KSCP Examination
2024/2025 Academic Session

September 2025

EBB514 – Principle and Processing of Advanced Materials

Duration : 2 hours

Please check that this examination paper consists of FIVE (5) pages of printed material before you begin the examination.

Instructions: Answer **ALL QUESTIONS**. All questions carry the same marks.

The answers to all questions must start on a new page.

All questions must be answered in English.

Should any candidate be caught cheating or in possession of materials not authorised to be brought into the Examination Hall during the examination, appropriate disciplinary action will be taken against the candidate concerned. In the event a candidate is found guilty of cheating, he/she can be expelled from the University.

(1). (a). Explain the stages of grain formation during metal solidification.

(7 marks)

(b). Propose and describe at least **TWO (2)** methods to control microstructure and properties of metal components in each of the following conditions:

(i). during casting process.

(ii). after casting process.

(18 marks)

(2). Advanced ceramics find numerous high-technology applications due to their enhanced mechanical, chemical, and/or electrical properties. Answer the following questions.

(a). Explain **TWO (2)** typical advanced ceramic production methods by detailing their various processing steps.

(8 marks)

(b). Outline **TWO (2)** examples of advanced ceramics and discuss their properties and functions separately.

(8 marks)

(c). Advanced ceramics are used in consumer products. Discuss the applications of advanced ceramics in the semiconductor and automobile industries by providing appropriate examples.

(9 marks)

(3). (a). Compare additive, subtractive, and formative manufacturing processes. Based on your knowledge explain two advantages of additive manufacturing.

(8 marks)

(b). By using appropriate examples, explain the differences between polymer blend and polymer composites

(4 marks)

(c). **Figure 1** shows the three types of dispersion in the processing clay in polymer matrices. Referring to a schematic diagram in **Figure 1**, discuss how dispersion (a), (b) and (c) can be achieved in polymer matrix composites. Explain a method to achieve the best dispersions of clay in viscous polymer matrix.

(13 marks)

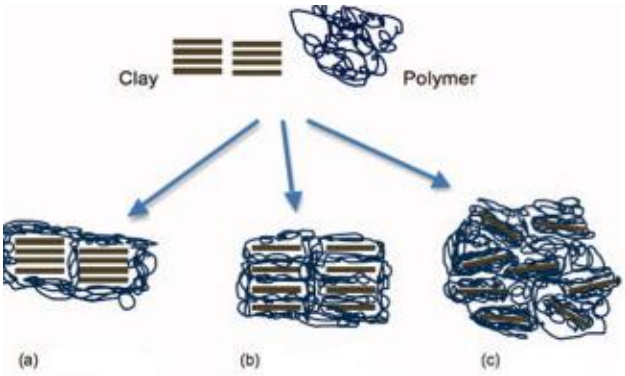

Figure 1: (a-c) Three types of dispersion of clay-polymer nanocomposites

(4). (a). You are a materials engineer, known for your expertise in nanomaterials. One day, you receive a special request from a high-profile research institution. They are intrigued by the possibility of band gap widening in nanomaterials and want a detailed explanation, particularly focusing on the phenomenon observed in silicon. The institution is keen to understand the underlying principles and implications of this behavior. You are tasked with explaining the intriguing phenomenon of band gap widening in nanomaterials. Consider the example of silicon, a semiconductor with a 1.2 eV band gap in its bulk form, which transforms into an insulator with a widened 3.0 eV band gap when manufactured at the nanoscale.

(i). Explain the concept of band gap widening in nanomaterials, using silicon as a prime example. Delve into the quantum confinement effects that drive this transformation, and discuss how the energy band structure evolves as the size of the material decreases.

(6 marks)

(ii). Outline the practical implications of silicon transitioning from a semiconductor to an insulator in the nanoscale regime. Highlight potential applications and challenges associated with this remarkable change in electronic properties.

(4 marks)

(b). Electrodeposition is a widely used technique in the manufacturing of various electronic devices and components, such as circuit boards, semiconductors, and sensors. It is also a versatile method to produce multisegmented nanorods, nanoparticle embedded nanorods, porous nanorods and core shell nanorods.

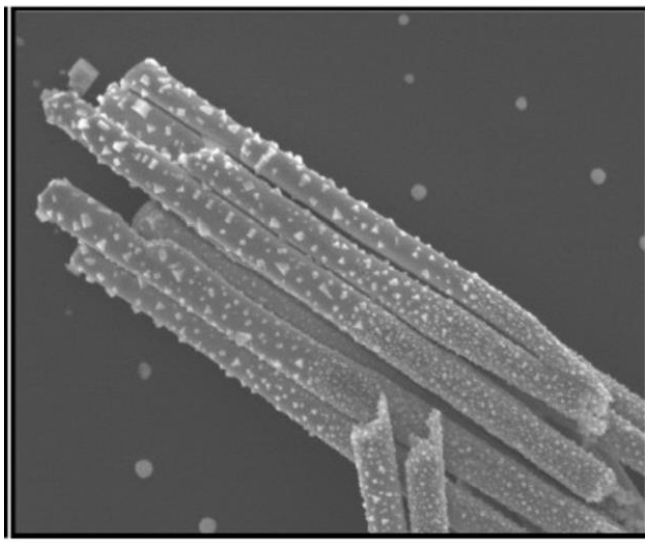

Figure 2 : Nanoparticles embedded polymer nanorods prepared by electrodeposition method.

(i). Explain the process of synthesizing nanoparticles embedded polymer nanorods shown in **Figure 2** by giving one specific example.

(6 marks)

(ii). Discuss the advantages of using this method for synthesizing such nanorods.

(5 marks)

(iii). Distinguish between the properties of nanoparticles embedded polymer nanorods and those of single-segmented nanorod.

(4 marks)

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