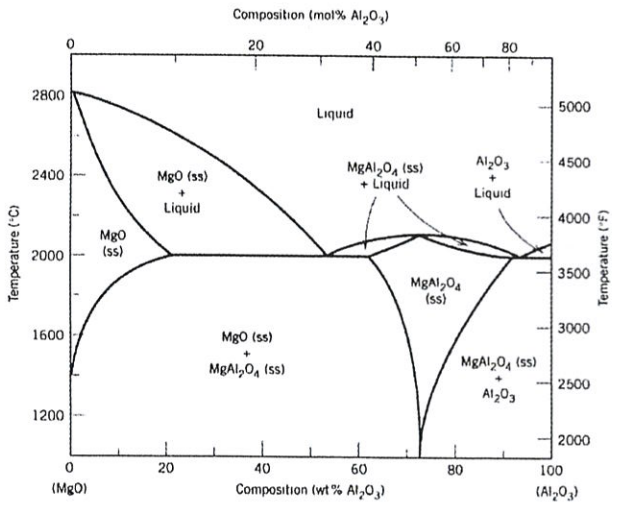
國立臺灣科技大學 107 學年度碩士班招生試題

系所組別：材料科學與工程系碩士班丙組

科　　目：材料導論

(總分為 100 分)

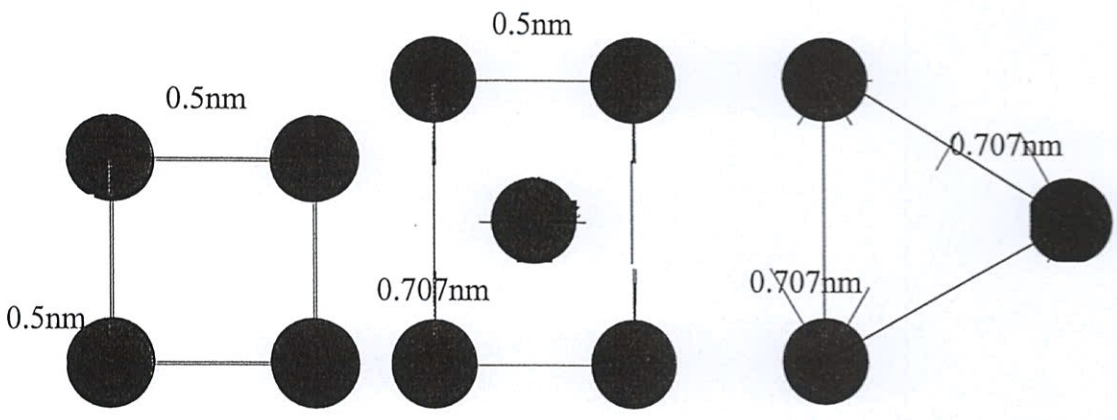
1. The phase diagram for the MgO-Al_2O_3 system is shown below for the following questions. (1) Please provide two possible point defects for Al_2O_3 as an impurity in MgO? **(6 Points).** (2) How many Al^{3+} ions must be added to form each of these defects? **(4 Points)**. (3) Please discuss about whether MgO solutes in Al_2O_3 using the phase diagram, and provide the possible reason. **(5 Points).** (4) Also, please discuss about whether Al_2O_3 solutes in MgO using the phase diagram, and provide the possible reason. **(5 Points)**



2. Calculate the **bonding energy** and **bonding length** of the $X^+ - Y^-$ by using the attractive and repulsive energies E_A and E_R as below

$E_A = \frac{-2.59}{r}$, $E_R = \frac{4.28\times10^{-5}}{r^{10}}$ **(10 points)** (Hint: unit of r is nm and unit of E_A and E_R are eV)

3. The accompanying figure shows three different crystallographic planes for a unit cell of a hypothetical metal. The circles represent atoms.



(1) To what crystal system does the unit cell belong and what is the corresponding lattice parameters? **(4 points)** (2) What would this crystal structure be called? **(2 points)**? (3) What is the relationship between the

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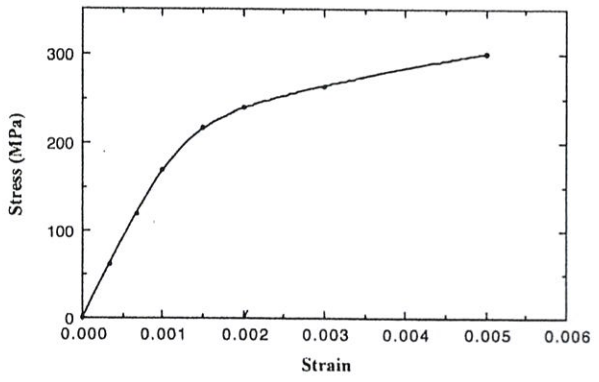
lattice parameter **"a"** and radius of its atoms **"R" (2 points)**? (4) What is the atomic packing factor **(APF)** of this unit cell **(2 points)**?

4. The following figure is the stress-strain plot for a cast iron. Please determine the elastic modulus and yield strength at a strain offset of 0.002. **(10 points)**



5. (a) Write the equation of Fick's first law of diffusion using D (diffusion coefficient), C (concentration), J (flux) and x (position). [5 point]

(b) Consider the self-diffusion of two hypothetical metals A and B with the preexponential (or diffusivity) $D_0(A) > D_0(B)$ and the activation energy for diffusion $Q_d(A) > Q_d(B)$. Plot and label curves of ln D versus $1/T$ on a schematic graph and explain how to get the D_0 and Q_d for both metals. (T is temperature.) [10 points]

6. A hypothetical peritectic system A-B consists of liquid L phase and two solid solutions α and β. The melting point of A is higher than B.

(a) Draw this peritectic phase diagram, label the phases and write the equation of peritectic reaction. [10 points]

(b) An AB alloy with the peritectic composition is cooled down to a single phase region at a temperature below the peritectic point. Draw the microstructures of the AB alloy obtained from nonequilibrium cooling and equilibrium cooling. [5 point]

7. (a) Draw the curve of heat capacity at constant volume C_v versus temperature T from 0 K to a temperature above the Debye temperature θ_D. Then write the equations to describe dependence of C_v on T below and above θ_D. [10 points]

(b) Draw the curves of thermal conductivity k versus temperature T for a doped semiconductor with low-concentration dopants and with high-concentration dopants. Then explain the origin of the change in thermal conductivity. [10 points]