

HOME EXAM

CHEM-E2200: Polymer Blends & Composites

The examination starts at **09:00 Monday 17th October 2022** and closes at **17:00 on Monday 24th October 2022**

PLEASE READ CAREFULLY:

- Answer all questions.
- Total 40 points. Questions 1-5 are worth 5 points each maximum. Question 6 is worth 7 points and question 7 is worth 8 points.
- Questions 1-6 require citations (see next comment, below). Question 7 requires a “free form” essay style answers, so no references are required for the answers to this question.
- This is a “home exam” and you should use literature sources (questions 1-6) to support/justify your answers.
- Remember to use proper citation techniques and be sure to list all your references for all relevant questions!
- Use peer-reviewed journal articles, patents, standards and/or scientific books as references.
- Points will be deducted from answers without proper citation!
- There is no limit to the length of the answers, although it is expected that questions 1-6 will require answers of no more than around half a page in length.
- Question 7, being an essay, should be a little longer but no more than about 2 pages.

Total marks 40

1. Briefly describe the resin transfer moulding (RTM) process and the extrusion process and explain the characteristics of the composite materials that can be manufactured using these processes.

(5 points)

2. Define what a “composite” material is and explain the functions of the reinforcement, matrix, and interface. Giving examples, briefly explain how “fibre architecture” affects the properties of a composite.

(5 points)

3. The “shear-lag” model is often used to describe axial elastic stress-transfer in polymer matrix composites. Describe the principles behind the model and explain how the aspect ratio of the reinforcement affects the distribution of both axial fibre stress and interfacial shear stress in a single fibre composite loaded parallel to its axis.

(5 points)

4. Natural fibres, such as flax and hemp, frequently contain defects, known as “kink bands” or “dislocations”. Explain how these can affect the properties of a composite reinforced with these fibres.

(5 points)

5. Explain why a composite composed of two brittle materials such as glass fibre and unsaturated polyester is regarded as a “tough” material.

(5 points)

6. You are preparing a composite out of HDPE (grade BB2581 from Borealis) and aluminium trihydroxide (grade Apyral 60D from Nabaltec). Calculate the theoretical modulus of your composite when the ATH concentration is 40 wt-%. Use the ‘extended Kerner equation’ which is presented in the article:

‘Stricker, F., Bruch, M. and Mülhaupt, R., *Polymer*, **38**, (1997), 5347-5353’

For the calculation you must find out some material related values/parameters. Describe clearly (i.e., (a) use reference(s)) where you have found these values.

(7 points)

7. Write short essay (max. 2 pages) on “*Composites in sustainable development*”

(8 points)