



MET E 5420/6420
Mineral Surface Chemistry of Aqueous Systems: A
Molecular View
Fall 2024
Department of Metallurgical Engineering

Instructor: Jiaqi Jin

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Pre-requisites: MET E 3630/MSE 3032 Thermal Dynamics II

Lecture: T/H 2:00-3:20 Full Semester

Credit Hours: 3

Text(s): Mineral Surfaces, D.J. Vaughan and R.A.D. Patrick

Physics and Chemistry of Interfaces, H.J. Butt, K. Carf,
and M. Kappl

Froth Flotation A Century of Innovation, M.C.
Fuerstenau, G. Jameson, and R.H. Yoon

Course Description: The course focuses on the surface chemistry study of multiphase systems involving mineral, liquid, and gas, considering the polarity and surface state of different mineral classes. Theory part include: 1) Surface reactions, intermolecular forces, and interfacial water; 2) Origins of surface charge and electrokinetic phenomena; 3) Surfactants and adsorption reactions; 4) Bubble/drop breakage, coalescence, attachment, and release; 5) Fundamental issues in froth flotation, solvent extraction, carbon adsorption, and semi-

conductor fabrication. Hands-on training include: 1) Contact angle and surface charge measurement; 2) Demonstration of spectrometers such as FTIR and SFVS; 3) Molecular Dynamics simulation of a mineral-water interface; 4) Ab-initio simulation.

Learning Outcomes: Understand the fundamentals between surface wetting and interfacial molecular behaviors.

Understand the importance of molecular polarity in surface adsorption and bubble/drop interactions.

Capability to study fundamental surface chemistry issues in practical applications using the experimental and simulation skills developed in this course.

Content Overview: **Topics**

Modules for lectures:

1. Fundamentals of Surface State (Introduction of minerals and surfaces; Hydrophobic surface state).
2. Origin of Surface Hydrophobicity (Nature of aqueous phase; Intermolecular forces; Interfacial water and surface polarity)
3. Surface Charge (Electric double layer; Electrokinetic phenomena).
4. Adsorption (Surfactants; Adsorption reactions; Characterization).
5. Bubbles and Drops (Breaking and coalescence; Attachment and spreading; Release).
6. Fundamentals of Molecular Simulation (Introduction of force field for Molecular Dynamics; Quantitative analysis; Ab-initio calculations).
7. Applications (Froth flotation; Solvent extraction; Carbon adsorption; Semi-conductor Fabrication).

Laboratories:

1. Contact Angle Measurement
2. Zeta potential measurement
3. Demonstration of FTIR and SFVS
4. Mineral Surface Structure (CrystalMaker)
5. Molecular Dynamics Simulation (LAMMPS)
6. Quantitative Analysis of Simulation Results

**Grading &
Evaluation
Methods:**

Class/Lab Participation:	10%
In Class Quizzes:	30%
After Class Assignments:	30%
Lab Reports:	15%
Presentation of Simulation Results:	15%

**Americans with
Disabilities Act
Statement:**

"The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodation in the class, reasonable prior notice needs to be given to the [Center for Disability Services](#), 162 Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations."

**Faculty and
Students'
Responsibilities:**

"All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. Students have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom

behaviors, and I will do so, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.”