Activity #2 - Solution

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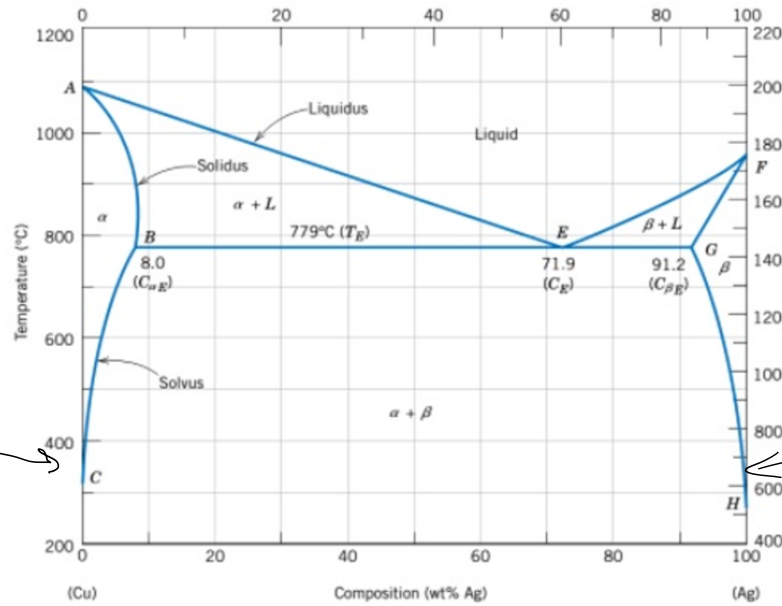
Activity #2 "Solution"



Our alloy is 95% Cu & 5% Ag ↳ both wt. %.

At room temp (I use 20°C), we have 2 phase system. Since the solvus curves reach the boundaries at points C & H, well above 20°C, then there is no solubility of Cu in Ag or Ag in Cu. This means α is pure Cu & β is pure Ag so don't need to consider impurity scattering within α or β.

At 20°C $\rho_{Cu}^{20} = 15.7\,n\Omega m\left[1 + \frac{1}{232}(20\,K)\right] = 17.053\,n\Omega m$

$\rho_{Ag}^{20} = \ldots\ 15.797\,n\Omega m$

These are similar, so can use series mixtures rule

$$\rho_{eff}^{20} = \chi_{Cu}\rho_{Cu}^{20} + \chi_{Ag}\rho_{Ag}^{20}$$

⇒ Need volume fractions

Since $\chi_{Cu} + \chi_{Ag} = 1$, just find one: $\chi_{Cu} = 1 - \chi_{Ag}$

$$\chi_\beta = \frac{w_\beta d_{alloy}}{d_\beta} \Rightarrow \frac{w_{Ag} d_{alloy}}{d_{Ag}}$$ since β is pure Ag.

densities

$$d_{alloy} = \left[\frac{w_{Ag}}{d_{Ag}} + \frac{w_{Cu}}{d_{Cu}}\right]^{-1} \Rightarrow d_{alloy} = 9.0262\ g/cm^3$$

$\approx 10.50\ g/cm^{-3}$ $\qquad$ $8.96\ g/cm^3$

$\Rightarrow$ $X_{Ag} = 0.04298$

$$\boxed{\rho_{eff}^{20} = 16.999\ n\Omega m}$$ $\leftarrow$ almost the same as pure Cu, which might be expected.

Can use Reynolds & Hough to check series mixtures rule.
$\hookrightarrow$ get $16.996\ n\Omega m$, so mixtures rule is pretty good.

At $800\,°C$, have a single phase alloy isomorphous solid solution. So now Ag is dissolved in Cu & acts as impurity.

$$\Rightarrow \quad \rho_{eff}^{800} = \rho_{Cu}^{800} + C X_{Ag}(1 - X_{Ag})$$

atomic fraction.

$$\rho_{Cu}^{800} = 69.838\ n\Omega m$$

$$X_{Ag} = \frac{w_{Ag}/m_{Ag}}{\frac{w_{Ag}}{m_{Ag}} + \frac{w_{Cu}}{m_{Cu}}} = 0.03007$$

107.87 g/mol $\qquad$ 63.55 g/mol

With $C = 2800\ n\Omega m$ for Nordheim coeff.

$$\Rightarrow \quad \boxed{\rho_{eff}^{800} = 152\ n\Omega m}$$ $\leftarrow$ much higher than $20°C$.

So what's the change in power?

$$\%\Delta\ \text{power} = 100\left(\frac{P_{800} - P_{20}}{P_{20}}\right) = \frac{\cancel{I^2} R_{800} - \cancel{I^2} R_{20}}{\cancel{I^2} R_{20}}$$

$\hookrightarrow$ I assume the current stays constant.

$$= \%\Delta\ \text{power} = \left(\frac{\rho_{eff}^{800} - \rho_{eff}^{20}}{\rho_{eff}^{20}}\right)100 = \boxed{791\%}\ !!$$

That's too much of a change.