

ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2015 SESSION

Open-book examination
Calculators: authorized models only
Duration: 3 hours

STRUCTURE OF MATERIALS
14-MT-A4

- *Please, answer all questions.*

Question 1. (5+5+5+5+5 points)

- 1) A Springium O-ring is used in a high-vacuum chamber. The O-ring is made of a 2mm diameter wire of 60 mm in length. How many Al atoms this O-ring contains? Density: 2.9 g/cm³, Molar mass: 25 g/mol.
- 2) After ionisation, why is the potassium ion smaller than the potassium atom?
- 3) What is the origin of elasticity in materials?
- 4) Are there metals transparent when 0.5cm thick? Why or why not?
- 5) What is polymorphism with respect to metals?

Question 2 (5+5+5+5+5 points)

- 1) What differences in behavior would you expect to exist between a single crystal metal component and a polycrystalline one?
- 2) Explain why surface diffusion is faster than bulk diffusion.
- 3) Draw the glide planes and glide directions in FCC and BCC structures.
- 4) What special technique must be used to produce a single crystal?
- 5) At the atomic level, what is the difference between plastic and elastic deformation?

Question 3 (5+5+5+5+5 points)

- 1) What are the differences between wrought and cast structures?
- 2) Is the strength of nanomaterials maintained with increasing temperature? Explain.

3) Define the hardness of a metal.

4) Consider casting of a sphere and a cube of the same volume in iron. Which one will solidify faster? Why?

5) Which of the following substitutional solid solution would you select if the higher tensile strength was the selection criterion: Cu-30wt%Ni or Cu-30wt%Zn? Why?

Question 4 (5+5+5+5+5 points)

1) Write the equation for Gibbs phase rule and define each of the terms.

2) What type of alloy is formed when the two components are poorly soluble in one another?

3) How are eutectoid and eutectic reactions similar?

4) What are the four Hume-Rothery rules for the solid solution solubility of one element in another?

5) Explain how the solidus and liquidus of binary phase diagram can be determined experimentally?