



## **CHEM 455: Chemical Nanotechnology**

**Units: 4**

**Spring 2025—MWF—11:00-11:50 am**

**Location:** GFS 213

**Instructor:** Richard Brutchey

**Office:** MCB 122

**Office Hours:** By appointment only

**Contact Info:** brutchey@usc.edu

### **Course Description**

The technologies that drive smartphones, electric cars, LED lighting, and solar panels all rely upon our ability to discover, create, and develop new materials, with increasingly smaller dimensions, through chemical processes. CHEM 455 is an upper-division undergraduate course in Chemical Nanotechnology. The intent of this course is to describe how properties change when reducing the size of materials to the nanoscale ( $10^{-9}$  m), and explain, using concepts of solid-state chemistry, why these changes occur. Representative properties that may be covered include optoelectronic properties, magnetic properties, dielectric properties, and superconductivity.

### **Learning Objectives**

By the end of this course, students will understand the basic concepts of solid-state chemistry by exploring the structure, bonding, and properties of various materials, to achieve a fundamental understanding of structure-size-property correlations, with an emphasis on crystalline solids.

### **Recommended Preparation**

The prerequisite for this course is **CHEM 322A** or **CHEM 325A**. This course will integrate concepts from **CHEM 453** (Advanced Inorganic Chemistry), **CHEM 430** (Thermodynamics and Kinetics), **CHEM 431** (Quantum Mechanics), and **PHYS 152** (Electricity and Magnetism). These courses are not formal prerequisites, so relevant material will be introduced as needed and taught in an accessible manner during the course.

Please note that this is an upper-division **chemistry** course (not an **engineering** course), and students are expected to be able to approach the material from a chemistry-focused perspective. Comfort with upper-division chemistry topics and methods will be important for success in this class.

### **Required Readings**

Woodward, Karen, Evans and Vogt, *Solid State Materials Chemistry*

### **Supplementary Materials**

Owens and Poole, *The Physics and Chemistry of Nanosolids*

### **Description and Assessment of Assignments**

Grading for CHEM 455 is based off two exams, a written report, problem sets, and pop quizzes. The problem sets and pop quizzes are important learning tools for exam preparation. Grading for CHEM 455 is curved.

**Table 1 Grading Breakdown**

<b>Assessment Tool (assignments)</b>	<b>Due Date</b>	<b>% of Grade</b>
Final Exam	Wednesday, May 7, 11 am–1 pm	40
Midterm Exam	Friday, March 28	20
Solid State Structure Report	Friday, February 28	20
Problem Sets	Tentatively due February 14, March 14, April 18	10
Pop Quizzes	Given periodically throughout semester	10
<b>TOTAL</b>		100

### **Assignment Submission Policy**

There will be absolutely no make ups, extra time, or special arrangements given for any exams or assignments without a properly documented excuse.

### **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. 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, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

Academic dishonesty has a far-reaching impact and is considered a serious offense against the university. Violations will result in a grade penalty, such as a failing grade on the assignment or in the course, and disciplinary action from the university itself, such as suspension or even expulsion.

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.

### **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 relation to the class, whether obtained in class, via email, on the internet, or via any other media. Distributing course material without the instructor's permission will be presumed to be an intentional act to facilitate or enable academic dishonesty and is strictly prohibited. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

### **Course Evaluations**

Learning Experience Evaluations will be conducted toward the end of the semester. This will be your opportunity to provide feedback about your learning experience in the class. This feedback helps the instructor determine whether students are having the intended learning experiences for the class. It is important to remember that the learning process is collaborative and requires significant effort from the instructor, individual students, and the class. Students should provide a thoughtful assessment of their experience, as well as of their own effort, with comments focused on specific aspects of instruction or the course. Comments on personal characteristics of the instructor are not appropriate and will not be considered. For this feedback to be as comprehensive as possible, all students should complete the evaluation.

### **Course Schedule**

- I. Introduction, Feynman Lecture
- II. Solid-State Structures (Woodward 1.3-1.5)
- III. Ionic Bonding (Woodward 5.1)
- IV. Defects in Ionic Solids (Woodward 2-3)
- V. Phase Diagrams and Phase Transitions (Woodward 4, 8.4)
- VI. Electronic Band Structure of Solids (Woodward 6)
- VII. Optical Properties of Solids (Woodward 7)

## Statement on University Academic and Support Systems

### **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).

### **Student Financial Aid and Satisfactory Academic Progress:**

To be eligible for certain kinds of financial aid, students are required to maintain Satisfactory Academic Progress (SAP) toward their degree objectives. Visit the [Financial Aid Office webpage](#) for [undergraduate-](#) and [graduate-level](#) SAP eligibility requirements and the appeals process.

### **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 consists 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) 740-2500

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.