Course Outline

CHEM3061

Chemistry of Materials

School of Chemistry

Faculty of Science

Term 1, 2021

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor and Lecturer	A/Prof Kris Kilian	k.kilian@unsw.edu.au	By appointment	9385 6998 740, Hilmer
Lecturer	Dr Anna Wang	anna.wang@unsw.edu.au	By appointment	9385 7928 720, Hilmer
Lecturer	Prof Martina Stenzel	m.stenzel@unsw.edu.au	By appointment	9385 4656 735, SEB
Lecturer	Prof Richard Tilley	r.tilley@unsw.edu.au	By appointment	9385 4425 EMU, LG, Chemical Sciences

2. Course information

Units of credit: 6

Pre-requisite(s): CHEM2011 and CHEM2041

Teaching times and locations: http://www.timetable.unsw.edu.au

Component	Day	Time	Location
Lecture (inc. wk 11)	Monday	1 – 3 pm	Online
Lecture	Wednesday	2 – 4 pm	Online
Laboratory Class	Thursday	2 – 6 pm	Room 113 Chemical Sciences Building

2.1 Course summary

Chemistry is fundamental not just to the design of small molecules, but increasingly to the preparation of materials ranging from hard colloidal nanomaterials to soft complex macromolecular architectures. These materials have been used by humans throughout the ages: from the Lycurgus Cup of ancient Rome to natural polymers such as wool and silk. Polymeric and nanomaterials are some of the most industrially important chemistries, used extensively in paint, cleaning solutions, washing powder, sun screen as well as high end applications, in medicine, electronics and sensors. These applications are constantly expanding because the enormous fundamental scientific interest in learning how to control the chemistry of materials at a molecular level has seen the discovery of many unique properties of nanoscale materials.

This course will explore the synthesis and characterisation of such materials, as well as the physical chemistry that underpins their behaviour both in solution and in the solid state. A particular emphasis will be placed on chemistry at the interface, the modification of surfaces, and the self-assembly of block copolymers for the preparation of nanostructures materials.

2.2 Course aims

To equip students with an understanding of the chemistry by which nano- and micro- scale materials such as hard inorganic, and self-assembled polymer particles are synthesised, characterised, and applied

2.3 Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. Identify the functional properties of colloidal nanoparticles and explain how these can be applied in technology
2. Prepare and stabilise colloidal nanoparticles of varying size and shape, and an understanding of the physical principles involved
3. Demonstrate an understanding of the principles and kinetics of controlled radical polymerisation
4. Identify how the underpinning chemical structure will determine the macroscopic properties
5. Relate the size and physical behaviour of polymers in solution and in the solid state to their structure, chemistry, molecular weight, and solvent, including an understanding of their self-assembly into nanostructures.
6. Explain what drives materials to build hierarchical structures
7. Demonstrate understanding of surface modification and the forces present at interfaces
8. Develop an insight into suitable tools for materials characterisation including size exclusion chromatography, light scattering techniques, electron microscopy and scanning probe microscopy
9. Work in teams to understand and evaluate scientific results as presented in published work

2.4 Relationship between course and program (RACI Threshold Learning Outcomes) learning outcomes and assessments

Course Learning Outcome (CLO)	Course content	Related Tasks & Assessment
CLO 1 CLO 2	**Section A** – Colloidal nanoparticles (4 x 2h lectures, 2 x 4h lab)	Lab 1: Pre and post-lab questions Final laboratory report Paper assignment 1 Exam
CLO 3	**Section B** – Polymer Chemistry (3 x 2h lectures, 2 x 4h lab)	Lab 2: Pre and post-lab questions Final laboratory report Paper assignment 2 Exam
CLO 4	**Section C** – Polymer physics and self	Paper assignment 3

CLO 5 CLO 6	assembly (7 x 2h lectures)	Exam
CLO 7	**Section D** – Biological materials and the biomaterials interface (4 x 2h lectures)	Paper assignment 4 Exam
CLO 8	Characterisation techniques for polymers and nanoparticles (4 x 2h lab)	Lab 3: Pre-lab questions Final laboratory report
CLO 9	Understanding scientific writing	Paper assignments (x4) Final laboratory report

3. Strategies and approaches to learning

3.1 Learning and teaching activities

The content of this course will be delivered in three main ways:

1. Lectures / Workshops (4 hours / week), with content delivered by online lecturers/tutorials and reinforced by group exercises in the lecture. One hour per week will be dedicated to problem solving questions

2. Laboratory work (4 hours, weeks 2-5, 7-10). Most of the characterisation component will taught through the face-to-face laboratory component of the course, as the students use the instruments involved. Experiments will also give students the opportunity to understand the content taught in lectures by putting into practice some of the theory.

3. Paper assignments (1 hour per week). Students will analyse and answer questions to a paper through reports, but the paper tutorials will also give students a chance to discuss papers as a group.

3.2 Expectations of students

Attendance: Students are expected to attend 90% of lectures/workshops and complete **all** laboratory tasks satisfactorily.

The student is expected to prepare the lab by reading and understanding the theoretical background and complete all the pre-quiz questions. Students are expected to follow the UNSW policy governing the use of email, social networks and discussion forums.

4. Course schedule and structure

1	***Section A: Colloidal nanoparticles (RT)*** • Mon: Introduction to nanoparticles (AuNPs, QDs, micelles, vesicles) and their synthesis including nucleation / growth and controlling particle shape. • Wed: Optical properties of hard NPs (SPR etc) and their characterisation (EM and XRD etc).	No lab
2	• Applications in catalysis and nanomedicine. • Colloidal and steric stability, and controlling the surface chemistry of NPs (DLVO, Hofmeister series).	**LAB 1** (wk2-3) CHEMSCI 113 AuNP synthesis
3	***Section B: Polymer Chemistry (MS)*** • Introduction to polymers, dispersity, and step growth polymerization • Introduction to Chain growth polymerization with a focus on free radical polymerization and copolymerization	
4	• Introduction to Chain growth polymerization with a focus on free radical polymerization and copolymerization ***Section C: Polymer physics and self assembly (MS)*** • Polymers in the solid state; crystalline and amorphous polymers	**LAB 2** (wk4-5) CHEMSCI 113 Controlled radical polymerisation and vesicle/micelle formation
5	• Polymers in the solid state; crystalline and amorphous polymers ***Section C: Polymer physics and self assembly (AW)*** • Polymer characterisation: How big is a polymer? Flory Huggins theory and thermodynamics.	
6	Flexibility week	
7	• Characterization of colloidal and nano materials by light scattering (DLS, MALS).	**LAB 3** (wk 7-10) Characterisation of Polymers, AuNPs and conjugates (UV-Vis, TEM, DLS and GPC)
8	• Self assembly of polymers and comparison with colloids and biological materials.	
9	***Section D: The chemistry of biological materials and the biomaterials interface (KK)*** • Introduction to modern biomaterials science and engineering • Biological materials – central dogma, polymers in biology	
10	• Bioconjugation essentials – from proteins to hydrogels to surfaces • Biomaterials for drug delivery, bioprinting, and tissue engineering	

RT=Richard Tilley; MS=Martina Stenzel; AW=Anna Wang; KK=Kris Kilian

Lab schedule

Week	Experiments
2	**Lab 1 – Gold colloid synthesis and assembly on surfaces** (CHEMSCI 113)
3	This lab will include a workshop on *working in groups*
4	**Lab 2 – Controlled radical polymerization** (CHEMSCI 113)
5	This lab will include a workshop on *data processing and drawing figures*

Week	Lab 3 – Characterization (in separate groups)			
	3.1 Polymer characterisation CHEMSCI 113	3.2 SPR of AuNPs by UV-Vis CHEMSCI 113	3.3 Size of AuNPs by TEM EMU*	3.4 Size of AuNPs by DLS CHEMSCI 113
7 (2-4pm) **7 (4-6pm)**	Group 1 Group 2	Groups 3 & 4 -	Group 5 Group 6	
8 (2-4pm) **8 (4-6pm)**		Groups 1 & 2 -	Group 4 Group 3	Group 6 Group 5
9 (2-4pm) **9 (4-6pm)**	Group 5 Group 6		Group 1 Group 2	Group 3 Group 4
10 (2-4pm) **10 (4-6pm)**	Group 4 Group 3	Groups 5 & 6 -		Group 2 Group 1

* For Lab 3.3 Meet in CHEMSCI 113 by 10 minutes into the lab class and you'll be taken down to the EMU in the basement of the CHEMSCI building.

5. Assessment

5.1 Assessment tasks

Assessment task	Length	Weight (%)	Assigned	Due date
Paper assignment 1*	1-2 pages	5	Mon week 1	Friday week 2
Post lab questions (Lab 1)	1-2 pages	4	Lab week 2	Friday week 4
Paper assignment 2*	1-2 pages	5	Mon week 3	Friday week 4
Post lab questions (Lab 2)	1-2 pages	4	Lab week 4	Friday week 7
Paper assignment 3*	1-2 pages	5	Mon week 5	Friday week 7
Paper assignment pitch	1-2 pages	5	Mon week 8	Thursday week 10
Pre-lab quizzes & notebook	5-10 online questions	12	--	Before the start of each lab (Thursday 2pm weeks 2, 4, 7, 8, 9, 10)
Final Laboratory Report	As per template	20	--	Friday Week 11
Final Exam	2 h	40	--	Exam period

* Individuals will submit their own paper assignments but should work together as a group and can submit identical answers to the questions if they choose. The paper assignment pitch will be given as a group.

Important note: To be awarded a pass in this subject, students must satisfy these conditions:

(i) An overall pass (≥ 50%) for the weighted average of all assessment tasks; and
(ii) Satisfactory overall performance (≥ 35%) in the final exam; and
(iii) A minimum attendance of 7/8 of the laboratory classes.

Failure to satisfy these criteria could result in either a FL (Fail) or UF (Unsatisfactory Fail) grade being awarded, or further assessment being offered at the sole discretion of the course coordinator. Students must ensure their availability to attend any supplementary examination that will usually be offered in the week suggested by UNSW; inability or failure to attend a supplementary examination may lead to a FL or UF grade being confirmed.

Further information

UNSW grading system: https://student.unsw.edu.au/grades

UNSW assessment policy: https://student.unsw.edu.au/assessment

5.2 Assessment criteria and standards

Rubrics for laboratory reports are provided in the laboratory manual or in the templates for the laboratory reports. Paper assignment expectations are laid out in the group project document.

5.3 Submission of assessment tasks

Pre-lab questions must be done on moodle prior to attending the labs. Laboratory notebooks will be marked during the lab session.

Paper assignments, post-lab questions and the final laboratory report must be submitted on moodle as a pdf prior to 11:55 pm on the due date. The paper assignment pitch will be marked during the lecture and laboratory session in week 10.

Any assessment task submitted past the due date will incur a 10% per day penalty up to a maximum of 7 days. After 7 days a mark of 0% will be awarded however students may still submit work after this period at the discretion of the unit coordinator to receive feedback. *Penalties will be applied to any day in excess of the due date including weekends, public holidays and non-teaching periods*.

Extensions for any assessment item will require application for Special Consideration through the UNSW formal channels.

5.4. Feedback on assessment

Feedback on the paper assignments will be provided within 2 weeks of submission

Feedback on the post-lab questions will be provided within 2 weeks of submission, so students can incorporate this feedback into their final reports.

Feedback from online quizzes will be provided immediately upon completion of the task.

6. Academic integrity, referencing and plagiarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.

Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits**:** honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and **plagiarism** can be located at:

- The *Current Students* site https://student.unsw.edu.au/plagiarism**,** and
- The *ELISE* training site http://subjectguides.library.unsw.edu.au/elise/presenting

The *Conduct and Integrity Unit* provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

7. Readings and resources

Suggested text book: “Principles of Polymerization”; George Odian; ISBN: 978-0-471-27400-1.

All other readings will be supplied through moodle or otherwise provided by lecturers. Computer laboratories and study spaces are available in the Gibson computer laboratory (Ground floor, Dalton building).

8. Administrative matters

Occupational Health and Safety	Information on relevant Occupational Health and Safety policies and expectations at UNSW: https://safety.unsw.edu.au/ School of Chemistry OH&S policy and requirements: see laboratory manual. To be admitted to a laboratory, you must wear safety glasses, a lab coat and covered shoes (no thongs, open sandals or clogs). You must also complete all safety pre-lab work, risk assessment or other prescribed preparation relating to carrying out safe laboratory work. Visitors are not allowed to undergraduate laboratories without the permission of the lab supervisor.		
Assessment Procedures **UNSW Assessment Policy**	Important note that the standard assessment procedures for chemistry are as follows: To be awarded a pass in this subject, students must satisfy three conditions: (i) An overall pass (≥ 50%) in the laboratory component; (ii) Satisfactory overall performance (≥ 35%) in the final exam; (iii) A minimum attendance of 7/8 laboratories is required. Failure to satisfy these criteria could result in either a FL or UF (Unsatisfactory Fail) grade being awarded, or further assessment being offered at the discretion of the course coordinator and the School Examiners’ Meeting, according to UNSW Procedures. Students must ensure their availability to attend any supplementary examination that will usually be offered in the week suggested by UNSW (25 – 29 May 2020); inability or failure to attend a supplementary examination may lead to a FL or UF (Unsatisfactory Fail) grade being confirmed.		
Equity and Diversity	Those students who are living with a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course Convenor prior to, or at the commencement of, their course, or with an Advisor in the Equitable Learning Services Unit (https://student.unsw.edu.au/elshttp://www.equity.unsw.edu.au/disabil.html). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.		
Student Complaint Procedure	**School Contact**	**Faculty Contact**	**University Contact**
	A/Prof John Stride Deputy Director of Teaching j.stride@unsw.edu.au	A/Prof Alison Beavis Deputy Dean (Education) sci.dde@unsw.edu.au	Student Conduct and Integrity unit. https://student.unsw.edu.au/complaint

		Tel: 9385 0752	Telephone 02 9385 8515, email studentcomplaints@unsw.edu.au University Counselling and Psychological Services[1] Tel: 9385 5418

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- The *ELISE* training site https://subjectguides.library.unsw.edu.au/elise

The *Conduct and Integrity Unit* provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

9. Additional support for students

- The Current Students Gateway: https://student.unsw.edu.au/
- Academic Skills and Support: https://student.unsw.edu.au/academic-skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Equitable Learning Services: https://student.unsw.edu.au/els
- UNSW IT Service Centre: https://www.myit.unsw.edu.au/