UNIVERSITY OF GHANA

BSC. MATERIALS SCIENCE AND ENGINEERING FIRST SEMESTER EXAMINATIONS: 2016/2017

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

MTEN 415: BIODEGRADABLE POLYMERS AND FIBROUS MATERIALS (2 CREDITS)

INSTRUCTIONS: ANSWER ALL QUESTIONS

TIME ALLOWED: TWO HOURS

1. Distinguish between the following as used in the fiber and textile industry:
   a. Yarn and warp
   b. Roving and tow
   c. Crimp and handle
   d. Spun bonding and woven roving
   e. Break length and carding
   f. Monofilament and filament
   g. Felt and mat
   h. Denier and tex
   i. Braid and weave
   j. Blend and bicomponent fiber
   k. Photodegradable polymers and oxidative degradable polymers
   l. Hydrolytically degradable polymers and environmentally degradable polymers

   24 marks

2. What is a biodegradable polymer? Give two examples each of natural and synthetic biodegradable polymers? Briefly describe all the stages involved in the biodegradation of degradable polymers.

   12 marks

3. Conventional wire drawing methods are quite reasonable for producing filaments of metals with diameters down to $100\mu m$. However, metallic wires of diameters down to 10 μm or less are mainly obtained by the Taylor process.
   a. Discuss the major requirements that must be met in order to produce fine metallic wires by the Taylor process.
   b. State any three applications of continuous metallic fibers.

   9 marks

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4. A pitched based precursor is used to produce the mesophase which is used in the production of carbon fibers.
   a. What is a mesophase and why is it advantageous in manufacturing of carbon fibers.
   b. Outline the important processing steps for fabricating a carbon fiber starting from a fiber precursor?
   c. Why are vapour grown carbon fibers preferred to than other conventional processing routes?
   d. Using a well labelled schematics only, describe how carbon fibers are grown from their vapours.

20 marks

5. The sol-gel technique is a versatile materials processing route which involves the formation of metal oxides from metal alkoxides. A metal alkoxide has the chemical formula of $M(OR)_n$, where M is a metal or metalloid and R is an alkyl group such as CH_3,C_2H_5, etc., and n is the valence of the metal atom.
   a. Considering a sol-gel approach, discuss how a silica based glass fibers can be drawn.
   b. How are your drawn fibers different from optical fiber glass used in optical cable system?
   c. Discuss the advantages and limitations of glass fibers for structural and non-structural applications.

15 marks

6. Whiskers are very useful because of their mono-crystallinity, extremely high strength and high aspect ratio. Using a VLS (vapour-liquid-solid) process, diagrammatically describe how you will make a silicon carbide (SiC) whisker. You should state all raw materials and the reactions involved.

15 marks

7. A material in fibrous form has a series of attributes characteristic of its fibrous state. Some of these characteristics stem mainly from their small cross-section and large aspect ratio, for example, a high degree of flexibility. High degree of flexibility is also a characteristic of a material having a low modulus and a small diameter.
   a. Using equations only, define a measure of flexibility for a fiber of cylindrical cross section.
   b. A carbon fiber with a modulus of 100 GPa and a diameter of 10 μm provide ease in weaving a fiber into a fabric.
   c. What is the fiber diameter that will provide similar weaving tendency if the fiber modulus is 400 GPa?
   d. Calculate the fiber length per unit volume and surface area per unit volume of the fiber for each modulus.

15 marks

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