

ChE 777: Adsorption and Nanoporous Materials

Fall 2026

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Class: Friday, 1:00-3:50 PM; Room: FMH 110
Office Hours: TBD

Course Objectives

The objective of this course is to introduce Ph.D. students to problems related to nanoporous materials, and phenomena important to their technological applications, with the primary focus on gas adsorption. Additionally, the course covers mechanical properties of nanoporous materials, and the thermodynamics of fluids confined in the pores.

Course Description and Requirements

Adsorption plays key roles in vital chemical engineering processes such as gas purification, carbon capture, and catalysis, where efficiency and selectivity determine performance and sustainability. Nanoporous materials is central to adsorption because they enable selective separation and storage at the molecular scale. Understanding adsorption phenomena also advances the design of new materials for energy storage and environmental applications. Adsorption science connects fundamental thermodynamics and transport with practical technologies that shape modern chemical engineering.

Pre-Requisites: ChE 611, MTSE 602 or similar.

Pre or Corequisites: ChE 626 or similar, or undergraduate course on differential equations.

The course requires background in thermodynamics at the graduate level, and background in math (calculus and differential equations) at an undergraduate level. Additionally, the students are expected to be proficient with software for engineering calculations and plotting (preferably Python or Matlab, at minimum Excel).

The course is designed for Ph.D. students. Outstanding MS or BS/MS students in physics, chemistry, and engineering should reach out to the instructor for permission to register as an exception.

Learning Materials

Course webpage on Canvas: All the updates and assignments will be posted on Canvas webpage.

Textbook: There is no required textbook. This is a research-based graduate course, and there is no textbook that covers the course material.

Other Learning Material: Much of the basics of adsorption is covered in: Rouquerol, J., Rouquerol, F., Llewellyn, P., Maurin, G. and Sing, K., 2013. "Adsorption by powders and

porous solids: principles, methodology and applications” Academic Press. Additionally, the reading will include a list of articles which will be provided.

Course Topics

The order of the topics listed here does not represent the order in which they are presented in class, neither this list is exhaustive.

- Thermodynamics of gas adsorption
- Nanoporous materials and their applications
- Nitrogen adsorption, BET surface area, pore size distribution
- Thermodynamics of nanoconfined phases
- Kinetics of gas adsorption
- Adsorption-induced deformation
- Sorption in polymers

Assessment and Grading

Homework: Homework assignments will be given regularly. Assignments will be of two types – reading and calculations/derivations. The assignments will be posted on Canvas.

Homeworks	20%	Percent	Grades	Points
Midterm project	30%	above 85%	A	4.0
Final project	35%	above 75%	B+	3.5
In class activities	15%	above 65%	B	3.0
	100%	above 55%	C+	2.5
		above 45%	C	2.0
		below 45%	F	0.0

Exams: There will be two exams in the form of the research mini-projects.

The midterm exam (project) will be based on critical analysis of the literature on one of the course topics. The literature will be assigned by the instructor. The assignment will include reading the literature, analyzing the literature data, performing calculations, and writing a report. The grade will take into account all the aspects of the assignment. If time permits, in-class presentation will be also included.

The final exam (project) will be an open-ended problem within the scope of interests of Laboratory for Materials Interfaces. The assignment will include reading the literature, analyzing the literature data, performing calculations, and writing a report. The grade will take into account all the aspects of the assignment. If time permits, in-class presentation will be also included.

Note that outstanding final reports can be developed into publishable research papers. The final projects from the different graduate elective course, taught by the same instructor, ChE 775 in 2020 and 2022, led to papers published in *J. Phys. Chem. B* <https://doi.org/10.1021/acs.jpcc.0c10505> and *ACS Appl. Mater. Interfaces* <https://doi.org/10.1021/acsami.3c02713>