06K: Problems Related to REDOX Reactions

Practice Homework Problems

1. Interpretation

Consider the following reaction

$$AO + B = BO + A \qquad (1)$$

(i) In the above reaction which species is being oxidized (and the other reduced).

(ii) Describe in words how you can visualize whether or not the reaction will move towards reduction or towards oxidation at a given temperature.

2. Analysis

(i) Write down the "Gibbs Free Energy Balance" equation for the reaction (1) in terms of the chemical potentials of the standard states of the four species in the equation and their activities. All species are in the solidstate.

(ii) Assume that the overall composition of the material system is $0.4A + 0.4B + 0.2O$ where the fractions are expressed as mole fractions. The energy of formation from the standard states is given by

ΔG^o_{AO} and ΔG^o_{BO}, where $\Delta G^o_{BO} = 2\Delta G^o_{AO}$.

Assume that in the final equilibrium state (at T Kelvin) the oxides are formed in their pure state by A and B remain atomically mixed with their activities being equal to their mole fractions in the alloy.

Write an equation that relates the activities of A and B to ΔG^o_{BO}. Note that $a_A + a_B = 1$

If ΔG^o_{BO} 50 kJ mol^{-1} and the temperature is 1000 K, calculate the activities of A and B.

3. The Example from drawn from Notes on the redox reaction $Cu_2O + Si = Cu + SiO_2$

A further question (please refer to the notes)

What will happen if the alloy was directly heated in air?

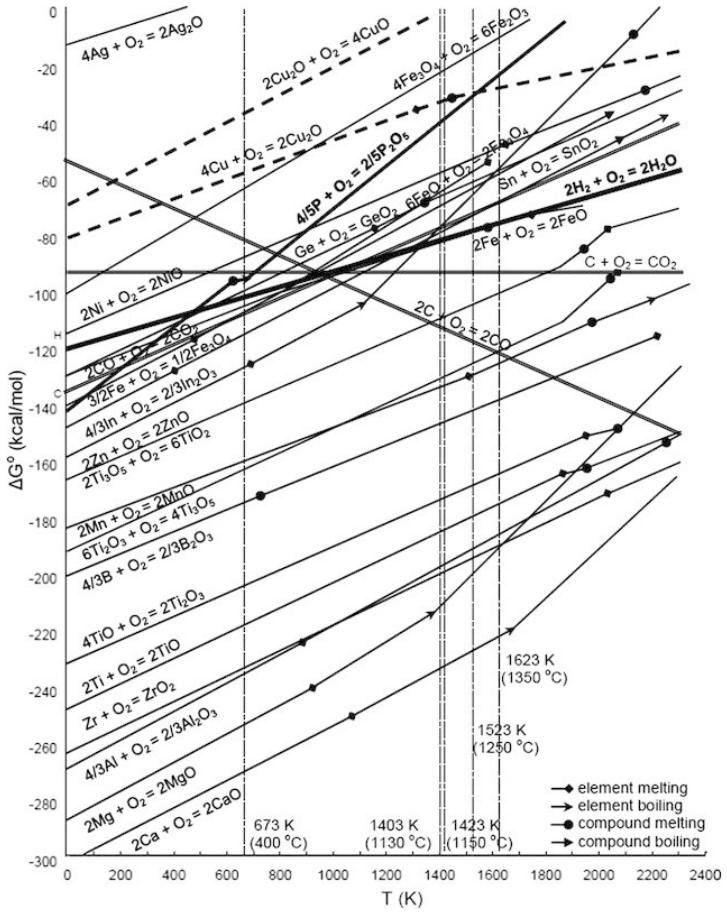
The oxygen activity in air will react first with copper to form the oxide. The oxide will continue to grow and forming a thick layer. Therefore we shall be oxidizing copper rather than the silicon atoms within the copper alloy.

Ellingham diagrams will inform you whether you will form Cu_2O or CuO. The answer to this question comes from considering the reaction

$$2Cu_2O + O_2 = 2CuO$$

Again we can quickly look up the partial pressure of oxygen for Cu_2O and CuO: whichever has the lower partial pressure will oxidize.

The Ellingham diagram below gives the line for the reaction $2Cu_2O + O_2 = 2CuO$. You can read the oxygen pressure where this reaction in in equilibrium. If the pressure is higher then the reaction will move to the right



HW Question: from the data given in the diagram on the left can you draw the line for the reaction:

$2Cu + O_2 = 2CuO$ check your answer below