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Exámenes resueltos 2012-2016

2° Materiales Aeroespaciales I

Grado en Ingeniería Aeroespacial

Escuela Politécnica Superior
Universidad Carlos III de Madrid



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JANUARY 2013

(1) a)

Strength: ionic > metallic > covalent

directionality: Ionic → non-directional ; Covalent → directional ; Metallic → non-directional

Ionic bonding: transfer of e^- → cations and anions → $\bar{F}_{Coulomb}$

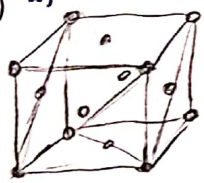
Covalent bonding: sharing e^-

Metallic bonding: e^- shared externally and very little tightened by the nucleus

b) Metals are ductile because electrons are free to move. The e^- which used to be in the outer shell of metal atoms are now delocalised and free to move throughout the giant metallic lattice, so as one layer of metal ions slides over another, the e^- can move too, keeping the whole structure bonded together.

Ceramics are not ductile because they have predominately ionic bonding, which results in positive and negative ions alternating. If the material is stressed and one layer moves with respect to another, the positive ions can end up lined up with each other, and the negative ions lined up with each other. This causes repulsion, so the ceramic fractures.

(2) a)



FCC

$M = 26.98\ g/mol$

$\rho_{[111]} = \frac{n^{\circ}at}{L_{[111]}} = \frac{2 \cdot 1/2}{r3\ a} = 1.43 \cdot 10^{7} \frac{at}{cm} \rightarrow \boxed{a = 4.04 \cdot 10^{-8}\ cm}$

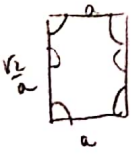
$r3a$

[110] $4r = r2a \rightarrow \boxed{r = \frac{r2\,a}{4} = 1.43 \cdot 10^{-8}\ cm}$

$r2a$

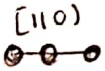
b) $\boxed{\rho = \frac{n M}{N_A V_C} = \frac{4 \cdot 26.98}{(4.04 \cdot 10^{-8})^3 \cdot 6.022 \cdot 10^{23}} = 2.72 \frac{g}{cm^3}}$

c) (110)



$\boxed{\rho_{(110)} = \frac{4 \cdot 1/4 + 2 \cdot 1/2}{r2\,a \cdot a} = \frac{2}{4.93 \cdot 10^{14}} = 4.06 \cdot 10^{14}\ at/cm^2}$

d) [110)



$\boxed{\rho_{[110)} = \frac{2 \cdot 1/2 + 1}{r2\,a} = 3.5 \cdot 10^{7}\ at/cm}$

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Pídele a los reyes:
El **mejor proyector**
relación calidad/precio
Los recomendados de amazon y WUOLAH



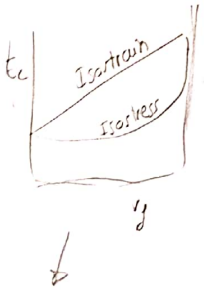
https://amzn.to/2Lg6wRM

③

a) Glass fibers, Carbon fibers and Aramid fibers

Fiber impregnation: sheet moulding compound (SMC)

1. Continuous fibers are chopped into short fibers
2. Short fibers are deposited over resin paste
3. Second layer of resin is deposited on top
4. Sheet is pressed between rollers.



b)

Parallel: $\varepsilon_c = \varepsilon_f = \varepsilon_m$

Isostrain $\sigma_c = V_f \sigma_f + V_m \sigma_m$

$E_c = V_f E_f + V_m E_m$

Perpendicular: $\sigma_c = \sigma_f = \sigma_m$

Isostres $\varepsilon_c = V_f \varepsilon_f + V_m \varepsilon_m$

$\frac{1}{E_c} = \frac{V_f}{E_f} + \frac{V_m}{E_m}$

(?)

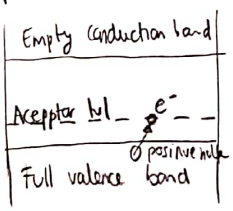
The highest properties are in the direction // to the fiber,

The minimum properties are in the ⊥ direction

④

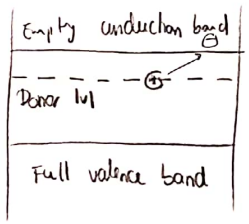
A) a) p-type

Slides:



b) n-type

Slides:



B) Case 1 a) is better because it minimizes tensile peeling (?)

Case 2 b) is better because it minimizes tensile loading



⑤

a)

T = 1493°C : Peritectic $L(0.53\%C) + \delta(0.09\%C) \rightarrow \gamma(0.16\%C)$

T = 1147°C : Eutectic $L(4.3\%C) \rightarrow \gamma(2.14\%C) + Fe_3C(6.7\%C)$

T = 727°C : Eutectoid $\gamma(0.76\%C) \rightarrow \alpha(0.022\%C) + Fe_3C(6.7\%C)$

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b) Max solubility of C in austenite (γ Fe)

1300°C : 1.3% C

1000°C . 1.7% C

730°C : 0.76% C

400°C : 0% C

c) $C_0 = 0.3\%C$

T = 1300°C

- phases. austenite same microconstituent

$C_\gamma = 0.3\%C$ $W_\gamma = 1$

T = 1000°C

- phases : austenite same micro

$C_\gamma = 0.3\%C$ $W_\gamma = 1$

T = 730 °C → just above eutectoid

- phases = micro: α and γ

$C_\alpha = 0.022\%C$ $W_\alpha = \frac{0.76 - 0.3}{0.76 - 0.022} = 0.62$

$C_\gamma = 0.76\%C$ $W_\gamma = 0.38$

T = 400°C

- phases : α and Fe_3C

$C_\alpha = 0.01\%C$ $W_\alpha = \frac{6.7 - 0.3}{6.7 - 0.01} = 0.96$ (x)

$C_{Fe_3C} = 6.7\%C$ $W_{Fe_3C} = 0.04$

- microconstituents: α' and pearlite ($\alpha + Fe_3C$)

$C_{\alpha'} = C_\alpha$ (727°C) = ~~0.022%C~~ 0.01%C $W_{\alpha'} = \frac{0.76 - 0.3}{0.76 - 0.01} = 0.62$

$C_{Fe_3C} = 0.76\%C$ $W_{pearlite} = 0.38$

$W_{\alpha, pearlite} = W_{\alpha,T} - W_{\alpha'} = 0.96 - 0.62 = 0.34$ (1)

d)

$m_{\alpha'} = 100 \cdot W_{\alpha'} = 100 \cdot 0.62 = \underline{62g}$

$m_{pearlite} = 100\ W_{\alpha, pearlite} = 100 \cdot 0.34 = \underline{34g}$

JAN 2013

2

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e) Ni is an element favouring γ (it stabilizes γ phase) → displaces eutectoid ↓T, ↓%C Enough?

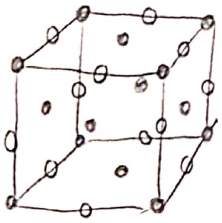
(6) internet

a) The two main factors which affect the packing of ions in ionic solids are:

1) The relative size of the ions in the ionic solid, assuming ions are hard spheres with definite radii

2) The need to balance the electrostatic charges to maintain electric neutrality within the ionic solid

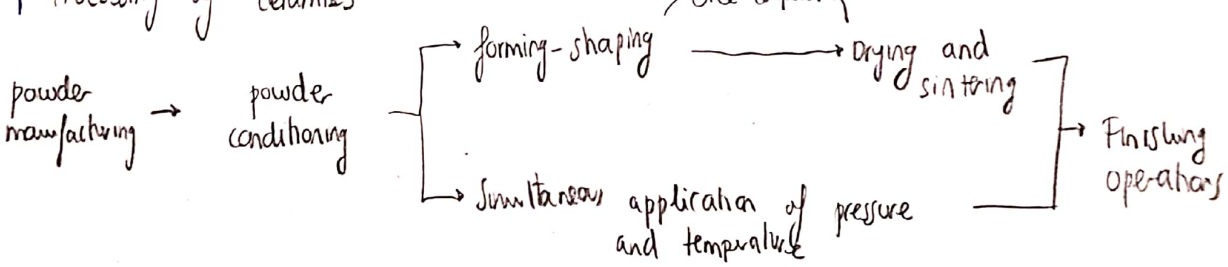
NaCl structure:



• Cl^-: FCC packing

○ Na^+: all octahedral interstitials

b) Processing of ceramics



(7)

a) Done

b) $\sigma_y = 185 MPa$ tensile strength: $\sigma_{max} = 239 MPa$

c) $E = \frac{177 MPa}{0.005} = 35400 MPa = 35.4 GPa$ (σ/ε)

$U_r = \frac{1}{2}\frac{(\sigma_y)^2}{E} = \frac{1}{2}\frac{185^2}{35400} = 0.48 MPa$

d) ~~$EL(\%) = \varepsilon_{frac} \cdot 100 = 0.093 \cdot 100 = 9.3\%$~~ $\frac{l_{fin} - l_0}{l_0} \cdot 100 = \frac{32.61 - 30}{30} \cdot 100$

$RA(\%) = \frac{A_0 - A_f}{A_0} \cdot 100 = \frac{\frac{\pi}{4}12^2 - \frac{\pi}{4}11.74^2}{\frac{\pi}{4}\cdot 12^2} \cdot 100 = 4.3\%$

e) At fracture, $\sigma_n = 221.2 MPa$

~~true stress: $\sigma_T = \sigma_n(1+\varepsilon_n) = 221.2(1+0.093) = 241.77 MPa$~~ there is necking

$\sigma = \frac{F_i}{A_i}$ using data for q_1

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