UNIVERSITY OF GHANA

BSC. MATERIALS SCIENCE AND ENGINEERING

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

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

FIRST SEMESTER EXAMINATIONS: 2018/2019

TIME ALLOWED: TWO (2) HOURS

INSTRUCTION: ANSWER ALL QUESTIONS

1. Distinguish between the following as used in the fiber and textile industry:
   (a) Yarn and warp
   (b) Roving and tow
   (c) Degradation and biodegradation
   (d) Biodegradable plastic and degradable plastic
   (e) Photodegradable polymers and oxidative degradable polymers
   (f) Fiber and fabric
   (g) Felt and mat
   (h) Braid and weave

(16 marks)

2.
   (a) Give three examples each of natural and synthetic biodegradable polymers?
   (b) Briefly describe the stages involved in the biodegradation of degradable polymers.
   (c) Discuss plastic degradation under the following mechanisms.
      (i) Microbial degradation
      (ii) Macro-organism degradation
      (iii) Photo-degradation
      (iv) Oxidative degradation

(20 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.

(10 marks)

4. A pitched based precursor is used to produce the mesophase which is used in the production of carbon fibers.

EXAMINER: Y. D. BENSAH

(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.

(15 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) What are 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 are required to state all reactions involved.

(15 marks)

7. Flexibility is highly desirable in fibers during processing. As such a carbon fiber with a modulus of 100 GPa and a diameter of 10 μm provide ease in weaving a fiber into a fabric. What is the fiber diameter that will provide similar weaving tendency if the fiber modulus is 400 GPa?

   The equations provided below would useful for your solution.

$$\frac{M}{I} = \frac{E}{R} \qquad MR = EI = \frac{E\pi d^4}{64} \qquad \frac{1}{MR} = \frac{64}{E\pi d^4}$$

   where d is the equivalent diameter, M is the bending moment, I is the moment of inertia of the cross section and E is the elastic modulus. The expression ($1/MR$) is a measure of the flexibility which is a very sensitive function of the diameter.

(9 marks)