Examination Answers: EEE402

Solutions to Numerical Questions

1(c) Plane spacing $d_{hkl} = a_0 / \sqrt{(h^2 + k^2 + l^2)}$

With $a_0 = 0.5646$nm

For (011) $d_{011} = 0.5646/\sqrt{(0 + 1 + 1)}$nm
$= 0.3992$nm

For (111) $d_{111} = 0.5646/\sqrt{(1 + 1 + 1)}$
$= 0.3260$nm

For (122) $d_{122} = 0.5646/\sqrt{(1 + 4 + 4)}$
$= 0.1882$nm

For (115) $d_{115} = 0.5646/\sqrt{(1 + 1 + 25)}$
$= 0.1087$nm

1(d) [-101]·[111] = 0: then the [-101] direction lies in the (111) plane.
[100]·[011] = 0: then the [100] direction lies in the (011) plane.

2(c) Calculation of time for layer regrowth:

i) velocity $= v_0[\exp(-E_A/kT)]$

$= 3.68 \times 10^8 [\exp(-2.76/8.61 \times 10^{-5} \times 873)]$

$= 3.68 \times 10^8 \times 1.130 \times 10^{-16}$cm/s

$= 4.16 \times 10^{-8}$cm/s

ii) time required to regrow 1.5×10^{-5}cm:

$= 1.5 \times 10^{-5} / 4.16 \times 10^{-8}$s

$= 361$s

3(c) The initial As concentration in the crystal is: 0.05x0.3% = 0.015%

If C_0 is initial concentration of impurity in the melt, C_s is the final concentration of impurity in the crystal, x is the fraction of melt solidified and k_0 is the impurity segregation coefficient, then

$$C_s = k_0 C_0 (1-x)^{k_0 - 1}$$

Therefore, with $C_s = 0.09$

$$(1-x)^{k_0 - 1} = C_s / k_0 C_0$$

$$(1-x)^{-0.7} = 0.09/0.3x0.05$$

$$(1-x)^{0.7} = 0.167$$

$$1-x = 0.077$$

Thus, the required fraction of melt solidified is 0.92 (92%).