529-0610-00G Interface Engineering of Materials

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Class Schedule: M 09:45 – 11:30 (HCI H8)
T 09.45 – 11:30 (HCI E8)
Office Hour: F 15:00 – 17:00 (upon schedule)

Abstract:

Advances in interface engineering, the control of molecular and charge behavior between two phases, are driving the development of new technologies across many industrial and scientific fields. This course will review the fundamental engineering concepts required to analyze and solve problems at liquid-solid and solid-solid interfaces.

Objective:

Introduce the students to the engineering principles of energy, mass, and electron transport at the liquid-solid and solid-solid interfaces, for the applications in materials processing and electronic devices.

Lecture Notes and Learning Materials:

https://shihlab.ethz.ch/education/IEM.html

Grading:

- Homework (20%)
  Five homework assignments.
  Each contains 1 - 3 problem sets. One of problem sets involves numerical coding.

- Midterm Exam (Oral) (20%)
  Qualitative description about concepts in Lectures 1- 10 (10-15 mins)

- Final Exam (Written) (60%)
  Range: Open book to all lecture notes and homework solutions.
  Style: Qualitative description (50%) and derivation / calculation (50%)

Scheduling:

- Midterm preparation days off: 31.03 and 01.04
- Midterm exam: 07.04 and 08.04

Prerequisites:

- Engineering Mathematics, Transport Phenomena, Undergraduate Physical Chemistry

Schedule:

- 17.02 Lecture 1 Molecular Interactions at Interfaces
- 18.02 Lecture 2 Wetting and Spreading
- 24.02 Lecture 3 Surfactant Science
- 25.02 Lecture 4 Fluid Mechanics Involving Interface
- 03.03 Lecture 5 Supercooling and Nucleation
- 04.03 Lecture 6 Growth of Nucleus Under Supercooling
- 10.03 Lecture 7 Crystal Growth: Engineering Solid/Melt Interface
- 11.03 Lecture 8 Physics of Electrostatics
- 17.03 Lecture 9 Electrostatic Nature of Intermolecular Forces

- 18.03 Lecture 10 The Dispersion Force and van der Waals Interaction
- 24.03 Lecture 11 Electrical Double Layer at Solid-Electrolyte Interface
- 25.03 Lecture 12 Electrowetting
- 07.04 Midterm Exam Day 1
- 08.04 Midterm Exam Day 2
- 14.04 Lecture 13 Stabilization of Charged Particles in Electrolyte Solutions
- 15.04 Lecture 14 Electrokinetic Phenomena
- 28.04 Lecture 15 Electrophoresis
- 29.04 Lecture 16 Solute Transport Across Partially Permeable Membranes
- 05.05 Lecture 17 Introduction to Semiconductors
- 06.05 Lecture 18 Motion and Recombination of Electrons and Holes
- 12.05 Lecture 19 Metal-Semiconductors Interface
- 13.05 Lecture 20 The p-n Junction
- 19.05 Lecture 21 Photodetectors and Solar Cells
- 20.05 Lecture 22 Field Effect Transistors
- 26.05 Concluding Remarks and Final Exam Examples