



## **CHEM 462L Properties and Sustainability of Polymers:**

**Units: 4**

**Spring—Lecture-Discussion Wednesday—3:30-4:50 am**

**Lab Thursday—1:00-3:50 pm**

**Thursday—5:00-8:50 pm**

**Friday—3:00-4:50 pm**

**Location:** Lecture (VHE 214), Lab (SGM 301)

**Instructor: Megan Fieser**

**Office:** SGM 223

**Office Hours:** TBD

**Contact Info:** [fieser@usc.edu](mailto:fieser@usc.edu), (213)821-4228, replies to emails within 48 hours

**Teaching Assistant: Kai Knight**

**Office:** SGM 223

**Office Hours:** TBD

**Contact Info:** [kdknight@usc.edu](mailto:kdknight@usc.edu)

### **Course Description**

This course aims to introduce the unique properties of polymers (plastics) that has led to their high demand for short- and long-term applications. Students in this course will develop an understanding of how the chemical structure of polymers influences the physical properties of the materials. While understanding the value of these materials, students will also gain insight into the challenges in sustainability for polymers. With this class, students will be made aware of future career directions to enable a more sustainable polymer industry.

### **Learning Objectives**

By the end of this course, students will be able to measure the physical properties of polymer samples and assess what applications these properties could be useful for. They will be able to state the chemical make-up of polymers in commercial products, along with the pros and cons of those materials. Additionally, students will be able to assess the sustainability and life cycle of emerging commercial products. Finally, students will be able to follow and understand emerging discussions about polymer recycling/upcycling in mainstream media.

**Prerequisite(s):** CHEM 322a or CHEM 325a

**Co-Requisites(s):** N/A

**Concurrent Enrollment:** N/A

**Recommended Preparation:** CHEM 461 or CHE 475

## Course Notes

Letter Grade

Course materials will be distributed through Blackboard

Lecture and Lab work will be complimentary, but will not directly influence each other, both will be in person.

Online mini-prelab discussions will be Zoom/YouTube recordings, available on Blackboard.

## Required Readings and Supplementary Materials

Laboratory Manual will be available in the bookstore and other readings provided throughout the class.

Readings for the course will include scientific and public articles on the perception and solutions to the plastic pollution problem. Readings will set the scene for plastic pollution, where the critical challenges are, and future directions for addressing the problem. These readings include, but are not limited to:

1) Three reports on "The New Plastics Economy" by the Ellen MacArthur foundation that sets the scene for the challenges and possible solutions to disposable plastic packaging pollution. We will discuss the content of these reports, while also discussing the importance of organizations like the Ellen MacArthur Foundation. <https://ellenmacarthurfoundation.org/topics/plastics/projects>

2) "Breaking the Plastic Wave" By The Pew Charitable Trusts, which discusses the needed changes to decrease the leakage of plastics into the ocean. We will discuss the environmental science that goes into this problem. <https://www.pewtrusts.org/en/research-and-analysis/articles/2020/07/23/breaking-the-plastic-wave-top-findings>

3) "Bold Goals for U.S. Biotechnology and Biomanufacturing" by the White House Office of Science and Technology Policy. We will discuss the importance of bioplastics and the influence of government on solutions to plastic sustainability. <https://www.whitehouse.gov/wp-content/uploads/2023/03/Bold-Goals-for-U.S.-Biotechnology-and-Biomanufacturing-Harnessing-Research-and-Development-To-Further-Societal-Goals-FINAL.pdf>

4) "Report of the Basic Energy Sciences Roundtable on Chemical Upcycling of Polymers" by the Department of Energy. We will discuss the importance of the end of life of polymers, as well as the collaboration between government agencies and scientists in academia, industry and national labs. <https://www.osti.gov/biblio/1616517>

5) The CROW Polymer Database will be used to discuss individual plastic use and properties. <https://polymerdatabase.com/main.html>

## Description and Assessment of Assignments

Assessment of performance in this course will be weighted 70% towards experimental lab work and prep and 30% to work from lecture discussion content. Each experiment will require a lab report (to be completed outside of lab), explaining results the students acquired in the experiment and answering prompted questions from the manual. During lecture, students will work on quizzes that are connected to the topic of their experiment. During the last few weeks of class, the students will work on a lab practical, using the techniques they learned in the semester to analyze an unknown polymer sample, which will be due during the final exam allocated time.

Students will work on a mid-semester written project, where they will analyze a commercial product and describe the reasons they believe the polymer is used for that application. Students will also complete a final video project analyzing a particular polymer product, what the pros and cons for this particular product are, if there are more sustainable items being marketed (and whether these items are indeed more sustainable), as well as any emerging technologies that may be an even better option.

## Grading Breakdown

**Table 1 Grading Breakdown**

Assessment Tool (assignments)	% of Grade
Lab Reports (x10)	40
Lab Practical	20
Mid Semester Project	15
In-Class Experiment Quizzes (x10)	10
Final Project	15
<b>TOTAL</b>	<b>100</b>

### Grading Scale

Laboratory work will be 70% of the grade (including quizzes on lab content). Lab reports and quizzes will all be equally weighted. The lowest graded lab report and quiz will be dropped.

Lecture work will be 30% of the grade.

Overall grades will be curved, based on performance. Students performing 2 standard deviations below the mean class performance will be at risk in this course.

### Assignment Submission Policy

Assignments will be turned in during class or via email. Lab reports will be due the Wednesday after the experiment by 5 pm. Quizzes will be turned in during the class period. The lab practical assignment will be done the last three weeks of the course, with the final report due during the scheduled final exam. The midterm project will be due the Friday before Spring Break, while the final lecture project will be due during the scheduled final exam.

### Grading Timeline

Experiment report grades will be provided the Monday after the student submitted their report (5-day delay). Quiz scores will be updated on Brightspace within 48 hours of the class period. The mid semester project will be graded within two weeks.

### Course Specific Policies

Late assignments will not receive credit.

### Attendance

In lecture and in lab attendance will be important to gain the information needed to complete the in-class quizzes and lab reports and is therefore required. One lab report and one quiz will be allowed to be dropped, in the case of a necessary absence, however all topics will be covered in the end-of-semester lab practical.

### Classroom norms

This course aims to provide new emerging topics in the area of polymer chemistry. As such, open discussion will be important for the best experience. Here are a few norms that should be considered before coming to class:

- Challenge one another but do so respectfully.
- Be courteous. Don't interrupt or engage in private conversations while others are speaking.
- Be aware of the fact that tone of voice and body language are powerful communicators. Some postures or facial expressions (e.g., crossed arms, eye rolls, loud sighs) can silence, provoke, intimidate, or hurt others. Others (e.g., facing and looking at the speaker, staying quiet, nodding) can show you are listening respectfully

- Build on one another's comments; work toward shared understanding.
- Ask questions when you do not understand; do not assume you know what others are thinking.
- Do not monopolize discussion.
- Try not to silence yourself out of concern for what others will think about what you say.
- Everyone in the group should participate in the conversation.

### **Zoom etiquette**

In the case of required Zoom lectures, active discussion will need to be maintained. In order to facilitate productive conversation, students will use the hand raise option to get into the queue to speak next in the conversation. If a student cannot have their web camera on, they should notify the instructor at least 12 hours prior to lecture.

### **Academic Integrity**

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct contrasts with the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the [USC Student Handbook](#). All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the [student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask me if you are unsure about what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

If found responsible for an academic violation, students may be assigned university outcomes, such as suspension or expulsion from the university, and grade penalties, such as an "F" grade on the assignment, exam, and/or in the course.

### **Course Content Distribution and Synchronous Session Recordings Policies**

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

### **Course Evaluations**

This course was established first during the Spring 2024 semester. As it is new and contains many modern topics, evaluation of the course is important. Students should actively participate in the university-developed course evaluation at the end of the semester, which will be used to adjust the course execution for future years. The instructor will also provide two, course specific surveys aimed to adjust the content in the lecture and lab portions of the course.

## Course Schedule

This course is a combined Lecture/Lab course. For weeks 2-12, students will need to watch a pre-recorded YouTube video (15-20 minutes) before they start the lab. There will also be videos prior to the start of the lab practical in Week 13 (no videos for Weeks 14 or 15). Reading material may be assigned prior to lectures and will be posted on Brightspace.

In Weeks 2-12, experiments will be bulked into two sets of 5 labs. Students will be distributed throughout the 5 experiments, working in groups of 3-4 to complete the assigned lab. Students will learn the value of each form of characterization, along with the limitations and error analysis associated with each. The Experiments will be conducted as described:

**Rotation 1 Labs:** Core Instrumentation to characterize the purity, morphology and thermal properties of polymers.

**SYNTH-** Students will synthesize a polymer and use nuclear magnetic resonance (NMR) spectroscopy to analyze polymer purity and structure.

**NMR/MALDI-** Students will use NMR spectroscopy and MALDI-TOF to analyze polymer purity, structure and end groups.

**TGA-FTIR-** Students will use thermal gravimetric analysis (TGA) to analyze thermal stability of polymers and Infrared Spectroscopy (FT-IR) to analyze polymer purity and structure.

**DSC-** Students will use differential scanning calorimetry (DSC) to identify glass transition temperature, melt temperature and crystallization temperature of polymer samples.

**GPC-** Students will use both room temperature and high temperature gel permeation chromatography (GPC) to analyze polymer length and dispersity.

**Rotation 2 Labs:** Core instrumentation to characterize more advanced properties of polymers.

**TENSILE-** Students will use a load frame to test the tensile properties of commercial polymer films.

**RHEO-** Students will use a rheometer to analyze flow and deformation of materials.

**DMA-** Students will use Dynamic Mechanical Analysis (DMA) to assess viscoelastic properties of polymer samples.

**PYGCMS-** Students will use pyrolysis-gas chromatography-mass spectrometry (PyrGCMS) to identify polymers present in a microplastic sample.

**LCA-** Students will learn to apply Life Cycle Assessment to a simple process to understand how it is used to aid in solutions to complex problems.

**Table 2 Course schedule**

	<b>Topics/Daily Activities</b>	<b>Deliverables</b>
<b>Week 1</b>	Lecture: Introduction to Polymers and the Course Lab: No Lab	
<b>Week 2</b>	Lecture: Polyethylene Lab: Intro Lab, check-in, lab tour	
<b>Week 3</b>	Lecture: Polypropylene Lab: Rotation 1A	Week 3 Lab quiz
<b>Week 4</b>	Lecture: Polystyrene Lab: Rotation 1B	Week 3 Lab report due Week 4 Lab quiz
<b>Week 5</b>	Lecture: Polyvinyl chloride Lab: Rotation 1C	Week 4 Lab report due Week 5 Lab quiz
<b>Week 6</b>	Lecture: Poly(ethylene terephthalate) Lab: Rotation 1D	Week 5 Lab report due Week 6 Lab quiz
<b>Week 7</b>	Lecture: Plastics # 7 Lab: Rotation 1E	Week 6 Lab report due Week 7 Lab quiz
<b>Week 8</b>	Lecture: Plastic Pollution Lab: Rotation 2A	Week 7 Lab report due Week 8 Lab quiz
<b>Week 9</b>	Lecture: Recycling of Plastics Lab: Rotation 2B	Week 8 Lab report due Week 9 Lab quiz Mid-Semester Project Due
<b>Week 10</b>	Lecture: Pyrolysis and Environmental Consequence of Polymers Lab: Rotation 2C	Week 9 Lab report due Week 10 Lab quiz
<b>Week 11</b>	Lecture: Life cycle assessment and technoeconomic assessment Lab: Rotation 2D	Week 10 Lab report due Week 11 Lab quiz
<b>Week 12</b>	Lecture: Replacements/ Substitutes Lab: Rotation 2E	Week 11 Lab report due Week 12 Lab quiz
<b>Week 13</b>	Lecture: Marketing/ Greenwashing Lab: Lab Practical Part 1	Week 12 Lab report due
<b>Week 14</b>	Lecture: Microplastics / MacArthur Foundation Lab: Lab Practical Part 2	
<b>Week 15</b>	Lecture: System Change Lab: Lab Practical Part 3	
<b>FINAL</b>	Lab Practical and Final Project Due	Refer to the final exam schedule in the USC <i>Schedule of Classes</i> at <a href="http://classes.usc.edu">classes.usc.edu</a> .

## Statement on Academic Conduct and Support Systems

### Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see [the student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

### Students and Disability Accommodations:

USC welcomes students with disabilities into all the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at [osas.usc.edu](https://osas.usc.edu). You may contact OSAS at (213) 740-0776 or via email at [osasfrontdesk@usc.edu](mailto:osasfrontdesk@usc.edu).

### Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services



(though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-5086 or (213) 821-8298

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or [otfp@med.usc.edu](mailto:otfp@med.usc.edu)

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.