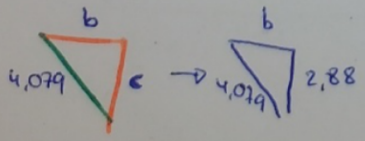
$c^2 + 4,079^2 = 4,996^2$

$c = 2,88$ Å

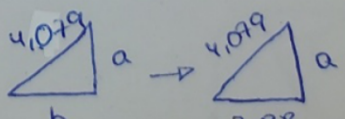
BCC ✓

$a = 2,88$ Å

Orange triangle



$b = 2,88$ Å



$a = 2,88$ Å

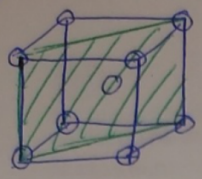
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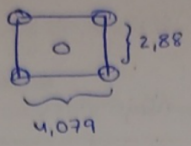
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b) Calculate planar density for the plane (1 1 0) in at/Å²



$P_p = P_{(1\,1\,0)} = \frac{n^{\circ}\,at\$}{S_{plano}} = \frac{4\left(\frac{1}{2}\right)+1}{4{,}079 \cdot 2{,}88} \Rightarrow \boxed{P_{(1\,1\,0)} = 0{,}255\ at/Å^2}$



c) Molecular mass of the element.

$\rho_v = 7{,}2\ g/cm^3$

$\rho = \frac{n(M)}{V_c \cdot N_A} \rightarrow M = \frac{\rho V_c N_A}{n} \rightarrow M = \frac{7{,}2\ \frac{g}{cm^3} \cdot (5{,}18\times10^{-8}\,cm)^3 \cdot 6{,}022\times10^{23}}{2\,at}$

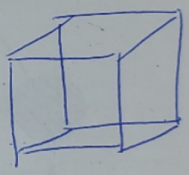
$1\,Å = 1{,}8\times10^{-8}\,cm$

$2{,}88\,Å = 5{,}18\times10^{-8}\,cm$

$M =$

d) Edge dislocation in (1 1 1) ¿$\vec{b}$?

$|\vec{b}| = \frac{a}{2}\sqrt{1^2+1^2+1^2} \Rightarrow \boxed{|\vec{b}| = 2{,}49\ Å}$ ✓



¿direction?

e) Distance between (0 1 3) planes.

$d = a \cdot \frac{1}{\sqrt{0^2+1^2+3^2}} = \frac{a}{\sqrt{10}} \rightarrow \boxed{d = 0{,}911\ Å}$ ✓

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