ESO 205T

Nature and Properties of Materials

Interaction session: 11-12 Monday
Tutorial: 11-12 Thursday

Assignment 5

Due by 22 October 2020 11 am

Question 1

Determine the activation energy for vacancy formation in aluminium if the equilibrium concentration of vacancies at 600 ˚C is 9×10^{23} m^{-3}.

Given: Atomic weight of aluminium= 27 g/mol and density = 2.60 $g.cm^{-3}$ at 600 ˚C

Question 2

Determine the concentration of Frenkel defects in ZnO at 1000 ˚C.

Given: Atomic weight and density of ZnO at 1000 ˚C is 2.5 eV and 5.5 $g.cm^{-3}$ respectively.

Question 3

We have seen the NaCl structure in great details. Determine the size of the tetrahedral site on MgO where the Mg^{2+} interstitial is found in a Frenkel defect. Compare the size of the tetrahedral void in MgO with that with only the O^{2-} sublattice.

Given: radius of Mg^{2+} and O^{2-} ions is 0.086 nm and 0.126 nm respectively. Assume anion-cation contact along the cell edge to determine the lattice parameter of MgO. For only oxygen ion sublattice, consider anions touching along 110.

Question 4

There is nothing like a pure material. One can obtain four 9 purity level that is 99.9999% pure material. Impurity content in such a material is 100 ppm. Write down the Kroger-Vink notation for defects in the following materials procured from Alfa Aesar. Also write down the chemical formulae of the compounds.

NaCl with $CdCl_2$ impurity

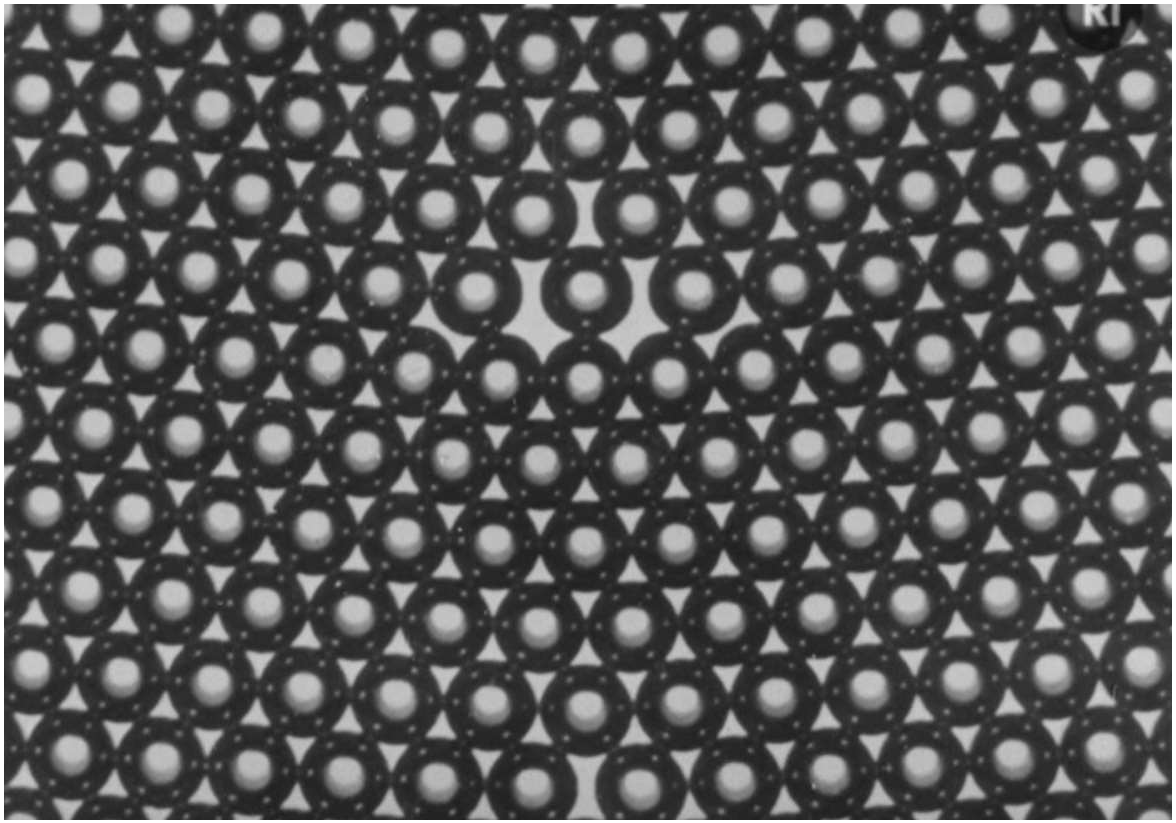
ZrO_2 with CaO impurity

Question 5

We have seen high resolution transmission electron image of Ti-Al showing atomic layers to apply the FSRH rule to determine the Burgers vector of the dislocation in the alloy. An easy way to study atomistic processes like dislocation motion, grain growth and diffusion by preparing a bubble raft. Think of sitting in a bath tub and having a lot of controlled froth around you. Quite a nice feeling but the bubble raft is used to study many processes in materials science. Spot the dislocation and mark the Burgers vector in the bubble raft shown on the next slide.

Check some cool videos here
http://homepages.cae.wisc.edu/~stone/bubble%20raft%20movies.htm

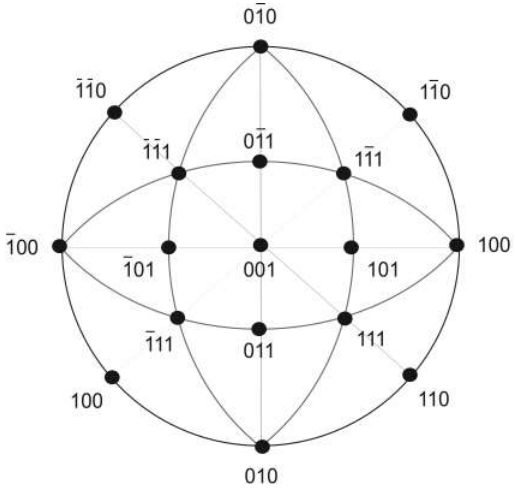
And a tweet too
https://twitter.com/bmatb/status/950368240408113152



Question 6

Determine the Schmid factor for single crystal of FCC aluminium with orientation of 001, 101, 111, 112 and 123 for tension along the axis. The 12 possible octahedral slip systems are provided below and you can write a simple program or even use excel for the same. Look at the number of slip systems with the highest Schmid factor and try to link this with stereographic projection.

Use some coding at least excel to make your life easy



Slip plane			Slip direction		
1	1	1	-1	0	1
1	1	1	0	-1	1
1	1	1	1	-1	0
-1	1	1	1	0	1
-1	1	1	0	1	-1
-1	1	1	1	1	0
1	-1	1	1	0	-1
1	-1	1	0	1	1
1	-1	1	1	1	0
1	1	-1	1	0	1
1	1	-1	-1	1	0
1	1	-1	0	1	1