CH415-15 Polymer Colloids

25/26

Department
Chemistry
Level
Undergraduate Level 4
Module leader
Stefan Bon
Credit value
15
Module duration
10 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

This module will explore how Polymer Colloids are made, behave, and can be formulated into sustainable industrial products.

Module web page

Module aims

The overall aim of this module is to provide an in-depth study of key topics of polymer colloid science, their underlying and founding physical principles, industrial applications, and sustainability/environmental outlooks and impacts.

The aims are to:

(1) gain a deep understanding of the scientific ideas and concepts associated with five selected core topics (polymer colloid synthesis, colloid motion, stability, industrial applications, and sustainability and environmental fate)

(2) Apply the gained knowledge in a discussion format to discuss examples of colloidal materials to improve learning.

(3) Place the gained knowledge into a wider scientific context linking to principles of chemistry,

chemical engineering, physics, and manufacturing.

(4) Develop a skill set to critically process, understand, and communicate/explain scientific principles and phenomena in the area of colloid science.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

The module will give students a solid understanding of several fundamental and contemporary aspects of polymer colloid science.

The module is divided into FIVE key learning blocks.

BLOCK 1: INTRODUCTION TO COLLOIDS & SYNTHESIS OF POLYMER COLLOIDS BY (MINI-)EMULSION POLYMERIZATION

In this block we will discuss:

Introduction to colloids: what is a colloid? Phases and colloidal systems. Specific properties. Ancient colloids. The importance of surface area. Capillarity. Laplace pressure. Variety of shapes. Lyophilic vs. lyophobic colloids.
Emulsion polymerization: what is an emulsion polymerization and how does it differ from a suspension polymerization, dispersion polymerization, precipitation polymerization, and miniemulsion polymerization? A brief history of emulsion polymerization. Pro's and con's of emulsion polymerization vs. bulk/solution polymerization. A typical recipe.
Mechanistic understanding of Emulsion Polymerization: rate of polymerization, particle formation (micellar and homogeneous nucleation), particle growth, particle swelling, diffusion limitation/starved conditions, compartmentalization, zero-one vs. pseudo bulk polymerization kinetics, Trommsdorf effect.
Miniemulsion polymerization: What is miniemulsion polymerization? Ostwald ripening, how to retard/arrest Ostwald ripening.

BLOCK 2: ON COLLOID MOTION AND RHEOLOGY In this block we will discuss

Motion of colloids: gravity, buoyancy, drag force (Newton/Rayleigh/Stokes), terminal velocity, Brownian motion, Osmotic pressure, Stokes Einstein (Smoluchowski/Langevin), Barometric height, Ballistic velocity, Propulsion on the microscale (Purcell). Kinetics of coagulation Rheology: We will (re-) introduce rheological concepts and apply these to colloidal dispersions. Key words: kinematics and dynamics, shear rate, stress, viscosity. Yield stress, visco-elasticity, shear thinning and thickening. Hydrodynamic effects. Brownian contributions. Flocculation and thixotropy (Reversible time effects).

BLOCK 3: COLLOID STABILITY
Colloidal stability: How to prolong the lifetime of a lyophobic colloid. Electrostatic stabilization. DLVO theory. Steric stabilization. Bridging and depletion flocculation. After recapping ways to stabilize colloids via electrostatic, steric, or depletion methods, we will look in detail into the DLVO theory. Key words: charged interfaces, van der Waals interactions, Hamaker coefficient, Derjaguin approximation, Coulomb repulsion, double layer, critical coagulation concentration.

BLOCK 4: INDUSTRIAL APPLICATIONS OF POLYMER COLLOIDS
We will look at industrial applications of polymer colloids and delve deeper into product formulations. Applications can include waterborne coatings and adhesives, dipped goods, polymer colloids in personal, agricultural and health care, paper manufacturing, and construction.

BLOCK 5: SUSTAINABLE POLYMER COLLOIDS AND ENVIRONMENTAL FATE
We will look at approaches to make polymer colloids environmentally sustainable, how products can be designed with circularity and end of product life in mind. We will look at the environmental fate and impact of micro- and nanoplastics.

Learning outcomes

By the end of the module, students should be able to:

- KNOWLEDGE: The module will provide students with a solid understanding of several fundamental and contemporary aspects of colloid science focussing on five key learning blocks. Students will develop specialized knowledge in the area of colloid science and integrate this across the wider areas of chemistry, chemical engineering, physics and manufacturing.
- APPLIED LEARNING: This module has a designed set of workshops associated with each block of learning in which concepts will be applied and integrated in an interactive discussion format.
- DIVERSE PERSPECTIVES: Through interactive workshops and a group project students will be able to evaluate diverse points of view embedded within varying frameworks which may include, technological/scientific context, societal and environmental impact, temporal and trending contexts.
- COMPETENCY SKILLS: Students will engage in critical inquiry and develop their skill set to process, understand, and communicate/explain and evaluate scientific principles and their impact.
- COMMUNICATION: Student will be able to communicate effectively in presenting ideas orally (especially in the workshop sessions), and in the format of an assessed group presentation
- ETHICAL REASONING: Students will be able to reason ethically in evaluating the design and use of colloidal materials in nowadays society and illustrate their learning in the form of a group project/presentation.

Indicative reading list

Reading lists can be found in Talis

International

e.g. includes mobility opportunities, explores concepts and ideas in a global context, fosters a global mindset and awareness of diversity, etc.

Subject specific skills

Numeracy
Problem solving
Critical thinking
Teamwork

Transferable skills

Numeracy
Problem solving
Critical thinking
Teamwork

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (13%)
Supervised practical classes	10 sessions of 2 hours (13%)
Online learning (independent)	10 sessions of 5 hours (33%)
Other activity	3 hours (2%)
Private study	37 hours (25%)
Assessment	20 hours (13%)
Total	150 hours

Private study description

Independent online learning: study the e-book.
Private study: includes preparation for the group presentation (20%) of the module.

Other activity description

Group Talk (assessed)

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D5

	Weighting	Study time	Eligible for self-certification
Presentation	20%		No
15 minute oral presentation followed by 3-10 mins of questions by the audience.			
Weekly group homework and feedback discussion	20%	20 hours	No
Each week, a group task is set, which needs to be completed. Feedback of the tasks will be provided in class			
Centrally-timetabled examination (On-campus)	60%		No

- Answerbook Pink (12 page)
- Students may use a calculator
- Periodic Tables

Assessment group R

	Weighting	Study time	Eligible for self-certification
Polymer Colloids	100%		No

- Students may use a calculator

Feedback on assessment

group feedback on presentations will be provided. Cohort level examination feedback provided via Moodle.

Past exam papers for CH415

Availability

Pre-requisites

To take this module, you must have passed:

- All of
  - CH3F6-15 Polymer and Colloid Science

Courses

This module is Optional for:

- UCHA-F110 Undergraduate Master of Chemistry (with Industrial Placement)
  - Year 4 of F110 MChem Chemistry (with Industrial Placement)
  - Year 4 of F112 MChem Chemistry with Medicinal Chemistry with Industrial Placement
- Year 5 of UCHA-F107 Undergraduate Master of Chemistry (with Intercalated Year)
- UCHA-F109 Undergraduate Master of Chemistry (with International Placement)
  - Year 4 of F109 MChem Chemistry (with International Placement)
  - Year 4 of F111 MChem Chemistry with Medicinal Chemistry (with International Placement)
- UCHA-4M Undergraduate Master of Chemistry Variants
  - Year 4 of F105 Chemistry
  - Year 4 of F110 MChem Chemistry (with Industrial Placement)
  - Year 4 of F109 MChem Chemistry (with International Placement)
  - Year 4 of F125 MChem Chemistry with Medicinal Chemistry
- Year 5 of UCHA-F127 Undergraduate Master of Chemistry with Medicinal Chemistry(with Intercalated Year)