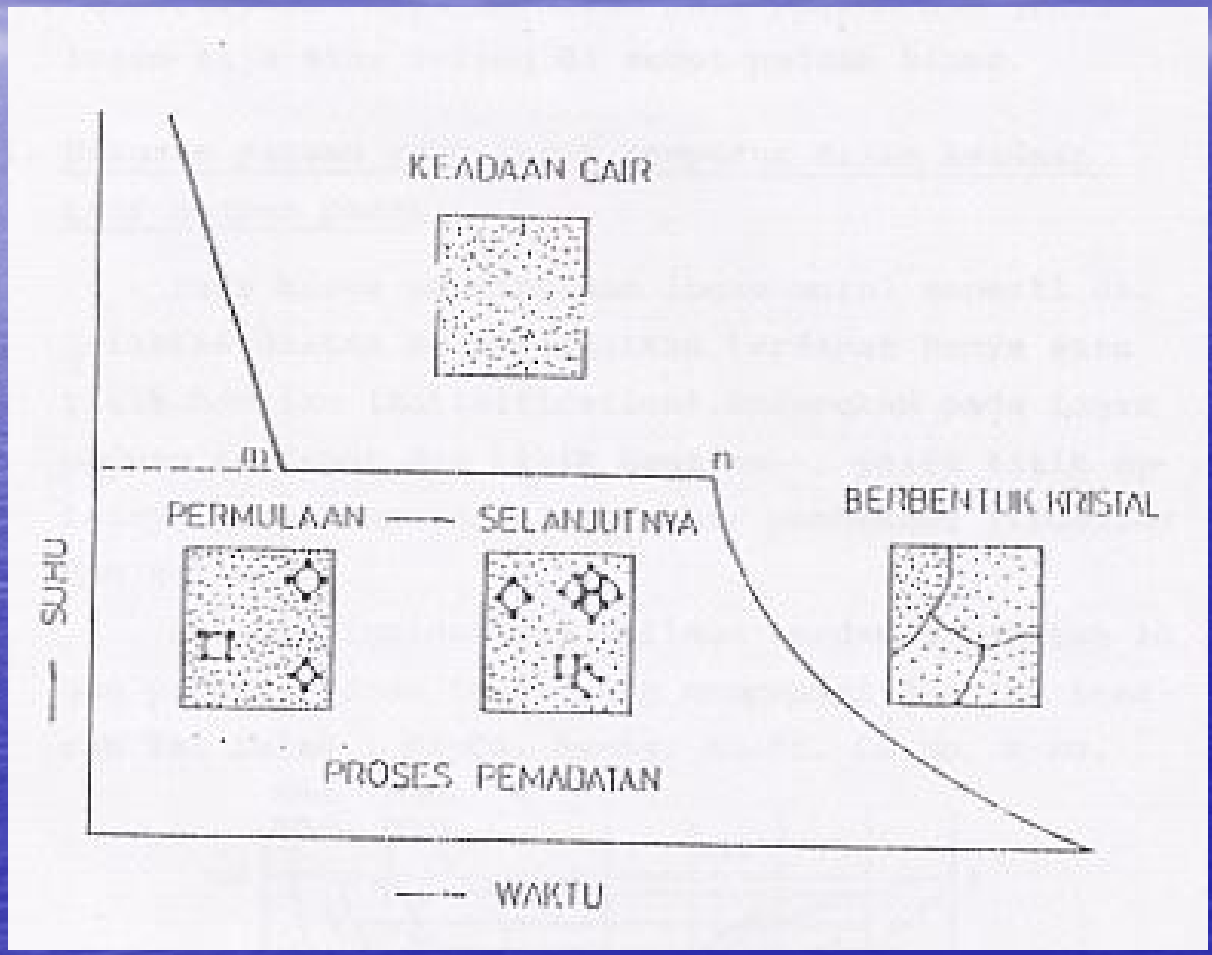
METALURGI FISIK

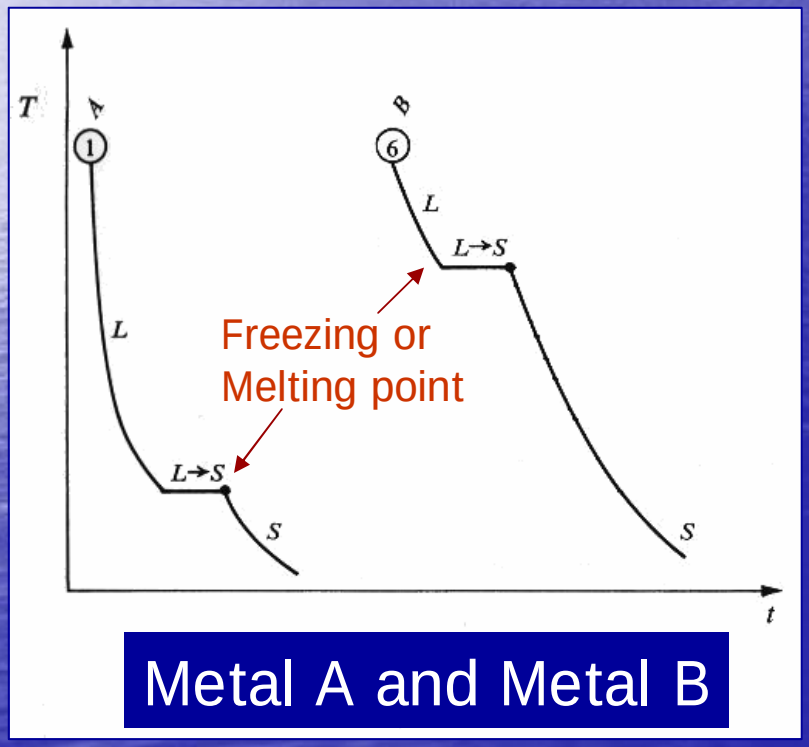
Transformasi Fasa

KURVA PENDINGIN LOGAM MURNI



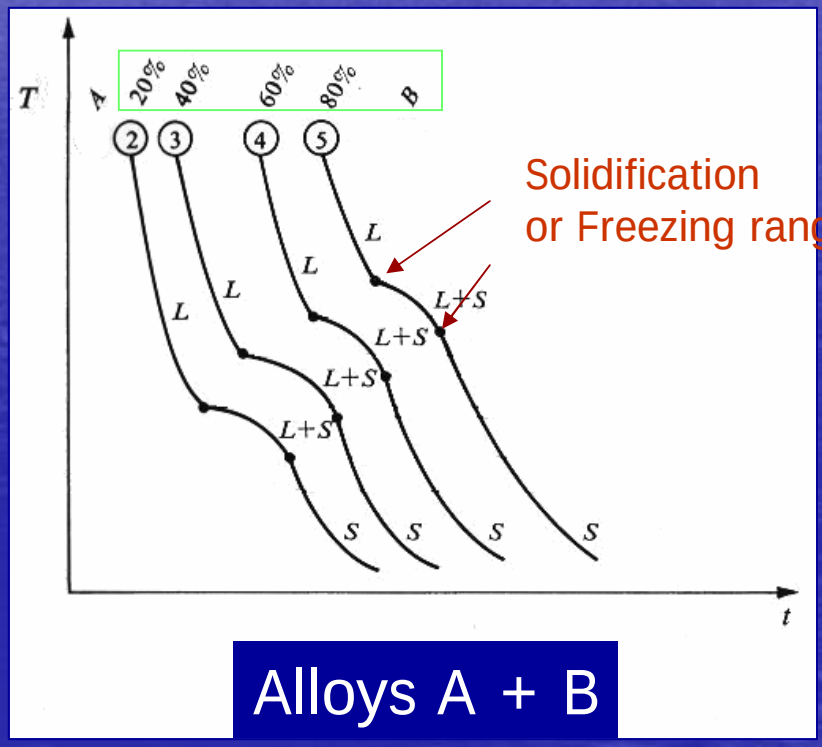
Cooling Curves

- Pure Metals



Metal A and Metal B

- Alloys



Alloys A + B

Cooling Curves and Phase Diagram

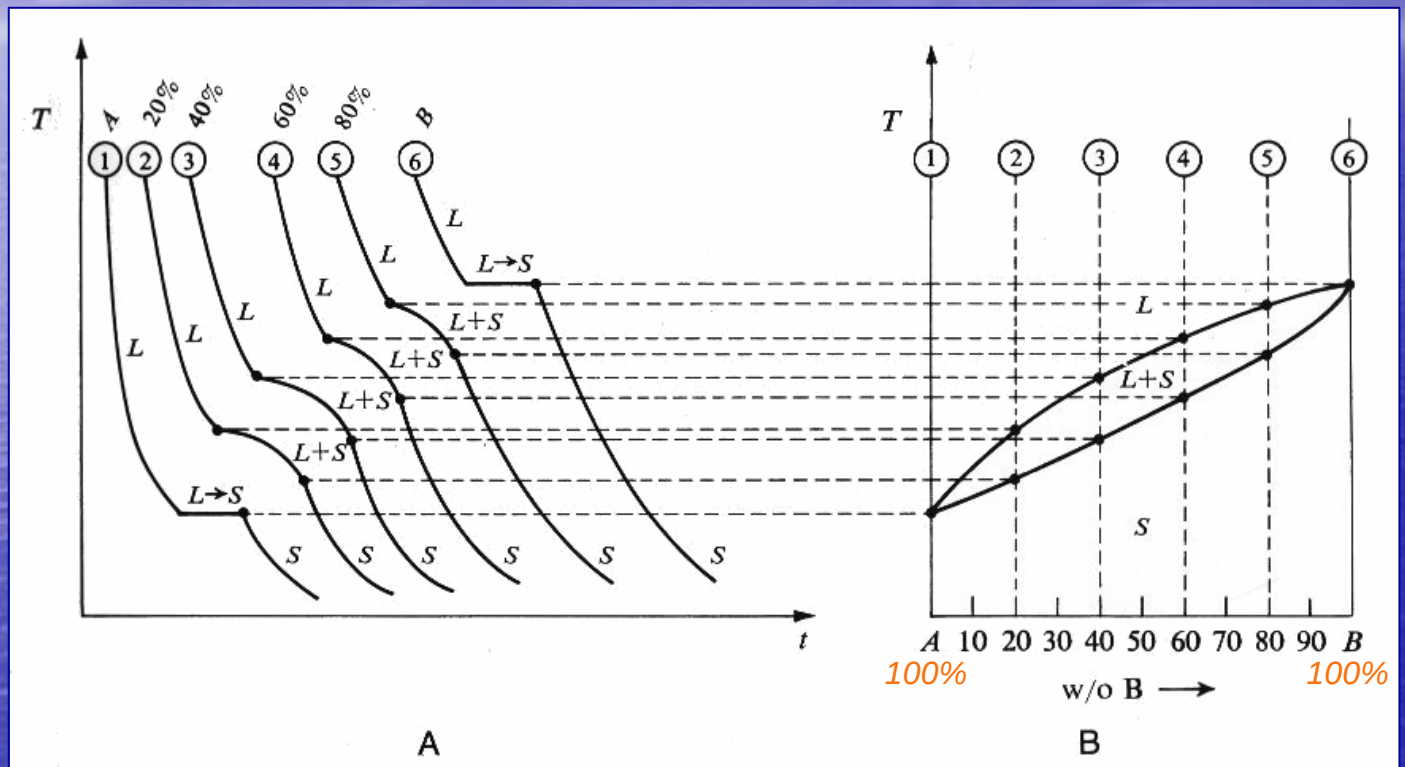


Figure 15–3. Determination of a phase diagram by thermal analysis. *A*, The cooling curves of six alloys of various compositions are determined experimentally. *B*, In addition, the temperature of fusion and the liquidus and solidus temperatures are plotted as a function of composition to form the phase diagram. (*A* and *B* from Richman M: An Introduction to the Science of Metals. Waltham, MA, Blaisdell, 1967, p 213.)

KURVA PENDINGIN BESI MURNI

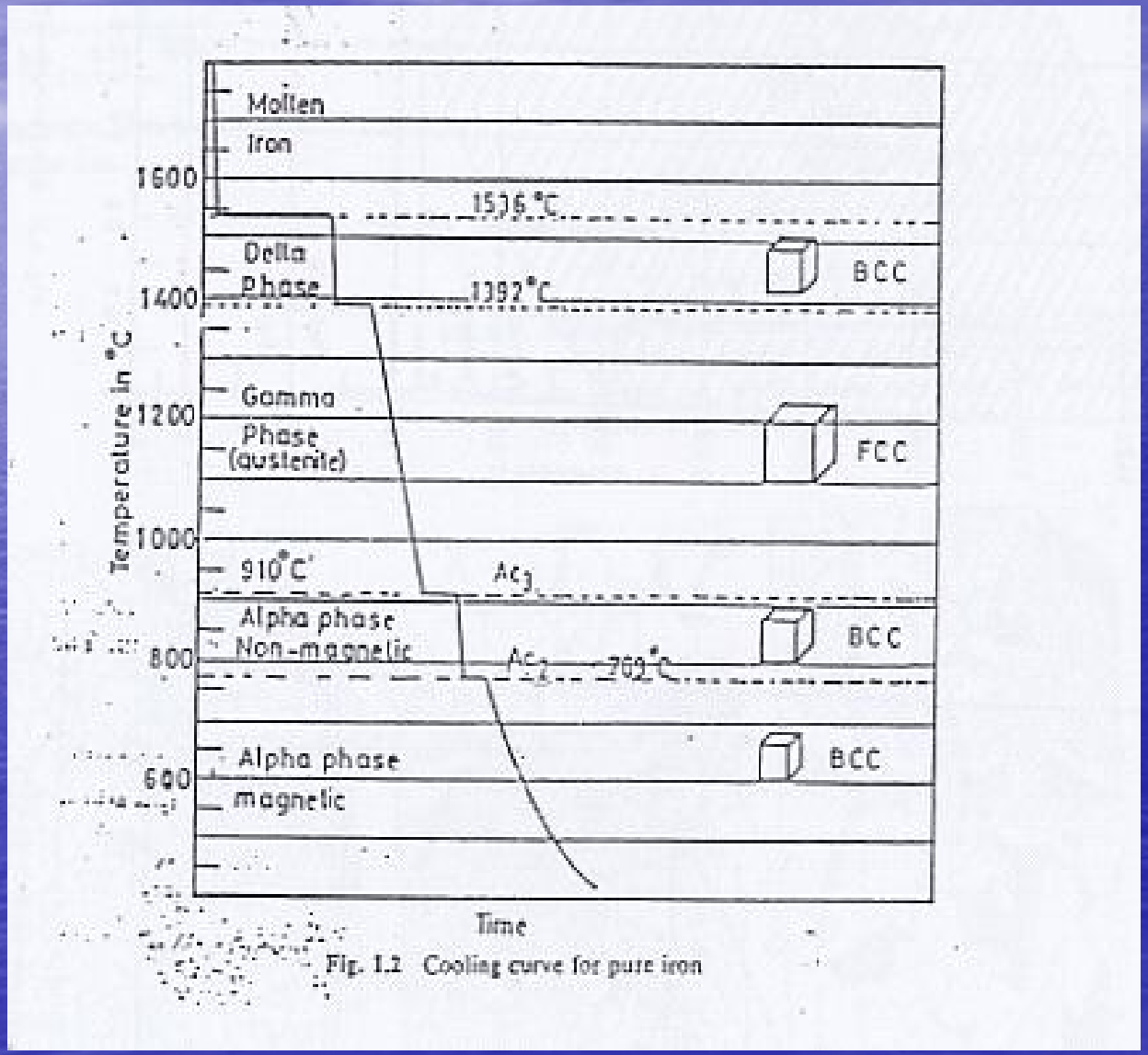
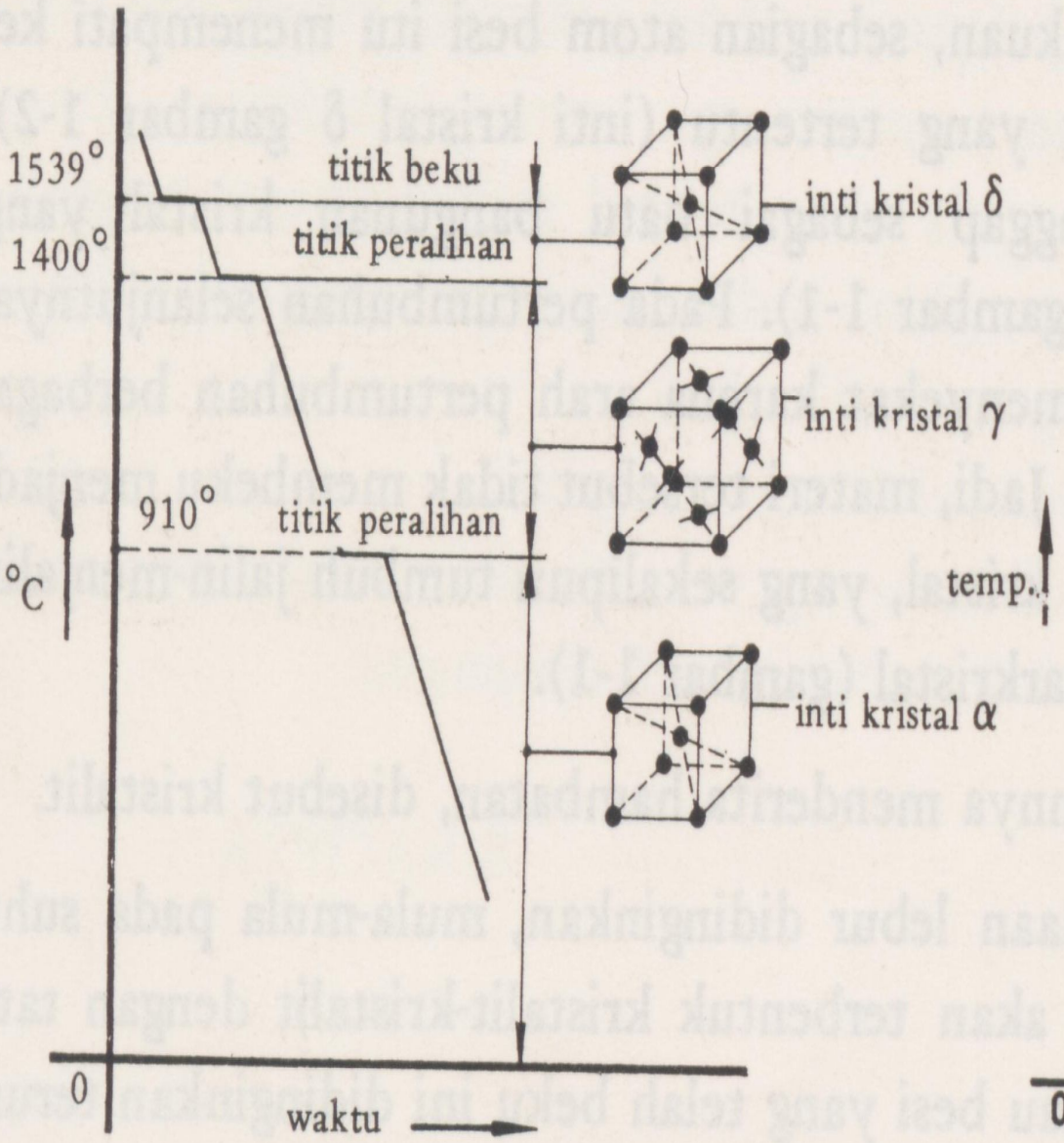
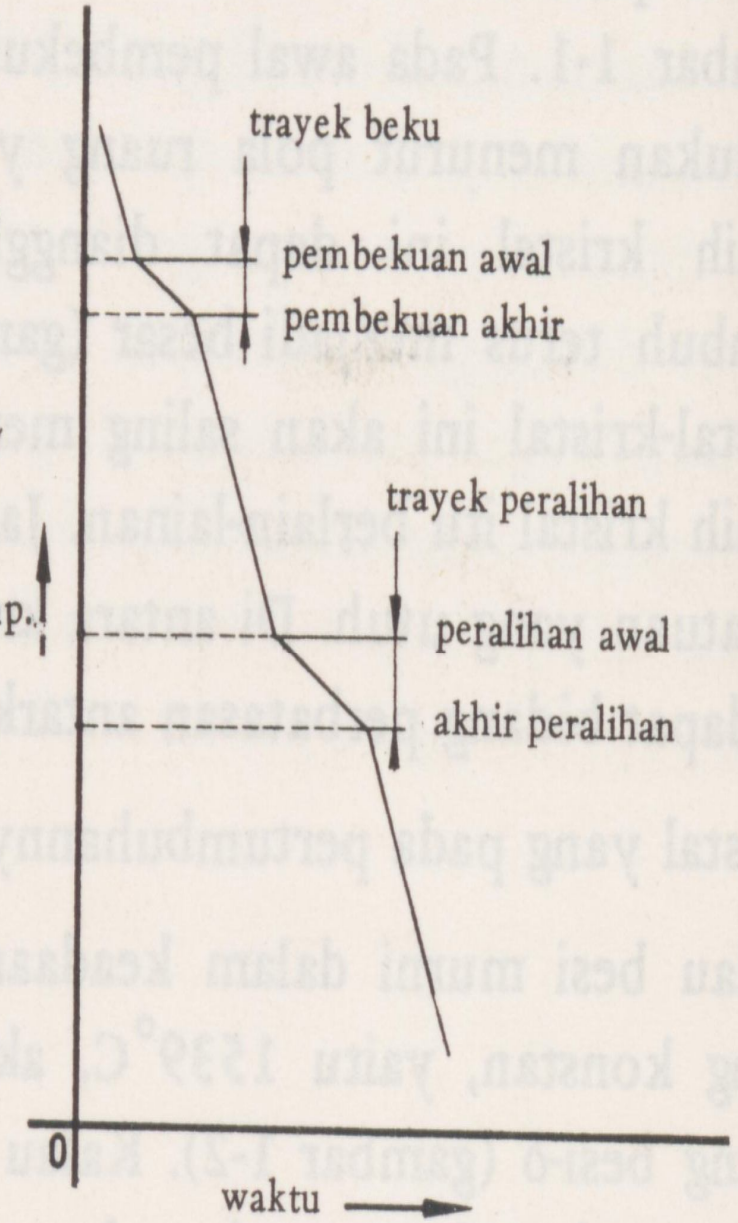


Fig. 1.2 Cooling curve for pure iron



Gambar 1-2. Proses pembekuan besi murni



Gambar 1-3. Proses pembekuan baja

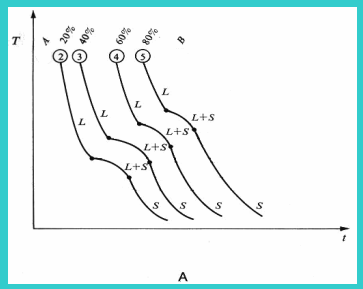
Diagram Paduan

1. Digram Paduan Zat larut sempurna dalam keadaan padat
2. Digram Paduan Zat yang tidak dapat larut dalam keadaan padat
3. Digram Paduan Zat yang larut terbatas dalam keadaan padat

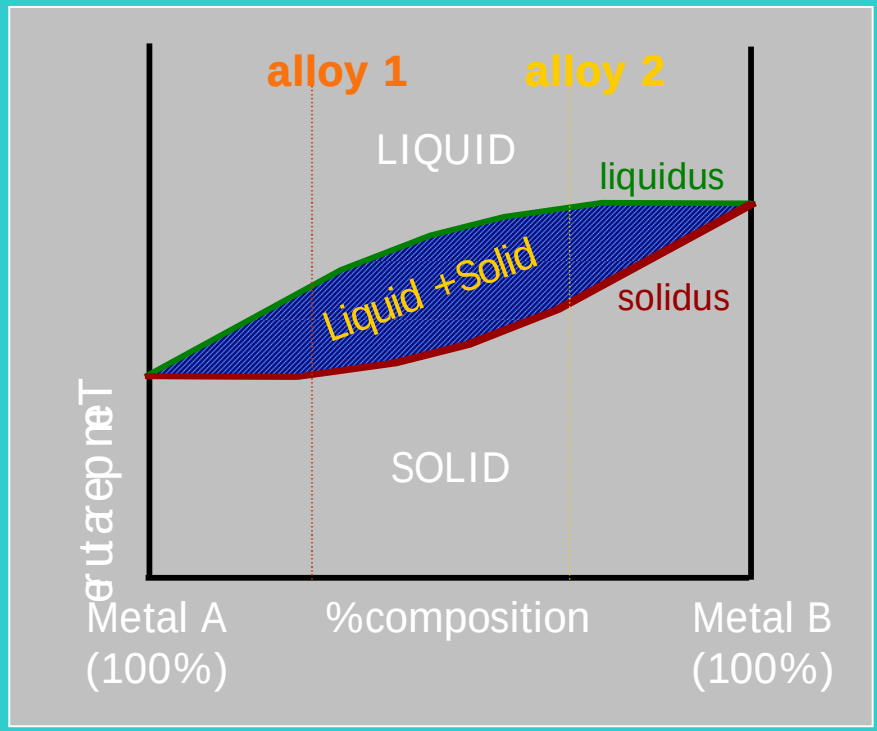
Solid solutions

- Two metals are completely miscible in the liquid state, and they remain completely mixed on solidification.
  - L → S
- A single -phase system
- Always have a range of possible compositions
  - e.g. the solid phase in the copper-gold (Cu-Au) system has a wide range of compositions between 100% Cu and 100% Au

Phase Diagram of a Solid Solution



- All compositions above the **liquidus line** are liquid, and those below the **solidus line** are solid.
- Solid and liquid exist in the area between both line.
- The solid has only one phase.

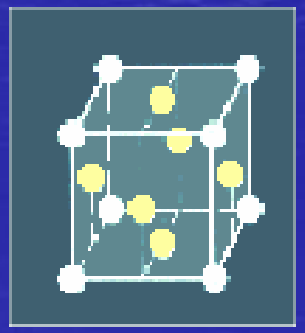


Intermetallic Compounds

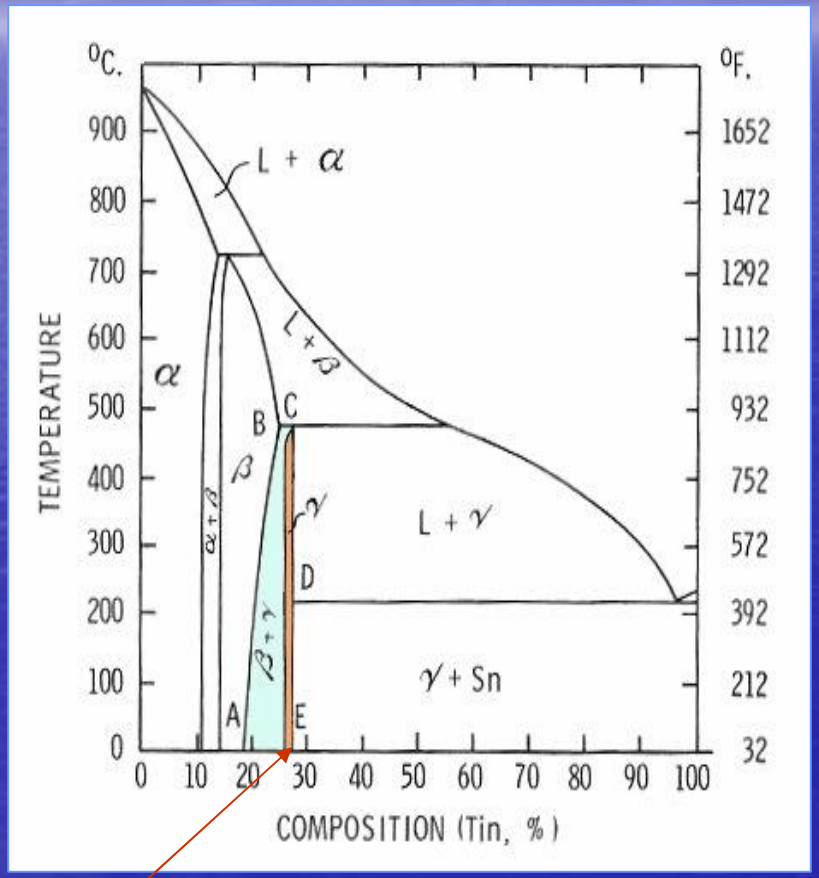
- The resulting phase has a fixed chemical composition or a narrow range of compositions.
  - e.g. in an amalgam alloy,

    73.2% Ag and 26.8% Sn → Ag_3Sn (one phase)

    Silver and tin atoms occupying definite positions in the space lattice.



Phase Diagram of an Intermetallic Compound



Ag_3Sn, 73.2% Ag and 26.8% Sn

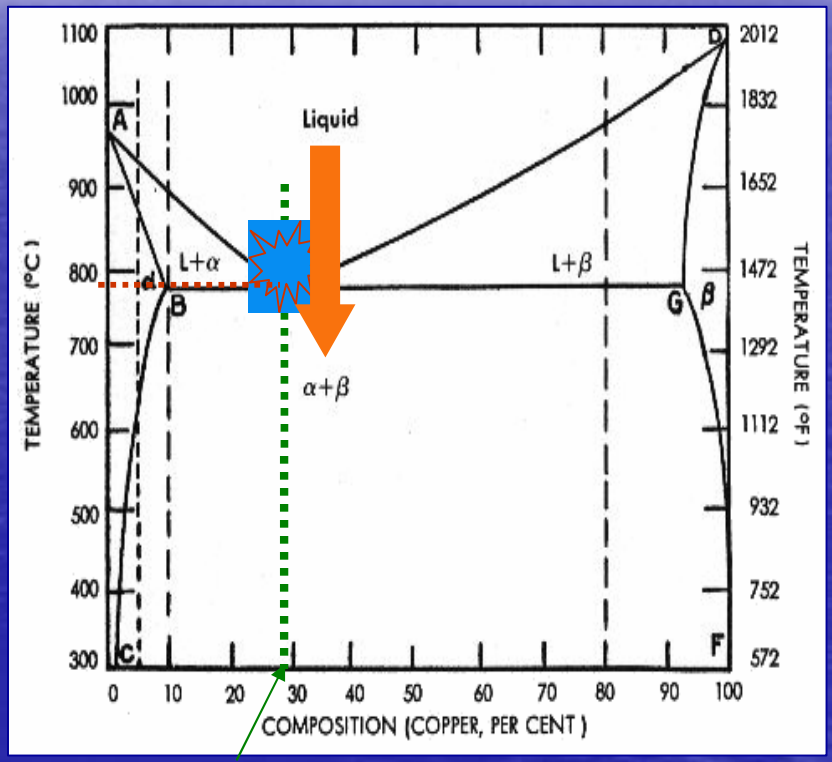
Eutectic Alloys

- The metals are soluble in the liquid state, but separate into two phases in the solid state.
  - $L \rightarrow S_1 + S_2$ *(= 2 solid solutions)*

Phase Diagram of a Eutectic Alloy

- L → α-solid solution + β-solid solution
- The lowest temperature at which any alloy composition is entirely liquid = "Eutectic Temp" (779.4°C, E)
  - The eutectic temperature is lower than the fusion temperature of either Ag and Cu.
- At eutectic point, there is no solidification range. (~pure metal)
- At eutectic composition (72%Ag + 28% Cu), the two phases often precipitate as very fine layers of one phase over the other one.

Silver-copper system

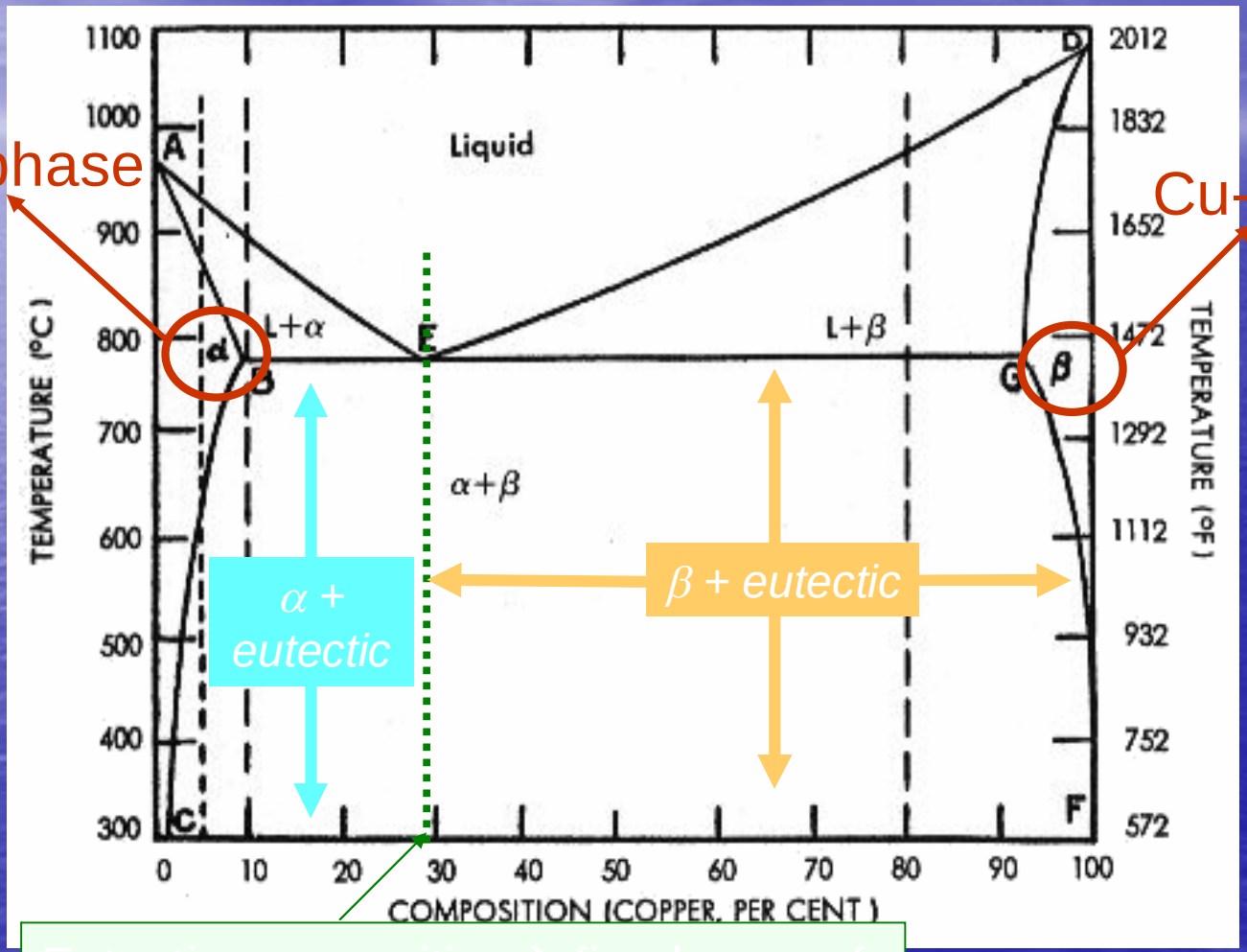


Eutectic composition

Silver-copper system

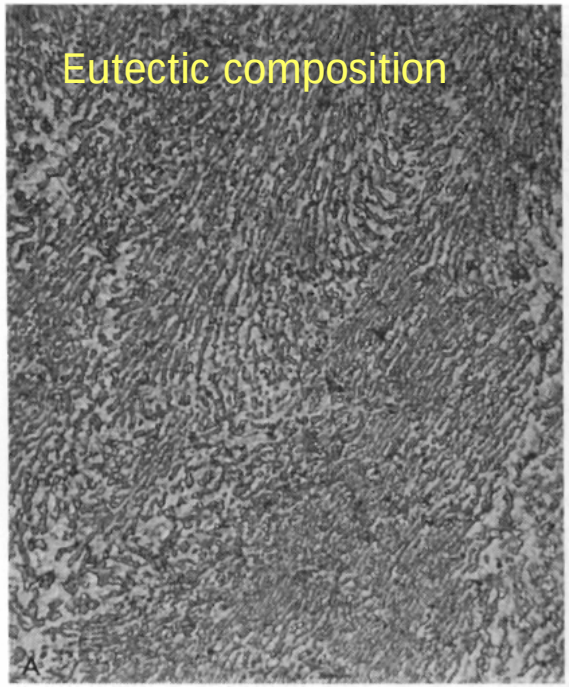
Ag-rich phase

Cu-rich phase



Eutectic composition→ fine layers of α phase over β phase

Ex. Lead-Tin Alloy



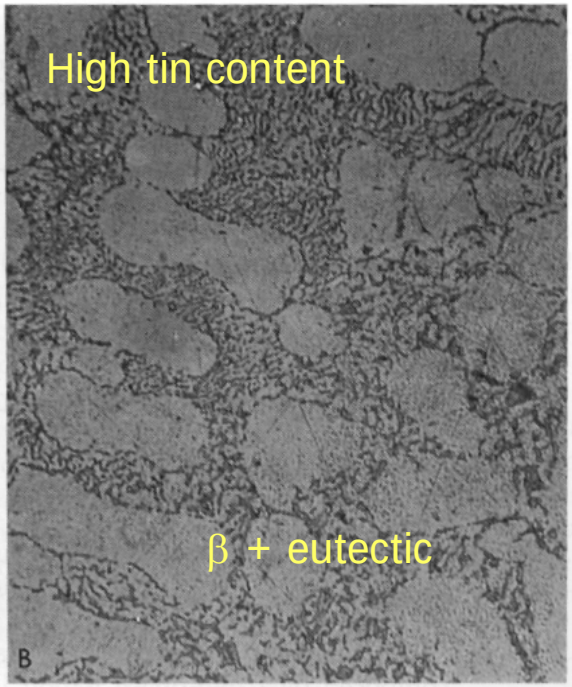


Figure 15–7. Microstructure of two lead-tin alloys. *A,* The alloy has the eutectic composition 62% Sn-38% Pb. The structure is composed of alternating layers (lamellae) of α-solid solution (dark) that is Pb rich and β-solid solution (light) that is Sn rich. ×1280. *B,* The alloy has a high tin content (75% Sn-25% Pb). The light islands are primary β phase that solidified first. They are surrounded by the eutectic that solidified when the eutectic temperature was reached ×560. (*A* and *B* courtesy of P. G. Winchell.)

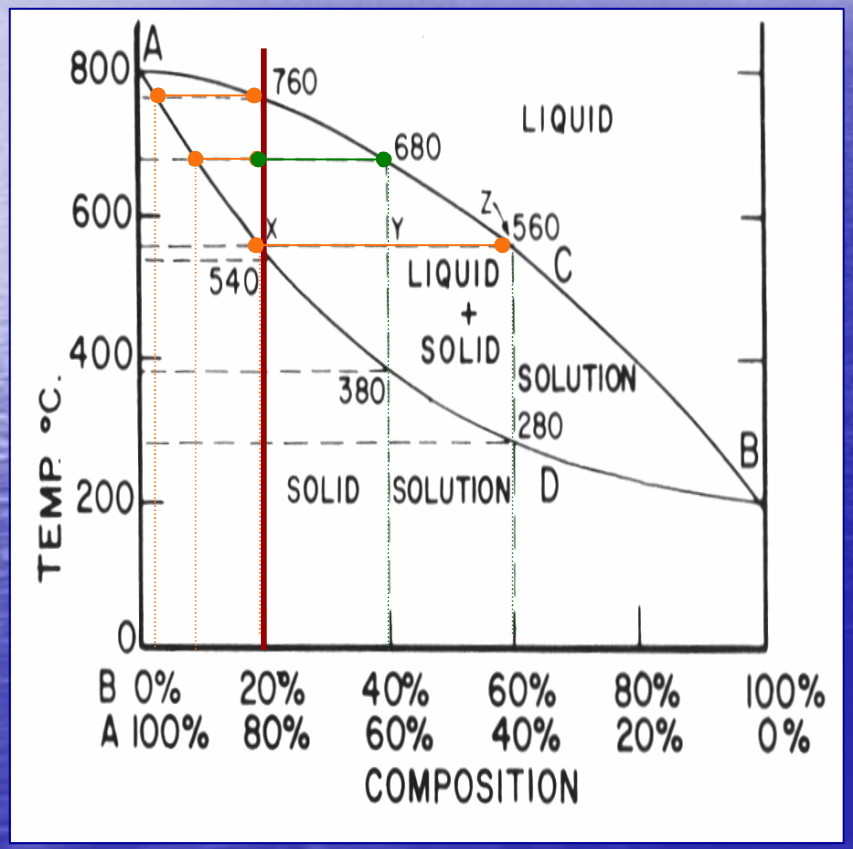
How to read a simple phase diagram?

(1) Composition of Liquid and Solid Phases at Various Temp.

(2) Amount of Liquid and Solid Phases at Various Temp.

Composition of Liquid and Solid Phases at Various Temp.

Alloy (80%A +20%B)



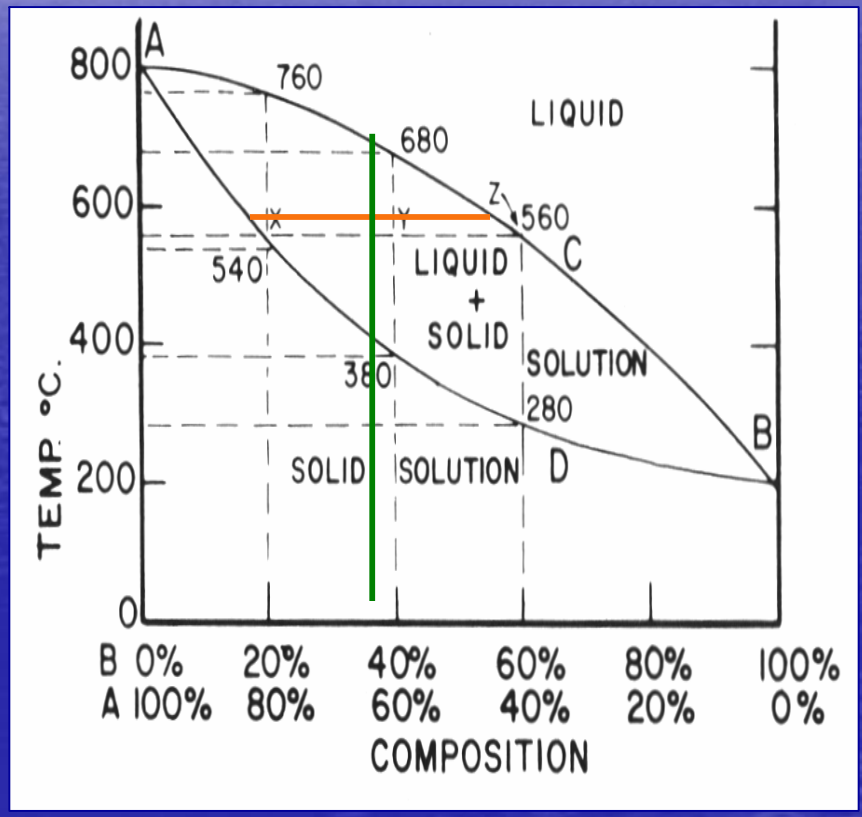
When the temperature reaches 560°C, the solid is 80%A and the liquid contains 40%A; below 540°C there is no liquid and the solid is 80%A.

Table 5-1. *Composition of Liquid and Solid Phases at Various Temperatures for the Alloy System AB*

Temperature (° C)	80% A and 20% B	
	Liquid	Solid
>760	80% A	None
760	80% A	97% A
680	60% A	90% A
560	40% A	80% A
<540	None	80% A

Amount of Liquid and Solid Phases at Various Temp.

- The relative amounts of the two phases in the liquid-solid region can be determined at a given temperature by the inverse lever rule.
  - At 560°C for 60%A and 40%B composition
    - Liquid = XY/XZ
    - Solid = YZ/XZ



Ex. Silver-Palladium System

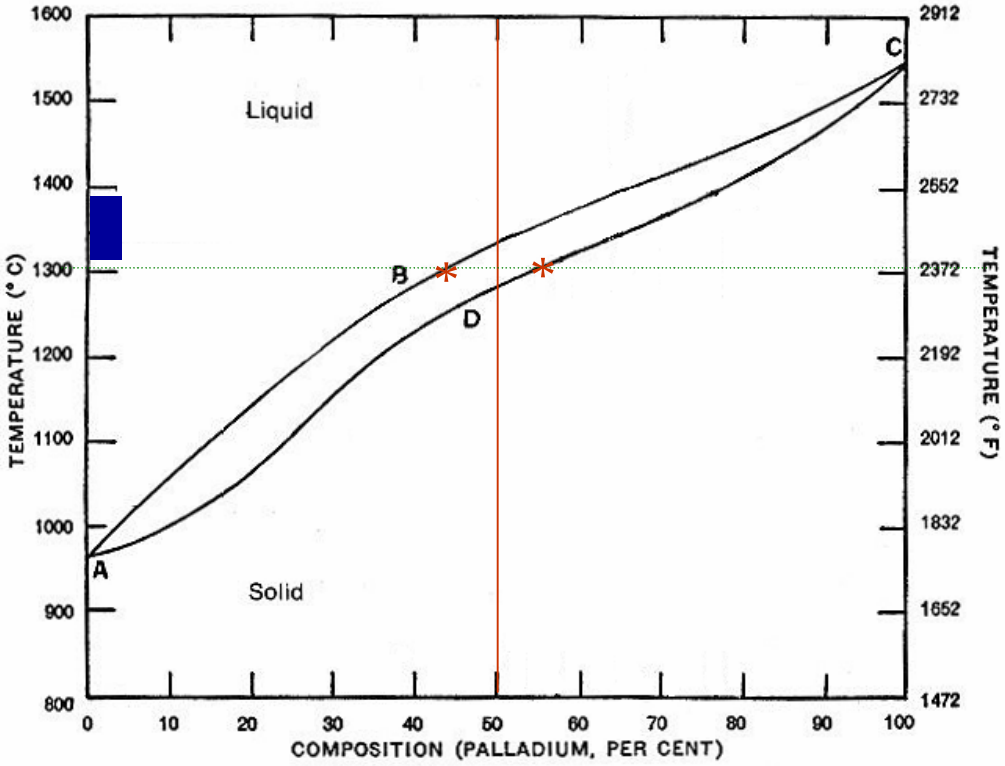
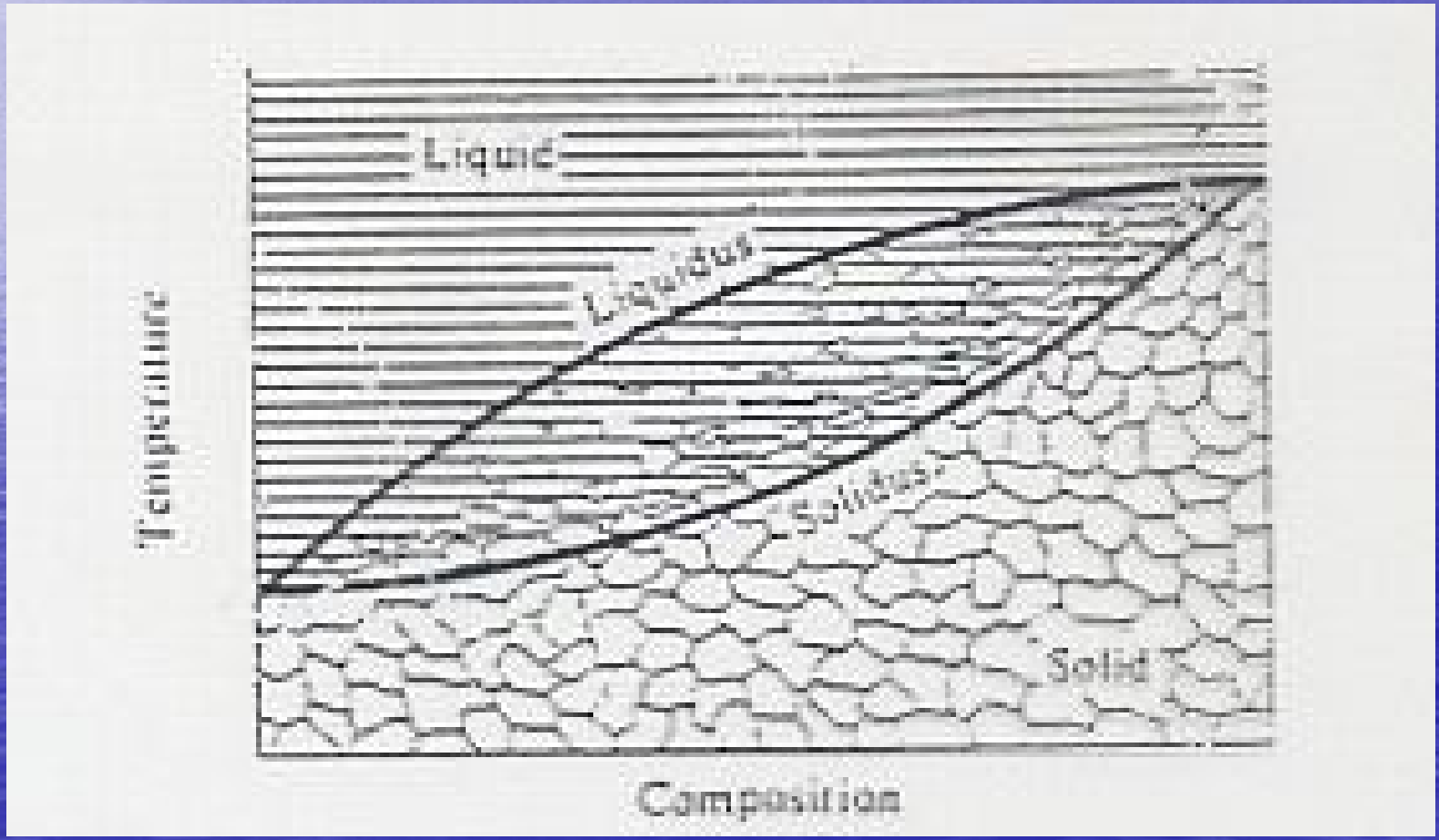
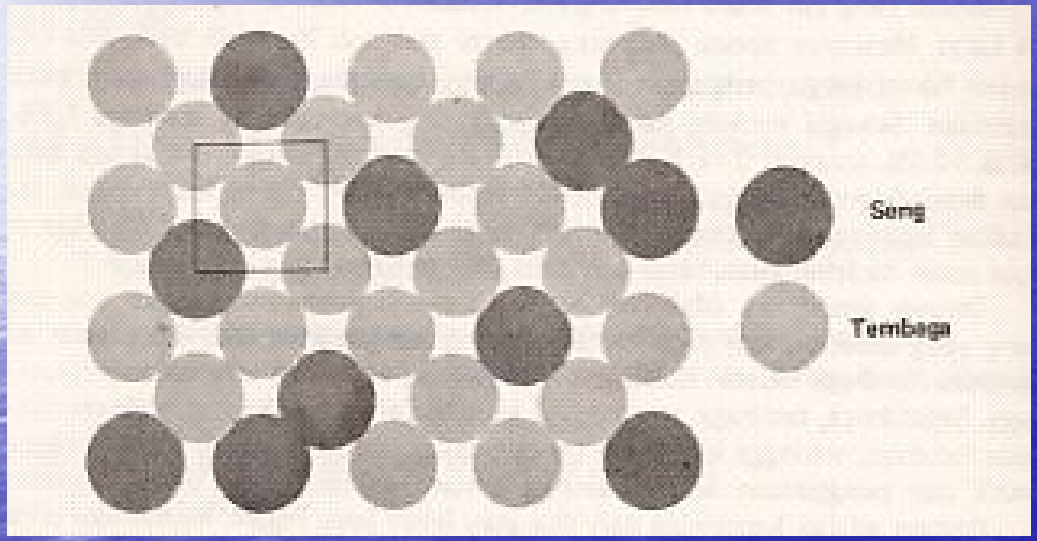


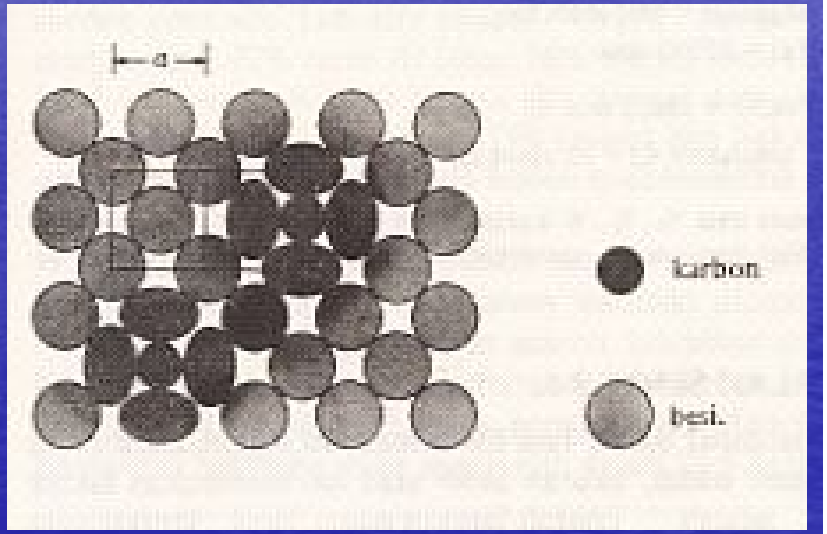
Figure 15–4. Equilibrium phase diagram for the silver-palladium system. Only the percentage composition for palladium is given; the percentage composition for silver is determined by subtracting the palladium composition from 100.

Diagram Zat Larut Sempurna



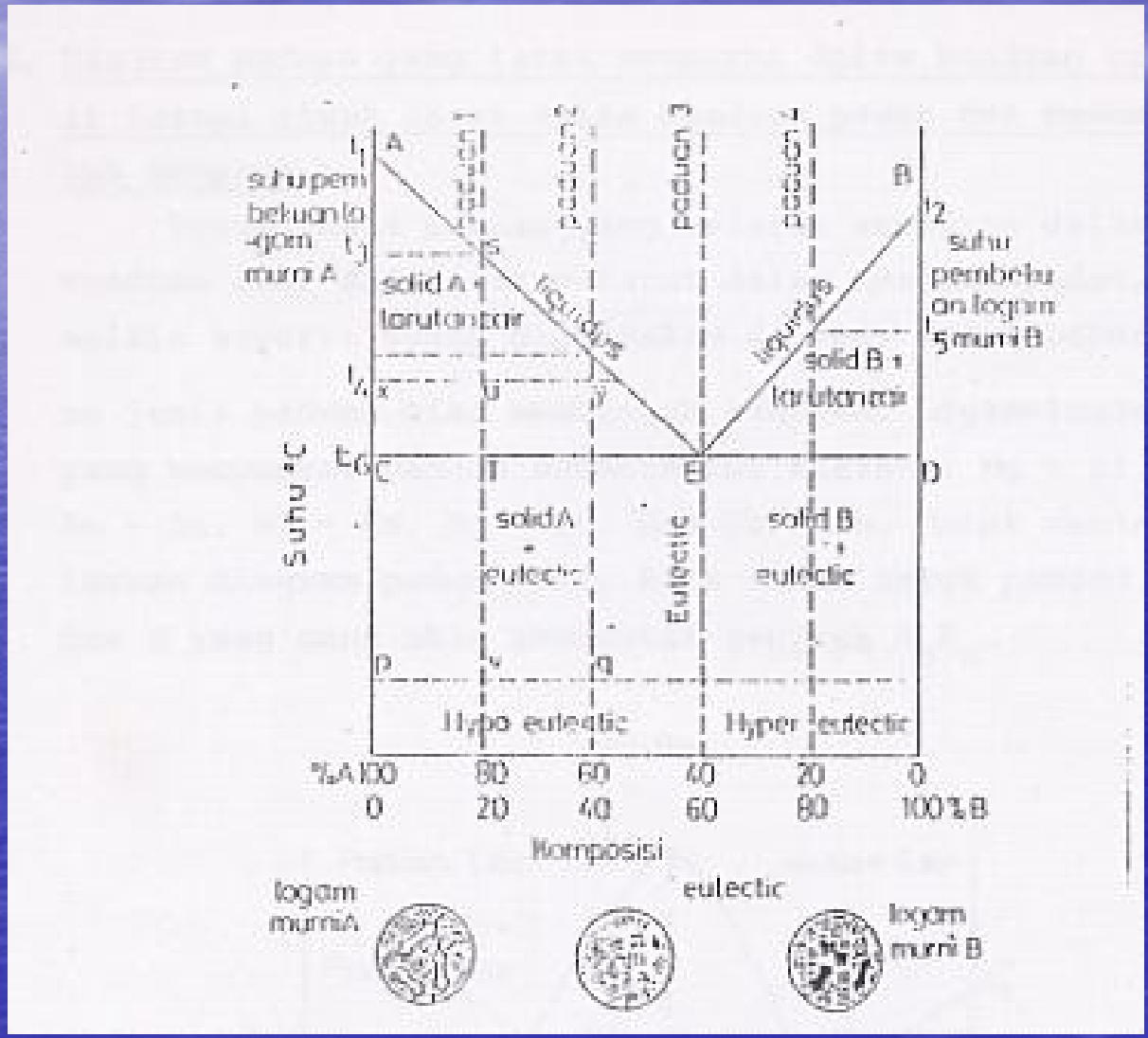


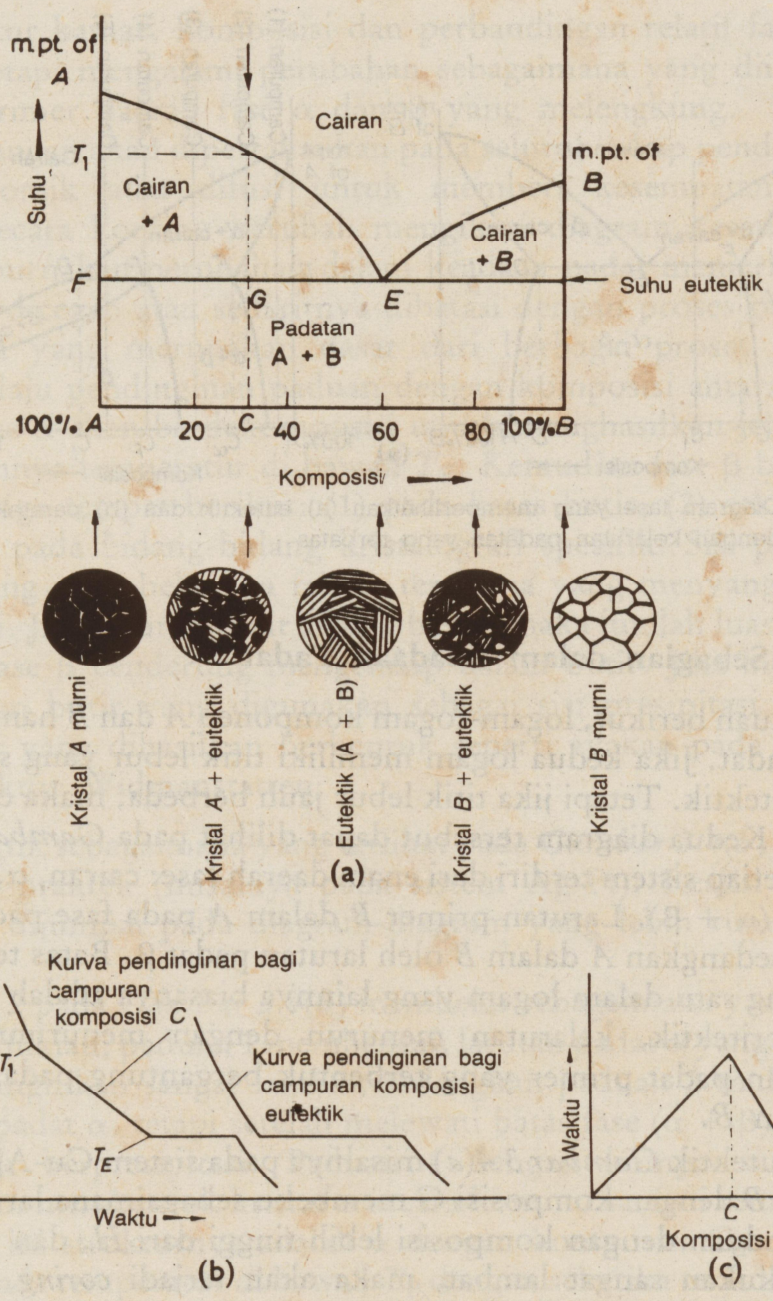
Larutan padat subsitusi



Larutan padat interstisi

Diagram Zat yang Tidak Dapat Larut Dalam Keadaan Padat





Gambar 3.3 (a) Diagram eutektik sederhana dengan mikrostruktur beberapa campuran logam terseleksi, dan (c) kebergantungan lama pendinginan bertahan pada suhu eutektik komposisi

Diagram Zat yang Larut Terbatas Keadaan Padat

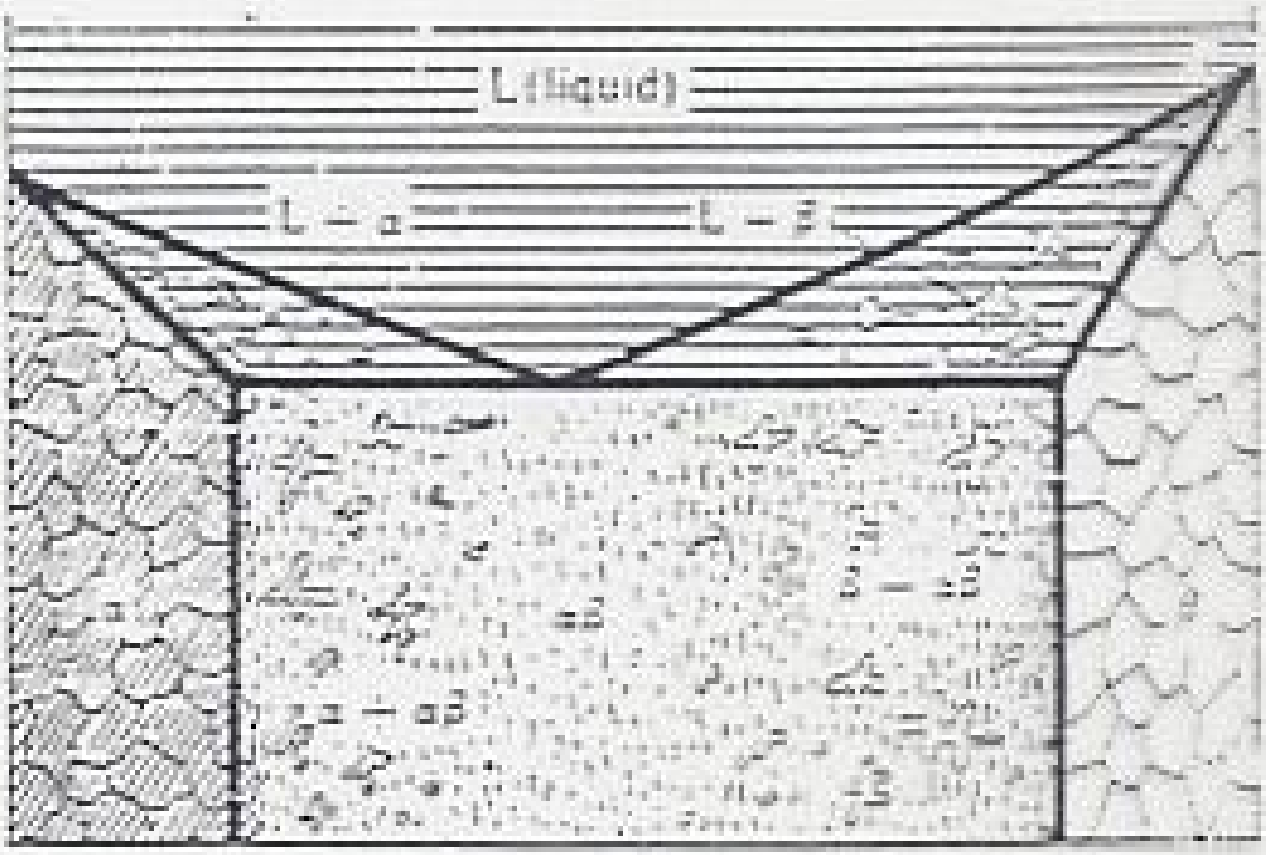


Diagram Zat Larut Terbatas Type Eutectic

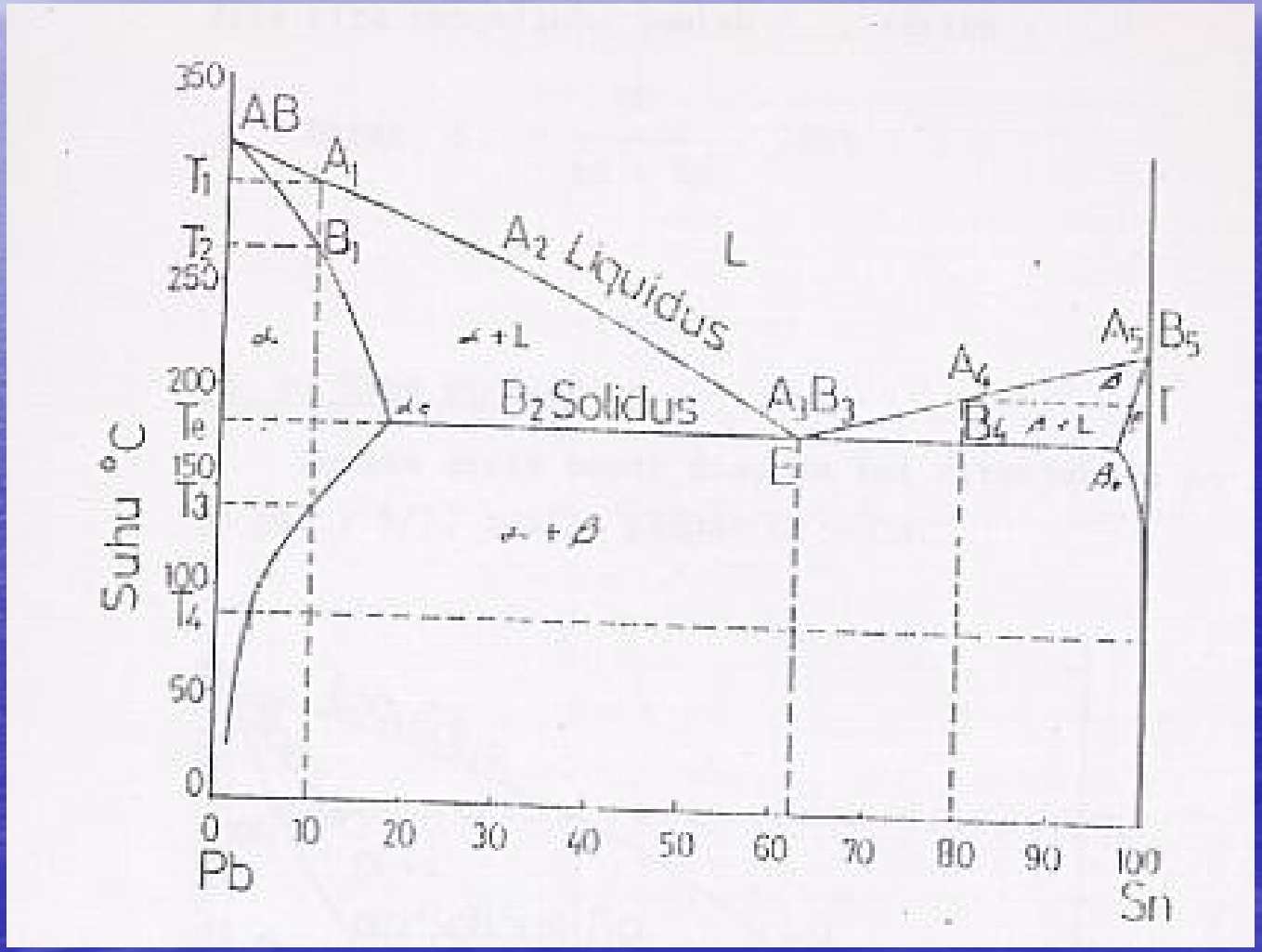


Diagram Zat Larut Terbatas Type Peritectic