University of Jordan

# Phase Diagram

9

Properties of Engineering materials lab

# contents




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# Safety


Safety is a state in which hazards and conditions leading to physical, psychological, or material harm are controlled to preserve the health and well-being of individuals and the community.

## Before starting the experiment in laboratory, we must follow safety rules:

**1.** Put on protective clothing like lab coat, a pair of safety glasses and a pair of disposable gloves.

**2.** Do not hold a workpiece by hand. Use tongs instead because of high temperature degrees.

**3.** Stay away of the oven and deal carefully with it.

**4.** Do not taste or sniff chemicals.

**5.** Rings and jewellery must not be worn.

**6.** Long and loose hair must be contained.

**7.** Close fitting / protective clothing must be worn.

# Objectives

Equilibrium phase diagrams are graphical presentations that can be used to display the alloy phases that are present at any given temperature, the composition of each phase, and the amount of each phase at that temperature and composition. Knowing how to draw a phase diagram and use it to estimate material behavior is thus quite useful.

# Materials and Apparatus

## MATERIALS :

- Lead (pb)
- Tin (Sn)
- A ring stands
- Crucible (ceramic or metal container)
- Mask
- Tongs
- flask

## APPARATUS :

- Scale
- Laboratory oven
- Mercury Thermometer
- Screen stopwatch

# Experimental procedure

1)weigh varying proportions of lead and Tin.

2)mix the two proportions in the crucible.

3)place the crucible into the furnace.

4)set the furnace temperature at 350C-500C.

5)wait for the alloy to melt, then remove the crucible from the furnace & place it on the stand.

6)fix the thermometer.

7) Record the time it takes to decrease 5°C in each time until it finally reaches 140°C.

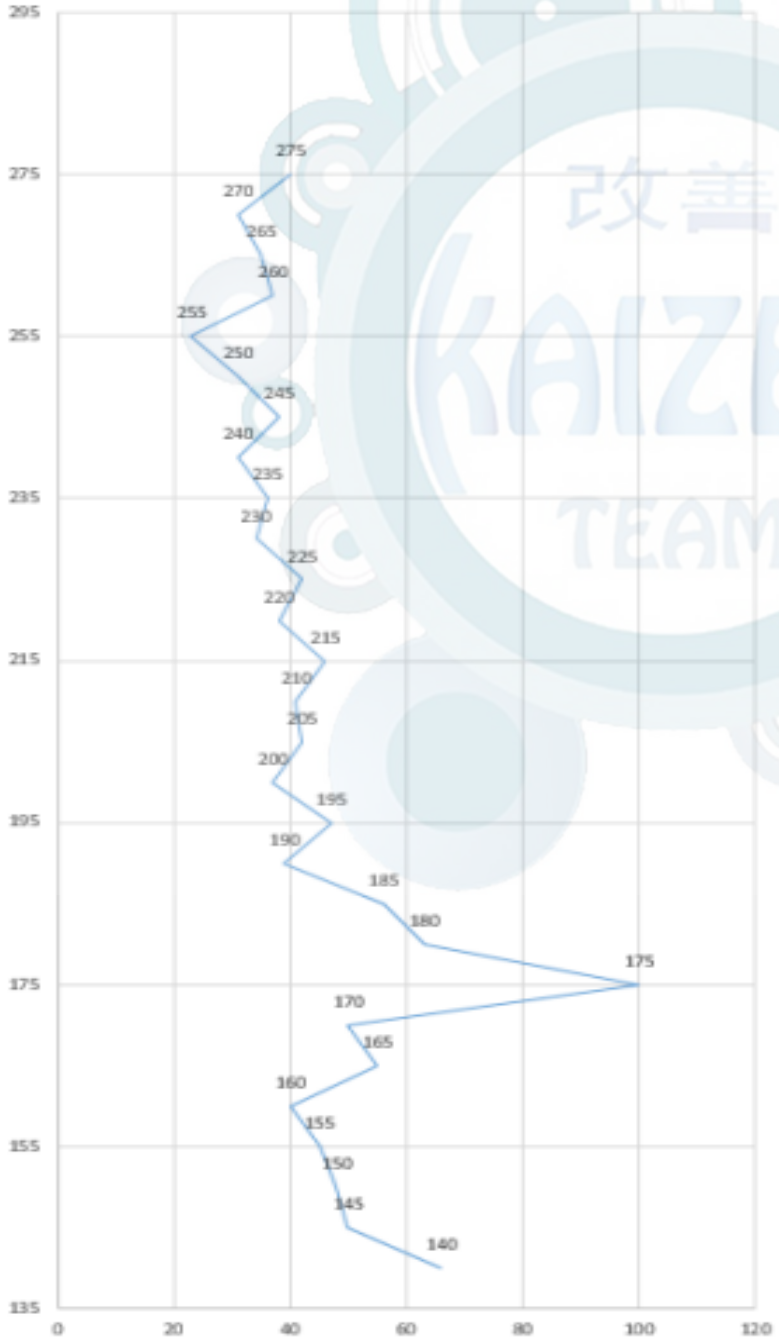
8)plot direct and inverse cooling curves & indicate the arrest points.

9)Construct the {Pb-Sn} phase diagram using the results of other groups.

# Results and discussion

Phase diagrams are useful to metallurgists for selection of alloys with a specific composition and design and control of heat treatment procedures that will produce specific properties in pb-Sn we have {4} cooling curves (different proportions of elements (0-100%).

cooling curve: is a type of graph used in chemistry, physics, engineering, and other disciplines to chart the progress of a cooling substance. One axis of graph, usually the ***x axis***, charts ***time***, while ***temperature*** is represented on the ***other axis***.




| Temperature © | Time (s) |
|---|---|
| 280 - 275 | 40 |
| 275 - 270 | 31 |
| 270 - 265 | 35 |
| 265 - 260 | 37 |
| 260 - 255 | 23 |
| 255 - 250 | 31 |
| 250 - 245 | 38 |
| 245 - 240 | 31 |
| 240 - 235 | 36 |
| 235 - 230 | 34 |
| 230 - 225 | 42 |
| 225 - 220 | 38 |
| 220 - 215 | 46 |
| 215 - 210 | 41 |
| 210 - 205 | 42 |
| 205 - 200 | 37 |
| 200 - 195 | 47 |
| 195 - 190 | 39 |
| 190 - 185 | 56 |
| 185 - 180 | 63 |
| 180 - 175 | 100 |
| 175 - 170 | 50 |
| 170 - 165 | 55 |
| 165 - 160 | 40 |
| 160 - 155 | 45 |
| 155 - 150 | 48 |
| 150 - 145 | 50 |
| 145 - 140 | 66 |

As such, a cooling curve generally ***slopes downward*** from ***left to right*** as the ***temperature decreases over time***.

So, we built the [inverse cooling curves] by the data we obtained during the cooling process of alloy, we did these steps until we got the inverse of cooling curve:

{Part one of the experiment}

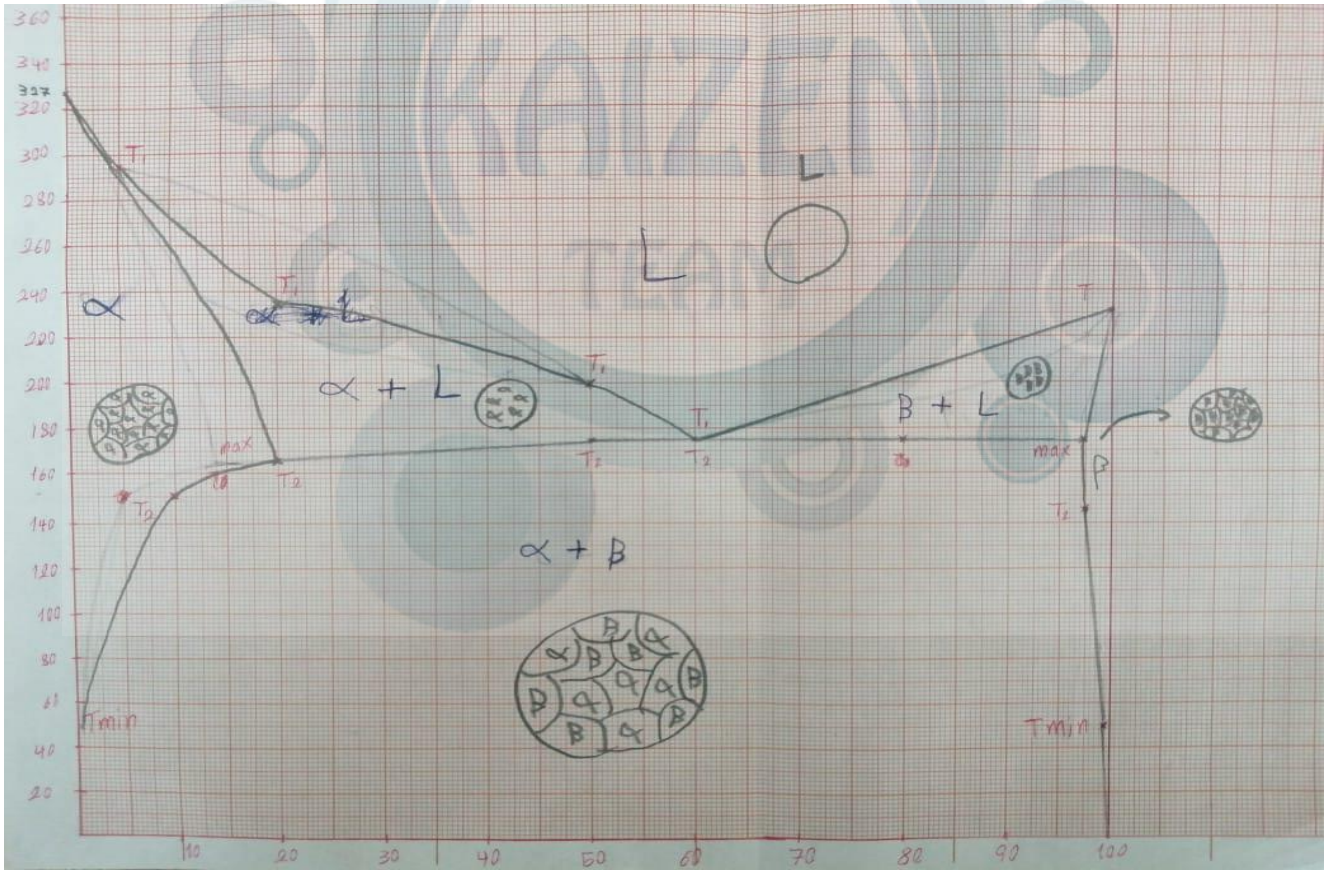
1.We received a sample of alloy that contains a composition of Pb and Sn (38% Pb) and (62% Sn).

2. We placed it on the stand and fixed the thermometer in the closed crucible by rings clamp.

3.We allowed the alloy to cool freely in a vacuum (at laboratory room temperature).

4.When the temperature of the thermometer reached to 230C we started to record the time in seconds it takes for the temperature to drop 5 degrees each time until the T (140C) is stabilized.

{Part two of this experiment}:




We construct the (Pb - Sn) phase diagram using the results that we obtained from cooling curve This table shows us the results we

obtained, we have the ratio of the composition Pb and Sn at the same time the temperature T1 AND T2.

| | Pb% | Sn% | T1 | T2 |
|---|---|---|---|---|
| 1 | 90 | 10 | 285 | 150 |
| 2 | 81 | 19 | 235 | 165 |
| 3 | 50 | 50 | 200 | 175 |
| 4 | 38.1 | 61.9 | 175 | 175 |
| 5 | 20 | 80 | 193 | 175 |
| 6 | 2.5 | 97.5 | 220 | 145 |

mixture of substances that either melts or solidifies at a particular given temperature that is lower than the melting point of any of the mixture of any of the constituent elements. (This temperature is known as the eutectic point)

1. Frist, we built two axes (the vertical axis shows the temperature in the two sided and between there we built horizontal axis shows us the ratios of Pb and Sn, where:

- Pb ratios ---------> decrease from left to right &
- Sn ratios ----------> decrease from right to left.

2. We selected the melting point of Pb and Sn (Pb= 327C , Sn=232C) on the diagram we built.

3. We selected the T1 and T2 with each ratio of Pb and Sn on the diagram as we see.

4. We marked the eutectic point on the diagram where it was the equilibrium point in diagram and the intersection of curve T1 and T2.

5. Selected the alpha and beta where:

##Alpha: Solid solution rich in Pb ... (Pb: solvent, Sn: solute)

**Max solubility of Sn in Pb ....19% Sn at 165C.

**Min solubility of Sn in Pb .....0.003 Sn at 50C.

## Beta: Solid solution rich is Sn ... (Pb: solute, Sn: solvent).

**Max solubility of Pb in Sn .... 2.5% Pb at 175C.

**Min solubility of Pb in Sn .... 0.02% Pb at 50C

6. We marked the max point and the min point for each other on the diagram.

7. T1 values connected to each other with the melting point of Pb and Sn and T2 values connected to each other with melting point of Pb and

Sn. Max and Min points of alpha connected with melting point of Pb in the one side and in the other with eutectic point, the same thing we did with points of beta but we connected there points with melting point of Sn, as we see.
Finally, we distributed the phases and we drew the structure of the composition as we see in the phase equilibrium diagram

# Conclusion

**In this experiment, the cooling curves are used to construct the phase diagram. The goal of creating this phase diagram is to show the alloy's phase at any given temperature, the composition of each phase, and the amount of each phase at that temperature and composition.**

# References


❖ **References**

- YouTube videos
- The manual
- Notes during the lab
- Wikipedia

❖ **Technology**

- Word