2011-XE-'53-65'

EE24BTECH11057 - SHIVAM SHILVANT*

1) A plain carbon steel was annealed just above the eutectoid temperature. Microstructural analysis revealed that the proeutectoid ferrite content was 30 wt % .The eutectoid reaction in the iron-iron carbide phase diagram is given below :

$$\gamma\,(0.76\ wt\%\ C) \underset{\text{heating}}{\overset{\text{cooling}}{\rightleftharpoons}} \alpha\,(0.022\ \text{wt\% C}) + \text{Fe}_3\text{C}\,(6.7\ \text{wt\% C})$$

The carbon content of the steel (in wt%) is

a) 0.24 b) 0.34 c) 0.44 d) 0.54

2) Match the materials in **Column-I**with the descriptions in **Column-II**.

Column-I	**Column-II**
P. Zirconia	1. Ultra-hard material
Q. Cubic boron nitride	2. High temperature superconductor
R. Hafnium carbide	3. Transformation toughening
S. Yttrium aluminium garnet	4. Ultra-high temperature material
	5. Host material for laser
	6. Micro-crack toughening

a) P-3, Q-4, R-1, S-2
b) P-6, Q-1, R-4, S-2
c) P-3, Q-1, R-4, S-5
d) P-4, Q-6, R-1, S-5

3) Match the materials in **Column-I**with the descriptions in **Column-II**.

Column-I	**Column-II**
P. Polyacrylonitrile	1. Hard and brittle material
Q. Nylon-6,6	2. Very high temperature resistant polymer
R. Polytetrafluoroethylene (PTFE)	3. H-bonding
S. Ebonite	4. Acrylic fibre
	5. Rubber
	6. Polyester fibre

a) P-6, Q-3, R-2, S-1
b) P-2, Q-6, R-4, S-5
c) P-4, Q-2, R-6, S-5
d) P-4, Q-6, R-1, S-5

4) Match the materials in **Column-I**with the descriptions in **Column-II**.

Column-I	Column-II
P. Differential scanning calorimetry	1. Residual stress measurement
Q. Atomic force microscopy	2. Surface morphology of a material
R. Scanning electron microscopy	3. Incident beam passes through a thin sample
S. X-ray diffraction	4. Thermal expansion measurement
	5. Resolution less than 1 nm is possible
	6. Measurement of enthalpy change

a) P-6, Q-5, R-2, S-1
b) P-4, Q-5, R-2, S-1
c) P-4, Q-1, R-3, S-2
d) P-6, Q-1, R-5, S-3

5) Match the materials in **Column-I**with the descriptions in **Column-II**.

Column-I	Column-II
P. Thermal conductivity	1. H m^{-1}
Q. Dielectric strength	2. Wb m^{-2}
R. Magnetic permeability	3. W $m^{-1}K^{-1}$
S. Capacitance	4. V m^{-1}
	5. C V^{-1}
	6. J $mol^{-1}K^{-1}$

a) P-6, Q-4, R-2, S-5
b) P-3, Q-5, R-1, S-4
c) P-3, Q-4, R-1, S-5
d) P-6, Q-5, R-1, S-4

6) It takes 4 h for carburising a steel at 900°C. If the same carburising is to be accomplished in 2 h, what should be the temperature? The activation energy of diffusion of carbon in the steel is 151 kJ mol^{-1}.

a) 850°C
b) 955°C
c) 1015°C
d) 1228°C

7) A steel specimen (12mm diameter and 60 mm length) undergoes elastic deformation under tension. The deformed specimen experiences a longitudinal strain of 0.001. If the Poisson's ratio is 0.3, the diameter of the deformed specimen (in mm) is

a) 12.0120
b) 11.9964
c) 11.9964
d) 11.9880

Common Data Questions

Common Data for Questions 8 and 9:

The first peak in the powder X-ray diffraction pattern of an FCC metal appears at a Bragg angle of 19.2°. The wavelength of Cu-K_α radiation used is 0.154 nm.

8) The lattice parameter of the metal (in nm) is

a) 0.4505 b) 0.4055 c) 0.3505 d) 0.3055

9) The full width at half maximum (FWHM) of the first peak is 0.35°. Ignoring micro-strain and instrumental broadening, the crystallite size of the sample (in nm) is

a) 20 b) 24 c) 200 d) 240

1 Common Data for Questions 10 and 11:

For an intrinsic semiconductor, the mobilities of free electrons and holes are 0.14 $m^2V^{-1}s^{-1}$ and 0.038 $m^2V^{-1}s^{-1}$, respectively. Its bandgap is 1.107 eV and electrical conductivity at 300 K is $3.99 \times 10^{-4}\Omega^{-1}m^{-1}$.

10) The free electron concentration $\left(\text{in } m^{-3}\right)$ at 300 K is

a) 13.99×10^{15} b) 27.98×10^{15} c) 13.99×10^{17} d) 27.98×10^{17}

11) What is the temperature at which the conductivity of the semiconductor is $0.399\Omega^{-1}m^{-1}$?

a) 343 K b) 443 K c) 493 K d) 543 K

2 Linked Answer Questions

Statement for Linked Answers Questions 12 and 13:
A continuous and aligned glass fibre reinforced composite has a modulus of elasticity of 150 GPa in the longitudinal direction. The matrix is a polyester resin with a modulus of 4.5 GPa. The glass fibre has a modulus of 340 GPa.

12) The volume fraction of the glass fibres is

a) 0.398 b) 0.434 c) 0.497 d) 0.566

13) If the cross-sectional area of the composite is 300 mm^2, and a stress of 100 MPa is applied in the longitudinal direction, what will be the total load (in kN) carried by the glass fibres?

a) 0.5
b) 5
c) 20.5
d) 29.5