Workshop M2: Phase Diagrams and Introducing Non-Metals

LEARNING OUTCOMES

- Understand the principles of developing phase equilibrium diagrams and their applications for metallic alloys.
- Understand the initial concepts of materials selection.

Activity 1: Phase Equilibrium Diagrams – Binary System

As a group, construct a Phase Equilibrium Diagram representing a binary alloy system of two elements *A* and *B*, using the following data:

(a) *A* melts at 1290°C and *B* melts at 950°C

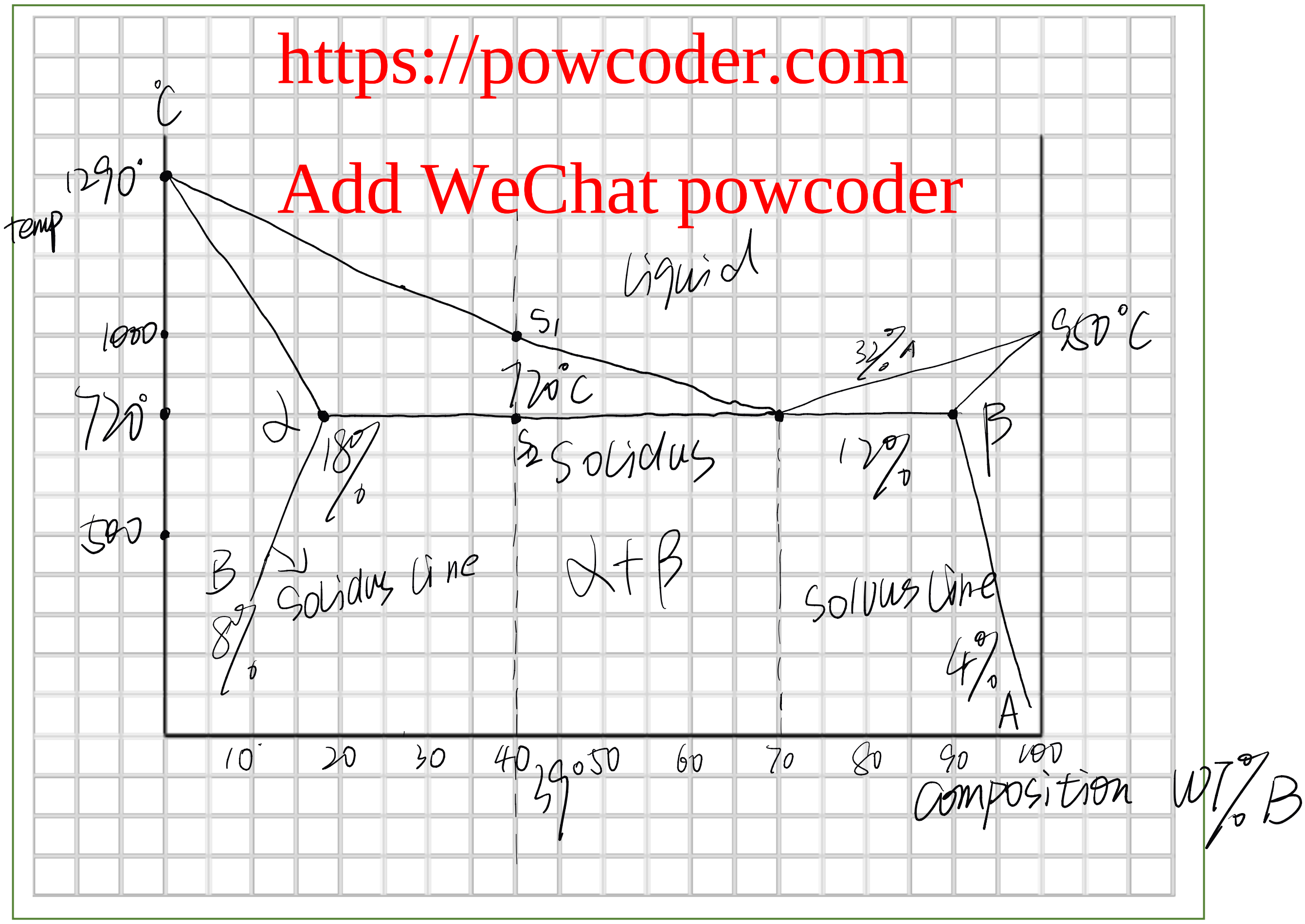
(b) *A* is soluble in *B* in the solid state to the extent of 12% A in B at 720°C, and 4% A in B at room temperature (20°C)

(c) *B* is soluble in *A* in the solid state to the extent of 18% B in A at 720°C and 8% B in A at room temperature (20°C)

(d) A eutectic is formed at 720°C at a composition of 32% *A*

Assume that the solid solution of B in A is known as α *- phase, and that the solid solution of A in B is known as* β *- phase.* Label all phase fields and phase boundary lines (solidus, liquidus, solvus).

You may draw your graph here, or copy and paste it in.



Activity 2: Phase Equilibrium Diagrams – Application and Interpretation

You are given an alloy at 860°C, and asked to describe the equilibrium solidification regime, by identifying specifically the phase compositions and approximate phase proportions that exist.

(a) Obtain your individual %B alloy composition by double-clicking on the Excel insert and entering the last 2 digits of your student ID. *Please ask your tutor if you cannot open the Excel sheet.*

last 2 digits of your student ID	**%B**
98	39

Label your phase diagram in Activity 1 with a vertical line for your alloy composition (eg: 25%B)

(b) Label your diagram with S1 and S2 to denotes the solid transitions below.

Point on diagram	**Solidification:**	**Temperature (◦C)**
S1	begins at	900°C
S2	is complete at	720°C

(c) Determine the compositions of the α-phase and liquid phase, for the alloy at 860◦C, labelling P1 and P2 your graph.

$\alpha = \frac{58-30}{58-13} = \frac{28}{45} = 62\%$

$\beta = \frac{100-32}{100} = 68\%$

Point on diagram	**Phase**	**Composition**	
P1	α-phase	62 %A	28 %B
P2	liquid phase:	32 %A	68 %B

(d) Identify which specific phases exist for your alloy at the given temperature. Apply the Lever Law to estimate the % of each phase for your alloy at 860◦C. Show your working below, and label the appropriate lines on your graph.

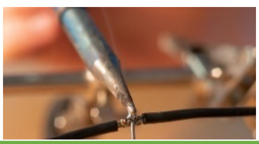
	Name of phase	**% of phase in alloy at 860◦C**
Phase 1	α - phase	62%
Phase 2	liquid phase	68%
Show your working here:	$\alpha = \frac{58-30}{58-13} = \frac{28}{45} = 62\%$ $\beta = \frac{100-32}{100} = 68\%$	

Activity 3: Materials Selection Exercise

Below is a list of materials:

Polyvinyl chloride	Tin-Lead alloy	Al – 4% Cu alloy	Borosilicate glass
CFRP (carbon fibre reinforced plastic)		Polycarbonate	Carbon steel

Select from this list *one* material that you think is best suited for *each* of the following applications, and give at least *one* reason or selection criteria for each choice: (NB. Materials listed can be selected more than once). Consider function, appearance and cost as factors for selection.

Application	Material	Reason for Material Choice
A car headlight shield 	Borosilicate glass	used to maintain optical clarity
A transparent pie dish 	Polycarbonate	strong transparent plastic
The outer skin components of an aircraft 	AL - 4% Cu alloy	It is light weight material having enough strength
The walls of a steam boiler 	carbon steel	It can only bear the pressure without producing cracks
A garden irrigation tube 	Polyvinyl chloride	good mechanical properties
Solder 	tin-lead alloy	low melting point