



University of
Nottingham

UK | CHINA | MALAYSIA

MMME2045

Teaching

Laboratory on

Lead-Tin Alloy

**Phase Diagrams, Thermal Analysis,
Cooling curves**

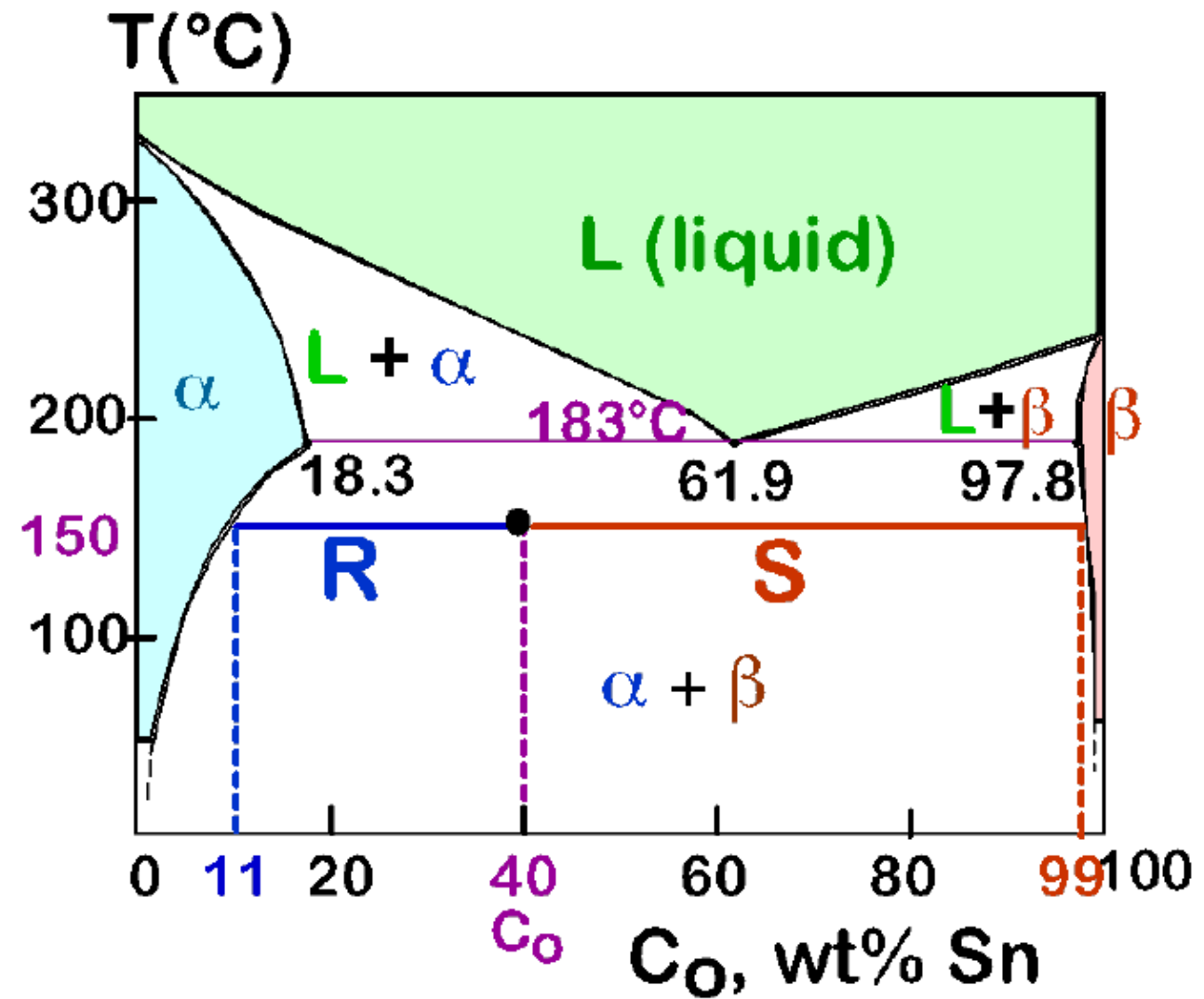
Sanliang Ling

Email: Sanliang.Ling@nottingham.ac.uk



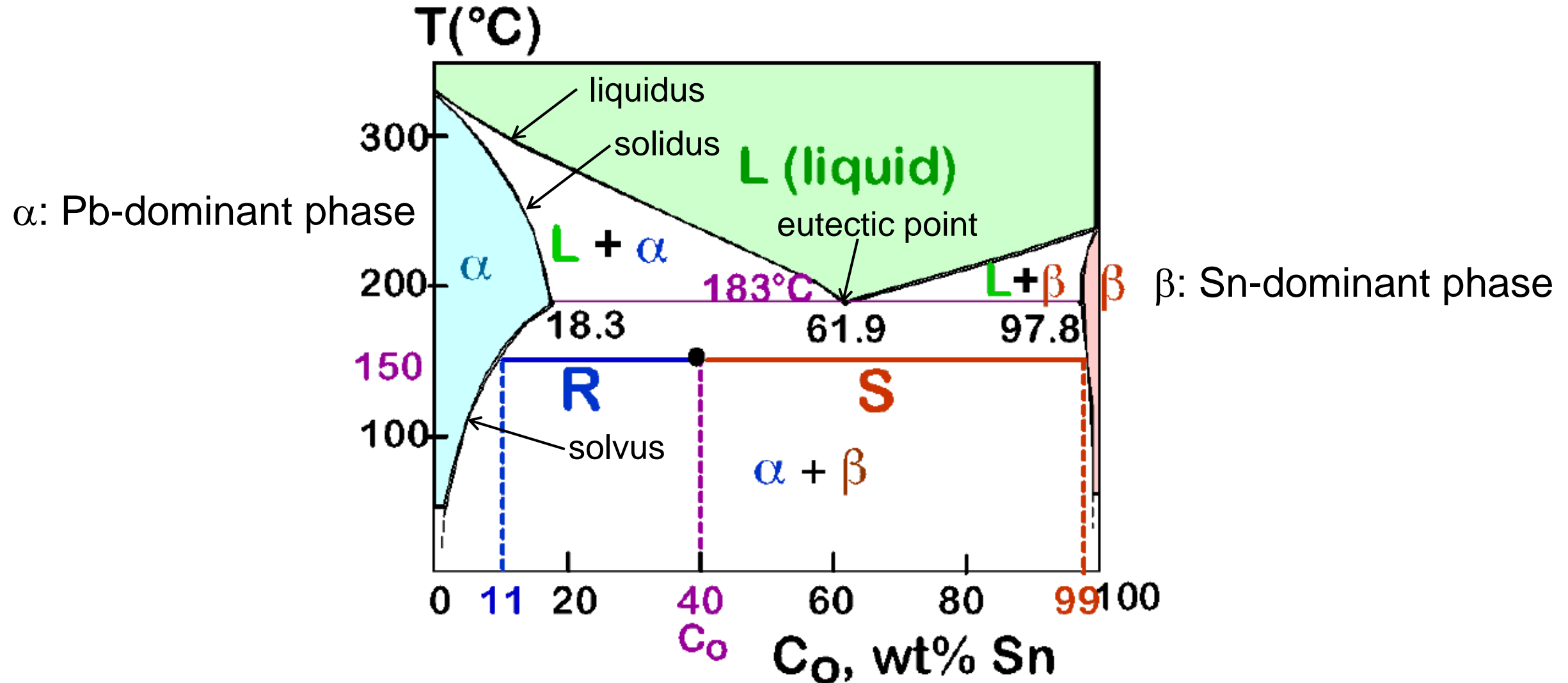
Lead-Tin Phase diagram

Pb-Sn system



Lead-Tin Phase diagram

Pb-Sn system





- Melting of Lead Tin Alloys
- Risks
 - Spills
 - Burns
 - Fire
 - Fume
- Loud Extract

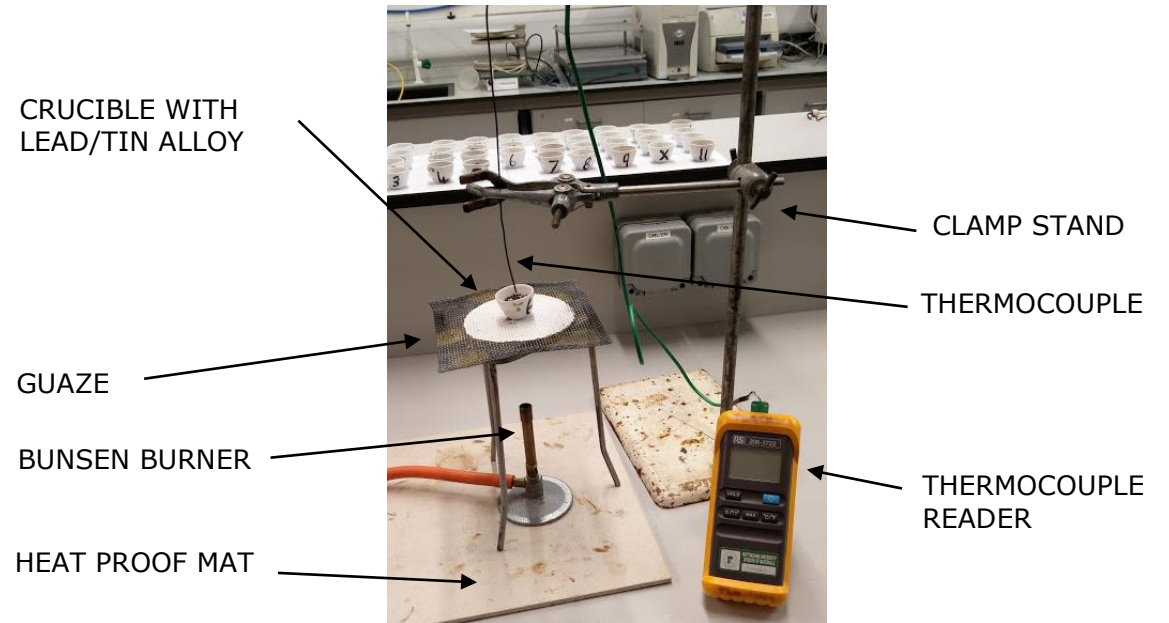
Table 1. The eleven compositions of lead-tin, Pb-Sn, to be explored with cooling curves for the class. The percentage is expressed as wt%

pure Pb	Pb - 10% Sn	Pb - 20% Sn
Pb - 30% Sn	Pb - 40% Sn	Pb - 50% Sn
Pb - 60% Sn	Pb - 70% Sn	Pb - 80% Sn
Pb - 90% Sn	Pure Sn	

(1) Heat the crucible, to 350°C;

(2) Natural cooling, record the temperature every 5 seconds;

(3) Until 150 °C;





You will need

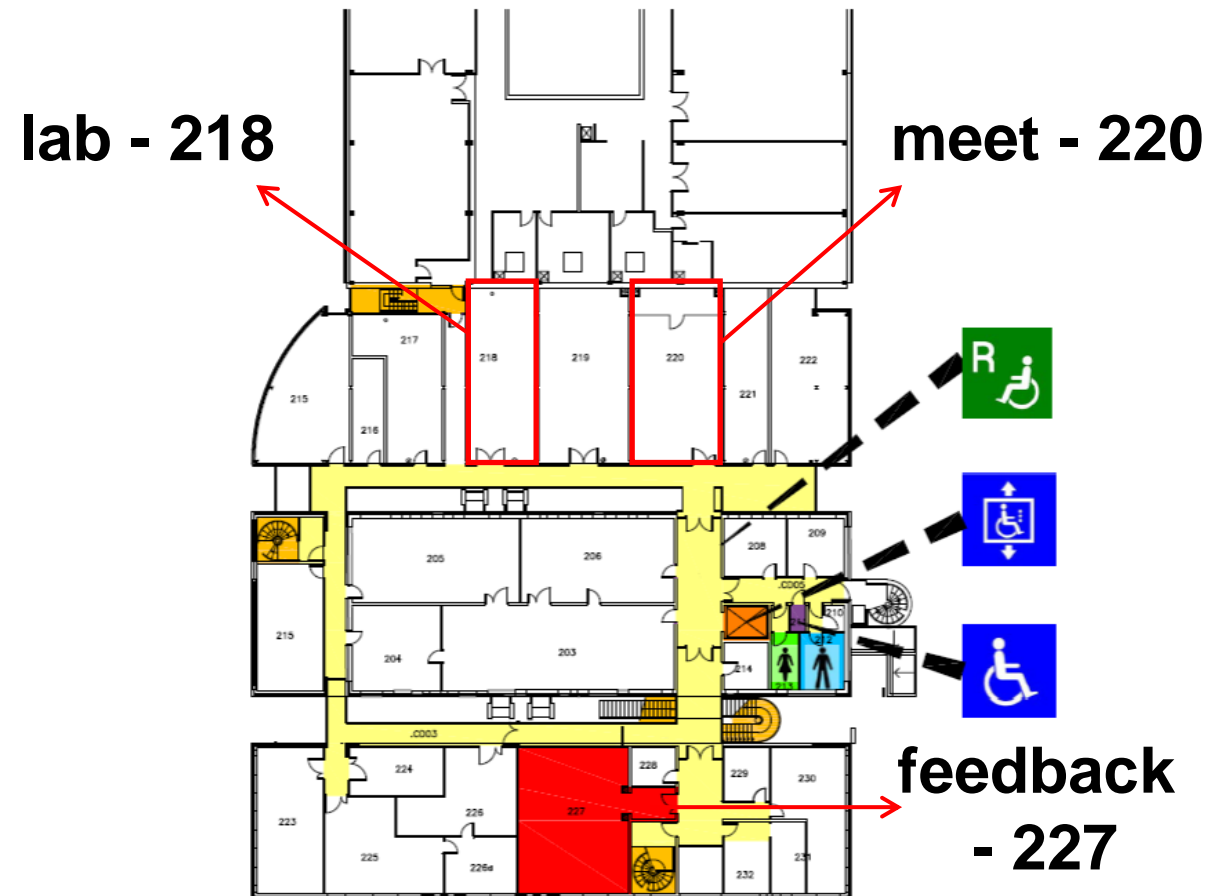
- Writing apparatus
 - Pen
 - Pencil, eraser
 - Ruler
- PPE – **MUST BE WORN AT ALL TIMES IN THE LAB**
 - Lab Coat
 - Safety Glasses
 - Safety Shoes
- Lab sheets



- Each lab session lasts for 1 hour and 30 minutes
- Lab sessions start at 09:00, 10:30, 13:00 and 14:30, respectively (be ready before your session starts, and don't be late!)
- 2~3 students per group
- Collect your data from the lab, make sure you're happy with the raw data before you leave the lab
- Complete the three lab tasks (see slide 15 for details), and bring your lab report to the feedback session in the week after
- Feedback sessions start at 09:15, 10:45, 13:15 and 14:45, respectively (don't be late!)

- check your personal timetable for time slots
- change to PPE and meet in Room 220 on arrival
- lab in Room 218 (PPE required)
- feedback in Room 227 (PPE not required in the feedback session)

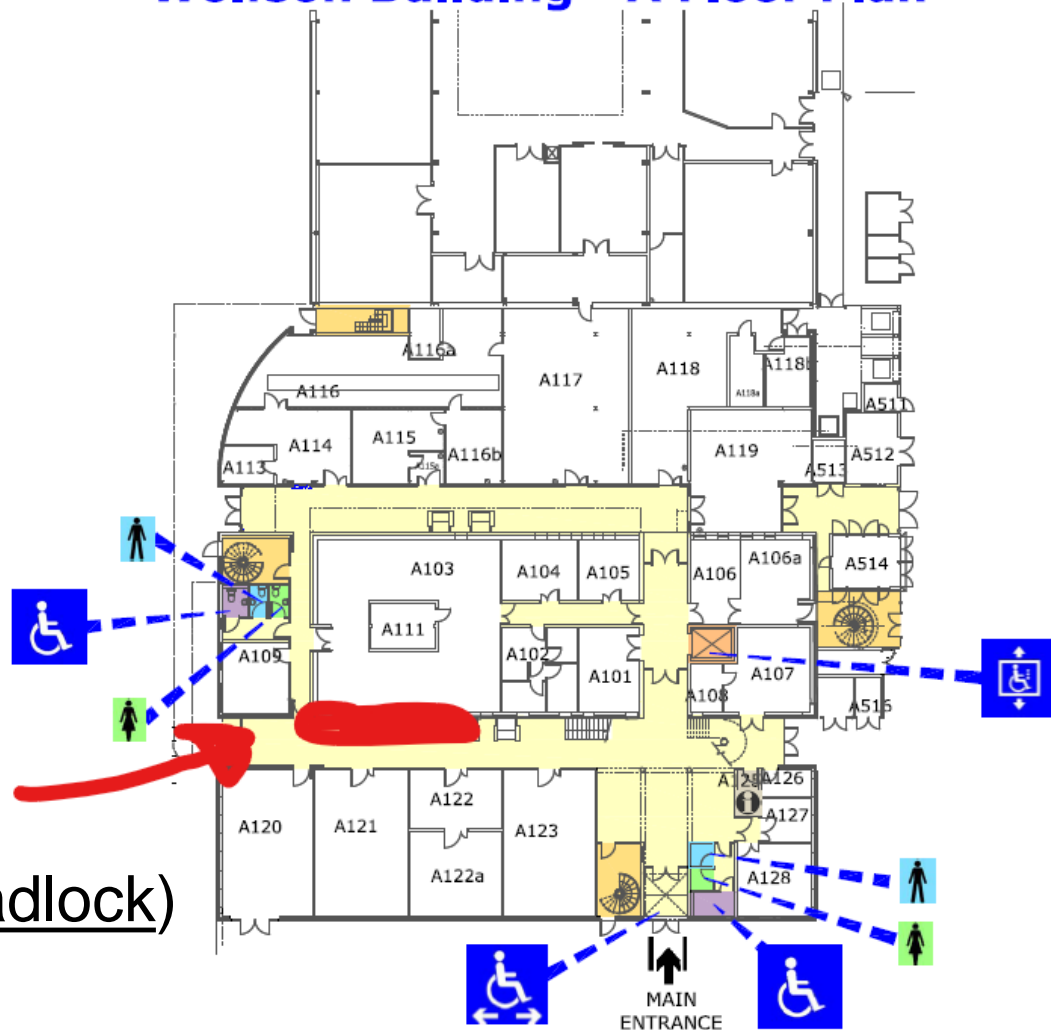
1421 Wolfson Building - B Floor Plan



You can leave your personal belongings either in Room 220 or in the lockers (in A floor)



Wolfson Building - A Floor Plan



lockers
(bring your own padlock)



- Offices and communal areas
 - Transport of good and apparatus
- Research and Teaching Activities
 - Mechanical
 - Electrical
 - Thermal
 - Chemical
 - Biological
 - Gases
 - Radiation
- **EVERYONE IS RESPONSIBLE FOR SAFE WORKING:** notes from HSE
 - Take care of your own health and safety and that of people who may be affected by what you do (or do not do)
 - Co-operate with others on health and safety, and not interfere with, or misuse, anything provided for your health, safety or welfare
 - Follow the training you have received when using any work items your employer has given you.



- Alarm Test
 - Wolfson - Thursday 8:15
- No fire drill is scheduled
- Follow the demonstrators and Exit via the nearest route
- Do not use lift in case of a fire
- Convene at assembly 8 for Wolfson

Wolfson Fire assembly point: **Point 8**

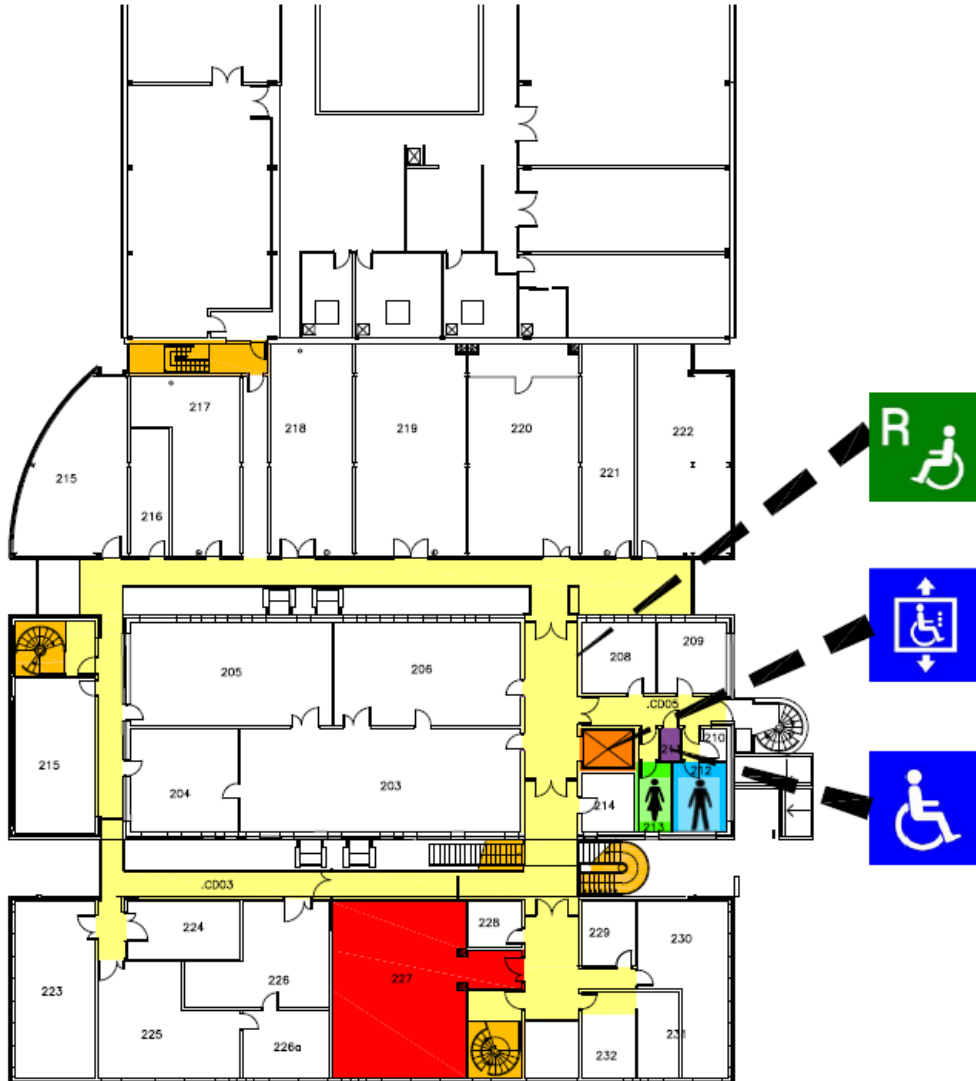
Located at the top end of L3

(L2 side of the L3 building)





1421 Wolfson Building - B Floor Plan



- Designated Badge-Holder Parking
- Access Ramp
- Automatic Doors
- Accessible Lift

- Entrance
- Accessible Entrance
- Evacuation Chair
- Emergency Refuge

- Toilet (Female / Male)
- } Accessible Toilet
- Reception

- Refectory/Cafe
- Central Timetabled Room
- Circulation
- Lift
- Fire Assembly Point

September 2017
Estate Office

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- PPE
 - Safety Glasses
 - Lab Coat
 - Safety Shoes
 - Hair tied back, no loose items
 - Long Trousers
- No Headphones in lab areas
- No food or drink in lab areas



- To plot **cooling curve** of a sample randomly assigned to you (you will need to run the experiment and record the temperature/time data)
- To re-create the **phase diagram** using the data of all the 11 samples provided to you (see slide 19)
- Sketch the **microstructure** you may expect to see if you looked down a microscope for each of the 11 compositions at room temperature assuming they had all been equilibrium cooled from the melt
- The above 3 tasks are individual work, not group activities.



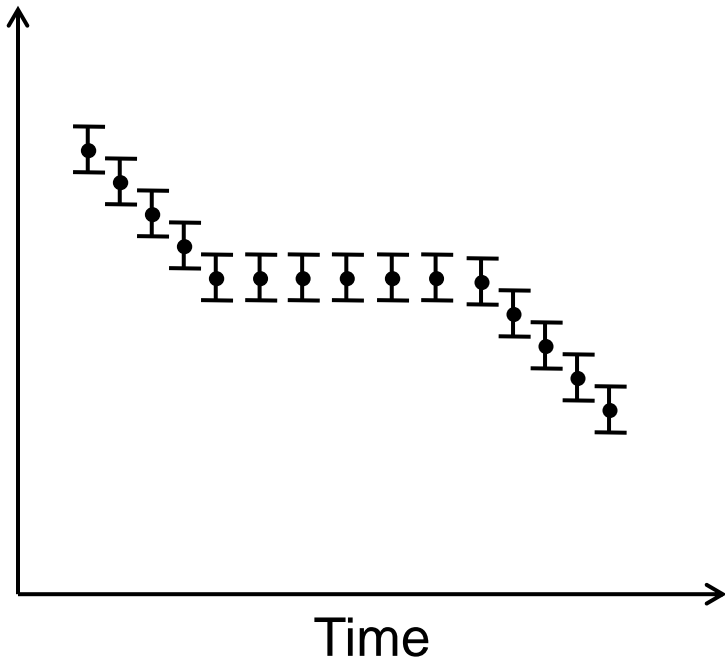
- Feedbacks will be provided to you (in small groups) in the week after.
- You must attend both the lab and feedback sessions.
- Completion of the three tasks will help you to improve your understanding of phase diagrams.
- **Assessment** of the laboratory will take the form of questions included in the 3rd ROGO test which must be taken along with questions on Block C.
- **If you miss either the lab or the feedback session without an approved EC, you will get 0 mark in the 5 questions on phase diagram in ROGO #3.**
- Timetable is managed by the Student Services. If you need to re-arrange either of your lab or feedback session, you should consider submitting an EC application.



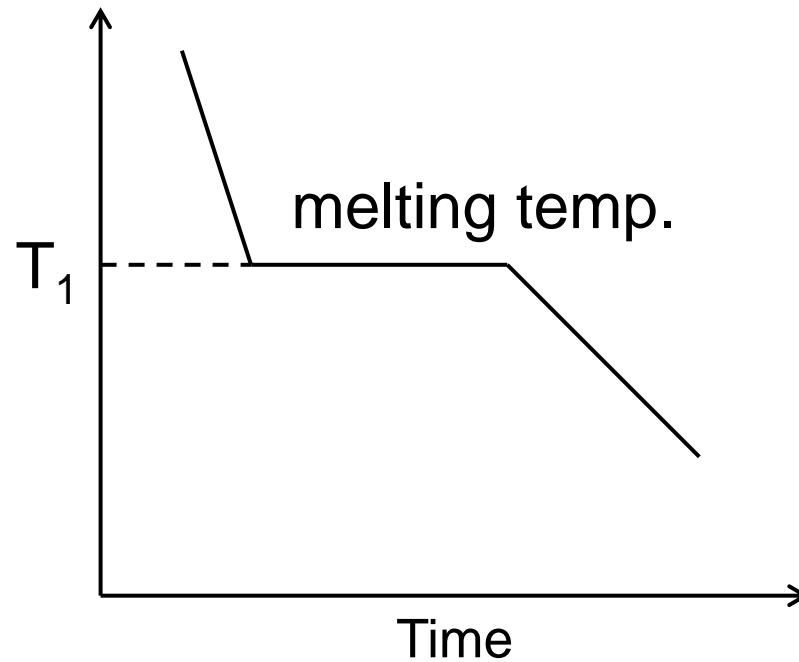
- All graphs should be **neat** and **tidy**
- Plotting can be done manually (on coordinate worksheet) or electronically (e.g. using Excel)
- Remember to label your drawings: axes, symbols, units, error bars, sample number, sample composition, date, author, etc

Cooling curve

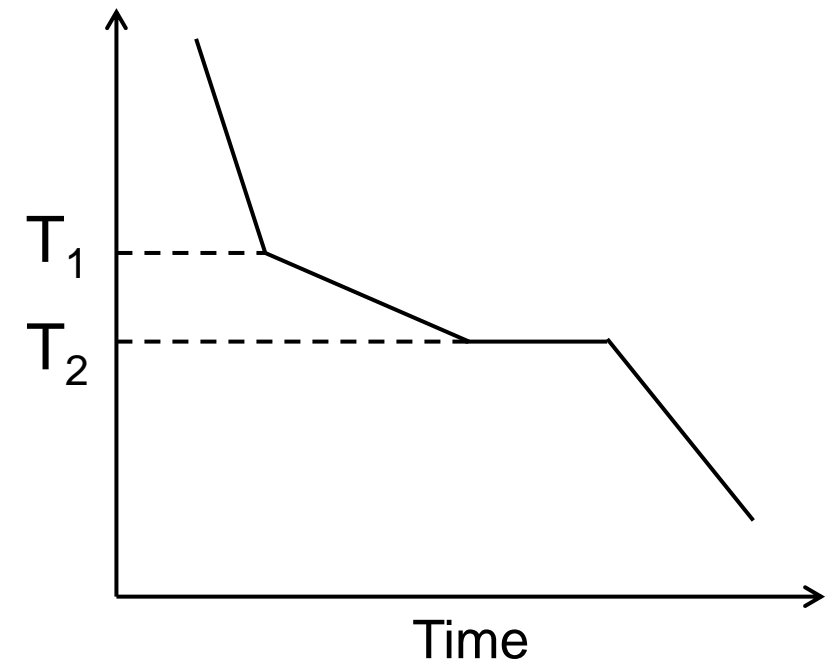
Temperature



Temperature



Temperature



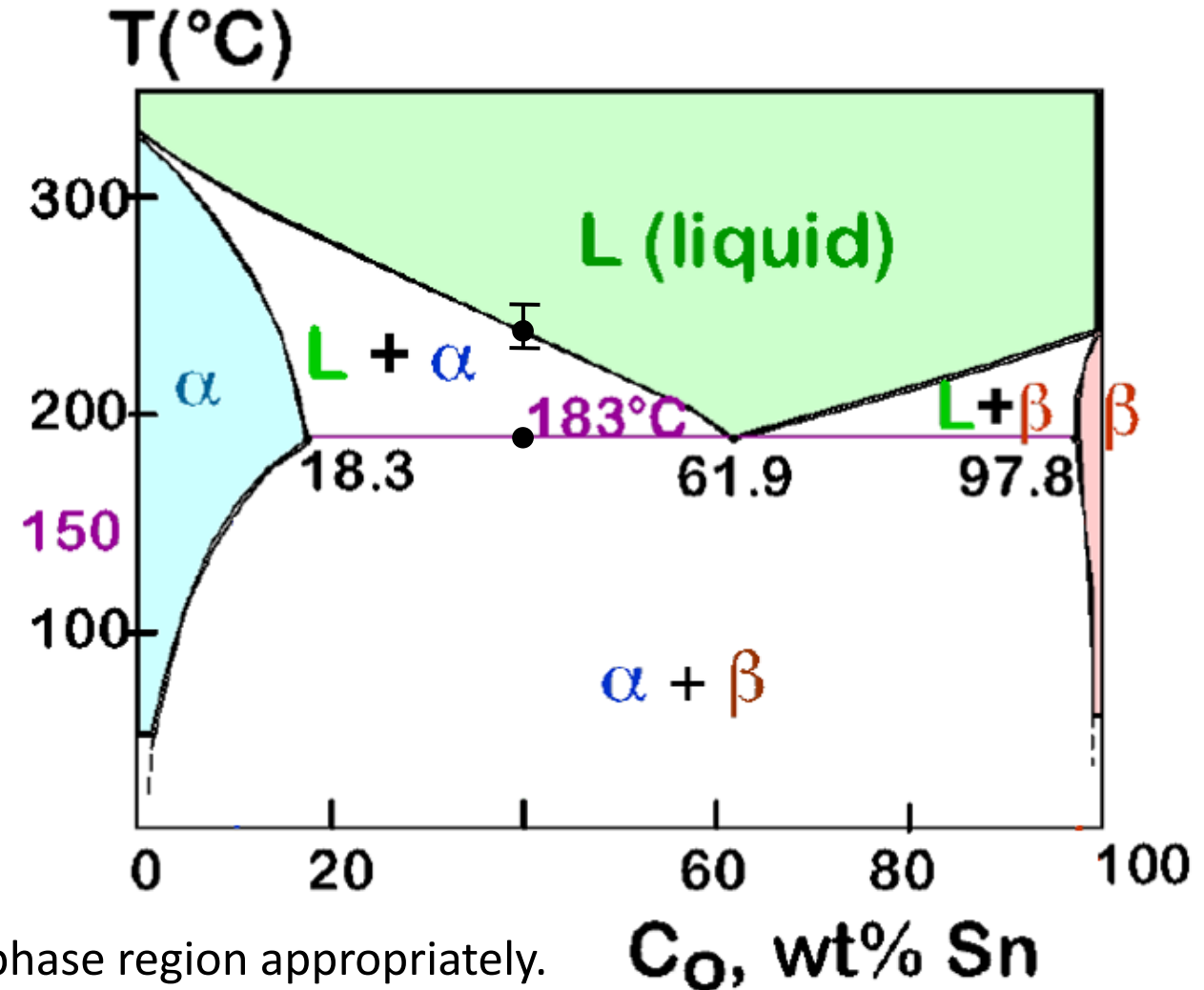
The main error in this experiment is the measurement of temperature, and we assume the error bar for temperature is $\pm 3\text{ }^\circ\text{C}$



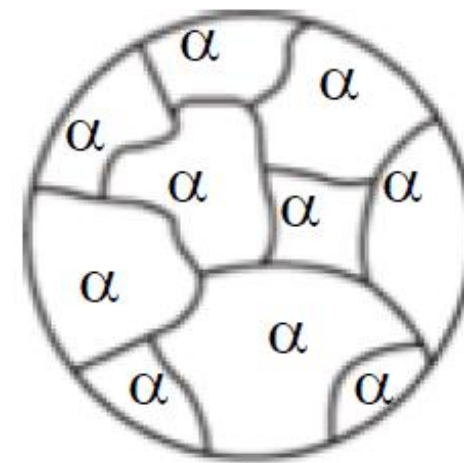
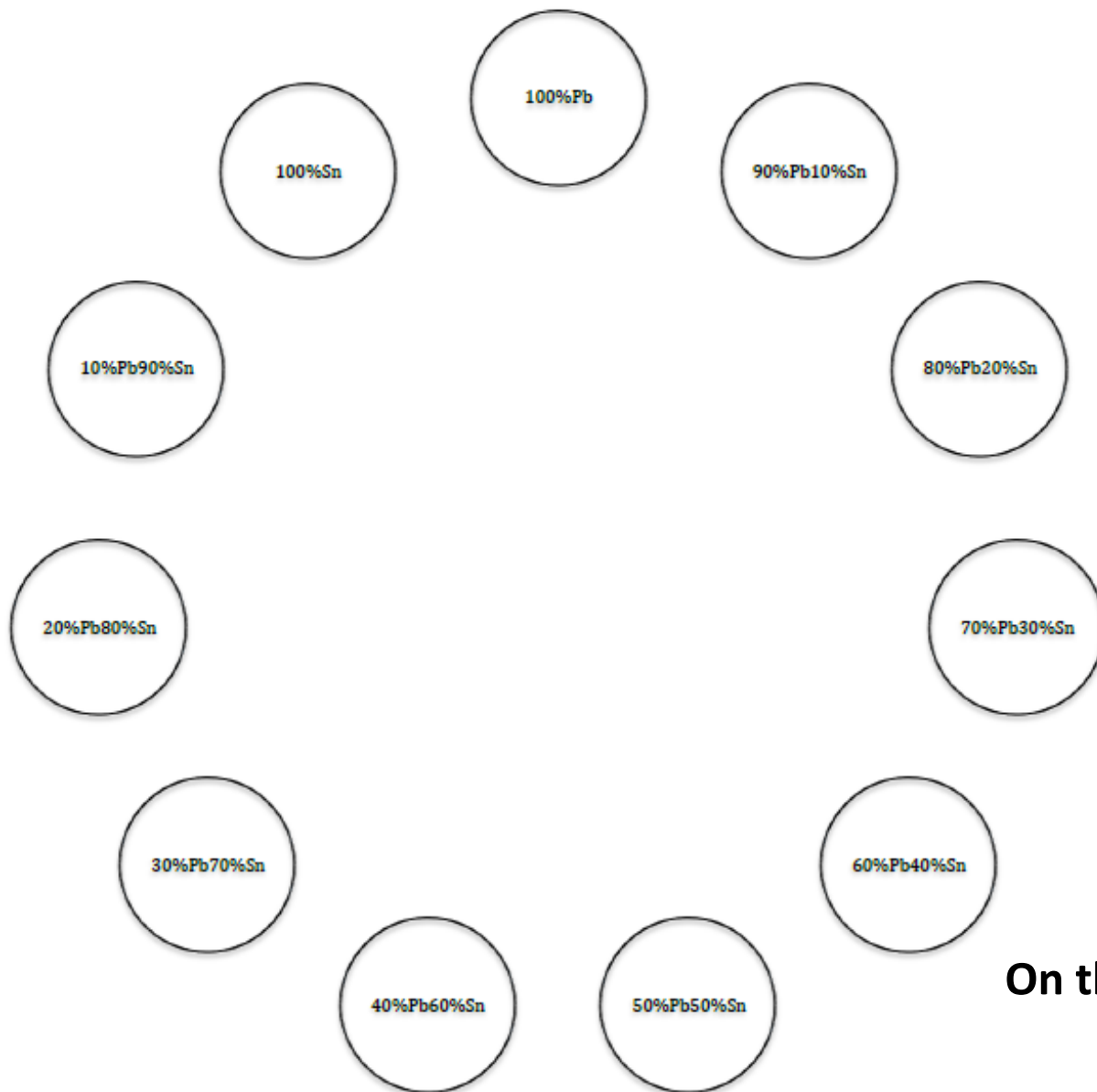
Pb-Sn Phase Diagram

Sample No.	%Pb	%Sn	Temp1 / °C	Temp2 / °C
1	100	0	327	-
2	90	10	296	288
3	80	20	275	184
4	70	30	254	183
5	60	40	235	183
6	50	50	213	183
7	40	60	-	183
8	30	70	188	183
9	20	80	203	183
10	10	90	216	183
11	0	100	232	-

Pb-Sn system



On your phase diagram, please label the single and two phase region appropriately.
Please also label the **three critical compositions**.



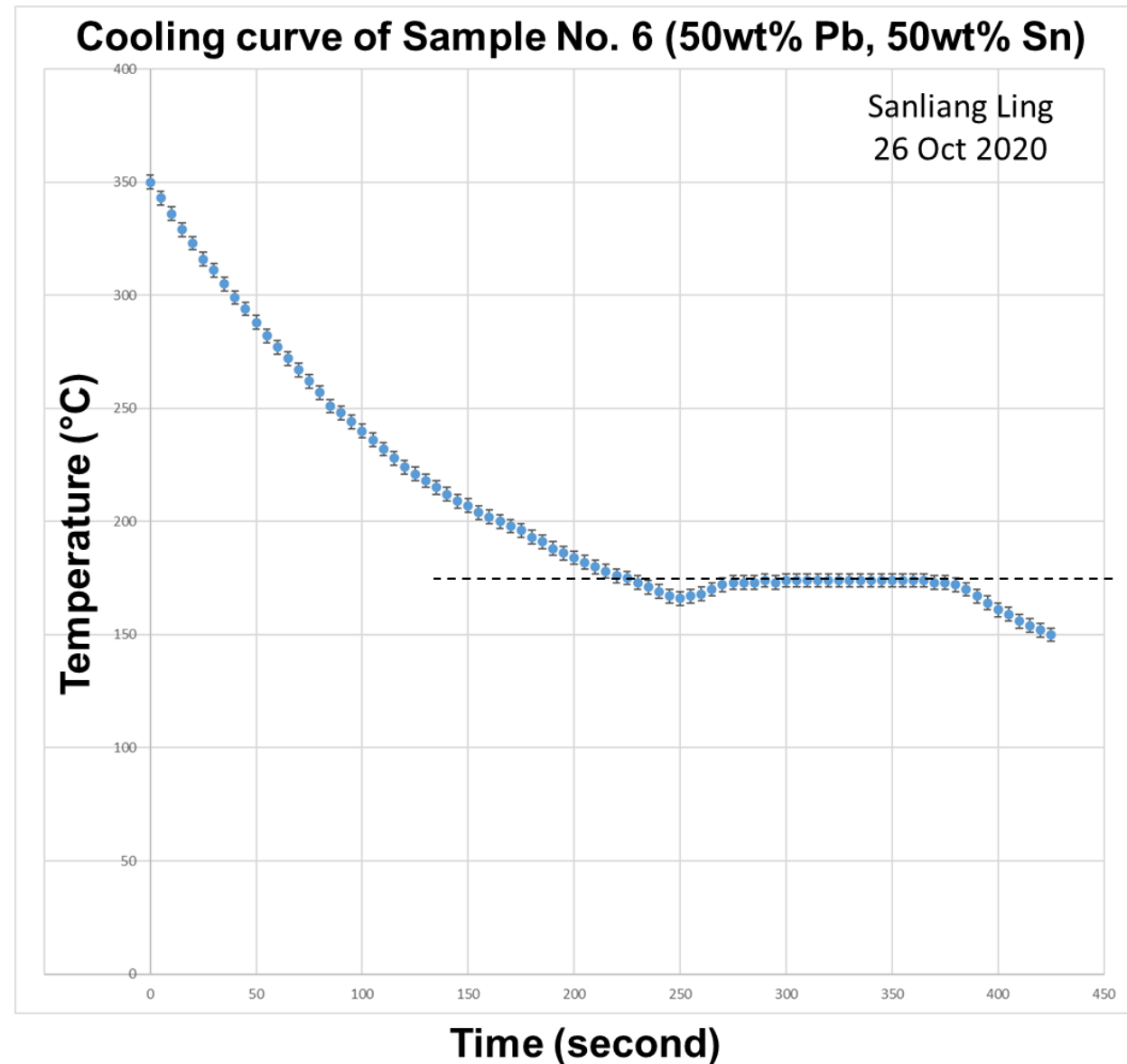
Example of 100% Pb

On the microstructures, please label different phases (e.g. primary α/β or eutectic α/β)



Cooling Curve

- To plot **cooling curve** of a sample randomly assigned to you (you will need to extract the temperature/time data from the video by yourself)





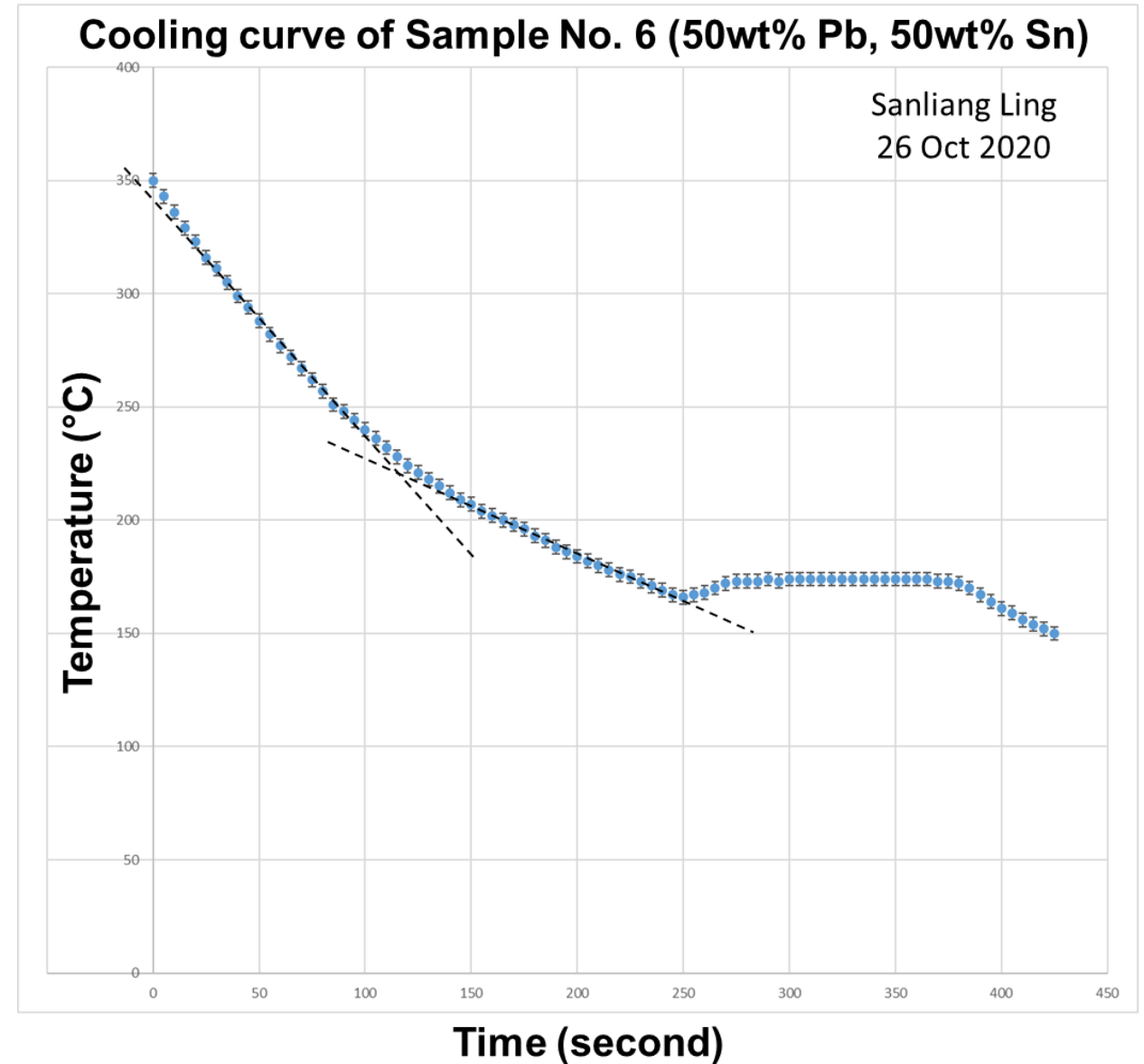
Cooling Curve

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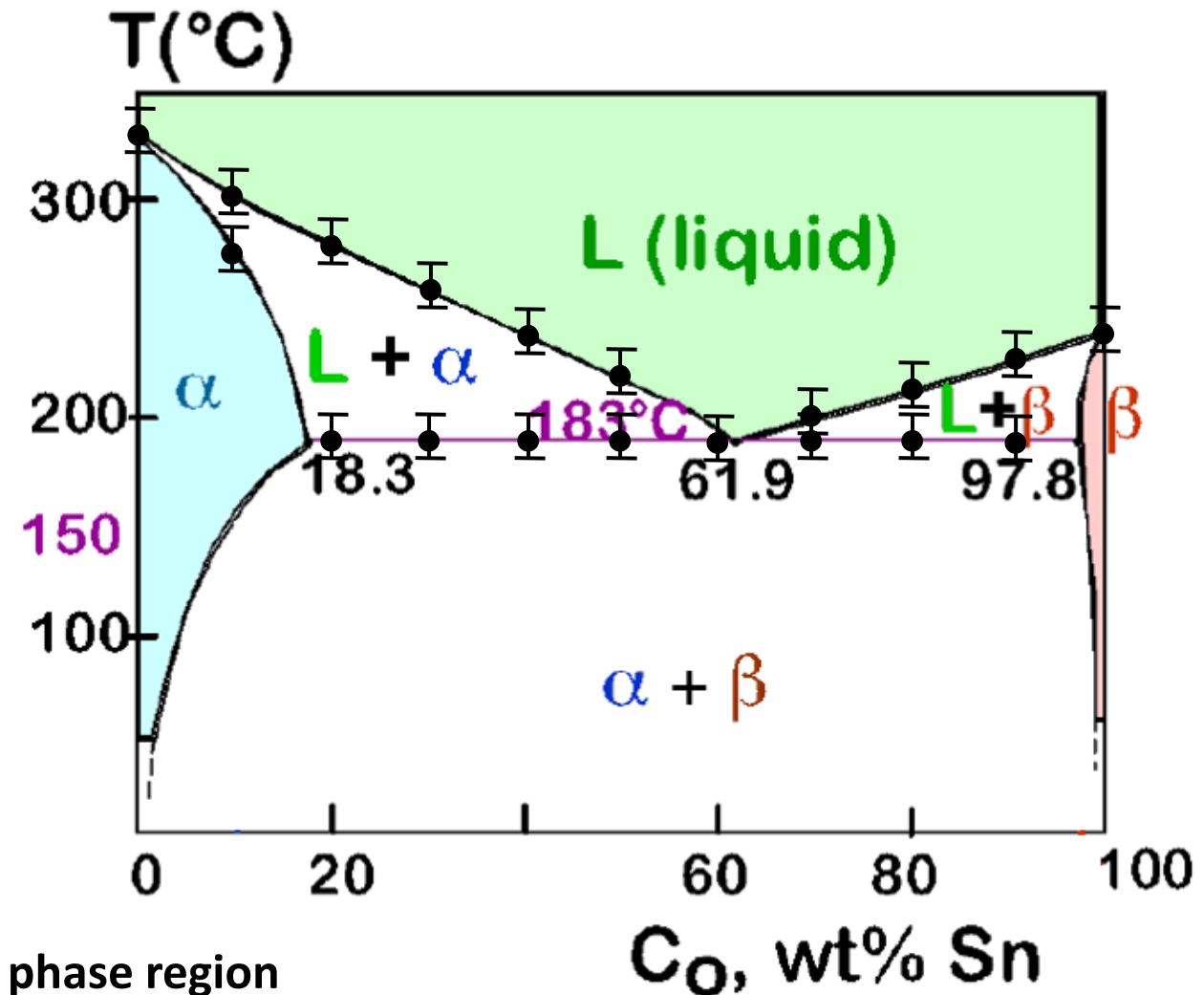


Pb-Sn Phase Diagram

- To create the **phase diagram** using the data of all the 11 samples provided to you

Sample No.	%Pb	%Sn	Temp1 / °C	Temp2 / °C
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6	50	50	213	183
7	40	60	-	183
8	30	70	188	183
9	20	80	203	183
10	10	90	216	183
11	0	100	232	-

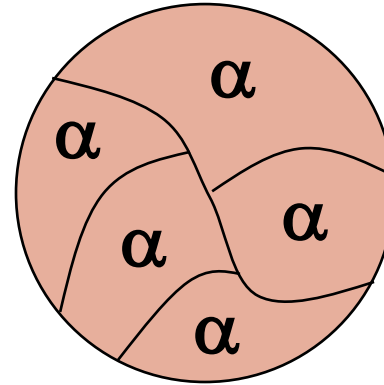
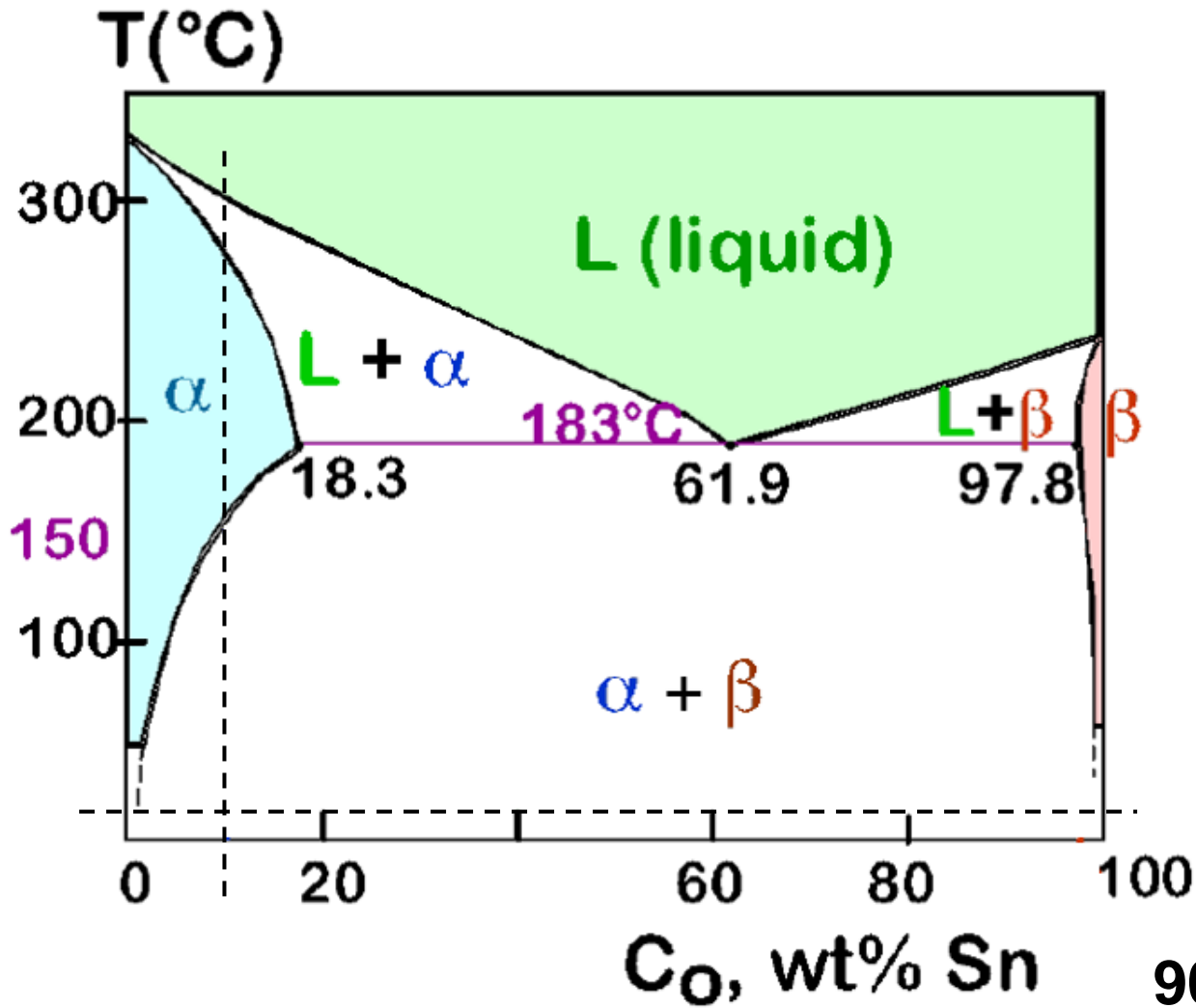
Pb-Sn system



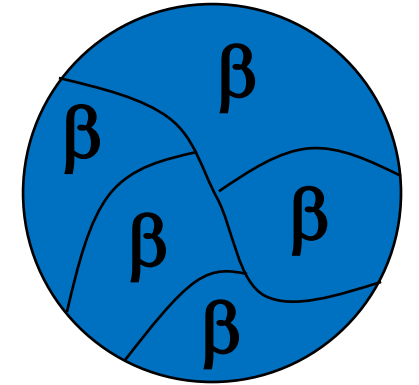
On your phase diagram, please label the single and two phase region appropriately. Please also label the three critical compositions.

Development of microstructure in eutectic alloys

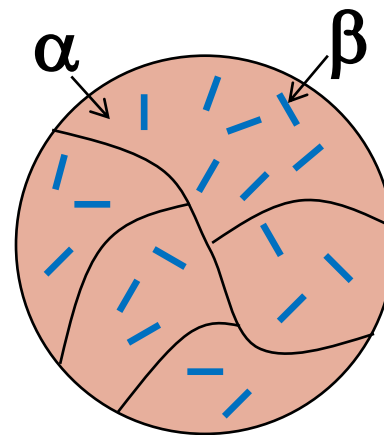
Pb-Sn system



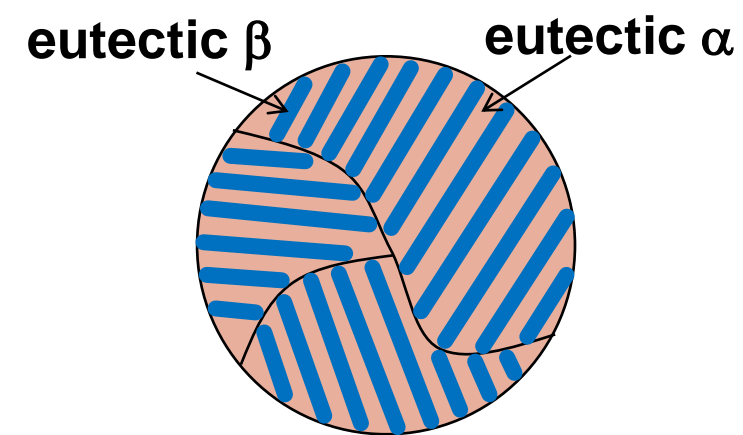
100wt%Pb



100wt%Sn

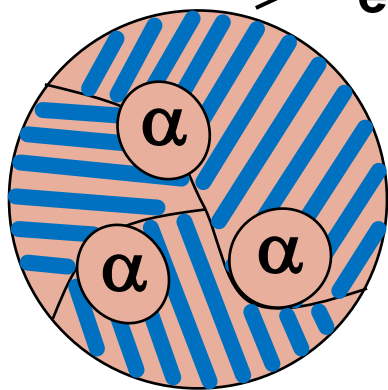
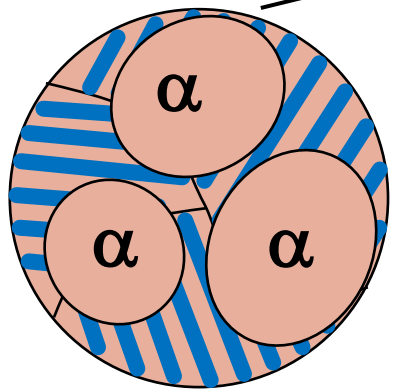
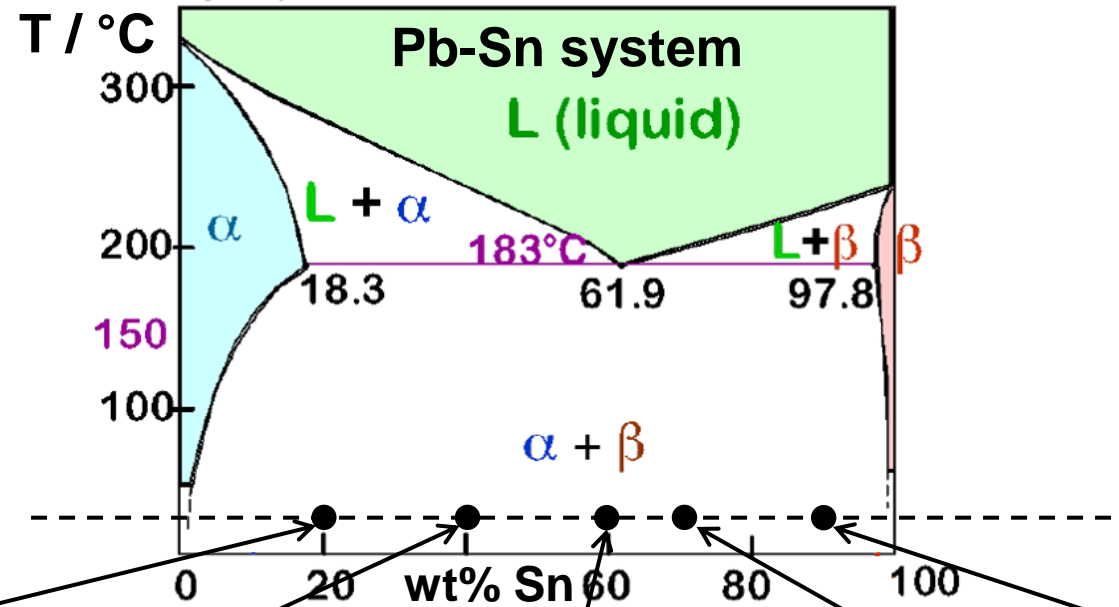


90wt%Pb+10wt%Sn

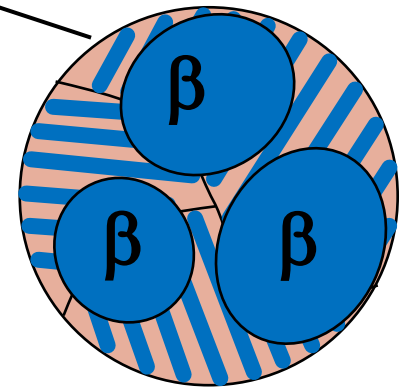
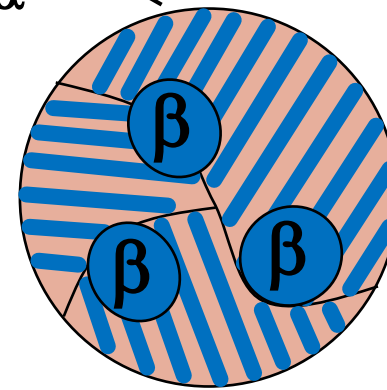
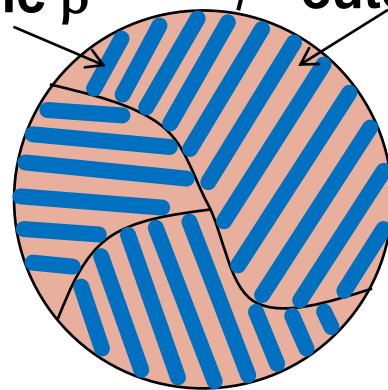


40wt%Pb+60wt%Sn

Development of microstructure in eutectic alloys

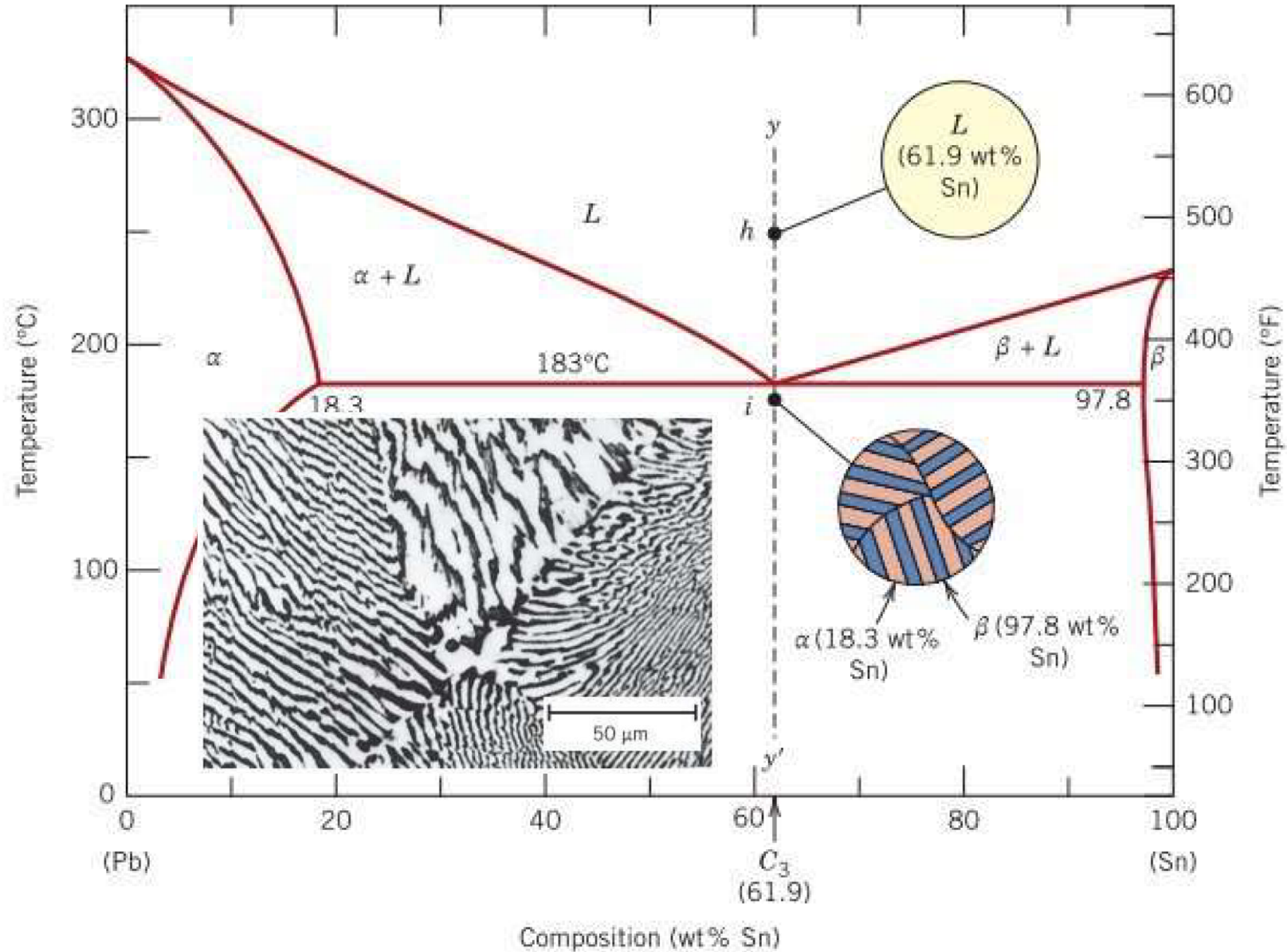
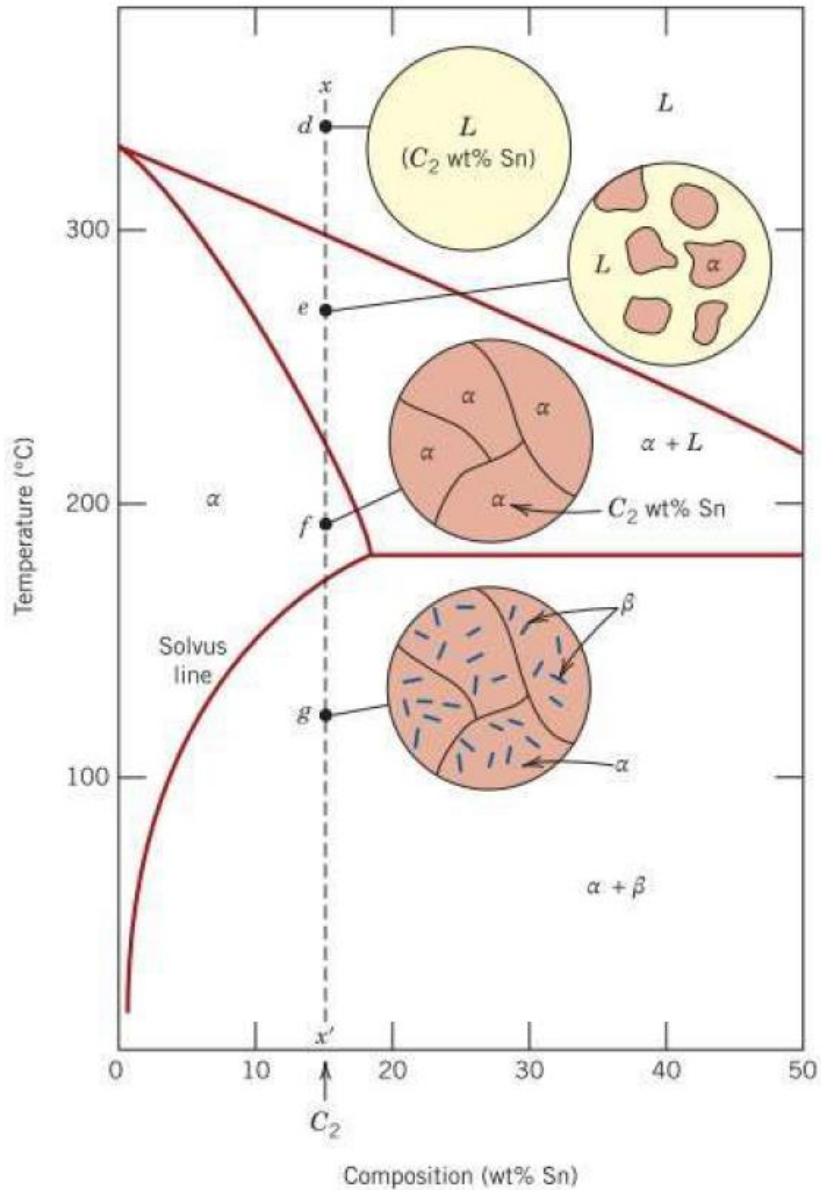


eutectic β eutectic α





Development of microstructure in eutectic alloys



Development of microstructure in eutectic alloys

