Homework for Lecture 10, 11, 12

A liquid metal ($\alpha$ phase) is contained in a container ($\delta$ phase). Assume the melting point of the metal is $T_m = 1500$ K, the molar heat of melting is $\Delta H_M = H_L^0 - H_S^0 = 16000$ J/mol, and the molar volume (for both the liquid and solid phase) is $V_M = 10^{-5}$ m$^3$/mol. Now, we super-cool the liquid metal to $T = 1000$ K,

1). What is the critical radius of homogeneous nucleation for solidification, if the interface energy between liquid ($\alpha$) and solid ($\beta$) phase, $\gamma_{\alpha \beta} = 0.1$ J/m$^2$?

2). If the interfacial energy between the liquid and the container is $\gamma_{\alpha \delta} = 0.15$ J/m$^2$ and that between the metal solid and the container is $\gamma_{\beta \delta} = 0.1$ J/m$^2$, what is the contact angle of the heterogeneous nucleus on the container wall?

3). What is the volume of the critical heterogeneous nucleus on the container wall? Draw a schematic diagram of the nucleus on the container wall.

Answer: covered in Lecture 10, 11, 12