MATE 318

Spring 2025

Homework #3

Due: May 2nd 2025

Group submission (up to 3 students per group) is allowed.

Question 1:

Iron and vanadium both have the BCC crystal structure and V forms a substitutional solid solution for concentrations up to approximately 20 wt% V at room temperature.

An X-ray diffraction experiment was performed on an iron-vanadium alloy using Cu Kα (λ = 0.1542 nm) and the first recorded diffraction peak (lowest hkl) was found at 44.502° (2θ). What is the vanadium concentration of this alloy in weight percent? State any assumptions you made.

Question 2:

For the A-B alloy system, five powder samples with different compositions were prepared and their XRD measurements were taken using Co K_α x-rays at some temperature T.
Use the data given below and determine
 a) the maximum solubility of B in A rich α phase at T.
 b) the lattice parameter of the α phase corresponding to the maximum solubility.

Show your work.
Note: A has FCC and B has BCC crystal structures.
For Co Kα λ = 0.17903 nm

Sample #	Composition (wt.% B)	2θ of the (331) plane of A rich α phase
1	0	145.47
2	10	139.35
3	20	134.05
4	30	130.82
5	40	130.82

Question 3:

Below is a portion of an x-ray diffraction pattern of a quenched steel obtained using Cr K_α (λ = 0.2291 nm). Determine the fraction of retained austenite in this steel assuming that <u>the intensity of each diffraction peak can be calculated from the area under that peak.</u> State any other assumptions you make. <u>Show your work.</u>
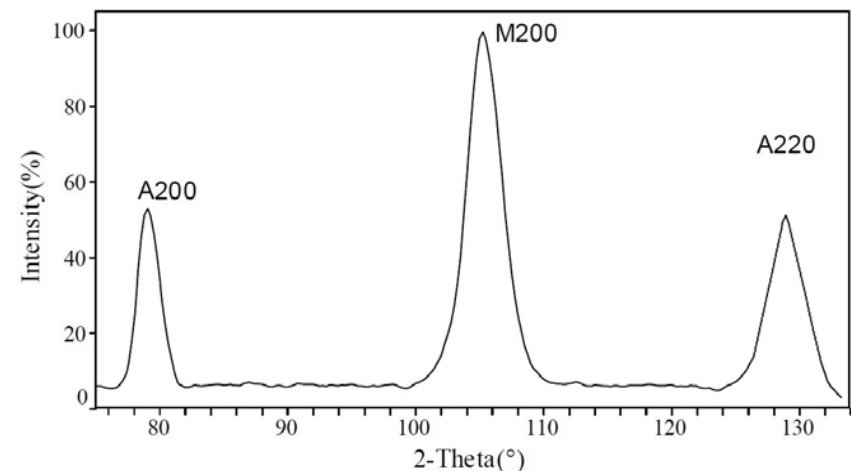
Question 4:

Using Cu K$_\alpha$ (λ= 0.15418 nm), an XRD measurement was made on a piece of single crystal M while it was under uniform elastic stress applied on its (010) surfaces.

What is the nature (tensile or compressive) and magnitude of this applied stress (in MPa) if the diffraction from the (001) planes was detected at 25.2654° in 2θ?

M has a simple cubic crystal structure with a lattice parameter of 0.35239 nm. Assume that it is isotropic in terms of its elastic behavior with an elastic modulus of 207 GPa. Take the Poisson's ratio as 0.31.

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