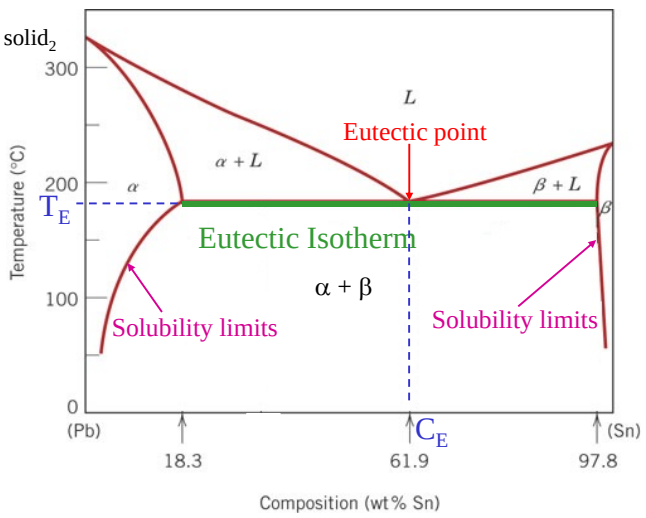
## Outline

- Eutectic phase diagram
  - *microstructure*
  - *composition of phases*
  - *relative amounts*
- Construction of phase diagram
  - *example*



## Eutectic Phase Diagram

Eutectic reaction:
Liquid → $solid_1$ + $solid_2$





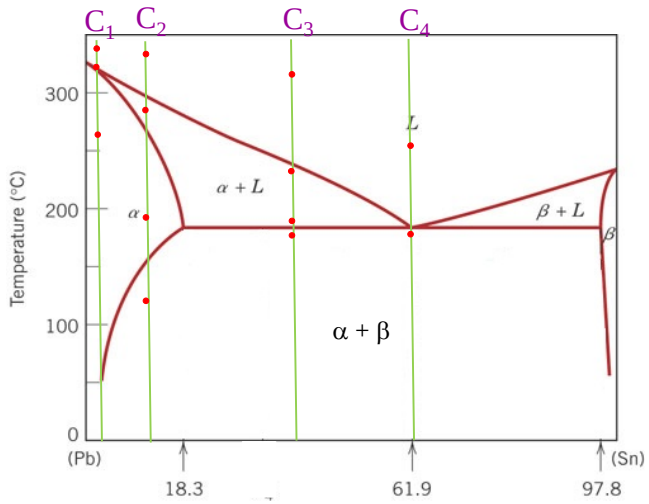

## What Information can we read from a phase diagram?

1) The phases that are present
2) Compositions of the phases
3) The relative amounts of the phases

➢ *Compositions and relative amounts of phases are determined from the same tie lines and lever rule, as for* ***isomorphous*** *phase diagram*



## *Development of microstructure*



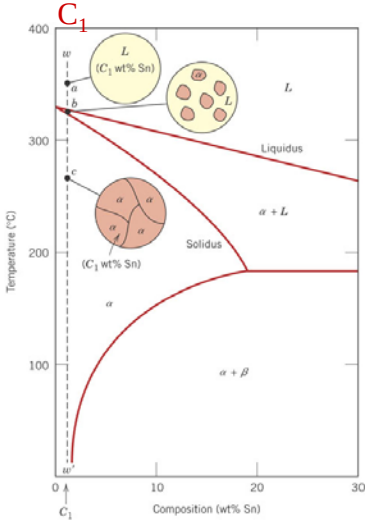

Lead-Tin Binary Phase Diagram

• *Schematic Representations of the* ***equilibrium microstructures*** *for lead–tin alloys as they are cooled from the liquid-phase region.*

## Lead-Tin Binary Phase Diagram

$L \rightarrow \alpha + L \rightarrow \alpha$

$C_1$

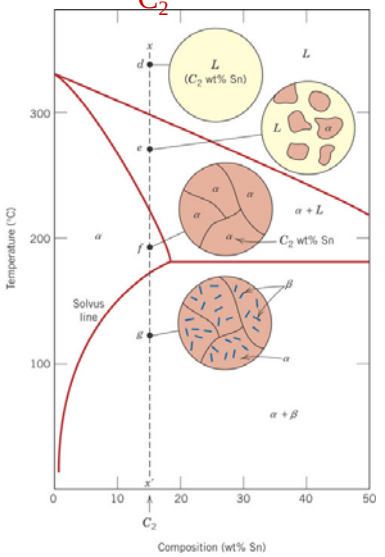





## Lead-Tin Binary Phase Diagram

$L \Downarrow \alpha + L \Downarrow \alpha \Downarrow \alpha + \beta$

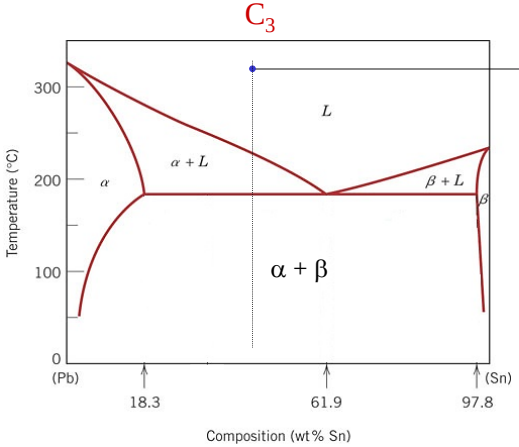
$C_2$

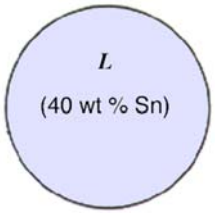





## Lead-Tin Binary Phase Diagram

$C_3$

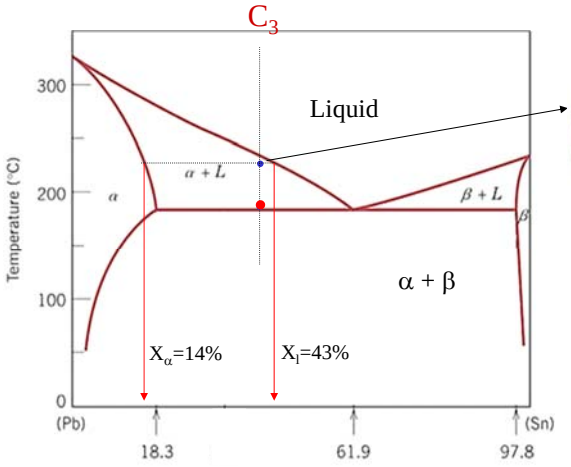


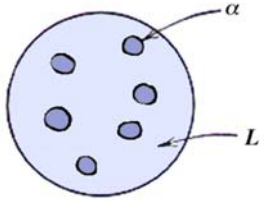






## Lead-Tin Binary Phase Diagram

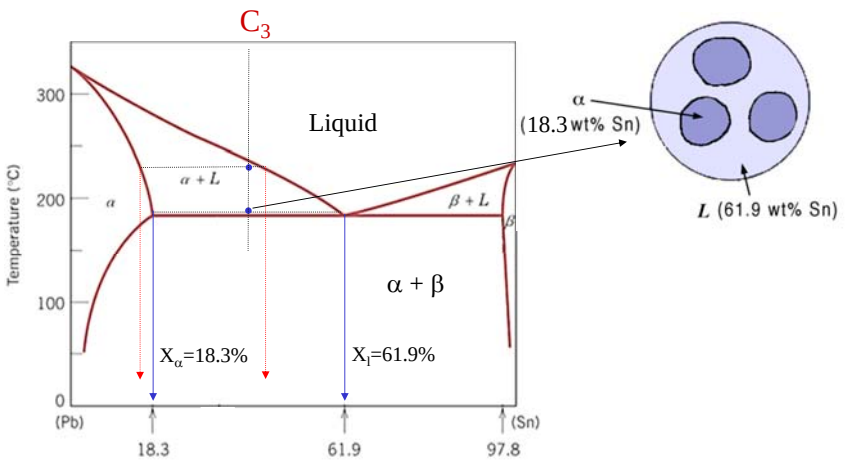
$C_3$




Liquid composition is: 43 wt% Sn
α composition is: 14 wt% Sn

## Lead-Tin Binary Phase Diagram

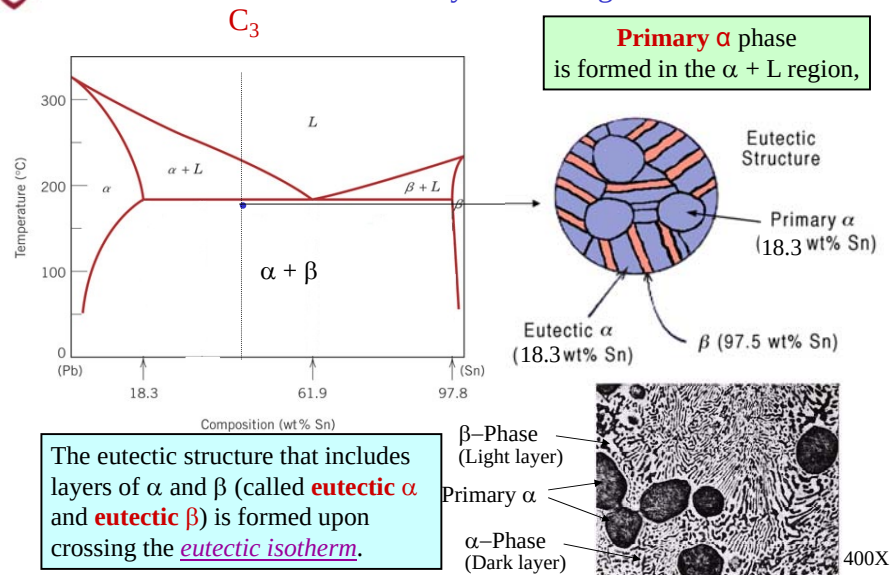



Liquid composition is: 61.9 wt% Sn

α composition is: 18.3 wt% Sn



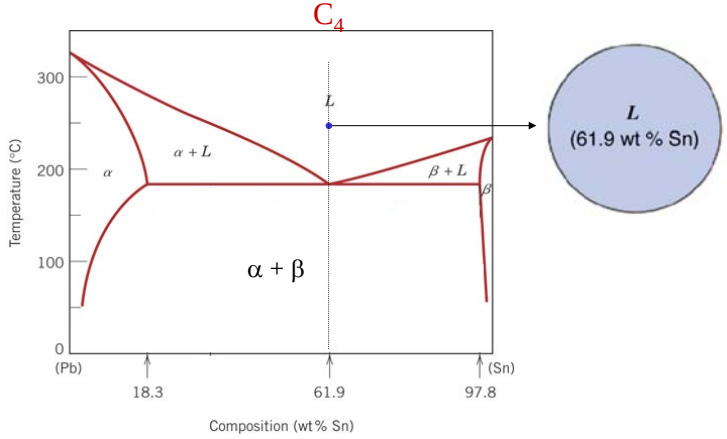
## Lead-Tin Binary Phase Diagram




The eutectic structure that includes layers of α and β (called **eutectic** α and **eutectic** β) is formed upon crossing the *eutectic isotherm*.

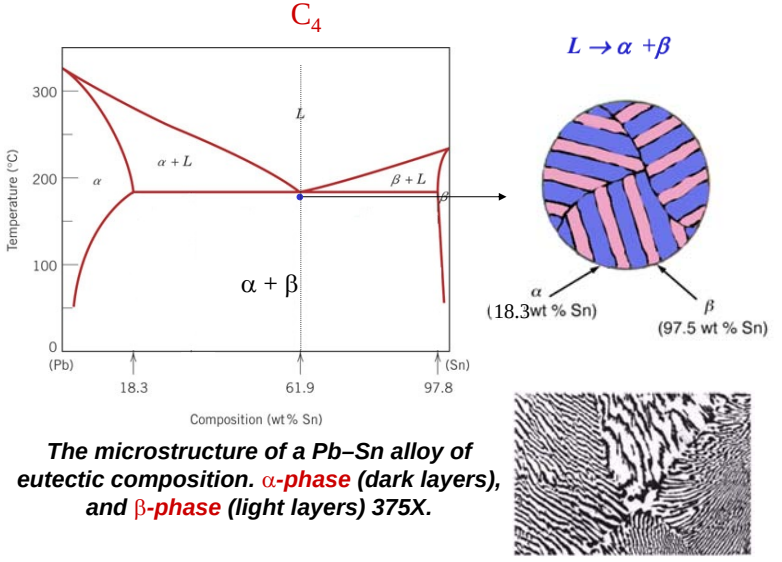


## Lead-Tin Binary Phase Diagram



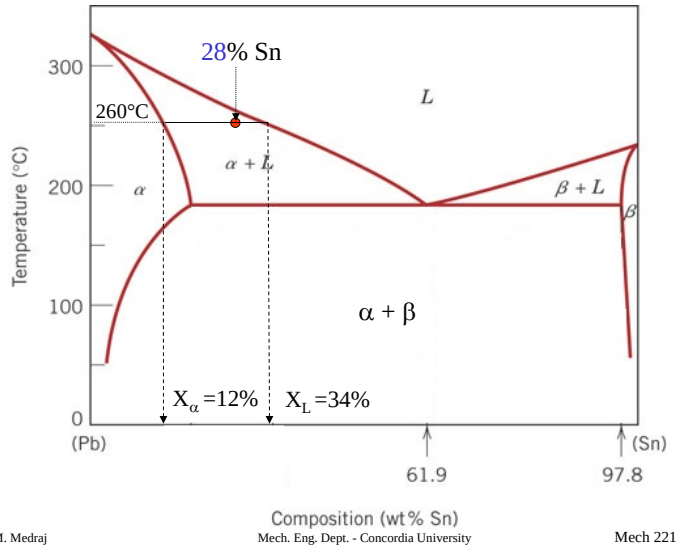



## Lead-Tin Binary Phase Diagram




***The microstructure of a Pb–Sn alloy of eutectic composition. α-phase (dark layers), and β-phase (light layers) 375X.***

***How much*** of each phase exists at the given temperature?

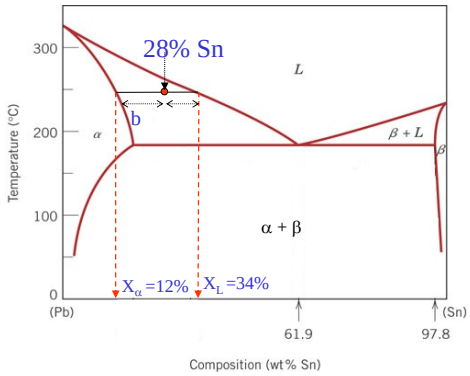





## Lever Rule

$$Fraction\ of\ \alpha = \frac{a}{a+b}$$

$$Fraction\ of\ liquid = \frac{b}{a+b}$$




$$\text{wt\% of } \alpha = \frac{34-28}{34-12}\times 100\% = 27.27\%$$

$$\text{wt\% of liquid} = 100 - 27.27 = 72.73\%$$



## How to calculate the total amount of α phase?

Question:

At $T_1$, just below the eutectic temperature, find the total amount of α phase (*both eutectic and primary*) in alloy C?

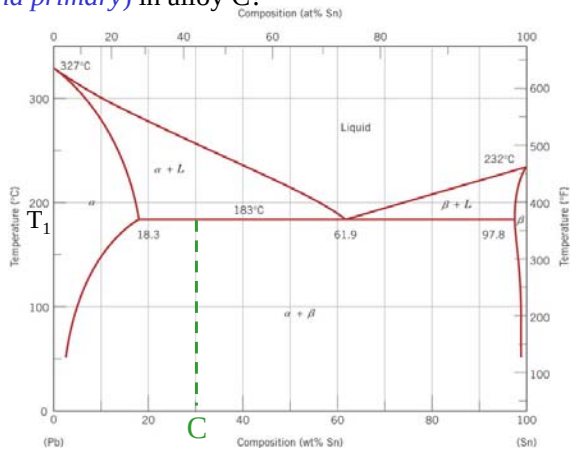
$$W_\alpha = \frac{Q}{Q+P}$$

$$= \frac{97.8-30}{97.8-18.3}\times 100\%$$

$$= \ldots\ldots\ wt\%$$

$$W_\beta = 100 - 85.3$$

$$= \ldots\ldots\ wt\%$$






## How to calculate relative amounts of microconstituents?

Question:

For alloy C, find the weight percentage of (1) primary α (2) eutectic phase and (3) eutectic α, at $T_1$ (just below the eutectic temperature)?

$$W_\alpha = \frac{Q}{Q+R}$$

$$= \frac{61.9-30}{61.9-18.3}\times 100\%$$

$$= \ldots\ldots\ wt\%\ \text{Primary } \alpha$$

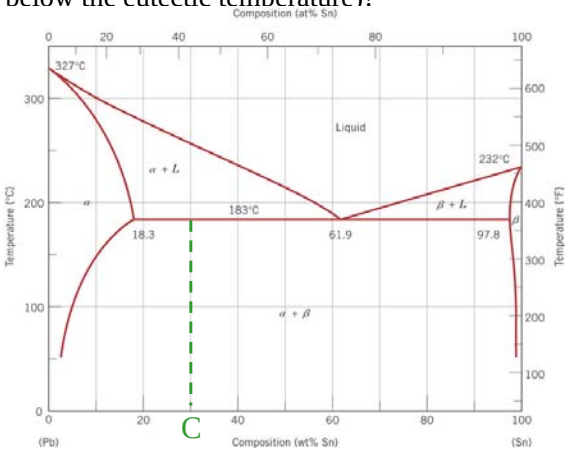
$$W_e = 100 - 73.2$$

$$= \ldots\ldots\ wt\%\ \text{Eutectic phase}$$

$W_{\alpha'}$ = total α – primary α

= 85.3 – 73.2

= …… *wt%* Eutectic α



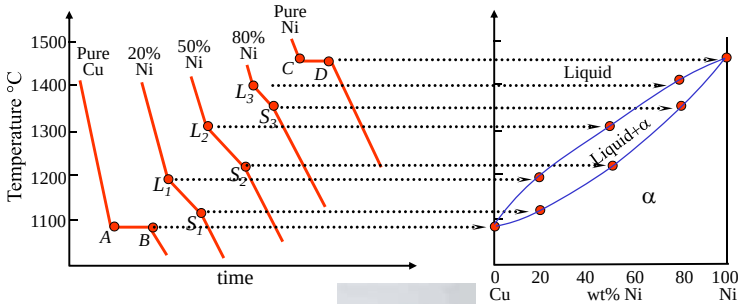
## Construction of Phase Diagram

**The data for the construction of equilibrium diagrams are determined experimentally by a variety of methods, the most common methods are:**

- **Metallographic Methods**
- **Diffraction Techniques**
- **Thermal Analysis**



## *How to construct a phase diagram using cooling curves*






Next time:

Phase diagrams with intermediate compounds