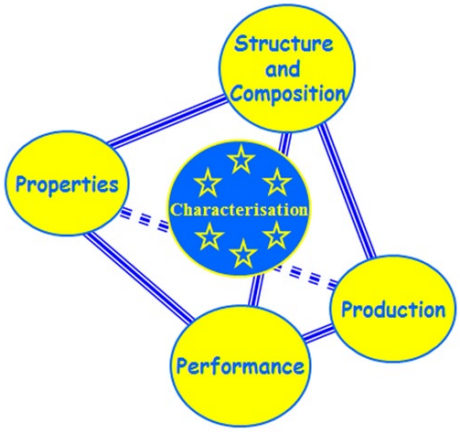
# MLZ 462 / 2020-2021 SPRING / QUESTIONS




**Question 1 Crystal Systems, Bravais Lattices, Crystal Symmetry, and Structure-Property Correlation**

**You are familiar with the crystal systems, unit cell parameters, the Bravais lattices, and know the relationship between 2D planar lattices and 3D Bravais lattices.*

(a) Please draw the family of densest planes and directions in BCC, FCC and HCP single crystal structures.

(b) Please draw the family of planes and directions with lowest density in BCC, FCC and HCP single crystal structures.

(c) Please draw the symmetry operations in BCC, FCC and HCP single crystal structures and give their point groups.

** The unit cell describes the structural properties and crystal anisotropy in an ideal single crystal, so the structure-property correlation in an ideal single crystal can be explained by the unit cell parameters.*

(d) Please describe the crystal anisotropy for BCC, FCC and HCP single crystal structures.

(e) Relate the importance of the crystal anisotropy at least for two of the following properties of materials; mechanical, thermal, magnetic, optical and electrical properties.

** Amorphous materials are non-crystalline, and polycrystalline materials are isotropic. Hence, such materials as a whole do not indicate structures with periodic repetition of a unit cell, like in a single crystal.*

(f) Do we need any structural, i.e. crystallographic information to explain or understand structure-property correlation in amorphous and in polycrystalline materials? With other words, is there any structure-property correlation in an amorphous and in a polycrystalline material? If no, please explain why? If yes, give an example for both an amorphous and a polycrystalline material.

**Question 2 Electrical, thermal and magnetic properties**

(a) How can we classify materials based on their electrical conductivity? Please, explain your answer by using electronic band structures.

(b) Write the general electrical conductivity equation and explain each terms.

(c) Although $Al_2O_3$ and YBaCu07-x are both ceramics, the former is one of the best insulators while latter is a superconductor. Please, explain how it happens.

(d) Are dielectric materials conductor, insulator or semiconductor? Why?

(e) 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.

(f) 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.

**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?

# MLZ 462 / 2020-2021 SPRING / QUESTIONS

**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