

DIAGRAMAS DE FASES

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- **3 - Sistemas binários isomorfos**
- **4 - Sistemas binários eutéticos**
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- **18 - Sistemas ternários complexos**

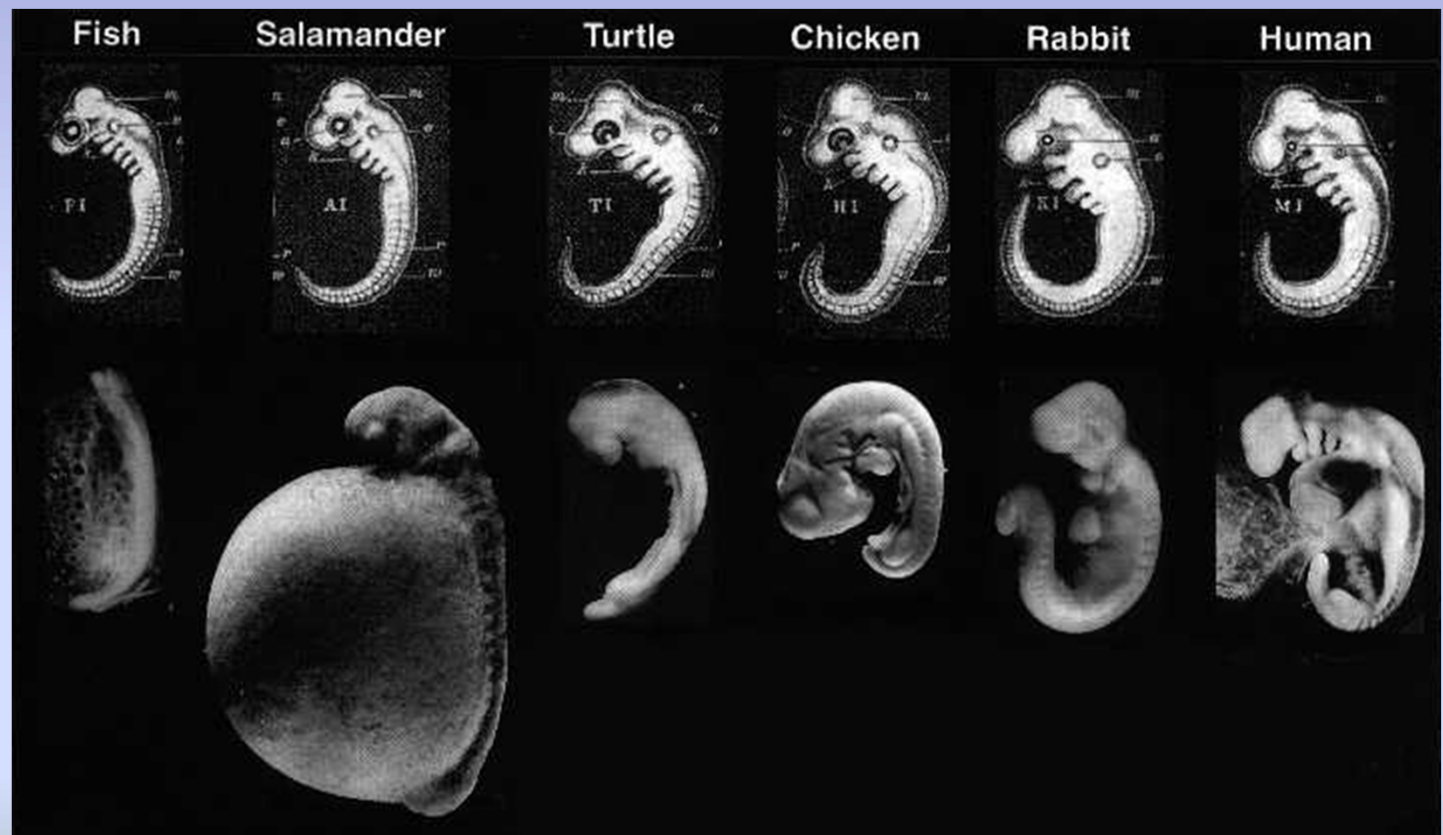
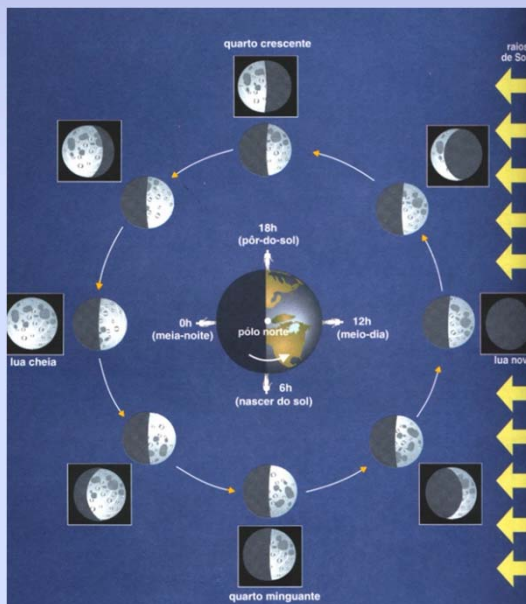
DIAGRAMAS DE FASES

- Professor: Carlos Angelo Nunes
- Carga Horária: 60 horas
- Bibliografia:
 - Campbell, F.C. Phase Diagrams : Understanding the Basics, ASM The Materials Information Society, Ohio, 2012.
 - Rhines, F. N. Phase Diagram in Metallurgy - Their Development and Application. Mcgraw-Hill, New York, 1956.
 - Prince, A. Alloy Phase Equilibria. Elsevier, Amsterdam, 1966.
 - Massalski, T. B. Binary Alloys Phase Diagrams. ASM, Metals Park, Ohio, 1990.

DE QUE FASES ESTAMOS FALANDO?

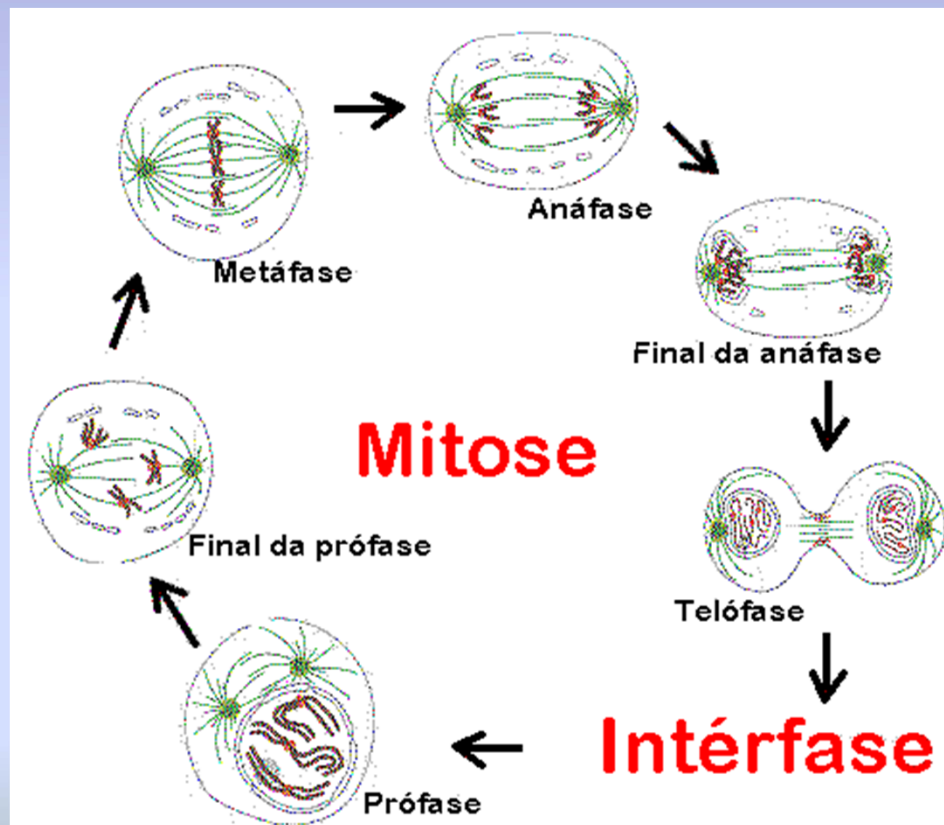
Fases da Gestação ?

Fases da Lua ?



DE QUE FASES ESTAMOS FALANDO?

Fases da Mitose ?

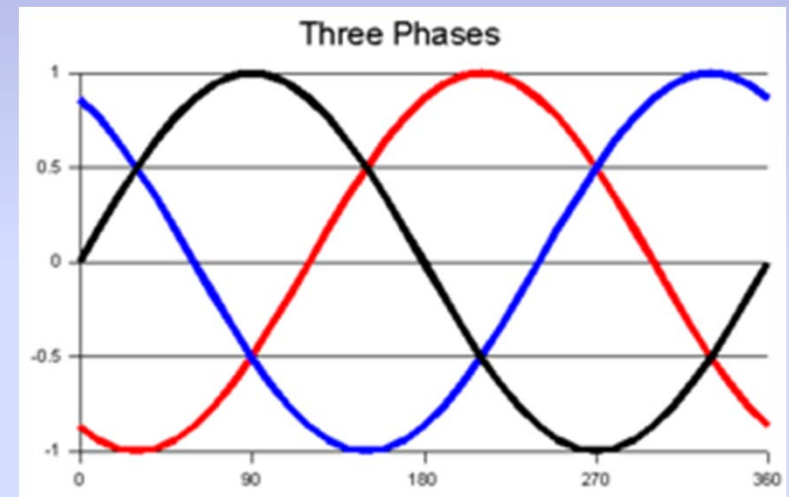


Fases da Vida ?



DE QUE FASES ESTAMOS FALANDO?

Fases: Eletricidade

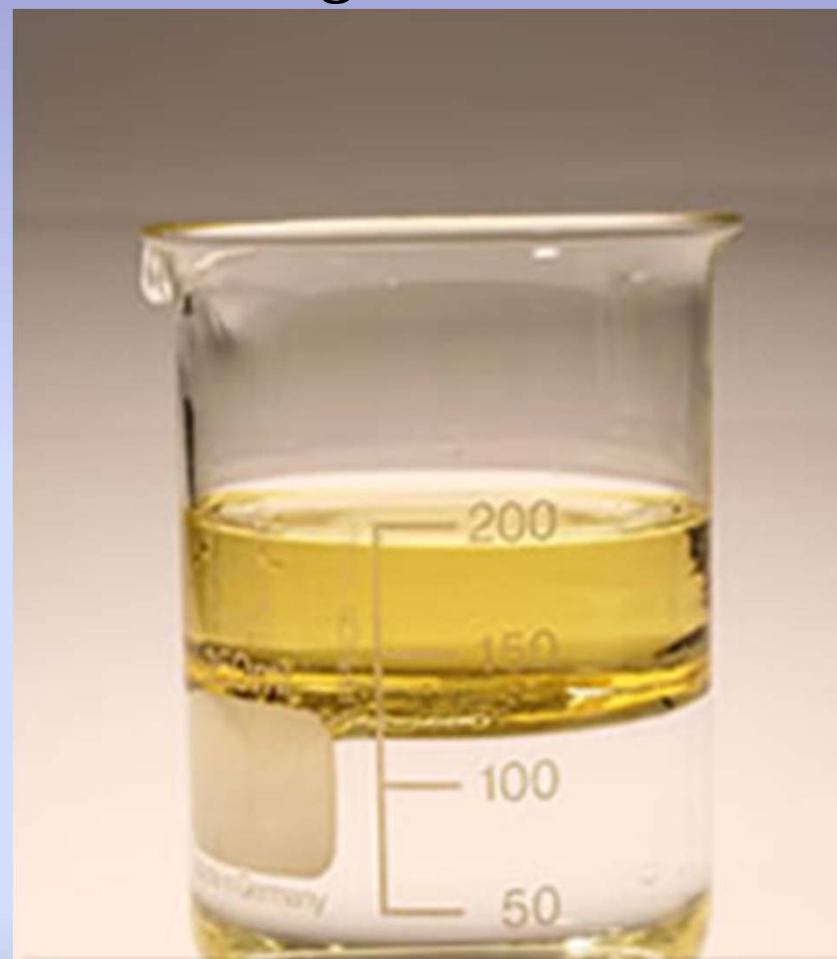


Como as fases se apresentam ?

Pé de Moleque



Água + óleo



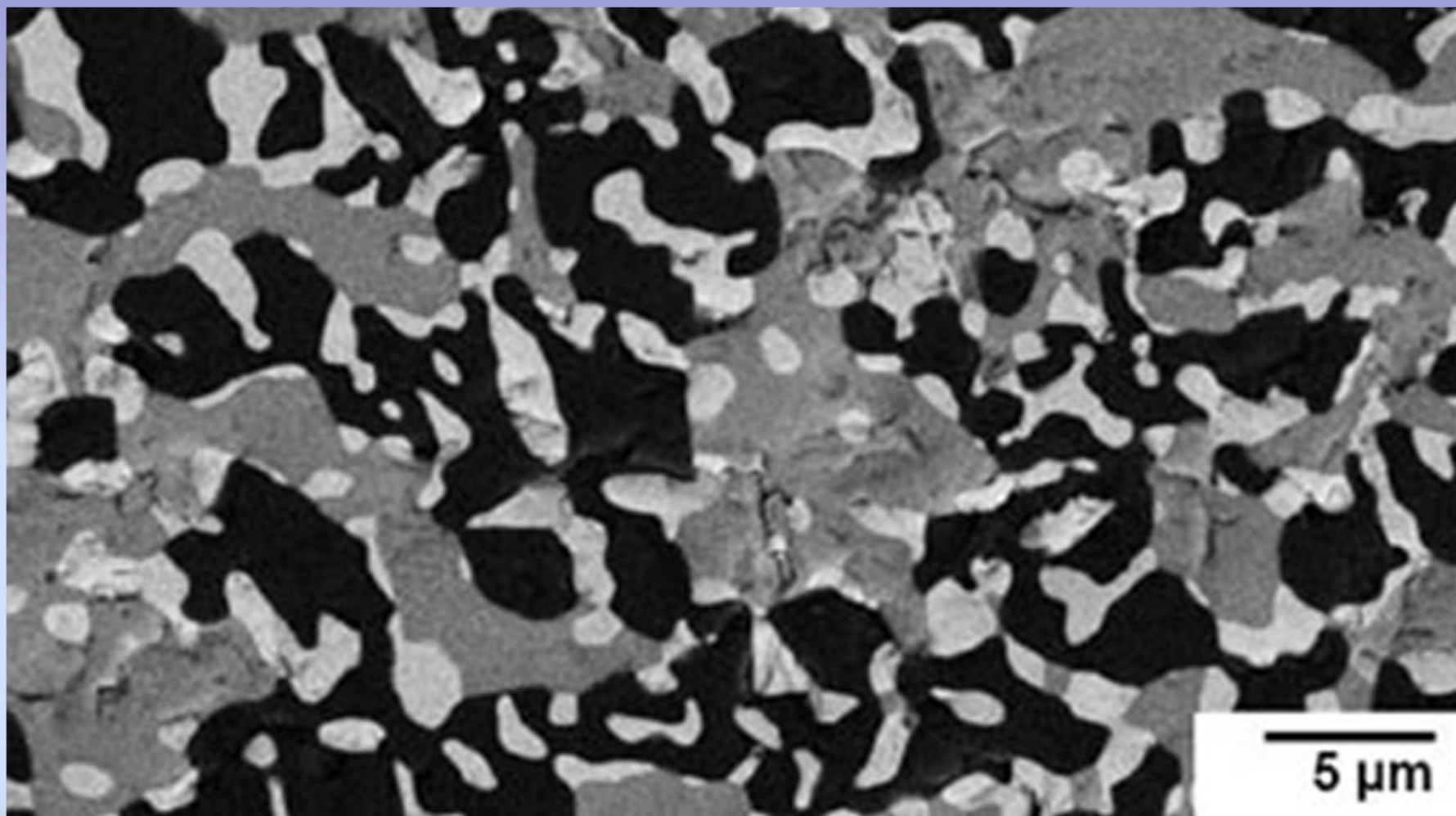
Como as fases se apresentam ?



Granito

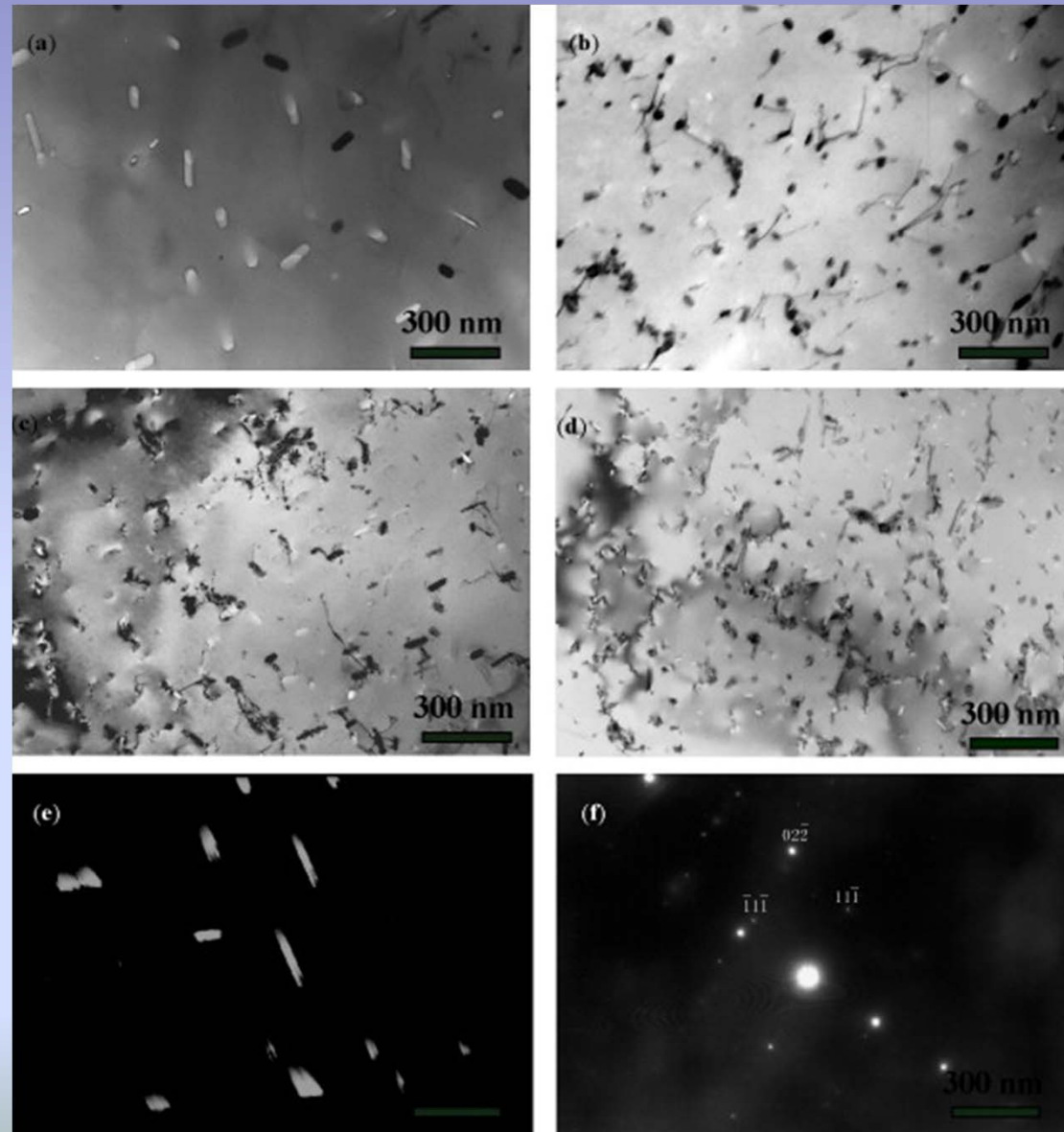


Como as fases se apresentam ?



Micrografia: liga Mo-Si-B

Fig. (a) TEM micrograph of epsilon copper precipitates in undeformed steel, (b–c–d) TEM micrographs of epsilon copper precipitates in light pre-deformed steels with a reduction of 10, 15 and 20%, (e) TEM dark field image of epsilon copper precipitates observed in (a), (f) the corresponding electron diffraction pattern ($[1\ 1\ 0]_{\text{EpsilonCopper}}$ zone axis).



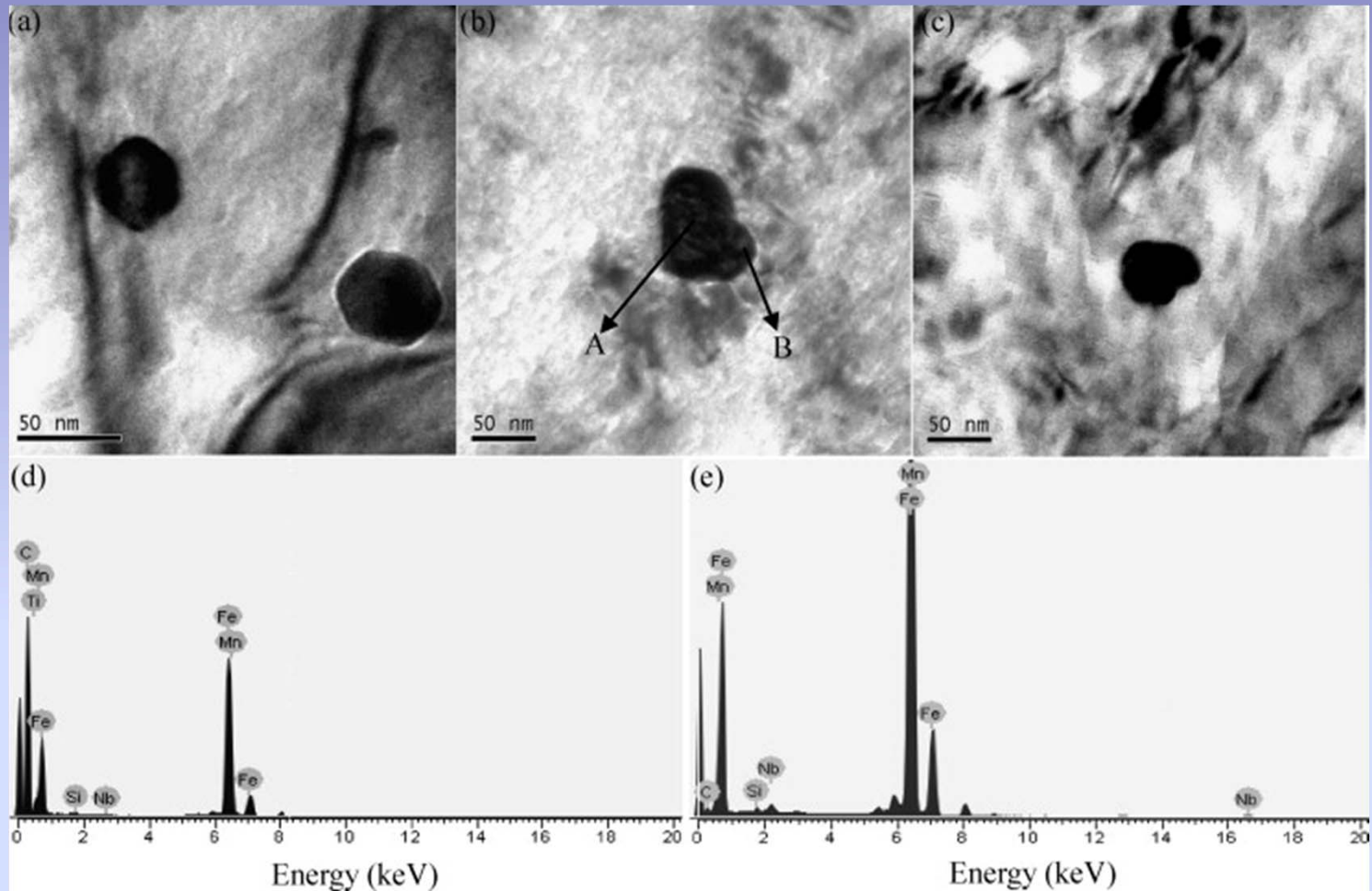


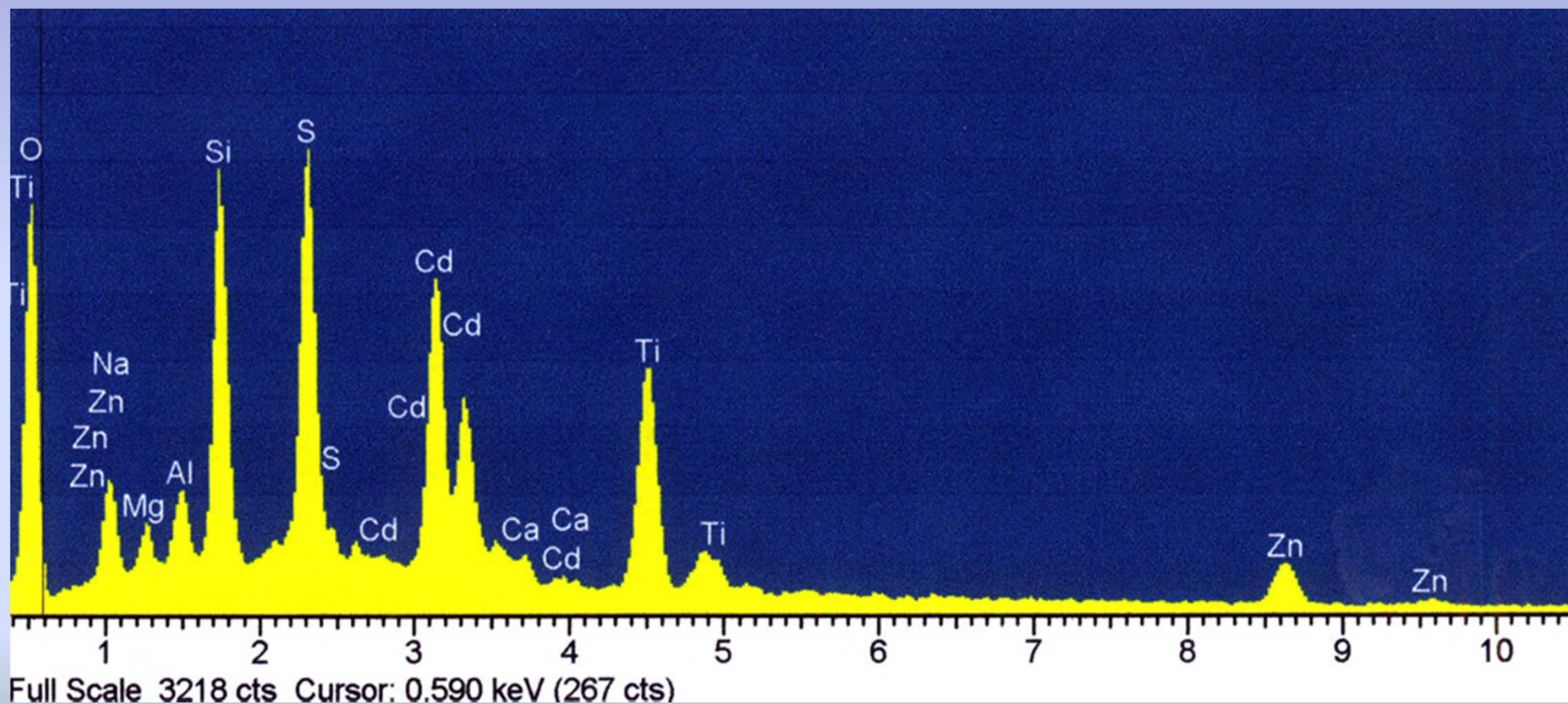
Fig. . TEM image of precipitates in Steel C after deformation and holding of 1000 s at 975 °C: (a) undissolved precipitates; (b) and (c) morphology of precipitates in cap shape; (d) EDX spectrum of the core marked as “A” in (b); (e) EDX spectrum of the cap marked as “B” in (b).

Determinando as fases presentes no material

Microscopia

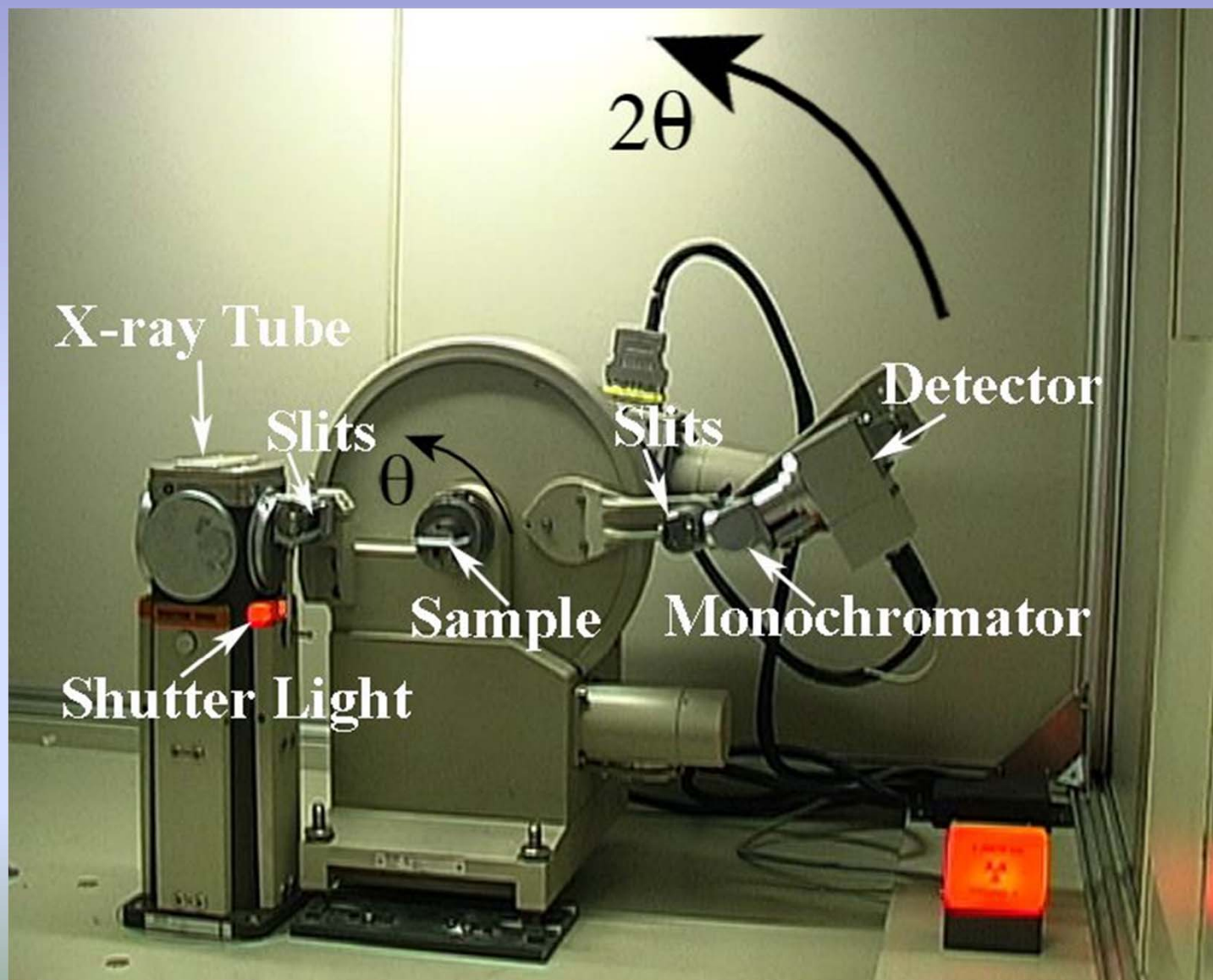


Determinando as fases presentes no material



EDS

Determinando as fases presentes no material

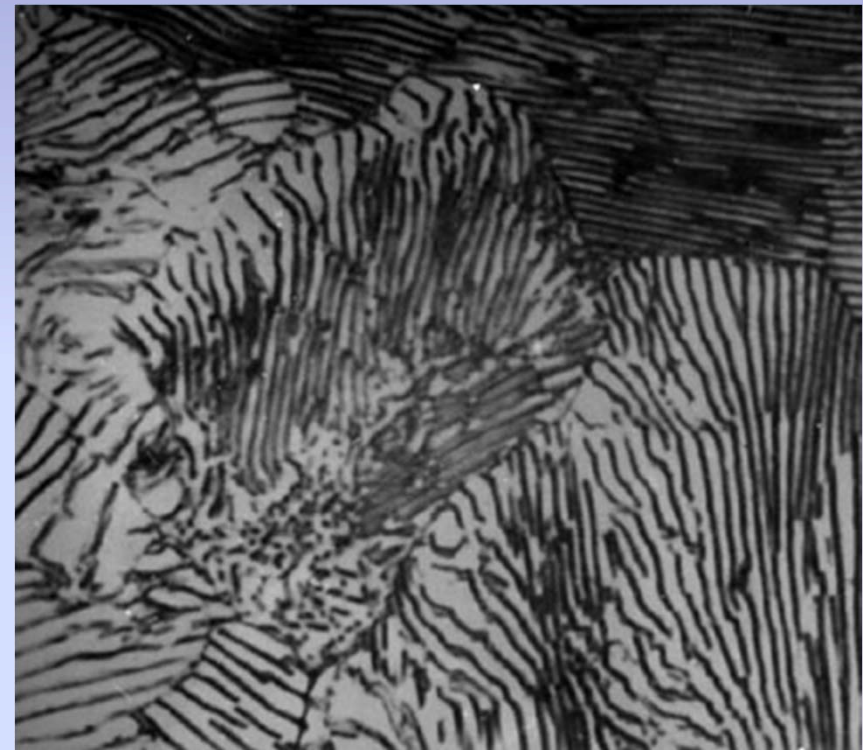
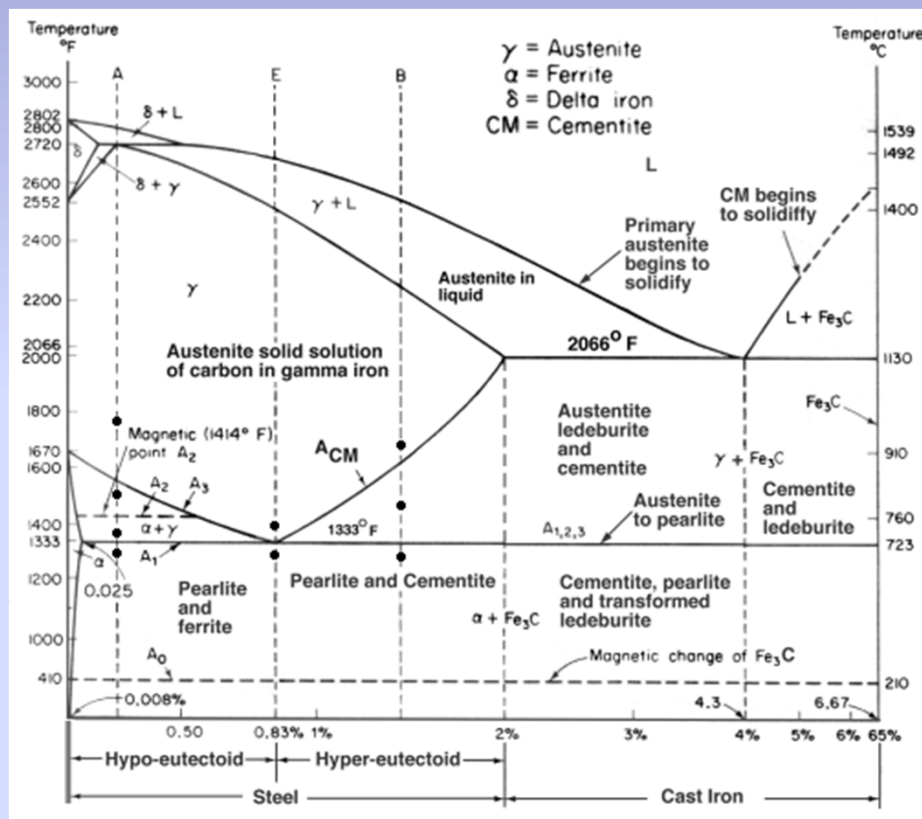


Determinando as fases presentes no material



Alumínio puro - EBSD

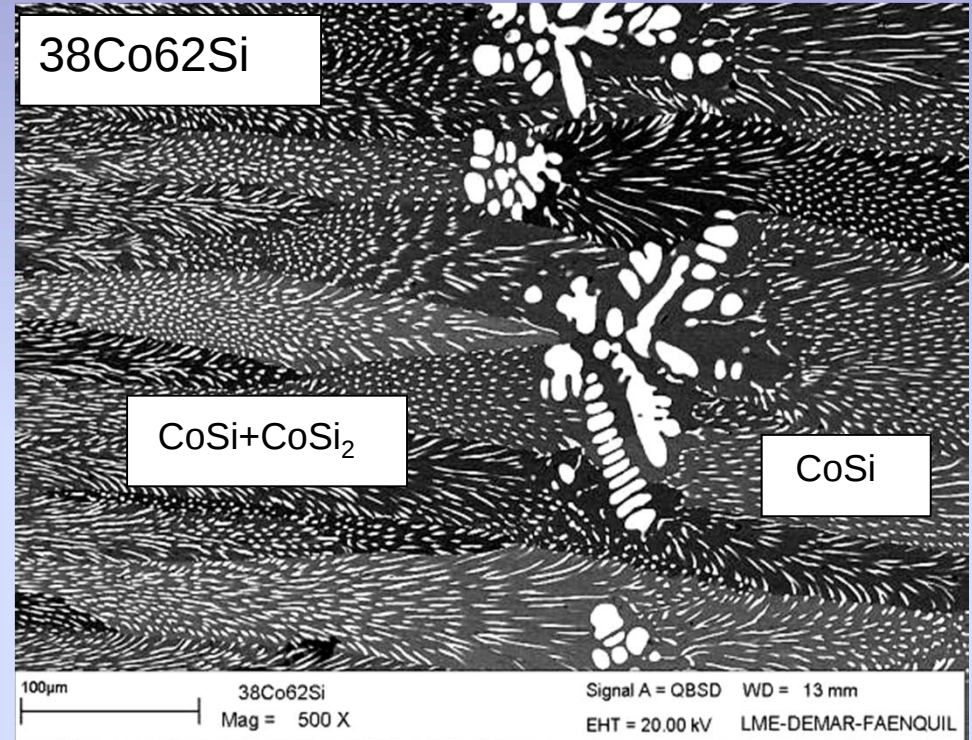
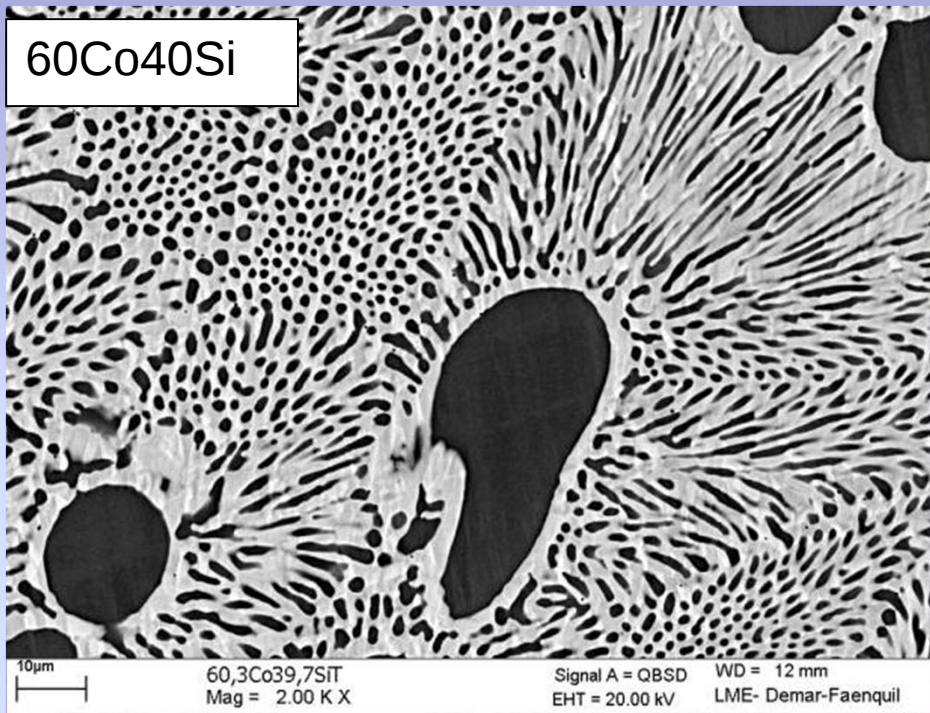
Diagrama de fases e fases na microestrutura



Sistema Fe-C

Perlita

Fases na microestrutura



Ligas do sistema Co-Si no estado bruto de fusão

Cristalografia das fases

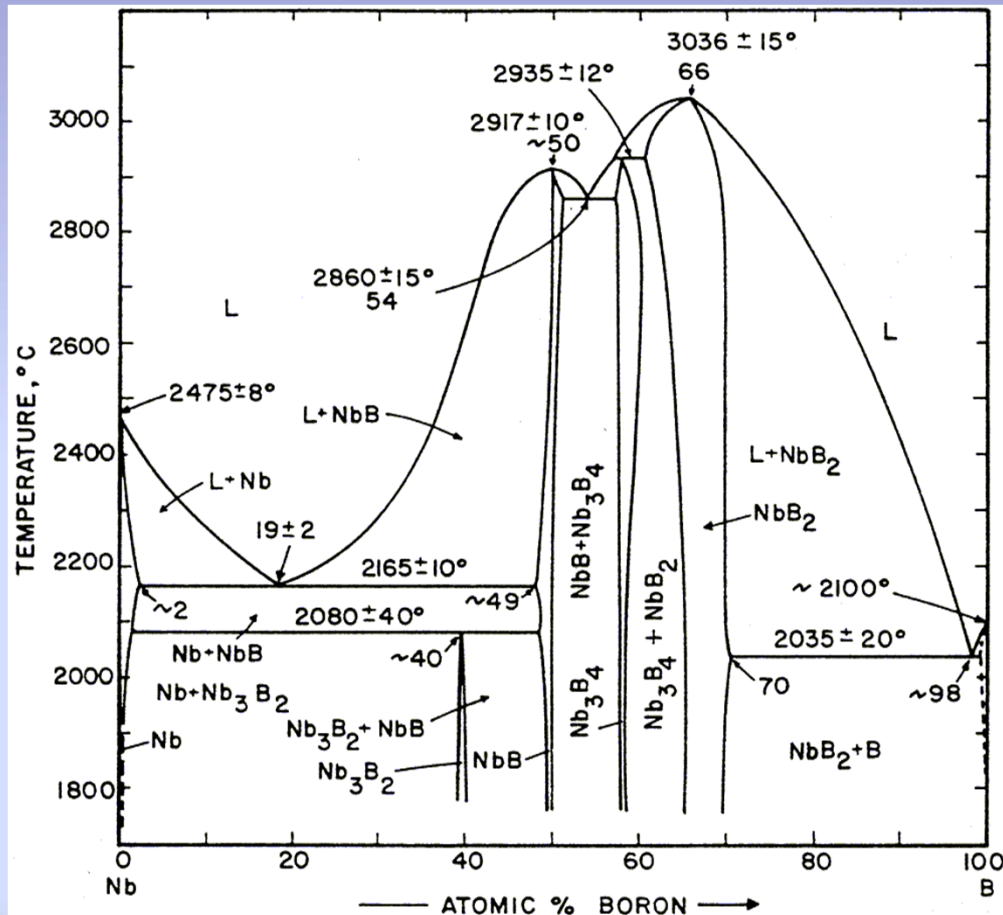
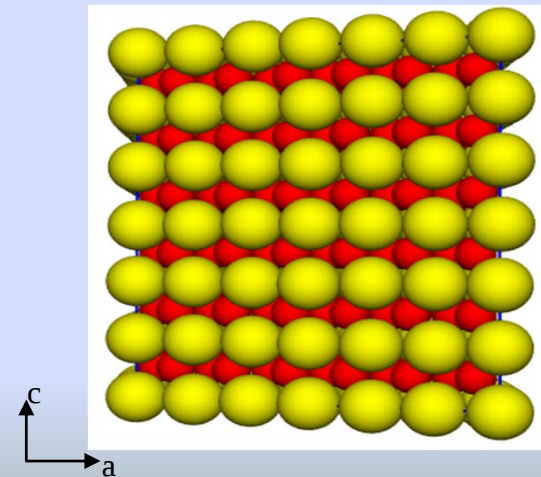
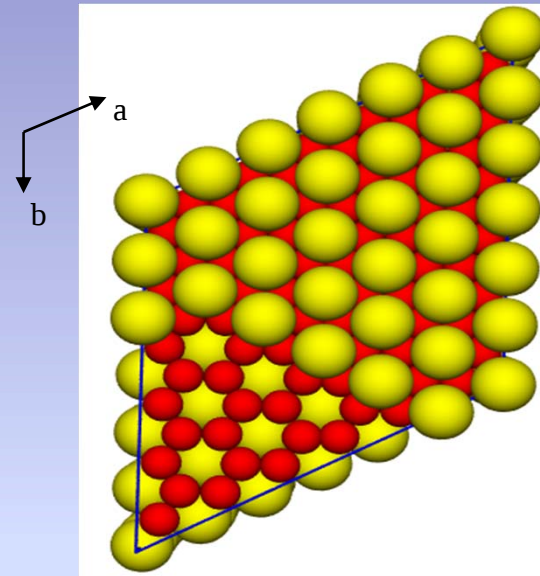
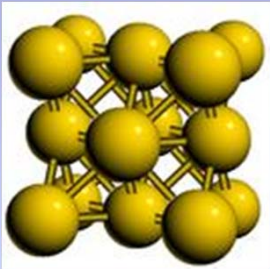


Diagrama Nb-B

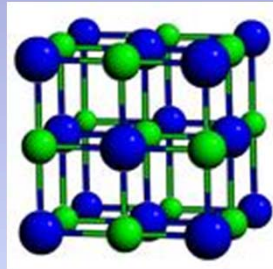


Fase NbB₂

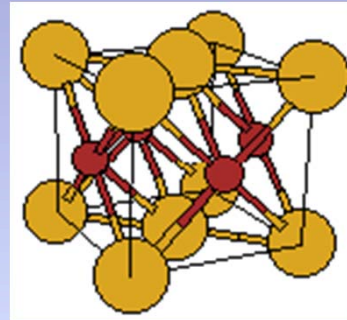
Fases ordenadas com base em CFC, CCC ou HCP



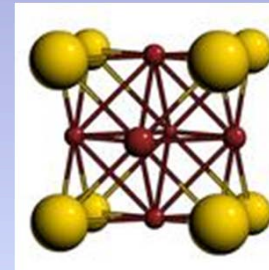
A1



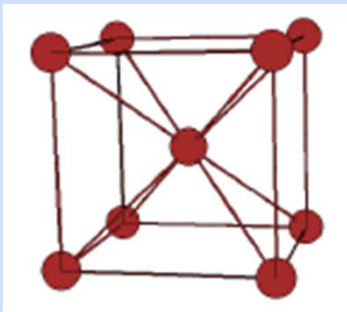
B1



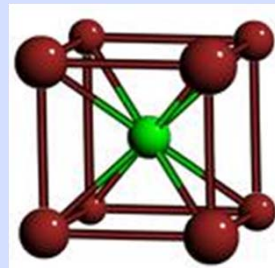
L1₀



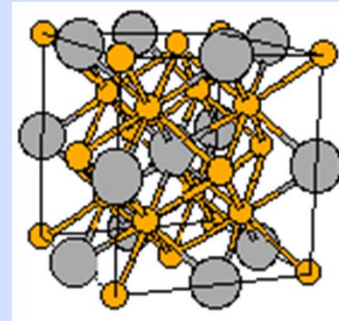
L1₂



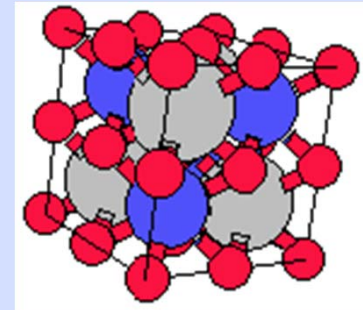
A2



B2

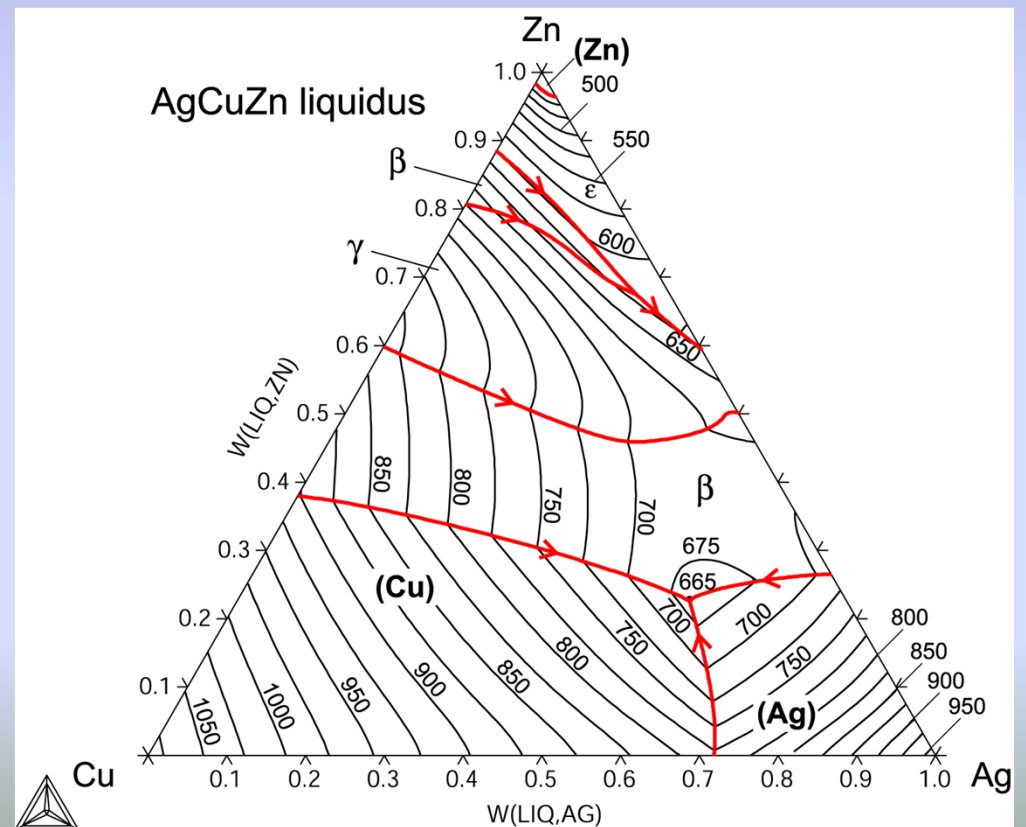
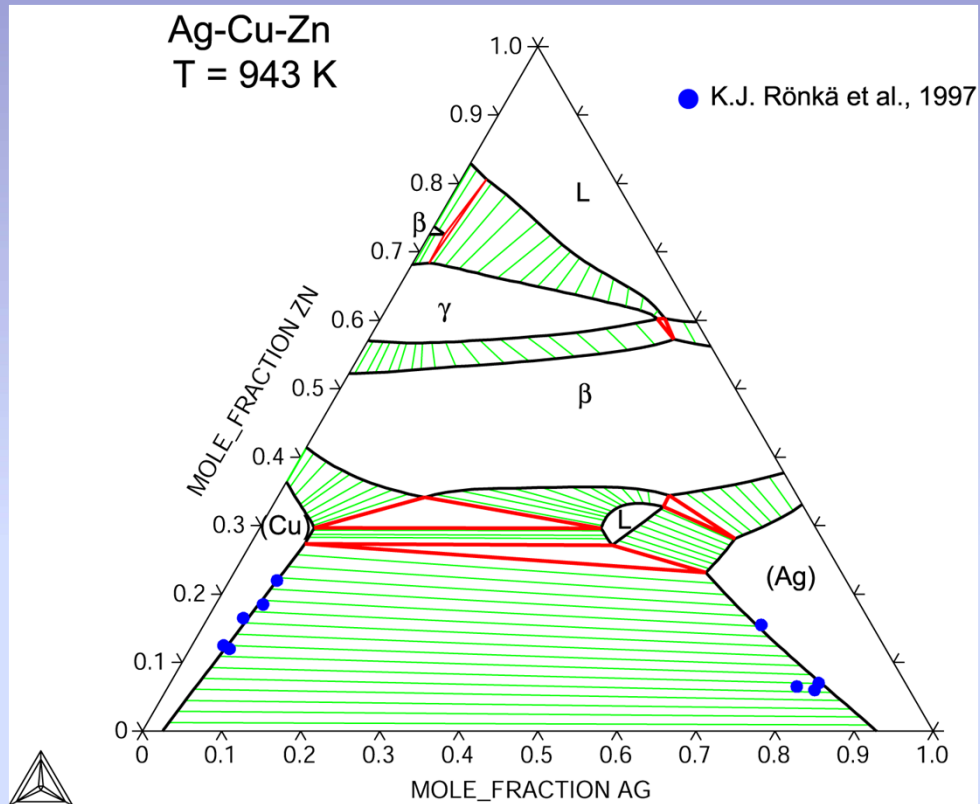


D0₃



L2₁

Representação : Sistemas Ternários



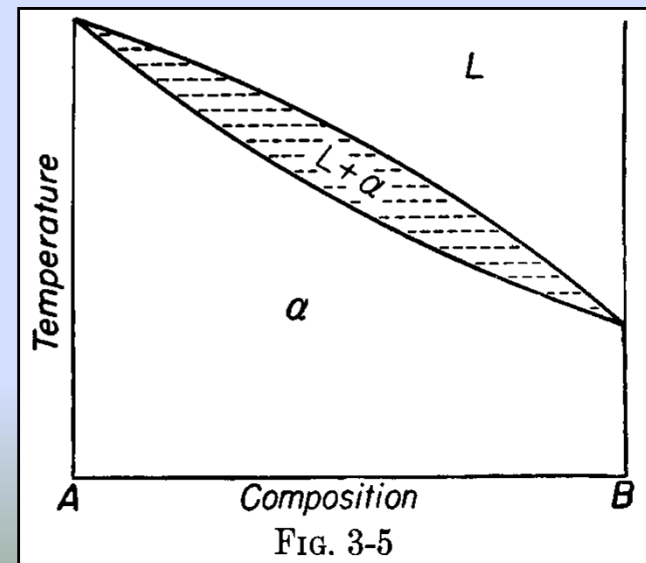
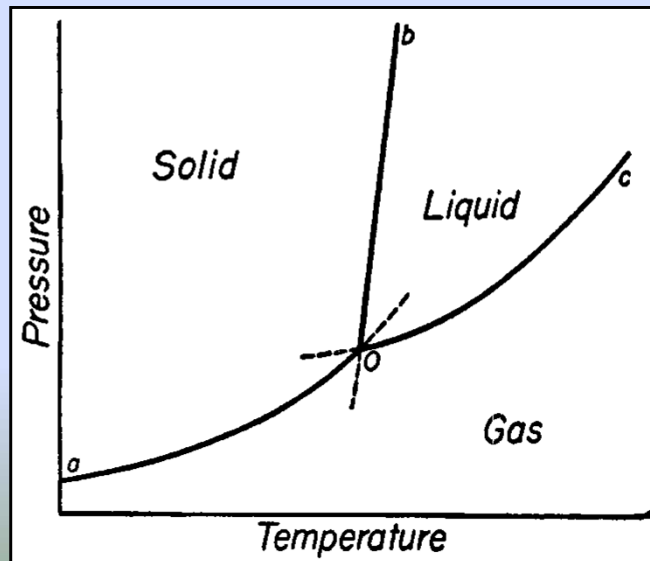
Constituição e Diagramas de Fases

DIAGRAMA

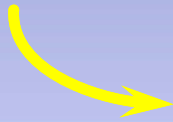
Variáveis termodinâmicas

- Pressão
- Temperatura
- Composição

FASE

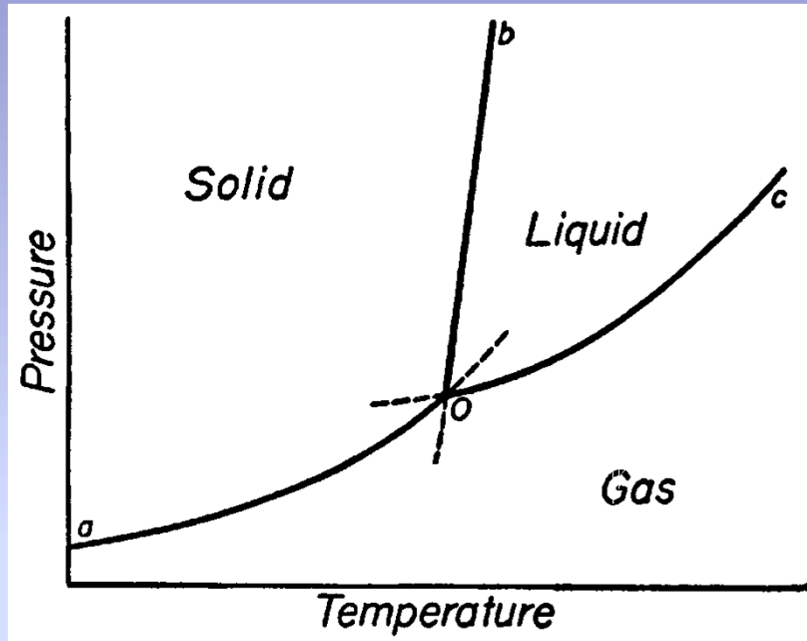


CONSTITUIÇÃO



- Calor específico, entalpia, entropia
 - Energia livre
 - EQUILÍBRIO
- (tempo?!? materiais na engenharia?!?)

REGRA DAS FASES



$$P + F = C + 2$$

$$(F = m - n)$$

P número de fases em equilíbrio (restrições)

F grau de liberdade

C número de componentes (+2 = variáveis independentes)

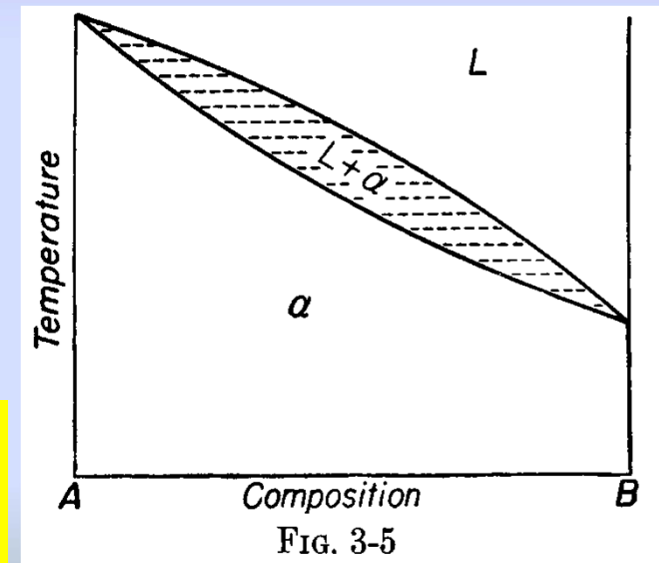
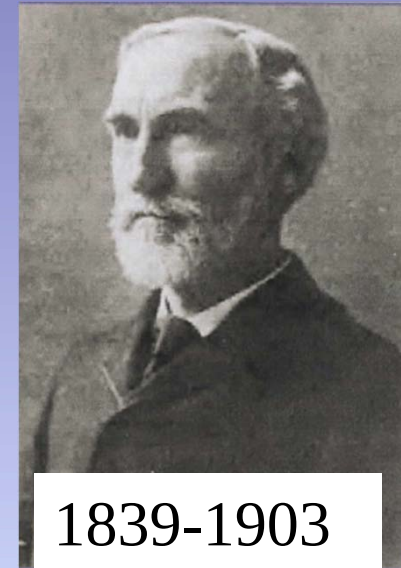
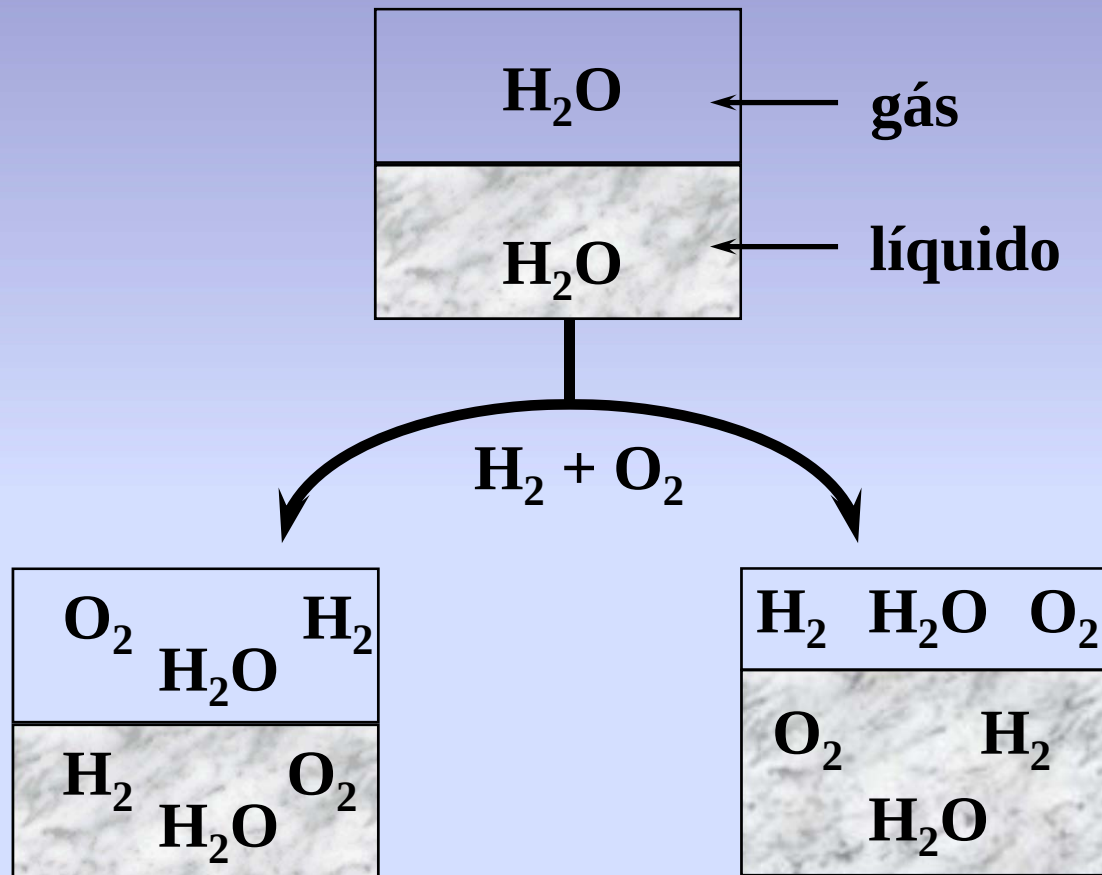


FIG. 3-5

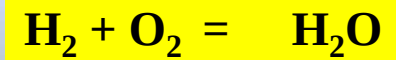
$$P + F = C + 1 \quad (P = \text{const.})$$

COMPONENTE (= ELEMENTO?)



baixa T
•2 elementos
•3 componentes

alta T
•2 elementos
•2 componentes



Fase

é qualquer porção homogênea de um sistema.

Diferentes porções homogêneas à mesma temperatura, pressão e composição como gotas ou grãos, são consideradas como a mesma fase.

Componente

o número de componentes de um sistema é o menor número de variáveis constituintes independentes através das quais a composição de cada fase envolvida no equilíbrio pode ser expressa.

Quantos componentes em cada um destes diagramas?

