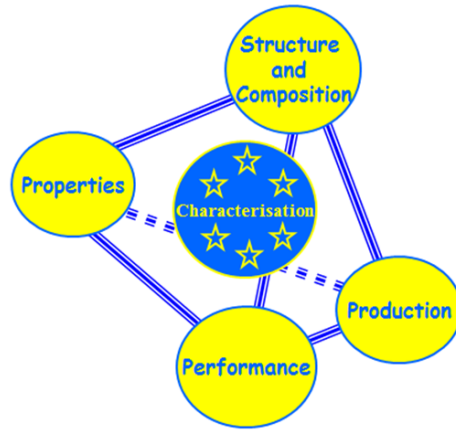


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Question 1 Atomic bonds, three-dimensional Bravais lattices generated by two-dimensional alignment, and structure-property relationship

- Please explain the relationship between 2D planar lattices and 3D Bravais lattices
- Please draw the family of densest planes and directions in fcc and bcc structure and relate the importance of these planes and directions with mechanical, magnetic and electrical properties

Question 2 Electrical, thermal and magnetic properties

- How can we classify materials based on their electrical conductivity? Please, explain your answer by using electronic band structures.
- Write the general electrical conductivity equation and explain each terms.
- Although Al_2O_3 and YBaCuO_{7-x} are both ceramics, the former is one of the best insulators while latter is a superconductor. Please, explain how it happens.
- Are dielectric materials conductor, insulator or semiconductor? Why?
- How can we classify materials according to their magnetic susceptibility? Please, explain your answer by using atomic dipole configurations with or without magnetic field for each material group.
- Please, draw the flux density vs. magnetic field strength curves for each material group and explain the graph.

Question 3 Production of ceramic materials

Discuss the effects of powder properties (primary particles and granules) on the production and final properties of advanced ceramics.

Question 4 Mechanical properties

Please explain and discuss the differences on the mechanical behaviours of metals, ceramics, polymers and composite materials by drawing figures.

Question 5 Oxidation and corrosion

Although, under oxidizing conditions, a protective surface layer is formed on the surface of some metals (for example Al) it does not form in others (for example Fe). Explain this phenomenon. Also explain the effect of macro and micro properties of the oxide layer as a function of temperature on the propagation rate of it by referring to thermodynamic, kinetic, transport, and diffusion aspects.

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Question 6 Amorphous materials

- a) In order to produce a glass what should be considered and then done from the very beginning of the process towards the end? Why is viscosity such an important factor from the viewpoint of crystallisation and bubble removal? Explain.
- b) Differentiate between glass and glass ceramics. Some of our modern kitchen stove top is made of glass- ceramic materials. List at least three important characteristics required of a material to be used for this application. On the basis of this comparison, select the material most suitable for the stove top.

Question 7 Phase Diagrams and production relationship

Equilibrium phase formation is not common in a sintering system because of two main reasons. First of all, sintering is not an equilibrium process since heating profiles are usually determined by considering only densification. Secondly, homogeneous mixtures of system components, which would yield the equilibrium phase, cannot be obtained in a real green compact. Despite these facts, sintering process requires a deep understanding of phase diagrams for a given system. Please discuss how phase diagrams can be used to understand densification and microstructural development during sintering. Constrain your research with solute drag and pinning mechanisms for microstructural development and liquid phase sintering for densification.

Question 8 Characterization

What are the interactions and resulting mechanisms between

- (i) light and solid,
- (ii) electron and solid,
- (iii) ion and solid,
- (iv) laser and solid and
- (v) x-ray and solid

and how do we use these interactions in Materials Science and Engineering?

Question 9 Production of polymeric materials

Discuss the interrelationship between the four components (performance, properties, processing and structure) of the discipline of the materials science and engineering with respect to polymer matrix composite materials in automobile industry.

Question 10 Production of metallic materials

Aluminium alloys are commonly used in aviation industry.

Discuss the applicability of aluminium alloys to be used in wings of a typical passenger airplane considering the aspects given below:

- (a) Performance (altering loads, thermal, chemical, corrosive, etc. effects)
- (b) Properties (mechanical, corrosive, erosive and thermal properties)
- (c) Structure (crystal structure, microstructure, alloying)
- (d) Processing

