Live Session -1

Course- Manufacturing Process Technology I & II

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A brief RECAP!

Introduction of Manufacturing Processes: Socio-economic impact, Routes (Additive, Subtractive, Hybrid), Challenges (Material, dimensional tolerance, accuracy, precision, etc.)

Evolution of Manufacturing processes: Conventional and non-conventional manufacturing processes, Micromachining, Evolution of machining accuracies in different domains.

Non-conventional Machining Processes: Overview; Classification based on the energy imparted for material removal – Mechanical (USM, AJM, WJM, AWJM) / Thermal (EDM, EBM, PBM, LBM, IBM) / Chemical & Electrochemical (CHM, PCM, ECM); MEMS fabrication (Semiconductor wafers manufacturing, structure generation- Etching, Photolithography, Oxidation, Deep RIE, etc.)
RECAP (contd.)

**Bonding Mechanisms in Solids:** Attractive & Repulsive regimes, equilibrium inter-atomic distance, Covalent, Metallic, Ionic and Van der Waal’s bonding; Arrangement of atoms - Crystal structures (SC, BCC, FCC, HCP)

**Crystallization on cooling of liquid metal:** Polycrystalline & Single crystal, Single crystalline Silicon - Czochralski’s growth method, thermal modeling for pull rate, Float Zone method (localized melting by high power RF signal or focused e-beam); Crystal Imperfections/defects.

**Elastic & Plastic deformation** at atomistic level; effect of dislocation on lowering the actual Yield shear stress value – Carpet Analogy

**Stress-Strain diagram** for various engineering materials, Yield and Ultimate strength, Ductility, Toughness; True and engg. Stress/strain
Q1. What is the coordination number of a simple cubic unit cell?
(a) 4
(b) 6
(c) 8
(d) 2

The Coordination number of an atom in a given molecule or a crystal refers to the total number of atoms, ion, or molecules bonded to the atom in question.
Coordination no. and APF of an HCP unit cell
#Numerical:

For a material having body centred cubic crystal structure, atomic mass = 55.85 g/mol and atomic radius = 1.241 Å, find its theoretical density (g/cc).
Q2. As the grain size of a meal increases, its ductility ________.
(a) Decreases
(b) Increases
(c) Remains constant
(d) No effect of grain size on ductility
Q4. Which of the following is a line defect?

(a) Vacancy  \[ \textbf{Point defect} \]
(b) Twinning \[ \textbf{Surface/ Planar defect} \]
(c) Screw dislocation  \[ \textbf{Line defect}: The atoms are arranged in a helical pattern (with \textbf{dislocation line} as its axis) that is normal to the direction of the stress. \]
(d) Interstitial impurity  \[ \textbf{Point defect} \]
Q8. The slope of the stress-strain curve in the elastic region is known as follows:
(a) Yield strength
(b) Modulus of elasticity
(c) Poisson’s ratio
(d) Percentage elongation

DROP in Stress value ???
Cottrell atmosphere
Q5. The permanent mode of deformation of a material is known as following:

(a) Elasticity  
(b) Plasticity  
(c) Slip deformation  
(d) Twinning deformation

Mechanisms of Plastic deformation

Breakage of atomic bonds
CLASSIFICATION OF DEFECTS IN CRYSTALLINE SOLID

Defects in Crystal

Point Defect
- Vacancy
- Interstitial
- Substitutional
- Schottky
- Frenkel

Line Defect
- Edge Dislocation
- Screw Dislocation

Surface Defect
- Grain Boundary
- Twin Boundary

Volume Defect
- Void
- Crack
- Inclusion
- Precipitate
Q9. Vacancy defects in solids is a subtype of the following defect:
(a) Point
(b) Line
(c) Volume
(d) Surface

Q. In Czochralski’s single crystalline growth of Silicon, what imposes a hindrance on the pull rate of the crystal?
(a) High temperature gradient across the solidification face of fusion zone causes thermal warping
(b) High temperature gradient across the solidification face of fusion zone causes point defects in crystal
(c) Low temperature gradient across the solidification face of fusion zone causes thermal warping
(d) Low temperature gradient across the solidification face of fusion zone causes point defects in crystal
Q3. The principle of material removal in Electrochemical machining is as following:
(a) Fick’s law
(b) Faraday’s laws
(c) Ionic dissolution
(d) Ohm’s law

Fick’s first law relates the diffusive flux to the gradient of the concentration. [solute will move from a region of high concentration to a region of low concentration across a concentration gradient].

The material removal in ECM occurs due to the anodic dissolution.
The rate of dissolution of the anode is governed by Faraday’s laws of electrolysis, according to which, the rate of anodic dissolution is directly proportional to the amount of current passed through the electrolyte and the electrochemical equivalent (A/n) of the anode material in the given electrolyte.

\[ m^* = \eta I A / nF \]

Where, \( I = \text{current (A)} \), \( \eta = \text{current efficiency} \), \( A = \text{molecular weight of the anode matl. (g mol}^{-1}) \), \( n = \text{valence of anode (also depends on the electrolyte and applied voltages)} \), and \( F = \text{Faraday constant} \) (amount of charge required to dissolve 1 g equivalent of the anode= charge carried by 1 mole of electrons) = 96 485 C

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Which of the following is a surface finishing process?
(a) Casting
(b) Rolling
(c) Grinding
(d) Welding

Name a few other common surface finishing processes.
THANK YOU