

Homework 0

Carefully review chapter 17 lecture slides and, if interested, read textbook sections of Askeland 17 and give an honor statement confirming the reading

Homework 17.1

A fully dense tungsten-silver (W – Ag) composite is made from 70 wt.% W – 30 wt% Ag. Knowing density is

19.2 g/cm³ for W, 10.5 g/cm³ for Ag

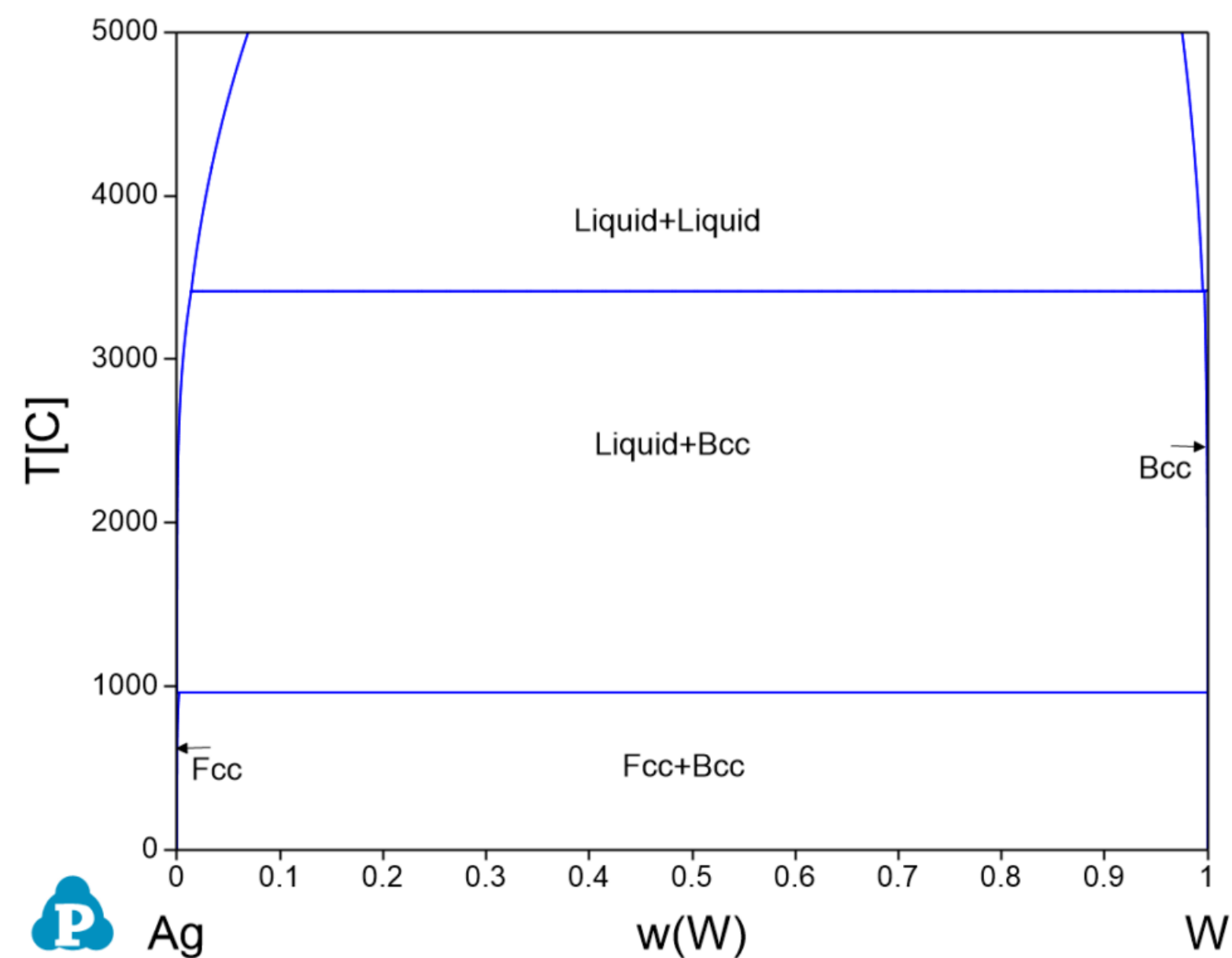
1) Based on W – Ag phase diagram, how many phases exist under equilibrium at 20°C? What is the volume fraction for each phase?

2) Calculate density of the composite

3) If the electrical conductivity σ for the 2-phase composite can be approximated by

$$\frac{1}{\sigma_{composite}} = \frac{V_1}{\sigma_1} + \frac{V_2}{\sigma_2}, \text{ please estimate the electrical conductivity for the composite}$$

if electrical conductivity is 1.8×10^7 S/m for W and 6.3×10^7 S/m for Ag



Homework 17.2

For fully dense WC-10 wt% Co cemented carbide, knowing density, Young's modulus, and fracture toughness for each phase

	Density (g/cm ³)	E (GPa)	K_{1C} (MPa·m ^{0.5})
WC	15.6	700	~8
Co	8.9	209	~150

- 1) Calculate the volume fraction or V_i for each phase
- 2) Calculate density of the cemented carbide
- 3) If upper bound of the composite's Young's modulus is $E_{composite} = V_1E_1 + V_2E_2$
lower bound of the composite's Young's modulus is $\frac{1}{E_{composite}} = \frac{V_1}{E_1} + \frac{V_2}{E_2}$

Please give the range of the estimated Young's modulus of the cemented carbide.

- 4) Please estimate the fracture toughness of the WC-10 wt% Co using the geometric mean model, i.e., $K_{WC-10Co} = K_{WC}^{V_{WC}} \cdot K_{Co}^{V_{Co}}$

Homework 17.3

A continuous and aligned long fiber-reinforced composite consisting of 60 vol.% of glass fiber with Young's modulus of 70 GPa and 40 vol% of polyester with Young's modulus of 3 GPa

- 1) Please estimate the modulus of elasticity of the composite along the fiber direction
- 2) Estimate the density of the composite, knowing glass fiber density of 2.5 g/cm^3 , and epoxy density is 1.25 g/cm^3
- 3) If an external tensile force of 10000 N is applied along the fiber direction, calculate the load carried by each of the fiber and matrix phase, if iso-strain condition is satisfied along that direction