University of Alberta
Department of Chemical and Materials Engineering

Lecturer: Dr. Stojan Djokić

MAT E 201
Materials Science I

Assignment No.4 **(14 marks)**
January 31, 2020
Due Date: February 7, 2020 by 3:00 pm

1. Number of vacancies in BCC chromium at room temperature (25 ^{o}C) is $4.78 \cdot 10^{7}$ vac./cm^{3}. a) Calculate the energy required to produce a mol of vacancies. b) At what temperature in ^{o}C the fraction of lattice points occupied by vacancies is 10^{-3}, if the energy required to create vacancies in chromium is 85 kJ/mol? **(3 marks)**

2. HCP titanium has the lattice parameters a_o = 2.9503 Å and c_o = 4.6831 Å. If the density of a sample of titanium is 4.502 g/cm^{3}, calculate a) the fraction of the lattice points that contains vacancies and b) the total number of vacancies in a cubic centimetre. **(3 marks)**

3. At 575 ^{o}C atoms are found to move from one lattice position to another at the rate of $8 \cdot 10^{8}$ jumps/s. If the activation energy for the movement is 300 kJ/mol, calculate the temperature in ^{o}C at which the jump rate is $9 \cdot 10^{13}$ jumps/s. **(2 marks)**

4. A change of number of vacancies in a material is related to temperature by an Arrhenius equation ($n_v = n_o \exp(-\frac{Q}{RT})$). If the fraction of lattice points containing vacancies at 900 ^{o}C is $3.85 \cdot 10^{-2}$ determine the activation energy Q. **(3 marks)**

5. A 0.5 mm thick wafer of silicon is treated so that uniform concentration gradient of arsenic (-0.0175 at.% As/cm) is produced. If the bottom surface contains 1 As atom per 10^{7} Si atoms determine the number of As atoms per 10^{7} Si atoms on the top surface of the wafer. The lattice parameter for Si is 5. 407 Å. Calculate the concentration gradient in As [atoms/cm^{3} cm]. **(3 marks)**