

SYLLABUS

PHYSICAL NATURES OF SURFACES

Winter Quarter ---- 1982

MSE 752/Pharmacy 752*/Bioengineering 752

(3 hours)

Instructor: J.D. Andrade, Professor

Office: 3372 MEB

Telephone: 581-8509 (277-1259, home)

Time and Place: Tuesday and Thursday, 2:15 - 3:40 p.m.
2047 MEB

Teaching Assistant: David Dong, Graduate Research Assistant

Office: 2062 MEB

Telephone: 581-7730

Text: R. Aveyard, and D. Haydon, Introduction to Principles of Surface Chemistry, Cambridge University Press, 1973, paperback.

Readings: Handout materials and reserve books.

Grading: 25% - Midterm (take home - open book) ← 100
15% - Homework, Quizzes and Seminars ← 100
25% - Final (written - closed book) ←
35% - Laboratory ← 140
50

* This is a two-quarter sequence; MSE 753/Pharmacy 753/Bioengineering 753 - Nature of Biological Interfaces will be offered Spring Quarter, 1982.

MSE/Pharmacy/Bioengineering 752 -- Physical Nature of Surfaces

Tentative Lecture Schedule
(Refer to Syllabus and Course Outline)

January	5	Introduction
"	7	Interface Thermodynamics and Semantics
"	12	Intermolecular Interactions - Introduction
"	14	" " " - in water and other media
"	19	Adsorption Dynamics
"	21	Liquid Surfaces - Surface Tension - Capillarity
"	26	Adsorption at L-A Interfaces
"	28	Solid Surfaces - in vacuo, air, and under water
February	2	The Metal - Aqueous Solution Interface
"	4	The Semiconductor - Aqueous Solution Interface
"	9	The Insulator - Aqueous Solution Interface
"	11	Solid - Liquid Interfaces - Contact Angles
"	16	" " " - Adsorption from Solution
"	18	X-ray Photoelectron Spectroscopy (XPS) I
"	23	" " " " " " II
"	25	Secondary Ion Mass Spectroscopy (SIMS) and Ion Scattering Spectroscopy (ISS)
March	2	Other Techniques: ATR: Ir - Raman - UV
"	4	Other Techniques - Ellipsometry and Microarea Methods
"	9	Intro to Second Quarter - Review
"	11	Final Examination

Seminars and Colloquia

The Department of Bioengineering, Pharmaceutics, Materials Science and Engineering, Chemistry, Physics and others all have seminars in the general area of surface science and technology relevant to the subject matter of this course. You will be informed of those seminars as the information becomes available. You will be expected to attend a minimum of five seminars during the quarter and to provide a critical summary and report for each of the five lectures. In addition, a number of past seminar speakers have been videotaped by the Educational Media Department; a number of these tapes may be shown to the class as part of the Seminar and Colloquia requirements.

COURSE OUTLINE

I. Introduction

- A. The concept of surface and interface
- B. Technological significance of surfaces and interfaces
- C. Biomedical significance of surfaces and interfaces
- D. What does one want to know about surfaces?
- E. How does one get that information?

II. Thermodynamics

- A. Brief review of thermodynamics
- B. Thermodynamics of interfaces
- C. Geometrical thermodynamics

III. Intermolecular Forces and Interactions

- A. Basic electrostatics and electrostatics
- B. Electrostatic forces
- C. Electrodynamic (London) forces
- D. Calculations for various geometries
- E. Nature of the dielectric constant and medium effects
- F. Hydrophobic interactions
- G. Theories of adsorption (gas-solid)

IV. Electrical Properties of Interfaces

- A. Surface and interface potentials - general
- B. Work functions, contact potentials, surface potentials, etc.
- C. Electrets and organic semiconductors
- D. Solid/solution interfaces - electrical double layer
- E. Electrokinetic phenomena

V. Solid-Gas Interfaces

- A. Dynamics of adsorption
- B. Langmuir and BET treatments - measurement of surface area
- C. Other treatments

VI. Liquid-Gas Interfaces

- A. Surface tension and capillarity
- B. Measurement of surface tension
- C. Monomolecular layers - general
- D. Monomolecular layers - experimental

VII. Solid-Liquid Interfaces

- A. Wetting and contact angles
- B. Thermodynamics of contact angles
- C. Measurement of contact angles
- D. Contact angle dynamics and hysteresis
- E. Adsorption from aqueous solution

VIII. Surface Characterizations

- A. Surface "energy" - contact angles
- B. Surface chemical nature and elemental composition
 - ESCA/Auger
 - ISS
 - SIMS
 - Specific stains and probes
- C. Subsurface chemical nature and elemental composition
 - MIR-IR, Raman
 - Depth profiling
- D. Surface electrical properties
 - Potential measurements
 - electrokinetic phenomena
- E. Surface Structure/Topography/Area
 - SEM
 - Adsorption
 - Other
- F. Other - ellipsometry

SECOND QUARTER - TENTATIVE SUBJECTS

Adsorption from Solution
Monomolecular Films
Macromolecule Adsorption
Protein Structure and Properties
Proteins at Air/Solution Interfaces
Proteins at Solid/Liquid Interfaces
Modeling and Treatment of Protein Adsorption
Blood "Compatibility"
Polymer Surface Modifications for Certain Biomedical Applications
Gels and Gel/Solution Interfaces
Nature of Cell Membranes
Other Topics

LABORATORY OUTLINE

35% of the course grade will be on the basis of performance in laboratory work, the efficient, economical and complete surface characterization of an unknown polymer surface. Details will be provided in the sixth week and a report on the unknown will be due during the ninth week.

LABORATORY GUIDELINES

At approximately the midpoint in the course, each of you will become an 'employee' of a hypothetical company. You will receive a memorandum from your research director which describes a possible application for a material recently developed by your firm. Attached to the memo is a sample of the material, and a 'P.S.' which states that your operating budget for investigating this material is limited to \$1,000.

Your job is to characterize the surface of this material as completely as possible, for the particular application specified by your employer. You will be expected to use all of the fundamentals developed in this course and any or all of the characterization equipment and techniques available in the "Intermountain Regional Surfaces Laboratory" (IRSL).

You cannot exceed your \$1,000 budget. You will be "billed" for all work performed, and will have to practice good 'economic sense' during the course of your investigation.

It is important to note that the cost of refabricating a second 'surface' (\$995.00) will instantly 'bankrupt' your sample size and characterization protocols accordingly.

The IRSL technician will provide all analyses on standard forms. Interpretation of your results, and consultation service are available, but remember they are costly. You should make every effort to analyze not only the most efficient procedures to obtain your results, but also your own interpretation of what you have obtained. Part of your lab grade will be determined by how efficiently you spend your 'company dollars.'

Samples are processed by appointment, and it will be to your advantage to be present during the analyses. The technician will only provide what you specifically request. Suggestions provided to you by IRSL will be considered as consultation, and you will be billed accordingly.

Upon completion of your characterization, you will be expected to provide a comprehensive report on your findings, including why you chose the analysis methods used, what the data means, and your recommendations regarding the use of this material for the application suggested by your employer. Remember that he is an extremely 'cost conscious' person and wants to see that his investment was well spent in terms of the information you obtained.

All samples are to be stored at IRSL, and you are not allowed access to them except during your appointment times.

'Limited' bulk analysis will be provided for \$75.00 per sample.

INTERMOUNTAIN REGIONAL SURFACES LABORATORY (IRSL)

Available Characterization Techniques

1. Surface Cleanliness - Wilhelmy plate test - \$75.00/sample
2. Surface Energy - Contact angle measurements by Wilhelmy plate - \$100/sample
3. Chemical Analysis - XPS - \$150.00/sample - 1 1/2 hrs. maximum
4. Surface Roughness - Optical Microscopy - \$75.00/sample, SEM (sub-contracted) - \$150.00/sample (1 hr. maximum)
5. Bulk Characterization - Includes sample identification, processing history, MW determinations, etc. - \$75.00 sample
6. Sample Fabrication - Duplication of original sample - \$995.00
7. Consultation Time - \$100.00/hr.
8. Data Interpretation - \$100.00/hr.

- NOTE:
1. One hour minimum on each characterization, i.e., you are billed for one hour regardless of how much of the first hour you use.
 2. A three-day advance notice is required for all appointments.
 3. For weekend appointments add \$20.00/hr or sample for each characterization.
 4. For 'RUSH' characterizations add \$50.00/hr or sample for each analysis.

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 Quarter(s) Circle A W S Su Loan Period (Indicate in Column Below):

CALL NUMBER	AUTHOR	TITLE	LOAN PERIOD		To be filled	
			2 hr.	1 day	C on Res.	Library St Notes
QD 506 K3	D.H. Kaelble	<u>Physical Chemistry of Adhesion</u> , Wiley, Interscience, 1971.		1		
QD 506 A94	R. Aveyard and D.A. Haydon	<u>Introduction to Principles of Surface Chemistry</u> . Camb. Univ. Press		1		
QD 506 B49	J.J. Bikerman	<u>Physical Surfaces</u> Academic Press, 1970		1		
QD 506 A	A.W. Adamson	<u>Physical Chemistry of Surfaces</u> , 3rd ed., Interscience, 1977		1		
533.1 B672d	J.H. deBoer	<u>Dynamical Character of Adsorption</u> 2nd ed., Clarendon Press (Oxford) 1968.		1		
QC 176 K33	P.F. Kane and G.B. Larrabee, eds.	<u>Characterization of Solid Surfaces</u> , Plenum, 1974		1		
QC 176.8 S8 P80	M. Prutton	<u>Surface Physics</u> , Clarendon Press (Oxford), 1975.		1		
541,3453 D256i	J.T. Davies and E.K. Rideal	<u>Interfacial Phenomena</u> , 2nd ed. Academic Press, 1963.		1		
QD 506 M37	A. Czanderna, ed.,	<u>Methods of Surface Analysis</u> , Elsevier, 1975		1		
QD 101.2, S95, 1977	N.S. McIntyre, ed.	<u>Quantitative Surface Analysis of Materials</u> , ASTM STP 643, 1978		1		
	D.T. Clark and W.J. Feast, eds.	<u>Polymer Surfaces</u> , Wiley, 1978		1		
	G.A. Somorjai	<u>Chemistry in Two Dimensions: Surfaces</u> , Cornell Univ. Press, 1981		1		

KEY TO ABBREVIATIONS AND NOTES:

C. on Res.: Number of copies on Reserve
 NIL: Library does not have this book (Not in Library)
 OP: Out of print
 RC: Book called in from borrower (Recalled)
 SEARCH: Book cannot be found and is being searched

Unknown # _____ Assigned to: _____

Identification/
Description:

Sources of Information:

Surface Analysis:

ESCA and Contact Angle: Contact Dave Dong, T.A., x7730
Optical Microscopy: " " " " "

Scanning Electron Microscopy: Contact Howard Spencer at 6806 or 7581
(one hour max!)

Total Internal Reflection Infrared Spectroscopy: Contact Dave Dong,
T.A., x7730

Other Surface Characterization: Not available

Report:

Limited to a maximum of seven typewritten pages plus up to five additional
pages of figures, tables, spectra. No more than 12 pages.

Due: Wednesday, March 19, 1982 by 5:00 p.m. (Deliver to 2059 MEB)