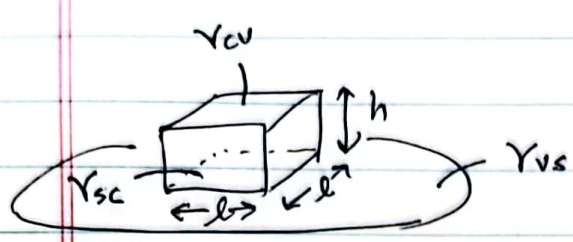
HW #4 20222980 정대훈.

1.



$$\Delta G = -l^2 h \Delta G_v + l^2 \gamma_{cv} + 4lh\gamma_{cv} + l^2\gamma_{sc} - l^2\gamma_{vs}$$
$$= -l^2 h \Delta G_v + l^2 \Delta\gamma + 4lh\gamma_{cv} \quad (\Delta\gamma = \gamma_{cv} + \gamma_{sc} - \gamma_{vs})$$

h, l are independent varinbles.

The critical size is where the signs of $\frac{\partial \Delta G}{\partial h}$ and $\frac{\partial G}{\partial l}$ change from (+) to (-)

$$\rightarrow \left.\frac{\partial \Delta G}{\partial h}\right)_{h^*, l^*} = -l^{*2}\Delta G_v + 4l^*\gamma_{cv} = 0 \quad \cdots ①$$

$$\therefore l^* = \frac{4\gamma_{cv}}{\Delta G_v} \quad \cdots ②$$

$$\left.\frac{\partial \Delta G}{\partial l}\right)_{h^*, l^*} = -2l^*h^*\Delta G_v + 2l^*\Delta\gamma + 4h^*\gamma_{cv} = 0.$$

from ②, $-\frac{4\gamma_{cv}}{\Delta G_v} h^* \Delta G_v + \frac{4\gamma_{cv}}{\Delta G_v}\Delta\gamma + 2h^*\gamma_{cv} = 0$

$$\rightarrow \frac{2\Delta\gamma}{\Delta G_v} = h^* \quad \cdots ③$$

with the values from ②, ③,

$$\Delta G^* = -\frac{16\gamma_{cv}^2}{\Delta G_v^2}\cdot\frac{2\Delta\gamma}{\Delta G_v}\Delta G_v + \frac{16\gamma_{cv}^2}{\Delta G_v^2}\Delta\gamma + \frac{32\gamma_{cv}^2\Delta\gamma}{\Delta G_v^2}$$

$$= \frac{16\gamma_{cv}^2\Delta\gamma}{\Delta G_v^2}$$

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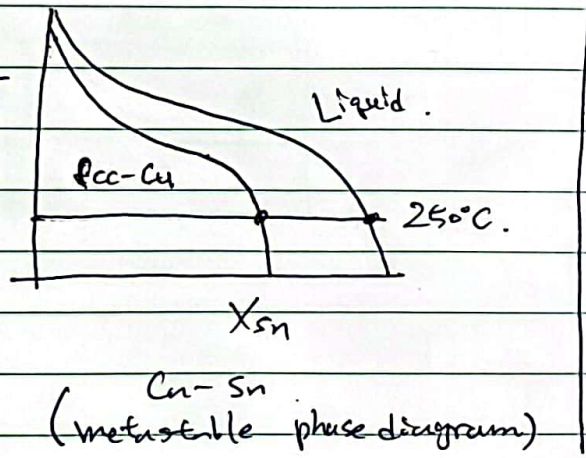
2. 1) "Prediction of Interface Reaction Products ~ "

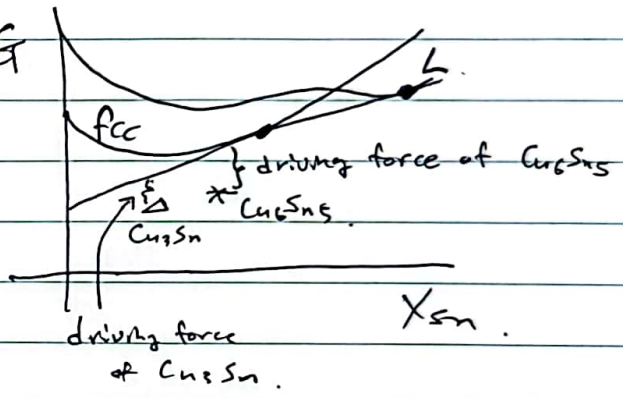
$$I = f_0 N_0 \exp(-\Delta G^*/kT) \qquad \Delta G^* \propto \frac{\gamma^3}{(\Delta G_v)^2} f(\theta)$$

Which phase will form during soldering process can be predicted by the driving force (ΔG_v).

① Binary system

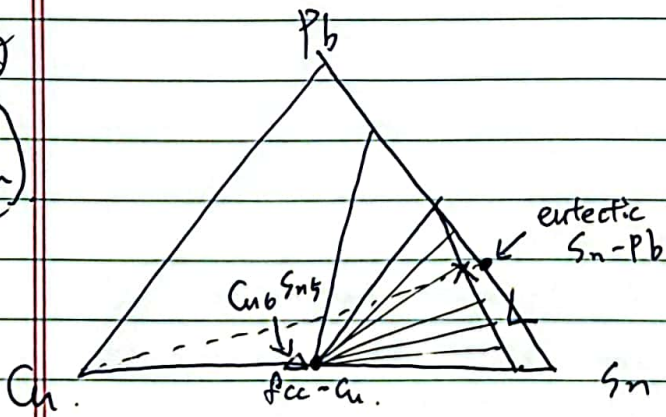


Cu-Sn (metastable phase diagram)



- From the above diagram, the phase with the highest driving force is Cu_6Sn_5.

② Ternary system



* assumption : the ratio of liquid elements (Pb/Sn) is the same as initial value.

- from the metastable phase diagram, the composition of Cu at the interface is fixed at a point, and the composition of liquid is determined by the tie-line where the line connecting the eutectic composition and Cu meets.

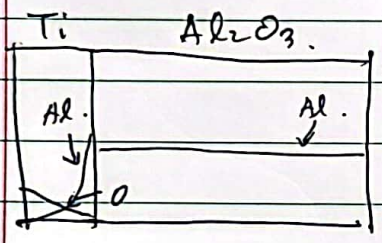
2. 2) "prediction of Ti/Al_2O_3 interface reaction products ~ "

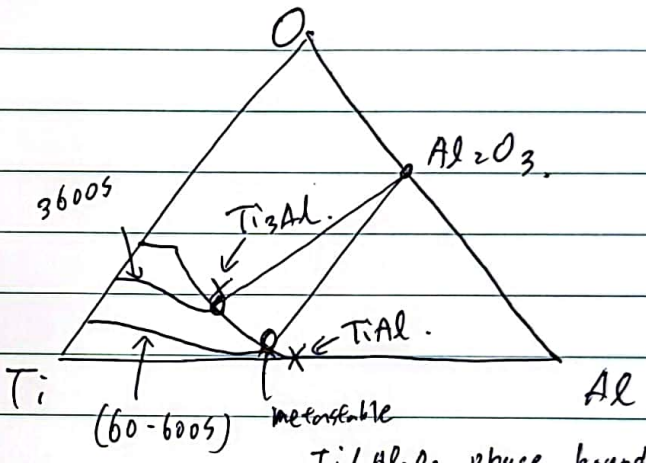
solid (Ti) / solid (Al_2O_3) interface reaction.

The assumption that the initial ratio of elements is the same doesn't hold for this case.

→ diffusion simulation was performed to calculate the interface composition of βTi.

(60 / -600s)





- Due to the higher diffusivity of O than Al, interface composition follows the isopotential lines of O.

- During 60 - 600s reaction time, the interface composition does not change much, which means saturation of O in Ti occurs first.

- In the initial stage of the reaction, the composition of Ti is close to TiAl phase, so TiAl has the highest driving force of formation.

- In the later stages, interface composition moves to the point where Ti_3Al is stable, so TiAl will transform to Ti_3Al phase.