EE24BTECH11053 - S A Aravind Eswar

1) Read the two statements related to sintering and select the correct option.

Statement-1: Sintering in vacuum leads to improved densification as compared to sintering under ambient (at atmospheric pressure) condition.

Statement-2: Closed pores formed during sintering inhibit full densification. [2020 - XE]

a) Both Statement-1 and Statement-2 are FALSE
b) Both Statement-1 and Statement-2 are TRUE
c) Statement-1 is TRUE but Statement-2 is FALSE
d) Statement-1 is FALSE but Statement-2 is TRUE

2) Select the correct option that appropriately matches the process to the material/product that can be fabricated using them. [2020 - XE]

Process	**Material/Product**
(I) Power Processing	(P) Organic Semiconductor thin films
(II) Spin coating	(Q) Single crystal silicon
(III) Czochralski Process	(R) Poly-silicon
(IV) Chemical vapour deposition	(S) Porous bronze bearings

a) I-S, II-P, III-R, IV-Q
b) I-S, II-R, III-Q, IV-P
c) I-S, II-P, III-Q, IV-R
d) I-P, II-R, III-Q, IV-S

3) Consider a FCC structured metal with lattice parameter a = 3.5 Å. If the material is irradiated using X-rays of wavelength λ = 1.54056 Å, the Bragg angle (2θ) corresponding to the fourth reflection will be: [2020 - XE]

a) 88.21°
b) 76.99°
c) 99.35°
d) 93.80°

4) The number of Schottky defects per mole of KCI at 300 $^{\circ}C$ under equilibrium condition will be: [2020 - XE]
Given:
Activation energy for the formation of Schottky defect = 250 $kJ \cdot mol^{-1}$
Avogadro number = $6.023 \times 10^2 3 mol^{-1}$
Universal Gas Constant = $8.314 J \cdot K^{-1} \cdot mol^{-1}$

a) 1.21 x 10^{18}
b) 1.52 x 10^{16}

c) 9.75
d) 2.42 x 10^{12}

5) In an industry, the probability of an accident occurring in a given month is $\frac{1}{100}$ Let P(n) denote the probability that there will be no accident over a period of 'n' months. Assume that the events of individual months are independent of each other. The smallest integer value of 'n' such that P(n)$\leq \frac{1}{2}$ is _____ (*round off to nearest integer*) [2020 - XE]

6) For a FCC metal, the ratio of surface energy of {111} surface to {100} surface is _____ (round-off to two decimal places). Assume that only the nearest neighbor broken bonds contribute to the surface energy. [2020 - XE]

7) Pure silicon (Si) has a band gap (Eg) of 1.1 eV. This Si is doped with 1 ppm (parts per million) of phosphorus atoms. Si contains 5×10^{28} atoms per m^2 in pure form. At temperature T = 300 K, the shift in Fermi energy upon doping with respect to intrinsic Fermi level of pure Si will be _____ eV (*with appropriate sign and round-off to two decimal places*).
Intrinsic carrier concentration of Si, n_i, is given as:

$$n_i = 2\left(\frac{2\pi m k_B T}{h^2}\right)^{3/2} exp\left(-\frac{E_g}{2k_B T}\right)$$

Given:

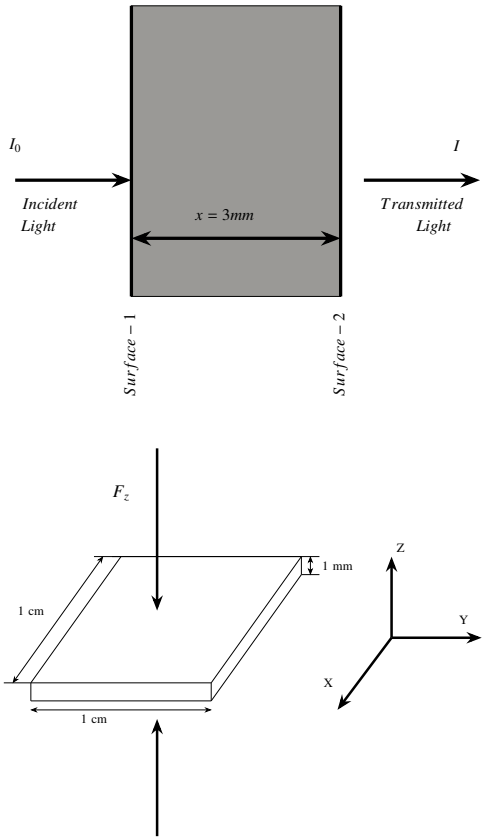
- Mass of an electron, m = $9.1 \times 10^{-31} kg$
- Charge of an electron, e =1.6×10^{-19} C
- Boltzmann constant, $K_g = 1.38 \times 10^{-23} J \cdot K^{-1}$
- Planck's constant, h = $6.6 \times 10^{-34} J \cdot s$

[2020 - XE]

8) The schematic diagram shows the light of intensity Io incident on a material (shaded grey) of thickness, x, which has an absorption coefficient, α and reflectance, R. The intensity of transmitted light is I. The reflection of light (of a particular wavelength) occurs at both the surfaces (surfaces indicated in the diagram). The transmittance is estimated to be _____ (*round-off to three decimal places*).
Given that for the wavelength used, $\alpha = 10^3$ m^{-1} and R = 0.05. [2020 - XE]

9) Fe_3O_4 (also represented as $FeO.Fe_2O_3$) is a FCC structured inverse spinel (AB_2O_4) material where 1/8 of tetrahedral sites are occupied by half of B cations and 1/2 of the octahedral sites are occupied by remaining B and A cations. The magnetic moments of cations on octahedral sites are antiparallel with respect to those on tetrahedral sites. Atomic number of Fe is 26 and that of O is 8. The saturation magnetic moment of Fe_3O_4 per formula unit in terms of Bohr magnetons (μ_B) will be _____ μ_B. Ignore contribution from orbital magnetic moments. [2020 - XE]

10) A piezoelectric ceramic with piezoelectric coefficient (d_{zz}) value of 100 x 10^{-12} $C \cdot N^{-1}$ is subjected to a force, $\mathbf{F_z}$, of 10 N, applied normal to its x-y face, as shown in the figure. If relative dielectric constant (ϵ_r) of the material is 1100, the voltage developed along the z-direction of the sample will be Volts _____(*round-off to two decimal places*). Ignore any nonlinear effects.
Given: Permittivity of free space (ϵ_r) is 8.85 x 10^{-12} $F \cdot m^{-1}$. [2020 - XE]



11) Silicon carbide (SiC) particles are added to Aluminum (Al) matrix to fabricate particle reinforced Al-SiC composite. The resulting composite is required to possess specific modulus (E/ρ; E: elastic modulus, ρ: density) three times that of pure Al. Assuming iso-strain condition, the volume fraction of SiC particles in the composite will be (*round-off to two decimal places*). [2020 - XE]

Material	**E(GPa)**	$\rho(\mathbf{g \cdot cm^{-3}})$
Al	69	2.70
Si	379	2.36

12) Isothermal weight gain per unit area (ΔW/A, where ΔW is the weight gain (in mg) and A is the area (in cm^2)) during oxidation of a metal at 600 °C follows parabolic rate law, where, ΔW/A = 1.0 $mg \cdot cm^2$ after 100 min of oxidation. The ΔW/A after 500 min at 600 °C will be $mg \cdot cm^2$ (round-off to two decimal places). [2020 - XE]
13) A plain carbon steel sample containing 0.1 wt% carbon is undergoing carburization at 1100 °C in a carbon rich surroundings with fixed carbon content of 1.0 wt% all the time. The carburization time necessary to achieve a carbon concentration of 0.46

wt% at a depth of 5 *mm* at 1100 °C is _____hour (round off to the nearest integer). [2020 - XE]

Given: Diffusivity of carbon in iron at 1100 °C is $6.0 \times 10^{-11}\ m^2 \cdot s^{-1}$ and

erf(z)	**z**
0.56	0.55
0.60	0.60
0.64	0.65
0.68	0.70