BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
MIDSEMESTER EXAMINATION (Open Book)
2022-23 I SEM
PHYSICS OF ADVANCED MATERIALS PHY F414
TIME 90MINS 90 MARKS DATE: 2.11.2022

1. Find the miller indices of all the directions of maximum linear density for (i) (111) plane in FCC unit cell and $(\bar{1}01)$ plane in a BCC unit cell. **[8]**

2. BCC lithium contains one vacancy per 200 unit cells. Calculate the vacancy concentration (vacancies/$cm^3$) and mass density (g/$cm^3$). **Given: atomic weight of Li = 6.94 g/mol, atomic radius = 0.152 nm. [10]**

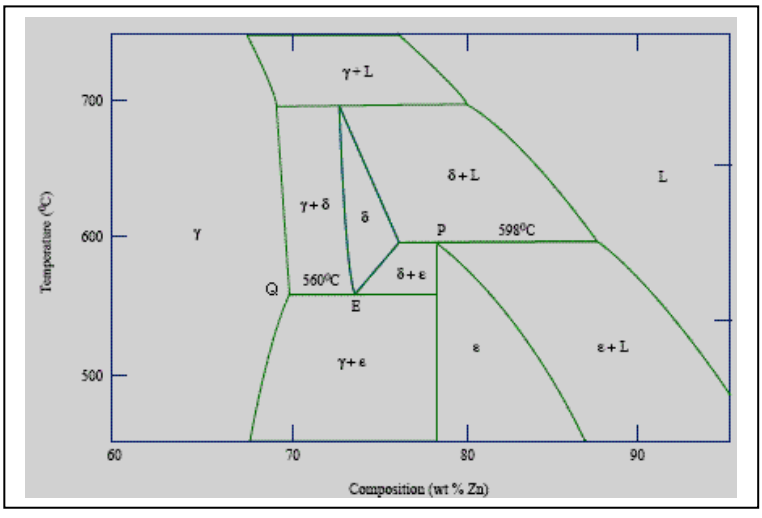
3. Given: ionic radii of Ni and oxygen as 0.069 nm and 0.14 nm, respectively. Write down the basis (atomic positions in a unit cell) of NiO. Find the packing fraction. Find the total Linear density of [110] direction and planar density of (110). **[16]**

4. A piece of Aluminum metal originally contains one copper atom for every ten million Aluminum atoms. In order to form an alloy with copper, a concentration of 500 copper atoms for every ten million Aluminum atoms is maintained at the surface of the metal piece. For an operating temperature of 700 $^0$C at what depth below the surface after 500 h the concentration corresponding to 40 atoms of Cu for every 10 million of Al atoms will be achieved? **[12]** **Given for Cu in Al: $D_0$ = 6.5 x$10^{-5}$ $m^2$/s, $Q_d$ =1.41 eV/atom)**

5. If same concentration of 40 atoms of Cu for every 10 million of Al atoms is to be achieved after 500 hrs at a depth of 5mm, calculate the operating temperature **[8]**

6. A region of Cu-Zn phase diagram has been enlarged to show the eutectoid point (E). The compositions corresponding to points Q, E and P are 70, 74 and 78.6 % of Zn respectively. For a 20 kg of 72 % Zn alloy, just below the eutectoid temperature, Calculate the amount of

(i) total γ and total ε phases. **[6]**
(ii) primary ε and eutectoid phase. **[6]**
(iii) γ in the eutectoid phase. **[6]**
(iv) Volume fraction of eutectoid and ε phase. **[8]**




- **Densities of Cu and Zn are 8.94 and 7.13 g/$cm^3$**

**7.** For a BCC crystal consider bond energy per atom to be E Joules. Would you expect the surface energy for a (110) plane to be greater or less than that for a (100) plane? Justify. **[10]**

**Table 5.1 Tabulation of Error Function Values**

| $z$ | $erf(z)$ | $z$ | $erf(z)$ | $z$ | $erf(z)$ |
|---|---|---|---|---|---|
| 0 | 0 | 0.55 | 0.5633 | 1.3 | 0.9340 |
| 0.025 | 0.0282 | 0.60 | 0.6039 | 1.4 | 0.9523 |
| 0.05 | 0.0564 | 0.65 | 0.6420 | 1.5 | 0.9661 |
| 0.10 | 0.1125 | 0.70 | 0.6778 | 1.6 | 0.9763 |
| 0.15 | 0.1680 | 0.75 | 0.7112 | 1.7 | 0.9838 |
| 0.20 | 0.2227 | 0.80 | 0.7421 | 1.8 | 0.9891 |
| 0.25 | 0.2763 | 0.85 | 0.7707 | 1.9 | 0.9928 |
| 0.30 | 0.3286 | 0.90 | 0.7970 | 2.0 | 0.9953 |
| 0.35 | 0.3794 | 0.95 | 0.8209 | 2.2 | 0.9981 |
| 0.40 | 0.4284 | 1.0 | 0.8427 | 2.4 | 0.9993 |
| 0.45 | 0.4755 | 1.1 | 0.8802 | 2.6 | 0.9998 |
| 0.50 | 0.5205 | 1.2 | 0.9103 | 2.8 | 0.9999 |