MATERIALS

UC Santa Barbara

GRADUATE STUDENT MANUAL

Fall 2011

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Who's Who in the Materials Department

FACULTY

	Professor	Joint Appt.	Area
*	Tresa M. Pollock (Chair)	—	Structural
*	Frank W. Zok (Associate Chair)	—	Structural
*	Guillermo C. Bazan	Chem	Macro/Biomolecular
	John Bowers	ECE	Electronic
*	Michael Chabinyc	—	Macro/Biomolecular
	Larry A. Coldren	ECE	Electronic
*	Steven P. DenBaars	ECE	Electronic
*	Craig Hawker	Chem	Macro/Biomolecular
	Alan J. Heeger	Phys	Macro/Biomolecular/Electronic
	Jacob N. Israelachvili	ChE	Macro/Biomolecular
*	Edward J Kramer	ChE	Macro/Biomolecular/ Structural
	Herbert Kroemer	ECE	Electronic
*	Carlos G. Levi	ME	Structural/Inorganic
	Robert M. McMeeking	ME	Structural
*	Shuji Nakamura	ECE	Electronic
	G. Robert Odette	ME	Structural
	Chris Palmstrøm	ECE	Electronic
	Philip A. Pincus	Phys/BMSE	Macro/Biomolecular
*	Cyrus R. Safinya	Phys/BMSE	Macro/Biomolecular
*	Omar Saleh	BMSE	Macro/Biomolecular
*	Ram Seshadri	—	Inorganic
	Hyongsok (Tom) Soh	ME	Macro/Biomolecular
*	James S. Speck	—	Electronic/Inorganic
*	Susanne Stemmer	—	Inorganic
	Galen D. Stucky	Chem	Inorganic/Electronic
*	Chris Van de Walle	—	Electronic
	Claude Weisbuch		Electronic
	Fred Wudl	Chem	Inorganic

** Majority appointment in Materials*

TECHNICAL STAFF

Brian Carralejo	Metalorganic Chemical Vapor Deposition Laboratory
Mark Cornish	Microscopy / Specimen Preparation (SEM)
Mike Edwards	Computer Consultant
John English	Molecular Beam Epitaxy (MBE) Laboratory
Michael Iza	Metalorganic Chemical Vapor Deposition Laboratory
Budd Jamieson	Computer Consultant
Stephan Kraemer	FIB, TEM and Atom Probe
Tom Mates	Thin films and interfaces, SIMS and XPS
Peter Maxwell	Materials Processing
Deryck Stave	Structural Materials Processing Laboratory

ADMINISTRATIVE STAFF

Mary E. Cummings	Associate Manager
Tawny Hernandez	Contracts & Grants/Financial Analyst/ Payroll Personnel
Aubriana Laube	Assistant to Profs. Levi, Pollock & Zok
Joanne McNie	Assistant to Profs. Pincus, Safinya, Stemmer & Seshadri
Dawn McTague	Management Services Officer
Oura Neak	Graduate Program Assistant
Tara Owens	Financial Manager, SSLEC
Alana Pague	Receptionist/Assistant to Profs. Chabinyc, Gossard, Kramer, Palmstrøm & Saleh
Ashley N. Thompson	Purchasing Coordinator
Yukina Warner	Corporate Programs Manager, SSLEC
Alison Woolery	Assistant to Profs. Denbaars, Nakamura, Speck, Van de Walle & Weisbuch

Introduction

THE UC SYSTEM

The University of California was chartered as a land-grant college in 1868. Ten UC campuses are now situated throughout the state, in Berkeley, Davis, Irvine, Los Angeles, Merced, Riverside, San Diego, San Francisco, Santa Barbara, and Santa Cruz. Together, the campuses have over 170,000 faculty members and a current enrollment of about 220,000 students. About one-fourth of UC students are studying at the graduate and professional level. The University also operates a variety of laboratories, agricultural field stations, extension offices, and other facilities. The University is the primary state-supported academic agency for research, and the pre-eminent system of public higher education in the country.

The ten UC campuses are governed by the Regents of the University of California, a corporate board of 26 members. The Regents in turn, delegate authority to the President, the Chancellor of each campus, and to the Academic Senate, which represents the faculty.

THE UCSB CAMPUS

The UCSB campus was established in 1944 and moved to its present location on the site of a former marine base in 1953. The 989 acre grounds include the main campus, the Santa Ynez and Storke apartments and the West campus. The student community of Isla Vista is surrounded by the UCSB campus and the Pacific Ocean.

Within its beautiful setting, the University of California, Santa Barbara is a major research institution offering undergraduate and graduate education in the arts, humanities, the social sciences, and science and technology. Large enough to have excellent facilities for study, research, and other creative activities, the campus is also small enough to foster close relationships among faculty and students. The total student population is about 22,000, with over 19,000 undergraduates and 3,000 graduate students. The UCSB faculty numbers over 1,000 and includes five Nobel laureates, recipients of the National Medal of Science, members of the National Academy of Sciences and the National Academy of Engineering, members of the Royal Society of London, numerous Guggenheim fellows, Fulbright scholars, and fellows of the National Endowments for the Arts and for the Humanities.

The UCSB campus has 6 academic units: the College of Creative Studies, the College of Engineering, the College of Letters and Sciences, the Gevirtz Graduate School of Education, the Donald Bren School of Environmental Science & Management and the Graduate Division.

THE COLLEGE OF ENGINEERING

The College of Engineering is the second largest undergraduate college at UCSB, including approximately 1200 undergraduate students and 700 graduate students. In recent years, the College has become one of the most dynamic engineering schools in the nation. It currently has a full-time, permanent faculty of 138 and consists of five degree-granting departments:

- Chemical Engineering
- Computer Science
- Electrical and Computer Engineering
- Materials
- Mechanical Engineering

The College of Engineering is home to major internationally funded Research Centers focused on Materials including:

- Materials Research Laboratory (an NSF-funded MRSEC)
- Nanotech - UCSB Node of the National Nanofabrication Infrastructure Network (NNIN)
- Mitsubishi Chemical Center for Advanced Materials
- Solid State Lighting and Energy Center
- Center for Multifunctional Materials and Structures
- International Center for Materials Research

THE MATERIALS DEPARTMENT

The Materials Department at UCSB was established as a Graduate Program in 1985, building on existing research programs in the College of Engineering as well as the Physics and Chemistry Departments. The Department was conceptualized and built under two basic guidelines: to educate graduate students in advanced materials and to introduce them to novel ways of doing research in a collaborative, multidisciplinary environment.

The Department is organized into four distinct – but not separate – groups specializing in electronic/photonic materials, macromolecular/biomolecular materials, structural materials and inorganic materials. Faculty, postdoctoral researchers, and students in the various specialties collaborate within and among these areas. Currently, the Materials Department has approximately 120 graduate students and 31 faculty, many of who have joint appointments with other departments. In addition, approximately 40 postdoctoral associates and visiting researchers are working within the department.

MATERIALS
UC Santa Barbara

Graduate Program Information

PROGRAM OF STUDY

The Department of Materials offers programs leading to the M.S. or Ph.D. degree with specializations in the following major areas: Electronic Materials (semiconductors, superconductors, quantum structures and optoelectronic materials); Inorganic Materials (ferroelectrics, photonic and magnetic materials, and zeolite molecular sieves); Macro/Biomolecular Materials (self-assembling polymers, biopolymers, biomembranes, and conducting polymers); and Structural Materials (metals, ceramics, composites, and coatings, including mechanics of materials). The curriculum in each area has the flexibility needed to provide multidisciplinary educational opportunities in the field of advanced materials, encompassing topics such as optoelectronic devices, composites, and micromechanics. Materials synthesis, processing and characterization feature prominently with courses in the processing of ceramics, alloys, composites, semiconductor materials, and polymers, as well as advanced topics in electron microscopy. Programs of study and research are individually tailored to accommodate research needs and student interest. Multidisciplinary education is strongly encouraged by means of joint faculty supervision of research and by the selection of courses. Students are also encouraged to cross over traditional boundaries into other departments on campus (for example, Electrical and Computer Engineering, Mechanical and Environmental Engineering, Chemical Engineering, Biology, Chemistry and Physics) through collaboration and taking courses in those departments as appropriate.

Incoming students are expected to design a tentative study program suitable to their interests and research field with the assistance of their advisor and submit it for approval to the Academic Affairs Committee within the first two quarters of residence. Students are expected to complete the Ph.D. program within five years after entry at the Bachelor's level and within three years after entry at the Master's level.

ADVISING AND ACADEMIC AFFAIRS

Decisions regarding the M.S./Ph.D. program and graduate student affairs reside with the Academic Affairs Committee. This committee consists of four faculty, including the Department Chair. The committee is responsible for approving examination and dissertation committees upon consultation with the student and research advisors. It is also the focus for discussions and recommendations concerning improvements in the graduate curriculum and examination procedures.

Each student must select a research advisor **within the first quarter of enrollment**, preferably earlier, based on mutual research interests and availability of research assistantships. Joint research advising by two faculty members is strongly encouraged to ensure that research programs have a strong multidisciplinary character.

FIVE YEAR BS ENGINEERING/MS MATERIALS PROGRAM

Students enrolled in the 5-year BS/MS program should refer to a separate brochure on that program available through the Materials Department Graduate Affairs Office.

MASTER'S PROGRAM

The Materials Department does not require completion of an M.S. degree before advancing to the Ph.D. Those students who elect to complete an M.S. degree first and then continue on for the Ph.D. must follow Plan 1. achieve a 3.5 grade-point average in their coursework and pass the preliminary examination as described on the "Doctor of Philosophy-Materials" section below. Students wishing to terminate their studies with a Master's Degree may choose from two Plans of Study. All students in the BS/MS program should follow Plan 2 for the M.S. degree.

Plan 1. Students in this plan are required to (1) complete 42 units including **27** units of formal coursework, of which a minimum of 21 units must be approved 200 level courses (200-289), at most 6 units of approved advanced undergraduate courses not used already for credit toward a previous degree, 3 units of seminars (Matrl 290) and 12 units of thesis research (Matrl 598), and (2) submit an acceptable thesis based on original research. There is no oral defense of the M.S. thesis. The thesis must be approved by a committee of three faculty members, including the student's advisor. At least one committee member must have a majority appointment in Materials, and one must have a non-zero appointment in Materials.

Plan 2. Students in this plan are required to (1) complete 42 units of coursework including a minimum of **27** units from approved 200 level courses (200-289), at most 6 units of approved advanced undergraduate courses not used already for credit toward a previous degree, no fewer than 3 and no more than 6 units of independent studies or research (Matrl 596), and 3 units of seminars (Matrl 290), and (2) submit an acceptable engineering report based on the independent studies. The report must be approved by a committee of two faculty members, including the student's advisor. At least one member of the committee must have majority appointment in Materials.

Appropriate course tracks for use in planning a program of study are presented in a subsequent section. Further details are also available from the Materials Graduate Affairs Office, or the Graduate Faculty Advisor.

Ph.D. PROGRAM

Students admitted with a Bachelor's degree are required to complete a minimum of 72 units of academic work structured in the following manner: 42 units of 200-level courses (excluding seminars and independent study), 15 units of seminars and/or independent studies, and 15 units of thesis research. Up to 8 units of upper division undergraduate courses may be taken for credit toward the 200 level course requirements with prior approval of the student's advisor. Students entering with a M.S. degree may petition to waive certain unit requirements for the Ph.D. (up to 15 units of 200-level courses and a possible six units of seminars) deemed to have been fulfilled by Master's studies elsewhere.

All Ph.D. students are required to complete the following series of core courses in the appropriate sequence:

Matrl 200A **–** Thermodynamic Foundation of Materials
Matrl 200B **–** Electronic & Atomic Structure of Materials (Prerequisite: Matrl 200A)
Matrl 200C **–** Structure Evolution (Prerequisite: Matrl 200A)

In preparation for more advanced and specialized courses within their area of specialization, students are strongly encouraged to complete this core course sequence during their <u>first year of study</u>. A minimum grade of B in each of these courses is required prior to taking the Qualifying Examination (described below).

Additionally, in developing an appropriate interdisciplinary course of study, Ph.D. students are expected to take both the available courses in their major area of interest as well as courses designed to broaden their knowledge of other materials. Individual students are required to develop their study plan in conjunction with their faculty advisor. Most courses will be selected from the main sequence of courses (offered every year) from one of the four principal areas of emphasis in the Department. Students should also not miss the opportunity to take any general or more specialized courses offered on a less frequent basis. The study plan must be approved by the faculty advisor and the department graduate advisor, although it may be modified during the course of the student's program. See the appropriate Course track from the following pages in planning a program of study.

Electronic/Photonic Materials Course Track

Course Number	Course Title	Units
Main Sequence Courses:		
206A-B	Fundamentals of Electronic Solids I, II	4
211A	Engineering Quantum Mechanics	4
215A-B-C	Semiconductor Device Processing	4
General Courses:		
209A	Crystallography and Diffraction Fundamentals	3
209BL	X-Ray Diffraction I: Principles and Practice	3
209B	X-Ray Diffraction II: Advanced Methods	3
209CL	Electron Microscopy I: Principles and Practice	4
209C	Electron Microscopy II: Crystalline Materials	3
219	Phase Transformations	3
228	Computational Materials	3
Specialized Courses:		
204	Introduction to Magnetism and Magnetic Materials	3
205	Wide-Band Gap Materials	3
216	Defects in Semiconductors	3
217	Molecular Beam Epitaxy & Band Gap Engineering	3
224	Optical and Luminescent Materials	3
226	Electrical and Functional Crystals and Ceramics	3
227	Metal Organic Chemical Vapor Deposition	3
263	Thin Films and Multilayers	3
288AA-ZZ	Special Topics in Electronic Materials	3
Background Courses:		
162A	Quantum Description of Electronic Materials	4
162B	Fundamentals of Solid State	4
ECE 162C	Optoelectrical Materials and Devices	4

Inorganic Materials Course Track

Course Number	Course Title	Units
Main Sequence Courses:		
209A	Crystallography and Diffraction Fundamentals	3
218	Introduction to Inorganic Materials	3
274	Solid State Inorganic Materials	3
General Courses:		
209BL	X-Ray Diffraction I: Principles and Practice	3
209B	X-Ray Diffraction II: Advanced Methods	3
209CL	Electron Microscopy I: Principles and Practice	4
209C	Electron Microscopy II: Crystalline Materials	3
219	Phase Transformations	3
222A	Colloids & Interfaces	3
228	Computational Materials	3
Specialized Courses:		
204	Introduction to Magnetism and Magnetic Materials	3
ChE 216A	Intro. To Magnetic Resonance Spectroscopy Tech.	3
224	Optical and Luminescent Materials	3
226	Electrical & Optical Properties of Oxides	3
251A	Processing of Inorganic Materials	3
251B	Densification & Microstructural Control	3
286AA-ZZ	Special Topics in Inorganic Materials	3
Background Courses:		
Chem 175	Physical Inorganic Chemistry	3

Macromolecular/Biomolecular Materials Course Track

Course Number	Course Title	Units
Main Sequence Courses:		
271A	Synthesis and Properties of Macromolecules	3
271B	Structure and Characterization of Complex Fluids	3
271C	Properties of Macromolecules	3
General Courses:		
214	Advanced Topics in Equilibrium Statistical Mechanics	3
222A	Colloids and Interfaces	3
228	Computational Materials	3
273	Experiments in Macromolecular Materials	3
Specialized Courses:		
253	Liquid Crystal Materials	4
276A	Biomolecular Materials I: Structure & Function	3
276B	Biomolecular Materials II: Applications	3
277	Synthesis of Biomolecular Materials	3
278	Interactions in Biomolecular Complexes	3
282	Transition Metal Catalyzed Polymerization	3
284	Synthetic Chemistry of Macromolecules	3
287AA-ZZ	Special Topics in Macromolecular Materials	3
Background Courses:		
ChE 102	Biomaterials and Biosurfaces	3
135	Biophysics and Biomolecular Materials	3
160	Introduction to Polymer Science	3
ChE 225	Principles of Bioengineering	3

Structural Materials Course Track

Course Number	Course Title	Units
Main Sequence Courses:		
207	Mechanics of Materials	3
220	Mechanical Behavior of Materials	3
234	Fracture Mechanics	3
General Courses:		
209A	Crystallography and Diffraction Fundamentals	3
209BL	X-Ray Diffraction I: Principles and Practice	3
209B	X-Ray Diffraction II: Advanced Methods	3
209CL	Electron Microscopy I: Principles and Practice	4
209C	Electron Microscopy II: Crystalline Materials	3
219	Phase Transformations	3
228	Computational Materials	3
Specialized Courses:		
230	Elasticity	3
240	Finite Element Structural Analysis	3
251A	Processing of Inorganic Materials	3
251B	Densification & Microstructural Control	3
261	Composite Materials	3
263	Thin Films and Multilayers	3
289AA-ZZ	Special Topics in Structural Materials	3

Registration Information

Registration is completed on the web via the GOLD system. Complete instructions on this process can be found in the Schedule of Classes, which is printed quarterly by the Office of the Registrar. In addition to elective courses, students must register for one unit of Matrls 290 every academic quarter in residency in order to receive credit for attending group meetings and seminars. Students must also enroll in at least one unit of either Matrls 598 or Matrls 599 every academic quarter after having selected an advisor and having begun research. The number of units in Matrls 598 or Matrls 599 should be selected to bring the quarter total to at least 12 units. Students should register for Matrls 598 until they have advanced to candidacy (by passing the qualifying examination), after which they register for Matrls 599. Also, while serving as teaching assistants, students must register for Materials 501 under the instructor in charge of the class (see below).

Foreign Language and Minors

There are no formal requirements regarding either foreign languages or minors. However, Ph.D. students are strongly encouraged to incorporate courses from outside their area of specialization into their curriculum in order to broaden their knowledge of the materials field. They are also encouraged to become proficient in one or more foreign languages relevant to the technical literature in their field. Students having a particular interest in strengthening their background in foreign languages for this purpose are encouraged to pursue the necessary coursework to fulfill that interest.

Special Preparation for Teaching

All Ph.D. students are required to act as Teaching Assistants for at least one quarter while in residence at UCSB (usually during the first year), in either Materials courses or within departments providing courses consistent with the student's undergraduate background. To receive credit for the required teaching, students must register for Matrls 501 under the instructor in charge of the class while serving as Teaching Assistants. (2 units for 25%TA, 4 units for 50%TA. These units may not be counted towards the 72 units of academic work required for graduation). Teaching Assistants supervise labs, conduct recitation, tutor undergraduate students and give seminars. Because this is a requirement of the program, students' stipends will remain unchanged while serving as Teaching Assistants.

Students are also required to present research seminars, thereby ensuring that experience be gained in organizing and presenting lectures. Seminars are required at the group level (about one per quarter), the program level (one per year) and at conferences. Such activities enable students to improve the skills necessary for the subsequent pursuit of teaching opportunities.

Monitoring Student Progress Through the PhD Program

The Materials Department has the following system of annual assessments to monitor the student's progress through the Ph.D. program.

Year 1	Preliminary Examination
Year 2	Qualifying Examination (Advancement to Candidacy)
Years 3, 4, …	Progress Assessments
End of Program	Dissertation defense

With the exception of the Dissertation defense, all assessments are to be performed by a faculty committee within ±2 months of each anniversary of the student's entrance into the department. All assessments are to include a written document (described below for each case), an oral presentation and a period of questions and discussion, after which the committee will render its assessment of the student's progress and make recommendations for future actions. Students must consult with the Graduate Program Assistant regarding the filing of necessary paperwork for each stage.

Preliminary Examination

The Preliminary Examination is administered 10-14 months after the student's entrance into the program. Students who do not meet this deadline may be put on academic probation and may become ineligible for financial support.

The examination committee consists of three faculty members from the student's major field, including the student's advisor. At least two of the members must be ladder faculty with a non-zero percent appointment in Materials, and preferably at least one should be a majority appointment. One member of the committee, other than the advisor, will serve as Chair of the Preliminary Examination committee. The committee members are selected by the student in consultation with his/her advisor.

Students with a GPA of 3.5 or better in the graduate program at UCSB are automatically eligible to take the examination. Students with a GPA above 3.2 may petition for a waiver of the 3.5 GPA requirement. The petition is filed with the Graduate Program Assistant and is evaluated by the Department's Graduate Advisor in consultation with the student's advisor. These students shall have two opportunities to pass the Preliminary Examination. Students with a GPA less than 3.2 are ineligible but will have one opportunity to take the Preliminary Examination in the following academic quarter, provided they can increase their GPA to 3.2 and gain the consent of the Graduate Advisor and their research advisor.

The Preliminary examination is intended to assess whether the student has the fundamental knowledge, intellectual maturity and degree of understanding of his/her major field and prospective research topic to be able to write a dissertation proposal successfully over the course of the following year. At least 3 months prior to the examination date the committee will assign the student a specific topic relevant to his/her intended research project. The student will research the literature on the assigned topic, identify key outstanding issues and/or research opportunities, propose ideas on how to address these issues and/or exploit the opportunities, and outline a tentative research plan. The student is expected to prepare a short document (10 pages maximum including a minimum number of figures and suitable references) summarizing his/her findings and ideas. The document must be submitted to the committee at least one week before the examination date. At the examination, the student will present a 30-40 min seminar outlining his/her findings, ideas and prospective research plan. After the presentation, the committee will probe the student's understanding of the subject, his/her knowledge of the fundamentals of materials science relevant to the problem, and his/her ability to think soundly and creatively. It is also expected that by this point in time the student should have had some initial research experiences and be able to relate those to the literature he/she has researched. After the examination the committee may render one of the following decisions, with recommendations for future action or corrective measures as appropriate:

(i) Advance to the Qualifying Examination without reservations.
(ii) Advance to the Qualifying Examination with a warning of deficiencies in the student's background or understanding that need to be corrected (e.g. by taking additional courses, independent reading, etc.) by the time of the Qualifying Examination.
(iii) Requirement that the student takes the Preliminary Examination again before he/she is allowed to advance to the Qualifying Examination. This second exam must take place within a 2-4 month period following the first one. Failure to advance after the second exam requires the student to leave the program, with the option of completing an MS degree.
(iv) Recommendation that the student finishes at the MS level, with an allowance of one year to finish the requirements for that degree.

Qualifying Examination (Advancement to Candidacy)

The Qualifying Examination is administered 22-26 months after the student's entrance into the program. Students who do not meet this deadline may be put on academic probation and may become ineligible for financial support.

The examination committee consists of at least four faculty: three having more than a 0% appointment in the Materials Department (at least one of them preferably with a majority appointment in Materials) and one with no more than a 0% appointment in the Materials Department. One member of the committee, other than the advisor, will serve as Chair of the Qualifying Examination committee. Members of the examination committee are nominated by the student and research advisor and must be approved by the Academic Affairs Committee. The examination committee typically becomes the dissertation committee.

Pre-requisites for the Qualifying Examination include: (i) successful completion of the Preliminary Examination; (ii) completion of the Materials Department core courses (200A, B, C) with a minimum of B in each one of them; and (iii) a minimum 3.5 GPA in the graduate program at UCSB. Students with a GPA above 3.2 may petition the Academic Affairs Committee for a waiver of the 3.5 GPA requirement.

The purpose of the qualifying examination is to assess whether the individual has acquired the requisite understanding of his intended research topic and critical thinking ability to elaborate and execute a sound research plan for his/her dissertation. Some preliminary research is required to elaborate the dissertation proposal, but the exam is not intended to evaluate a project that is well past the planning point.

The examinee must submit a formal dissertation proposal (maximum 10 pages of text plus a sensible number of figures and a substantial list of references) that summarizes the intended research problem, the research approach, results to date, and future directions. This proposal should be submitted to the examination committee <u>at least two weeks before the examination</u>. (Failure to deliver the thesis proposal to the committee on time may result in postponement of the examination.) The format of the examination includes a 40-45 min presentation of the dissertation proposal by the student, during which time only questions of clarification will be allowed. The presentation will be followed by questions from the committee for a period of approximately 60-80 min. A decision will be rendered by the committee at the end of the examination, with one of the following recommendations:

i) Advance to Candidacy without reservations.
ii) Advance to Candidacy with reservations, which should be re-evaluated in the subsequent annual assessment.
iii) Requirement that the student takes the examination again before he/she is allowed to advance to Candidacy. This second exam must take place within a 6 month period following the first one. Failure to advance to candidacy after the second exam requires the student to leave the program, with the option of completing an MS degree.

Annual Progress Assessments

After advancement to candidacy, each student is required to report his/her progress to the dissertation committee at least once a year on a formal basis (*i.e.* 36±2, 48±2 and, if needed, 60±2 months after the student's entrance into the program). Students who do not meet this deadline may be put on academic probation and may become ineligible for financial support.

The student is expected to prepare a short written progress report for the committee, deliver it to the members and meet with them for an oral presentation of the progress report and discussion of his/her progress, research findings and ideas for the remaining work. The committee will assess the progress and provide advice to the student on problems that may hinder the completion of the dissertation on a timely basis. If the student is not progressing satisfactorily toward completing his/her degree, the committee may recommend that the student be put on probation (e.g. by giving incomplete or unsatisfactory grades in the thesis units) and, if the problem is not corrected, recommend that the student finishes with an MS degree after completing the appropriate requirements.

Dissertation Defense

The purpose of the dissertation defense is to ascertain that the student has completed a coherent, original body of research on his/her chosen topic and is able to defend the results and conclusions in front of a knowledgeable public. Students prepare and submit the final draft of the dissertation to the dissertation committee (as constituted for the Qualifying Examination) and the Department four weeks prior to the intended date of the dissertation defense. (Failure to deliver the dissertation draft to the committee and the Department on time may result in postponement of the defense.) The Department copy is made available for general inspection. The committee ascertains the suitability of the draft and provides comments and recommendations for amendments to the dissertation. The candidate is responsible for addressing any issues raised by the committee and for submitting a corrected version of the dissertation at least one week prior to the date of the defense. Once approved by the committee, permission is granted for the candidate to present a formal defense of the dissertation, which should be done in a public seminar.

The seminar must be attended by the dissertation committee, which will be chaired by the student's advisor. Any attendee at the defense can question the candidate. However, the committee chair has the authority to terminate inappropriate questioning. After public discussion is concluded, the audience will be asked to leave the room and the committee will continue the examination of the candidate in private. After the examination, the committee will deliberate and render a decision on whether the candidate has earned the Ph.D. degree.

Once the candidate has passed his/her dissertation defense, the last requirement is to file the dissertation with the Davidson library via the Graduate Division. A Guide to Filing Theses and Dissertations is available on the Graduate Division web page (http://www.graddiv.ucsb.edu/pubs/filingguide.shtml). In addition to the two copies that are filed in the Davidson library, the student should submit two copies of the final version of the dissertation to the Department to be bound. One copy will be kept in the departmental collection and the other will be returned to the student after binding.

MATERIALS
UC Santa Barbara

2011-2012 Course Schedule

Course Listing for 2011-2012

	F11	W12	S12	Cross Listed Course
100A Structure and Properties I	Seshadri			
100B Structure and Properties II		Pollock		
100C Fundamentals of Structural Evolution			Odette	
101 Introduction to Structure and Properties		Speck		
135 Biophysics and Biomolecular Materials		Safinya		Physics 135
160 Introduction to Polymer Science		Kramer		CH E 160
162A Quantum Description of Electronic Mtrls.	Yeh			ECE 162A
162B Fundamentals of the Solid State		DenBaars		ECE 162B
185 Material in Engineering	Odette			
186 Manufacturing and Materials		Levi		
200A Thermodynamic Foundation of Materials	Saleh			
200B Electronic and Atomic Structure of Materials		Chabinyc		
200C Structure Evolution			Levi	
205 Wide-Band Gap Materials and Devices				
206A Fundamentals of Electronic Solids I				ECE 215A
206B Fundamentals of Electronic Solids II			TBA	ECE 215B
207 Continuum Mechanics	Begley			ME 219
209A Crystallography & Diffraction Fundamentals	Stemmer			
209B Xray Diffraction II			Speck	
209C Electron Microscopy I: Principles & Practice			Stemmer	

	F11	W12	S12	Cross Listed Course
211A Engineering Quantum Mechanics I		Van de Walle		ECE 211A
211B Engineering Quantum Mechanics II			Van de Walle	ECE 211B
214 Advanced Topics in Equilibrium Statistical Mechanics		Fredrickson		Ch E 210B
215A Semiconductor Device Processing	Palmstrom			ECE 220A
215B Semiconductor Device Processing		Palmstrom		
215 C Semiconductor Device Processing			Nakamura	ECE 220C
217 Molecular Beam Epitaxy and Band Gap Engineering			Palmstrom	ECE 217
218 Introduction to Inorganic Materials		Seshadri		CHEM 277
220 Mechanical Behavior of Materials		Zok		ME 264
222B Colloids and Interfaces		Israelachvili		Ch E 222B BMSE 222B
226 Electrical and Functional Crystals and Ceramics			Stemmer	
227 Metal Organic Chemical Vapor Deposition			DenBaars	
234 Fracture Mechanics		McMeeking		ME 275
240 Finite Element Structural Analysis		Begley		ME 271
261 Composite Materials	Zok			
271A Synthesis and Properties of Macromolecules	Hawker			
271B Structure & Characterization of Complex Fluids		Saleh		
271C Properties of Macromolecules			Kramer	
272 Mechanical Force and Biomolecules			Saleh	
273 Experiments in Macromolecular Materials	Chabinyc			

	F11	W12	S12	Cross Listed Course
274 Solid State Inorganic Materials	Stucky			
276A Biomolecular Materials I	Safinya			
276B Biomolecular Materials II			Safinya	
279 First-Principles Calculations for Materials	Van de Walle			
280B Organic Electronic Devices		Bazan		
280C - Fabrication and Measurement of Devices with Soft Matter			Chabinyc	
286G Special Topics in Inorganic Materials			Seshadri	
290 Research Group Studies				
501 Teaching Assistant Practicum				
596 Directed Reading and Research				
598 Master's Thesis Research and Preparation				
599 Ph.D. Dissertation Research and Preparation				

Course Descriptions

COURSE DESCRIPTIONS

10 **Materials in Society, the Stuff of Dreams (4 Units)**
A survey of new technological substances and materials, the scientific method used in their development, and their relation to society and the economy. Emphasis on uses of new materials in the human body, electronics, optics, sports, transportation, and infrastructure.

100A **Structure and Properties I (3 Units)**
An introduction to materials in modern technology. The internal structure of materials and its underlying principles: bonding, spatial organization of atoms and molecules, structural defects. Electrical, magnetic and optical properties of materials, and their relationship with structure. *(Prerequisite: Chem 1A-B, Physics 4, Math 5A-B-C)*

100B **Structure and Properties II (3 Units)**
Mechanical properties of engineering materials and their relationship to bonding and structure. Elastic, flow, and fracture behavior; time dependent deformation and failure. Stiffening, strengthening, and toughening mechanisms. Piezoelectricity, magnetostriction and thermo-mechanical interactions in materials. *(Prerequisite: Materials 100A. Not open for credit to students who have completed Materials 101)*

100C **Fundamentals of Structural Evolution (3 Units)**
An introduction to the thermodynamic and kinetic principles governing structural evolution in materials. Phase equilibria, diffusion and structural transformations. Metastable structures in materials. Self-assembling systems. Structural control through processing and/or imposed fields. Environmental effects on structure and properties. *(Prerequisite: Materials 100A or ECE 132, and Materials 100B or 101, or Chemical Engineering 185 or Mechanical Engineering 180)*

101 **Introduction to the Structure and Properties of Materials (3 Units)**
An introduction to the structure of engineering materials and its relationship with their mechanical properties. Structure of solids and defects. Concepts of microstructure and origins. Elastic, plastic flow and fracture properties. Mechanisms of deformation and failure. Stiffening, strengthening, and toughening mechanism. *(Prerequisite: Upper division standing. Not open for credit to students who have completed Materials 100B)*

135 (Phys 135) **Biophysics and Biomolecular Materials (3 units)**
Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Genetic engineering techniques of molecular biology. Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems). *(Prerequisite: Physics 5 or 6C or 25)*

160 (ChE 160) **Introduction to Polymer Science (3 units)**
Introductory course covering synthesis, characterization, structure, and mechanical properties of polymers. The course is taught from a materials perspective and includes polymer thermodynamics, chain architecture, measurement and control of molecular weight as well as crystallization and glass transitions. *(Prerequisite: Chem 107A-B or 109A-B)*

162A (ECE 162A) **Quantum Description of Electronic Materials (4 Units)**
Electrons as particles and waves, Schrodinger's equation and illustrative solutions. Tunneling. Atomic structure, the Exclusion Principle and the periodic table. Bonds. Free electrons in metals. Periodic potentials and energy bands. *(Prerequisite: ECE 130A-B and 134 with a minimum grade of C- in all. Open to EE and Materials majors only)*

162B (ECE 162B) **Fundamentals of the Solid State (4 Units)**
Crystal lattices and the structure of solids, with emphasis on semiconductors. Lattice vibrations, electronic states and energy bands. Electrical and thermal conduction. Dielectric and optical properties. Semiconductor devices: Diffusion, P-N junctions and diode behavior. *(Prerequisite: ECE 162A with a minimum grade of C-. Open to EE and Materials majors only)*

185 (ME 185) **Materials in Engineering (3 units)**
Introduction to the main families of materials and the principles behind their development, selection, and behavior. Discussion of the generic properties of metals, ceramics, polymers, and composites more relevant to structural applications. Emphasis on the relationship of properties to structure and processing. *(Prerequisite: Materials 100B or 101)*

186 (ME 186) **Manufacturing and Materials (3 units)**
Introduction to the fundamentals of common manufacturing processes and their interplay with the structure and properties of materials as they are transformed into products. Emphasis on process understanding and the key physical concepts and basic mathematical relationships involved in each of the processes discussed. *(Prerequisite: ME 151C; and ME 15; and Materials 100B or 101)*

188 **Topics in Materials (2 units)**
Topics in Materials for renewable energy-efficient applications: Thermo-electrics, Solid State Lighting, Solar Cells, High Temperature coatings for turbines and engines.

200A **Thermodynamics Foundation of Materials (4 units)**
The microscopic statistical mechanical foundations of the macroscopic thermodynamics of materials, with applications to ideal and non-ideal gases, electrons and photons in solids, multicomponent solutions, phase equilibria in single and multicomponent systems, and capillarity.

200B **Electronic and Atomic Structure of Materials (4 units)**
The free electron model; electron levels in periodic potentials. Classification of solids. Role electronic structure in atomic bonding and atomic packing, cohesion. Surfaces, interfaces, and junction effects. Semiconductors. Transition-metal compounds. Amorphous solids. Liquid crystals. Colloids and soft materials.

200C **Structure Evolution (4 units)**
Structure evolution. Study of phenomena underlying the evolution of structure across the relevant length and time scales in materials. Structural defects. Driving forces, mechanism and kinetics of structural change. Diffusional transport. Fundamentals of phase transformation. Crystallization. Evolution of microstructural features and patterns.

204 **Introduction to Magnetism and Magnetic Materials (3 units)**
Review of elementary magnetism magnetostatics. Discussion of atomic origins of magnetism. Properties of ferro-, ferri-, para-, dia-, and antiferro-magnetics, and the theories that describe them. Magnetic phenomena, and magnetic materials in technological applications.

205 **Wide-Band Gap Materials and Devices (3 Units)**
Optical and electrical properties of GaN, ZnSe, SiC, and diamond-based semiconductor materials. Theory and practical application of wide-band gap materials in devices. Materials growth techniques of MOCVD, CVD, and MBE are discussed. Applications of these materials in blue lasers, LEDs (UV, blue, green, and white) are emphasized.

206A (ECE 215A) **Fundamentals of Electronic Solids I (4 Units)**
Introduction into the physics of semiconductors for beginning engineering graduate students. Crystal structure. Reciprocal lattice and crystal diffraction. Electrons in periodic structures. Energy and bands. Semiconductor electrons and probes, Fermi statistics. *(Prerequisite: ECE 162A-B)*

206B (ECE 215B) **Fundamentals of Electronic Solids II (4 Units)**
Phonons, electron scattering, electronic transport, selected optical properties, heterostructures, effective mass, quantum wells, two-dimensional electron gas, quantum wires, deep levels, and crystal binding. *(Prerequisite: ECE 162A-B)*

207 (ME 219) **Mechanics of Materials (3 Units)**
Matrices and tensors, stress deformation and flow, compatibility conditions, constitutive equations, field equations and boundary conditions in fluids and solids, applications in solid and fluid mechanics.

209A **Crystallography and Diffraction Fundamentals (3 Units)**

Diffraction theory: fourier transformation, schrodinger equation, Maxwell'sequations, kinematical theory, Fresnel diffraction, Fraunhofer diffraction, scattering of x-rays, electrons and neutrons by isolated atoms and assemblies of atoms, pair correlation and radial distribution functions. Basic symmetry operations, point groups, space groups.

209BL **X-Ray Diffraction I: Principles & Practice (3 Units)**

Exposes students to practical aspects of powder and single crystal x-ray diffraction, including the determination and refinement of crystal structures.

209B **X-Ray Diffraction II: Advanced Methods (3 Units)**

Focuses on modern diffraction techniques from crystalline materials. High resolution x-ray diffraction. Analysis of epitaxial layers. X-ray scattering theory. Simulation of x-ray rocking curves. Analysis of thin films and multiple layers. Triple-axis x-ray diffractometry. Topography. Synchrotron techniques.

209CL **Electron Microscopy I: Principles & Practice (4 Units)**

Laboratory course with lecture component. Topics include: TEM alignment, basic functions, electron diffraction and reciprocal space, basic imaging, bright field and dark field, diffraction contrast, quantitative analysis of defects, HRTEM imaging and simulation. Course also involves TEM sample preparation. *No prerequisites, but students should show a need for TEM in their research. Part of the course involves analysis of student's own samples. Students encouraged to enroll in 209C before or after 209CL.*

209C **Electron Microscopy II: Crystalline Materials (3 Units)**

Electron microscopy to study defect structures, elastic and inelastic scattering, kinematic theory of image contrast, bright and dark field imaging, two-beam conditions, contrast from imperfections, dynamical theory of diffraction and image contrast. Howie Whellan equations, dispersion surface.

211A (ECE 211A) **Engineering Quantum Mechanics (4 Units)**

Wave-particle duality; bound states; uncertainty relations; expectation values and operators; variational principle; eigenfunction expansions; perturbation theory I. Treatment matches needs and background of ECE and materials students emphasizing solid state or quantum electronics. *(Prerequisite: ECE 105 and 162 A-B)*

211B **Engineering Quantum Mechanics II (4 Units)**

Continuation of Materials 211A; symmetry and degeneracy; electrons in crystals, angular momentum; perturbation theory II; transition probabilities; quantized fields and radiative transitions; magnetic fields;electron spin; indistinguishable particles. *(Prerequisites: ECE 211A or Materials 211A, or ECE 215A or Materials 206A.*

214 **Advanced Topics in Equilibrium Statistical Mechanics (3 Units)**
(ChE 210B) Application of the principles of statistical mechanics and thermodynamics to treat classical fluid systems at equilibrium. Topics include liquid state theory, computer simulation methods, critical phenomena and scaling principles, interfacial statistical mechanics, and electrolyte theory.

215A **Semiconductor Device Processing (4 Units)**
(ECE 220A) Intensive theoretical and laboratory instruction in solid-state device and integrated circuit fabrication. Topics include 1) semiconductor material properties and characterization; 2) phase diagrams; 3) diffusion; 4) thermal oxidation; 5) vacuum processes; 6) thin-film deposition; 7) scanning electron microscopy. Both gallium arsenide and silicon technologies are presented. *(Prerequisite: ECE 1132 or equivalent)*

215 B-C **Semiconductor Device Processing (4-4 Units)**
(ECE 220B-C) Continued theoretical and laboratory instruction in the fundamentals, the design, the fabrication, and the characterization of junction and field-effect devices. Topics will include bipolar characterization, design, fabrication, and testing. The laboratory effort initiated in Materials 215A will be continued in these two quarters. *(Prerequisite: Materials 215A)*

216 **Defects in Semiconductors (3 Units)**
(ECE 216) Structural and electronic properties of elementary defects in semiconductors. Point defects and impurity complexes. Deep levels. Dislocations and grain boundary electronic properties. Measurement techniques for radiative and nonradiative defect centers. (Normally offered in alternate years.) *(Prerequisite: ECE 162A-B)*

217 **Molecular Beam Epitaxy and Band Gap Engineering (3 Units)**
(ECE 217) Fundamentals and recent research developments in the growth and properties of thin crystalline films of electronic and optical materials by the process of molecular beam epitaxy. Artificially structured materials with quantized electron confinement and artificially engineered electronic band structure properties. (normally offered alternate years) *(Prerequisite: ECE 162A-B)*

218 **Introduction to Inorganic Materials (3 Units)**
(Chem 277) Structures of inorganic materials: close-packing, linking of simple polyhedra. Factors that control structure: ionic radii, covalency, ligand field effects, metal-metal bonding, electron/atom ratios. Structure-property relationships in e.g. spinels, garnets, perovskites, rutiles, fluorites, zeolites, B-aluminas, graphites, common inorganic glasses. *(Prerequisite: Chem 274)*

219 **Phase Transformations (3 Units)**

Introduction to the unifying concepts underlying phas transformations in metals, ceramics, polymers, and electronic materials. Includes the thermodyanamics, kinetics, crystallography and microstructural characteristics of displacive and diffusional transformations. Role of elastics, compositional, configurational, electrical, magnetic and gradientenergy contributions.

220 (ME 264) **Mechanical Behavior of Materials (3 Units)**

Concepts of stress and strain. Deformation of metals, polymers, and ceramics. Elasticity, viscoelasticity, plastic flow, and creep. Linear elastic fracture mechanics. Mechanisms of ductile and brittle fracture.

222A (CH E 222A & BMSE 222A) **Colloids and Interfaces (3 Units)**

Introduction to the various intermolecular interactions in solutions and colloidal systems: Van der Waals, electrostatic, hydrophobic, solvation, H-bonding. Introduction to colloidal systems: particles, micelles, polymers, etc. Surfaces: wetting, contact angles, surface tension, etc.

222B (CH E 222A & BMSE 222A) **Colloids and Interfaces II (Units 3)**

Continuation of 222A. Interparticle interactions, coagulation, flocculation, DLVO theory, steric interactions, polymer-coated surfaces, polymers in solution, viscosity in thin liquid films. Surfactant self-assembly: micelles, micro-emulsions, lamellar phases, etc. Surfactantson surfaces: Langmuir-Blodgett films, adsorption, adhesion.

224 **Optical and Luminescent Materials (3 Units)**

Description of the principles underlying the optical and luminescent behavior of materials illustrated with applications drawn from phosphors, optical fibers, optical memories, and electro-optical components and immuno-assay techniques. Fundamental concepts of absorption and emission, and their relation to electronic structure and crystal properties.

226 **Electrical and Functional Crystals and Ceramics (3 Units)**

Description of the principles underlying the behavior of functional crystals and ceramics, ranging from dielectrics, piezoelectrics, ferroelectrics to linear and nonlinear materials. Fundamental concepts, tensorial and mathematical description of functional behavior, point defects, and applications.

227 **Metal Organic Chemical Vapor Deposition (3 Units)**

Electronic and optical properties of thin films grown by vapor phase transport techniques. Growth mechanisms, kinetics and thermodynamics of vapor phase epitaxy. Special emphasis on the process of metalorganic vapor phase epitaxy for optoelectronic materials and devices. (normally offered alternate years)

228 **Computational Materials (3 Units)**
Basic computational techniques and their application to simulating the behavior of materials. Techniques include: finite difference methods, Monte Carlo, molecular dynamics, cellular automata, and simulated annealing. (Normally offered in alternate years.)

230 **Elasticity and Plasticity (3 Units)**
(ME 230) Review of the field equations of elasticity. Energy principles and uniqueness theorems. Elementary problems in one and two dimensions. Stress functions, complex variable methods, and three-dimensional potential functions. Fundamental solutions in two and three dimensions. Approximate methods. *(Prerequisite: Materials 207 or ME 219; consent of instructor)*

234 **Fracture Mechanics (3 Units)**
(ME 275) Analytic solutions of a stationary crack under static loading. Elastic and elastoplastic analysis. The J integral. Energy balance and crack growth. Criteria for crack initiation and growth. Dynamic crack propagation. Fatigue. The micromechanics of fracture. *(Prerequisite: Materials 207)*

238A **Rheology of Polymeric Liquids (3 Units)**
An introduction to molecular and microscale theories for the viscoelastic behavior of complex fluids: suspensions, colloidal dispersions, liquid crystals, dilute polymer solutions.

238B **Rheology of Polymeric Liquids (3 Units)**
Continuation of Materials 238A: Emphasis of the second term is on concentrated systems and polymeric liquids, reptation theory and extensions of reptation theories to complex architectures in the linear viscoelastic regime. Nonlinear Rheology for polymers.

240 **Finite Element Structural Analysis (3 Units)**
(ME 271) Definitions and basic element operations. Displacement approach in linear elasticity. Element formulation: direct methods and variational methods. Global analysis procedures: assemblage and solution. Plane stress and plane strain. Solids of revolution and general solids. Isoparametric representation and numerical integration. Computer implementation. *(Prerequisite: Materials 207 or equivalent)*

251A **Processing of Inorganic Materials (3 Units)**
Fundamental concepts are presented for the synthesis of inorganic materials (zeolites, mesoporous materials, and epitaxial films) via chemical routes, and the processing of powders to form engineering shapes. The latter stresses fundamentals for manipulating the forces between particles that control rheological properties, particle packing and the plastic/elastic transition.
(Not open for credit to students who have completed Nuclear Engineering 219A)

251B **Densification and Microstructural Control (3 Units)**
Mass transport and kinetic sintering theories. Thermodynamics of pore phase disappearance. Grain growth during densification. Effects of a liquid phase (liquid phase sintering). Effects of inert phases on densification. Effects of applied pressure. Control of grain growth after densification.

253 **Liquid Crystal Materials (4 Units)**
Thermotropic and lyotropic liquid crystals (LC's). Classification and phase transitions. LC's in display technology. Laboratory experimentation using X-ray diffraction and polarized optical microscopy to characterize LC phases.

261 (ME 265) **Composite Materials (3 Units)**
Stress/strain relations in composites. Residual stresses. Fracture resistance of organic and inorganic matrix composites. Statistical aspects of fiber failure. Composite laminates and delamination cracks. Cumulative damage concepts. Interface properties. Design criteria. (Normally offered in alternate years.)

263 **Thin Films and Multilayers (3 Units)**
The development of stresses in thin films and its relaxation. Edge effects and discontinuities. Cracks in films and at interfaces. Delamination of residually stressed films. Buckling and buckle propagation of compressed films. Cyclic behavior and ratcheting effects.

264 **Hydrogen in Materials (3 units)**
Hydrogen has major effects on materials properties, and can serve as an energy carrier. Topics: experimental detection techniques; thermodynamic and kinetics; role in semiconductors; role in growth and processing; sensors; embrittlement in structural materials; hydrogen generation, storage, and proton exchange membranes.

265 **Nanophase and Nanoparticulate Materials (3 Units)**
Course introduces graduate student to nanophase and nanoparticulate inorganic materials and their applications. Emphasis on how the properties of materials change when their size is diminished. The manner in which nanomaterials (particularly nanoparticulate materials) bridge the world of molecules with the world of solids is shown. Preparation, characterization and applications of nanomaterials is an integral part of the course. *(Prerequisite: Materials 218 or equivalent)*

267 (ECE 267) **Confined Electrons and Photons in Semiconductor Structures (3 Units)**
The properties of 1D, 2D and 3D confined electrons in semiconductors are reviewed. Properties of photons in microcavities and photonic crystals are introduced. Applications of photonic crystals to light extraction and modifications of the emitter properties are developed.
(Prerequisite: Materials 162A-B or ECE 162A-B.)

271 A **Synthesis and Properties of Macromolecules (3 Units)**
Basics of preparation of polymers and macromolecular assemblies, and characterization of large molecules and assemblies. Discussion of chemical structure, bonding, and reactivity.

271B **Structure and Characterization of Complex Fluids (3 Units)**
Structure, phase behavior, and phase transitions in complex fluids. Characterization techniques including x-ray and neutron scattering, and light and microscopy methods. Systems include colloidal and surfactant dispersions (e.g., polyballs, microemulsions, and micelles), polymeric solutions and biomoleculmaterials (e.g., lyotropic liquid crystals)

271C **Properties of Macromolecules (3 Units)**
Fundamentals of the properties of macromolecular solutions, melts, and solids. Viscosity, diffusion and light scattering from dilute solutions. Elements of macromolecular solid state structure. Thermal properties and processes. Mechanical and transport properties. Introduction to electrical and optical properties of macromolecules.

272 **Mechanical Force and Biomolecules (3 Units)**
Explores single-molecule biophysics and the role of mechanical force in biomolecular behavior. Emphasis is placed on modern experimental techniques and the effects of mechanical stress on DNA conformation, protein unfolding, and force-generation by motor proteins. Recent literature is used throughout.

273 **Experiments in Macromolecular Materials (3 Units)**
Experiments using X-ray and light scattering, optical and electron microscopy. Crystalline, quasi-crystalline, and amorphous materials. Solid, solution, and colloidal samples.

274 **Solid State Inorganic Materials (3 Units)**
(Chem 274) An introductory course describing the synthesis, physical characterization, structure, electronic properties and uses of solid state materials. *(Prerequisite: Chem 173A-B)*

276A **Biomolecular Materials I: Structure and Function (3 Units)**
Survey of classes of biomolecules (lipids, carbohydrates, proteins, nucleic acids). Structure and function of molecular machines (enzymes for biosynthesis, motors, pumps).

276B **Biomolecular Materials II: Applications (3 Units)**
Interactions and self assembly in biomolecular materials. Chemical and drug delivery systems. Tissue engineering. Protein synthesis using recombinant nucleic acid methods: advanced materials development. Nonviral gene therapy. (normally offered alternate years) *(Prerequisite: Phys 135 or Materials 276A)*

277 **Synthesis of Biomolecular Materials (3 Units)**

Methods of preparation of biopolymers and biomolecular assemblies. Uses of biological techniques to engineer biomaterials. Uses of chemical techniques to prepare biological molecules as well as artificial biomimetic materials. Comparison of biological, chemical, and mixed synthesis for different applications. (normally offered alternate years)

278 **Interactions in Biomolecular Complexes (3 Units)**

Focuses on the interactions, structures, and functional properties of complexes comprised of supramolecular assemblies of biological molecules. Systems addressed include lipid membranes, lipid-DNA complexes, and assemblies of proteins of the cell cytoskeleton.

279 **First-Principles Calculations for Materials (3 units)**

Basic theory and methods of electronic structure, illustrated with examples of practical computational methods and real-world applications. Topics: Band structure; Uniform electron gas; Density functional theory; Exchange and correlation; Kohn-Sham equations; Pseudopotentials; Basis sets; Predicting materials properties: bulk, surfaces, interfaces, defects.

280A **Synthesis and Electronic Structures of Conjugated Polymers (3 units)**

Synthetic routes to conjugated polymers. Band structure and electronic properties. Effects of molecular structure. Processing methods for organic optoelectronic devices. Influence of processing on electronic properties.

280B **Organic Electronic Devices (3 units)**

Detailed discussion of thin film electronic devices using organic semiconductor. Electronic Structure of disordered organic semiconductors. Transport models. Defects in organic materials. Electrical transport in diodes, light emitting diodes, photovoltaics, and thin film transistors.

280C **Fabrication and Measurement of Devices with Soft Matter (3 units)**

Laboratory course and lecture on the fabrication of electronic devices with soft materials with an emphasis on organic semiconductors. Novel fabrication methods for organic devices. Surface functionalization. Biosensors. Measurement of optoelectronic properties of organic photovoltaics and thin film transistors.

281 **Technical Communication and Presentation Design (3 units)**

Focuses on a practical, hands-on, interactive approach to developing communication skills and presentation style. Using current literature and seminars, critical attributes such as clearly explaining complex ideas, the do's and don'ts of presentation will be covered.

282 **(Chem 221)** **Transitions Metal Catalyzed Polymerization (3 Units)**
Examination of strategies for controlling molecular weight, chain distribution, sequence, end groups and stereochemistry. Discussion of the influence of these variables over structure and properties. Tacticity, control, Ziegler-Natta catalysis, living polymerizations, stereoselective and enantioselective polymerizations, secondary and tertiary structures, polymer assemblies, and biological polymerizations.

284 **(Chem 285)** **Synthetic Chemistry of Macromolecules (3 Units)**
Molecular architecture and classification of macromolecules. Different methods for the preparation of polymers: free radical polymerization, ionicpolymerization, condensation polymerization and coordination polymerization. Bulk, solution, and emulsion polymerization. Principles of copolymerization, blockcopolymerization, grafting, network formation, chemical reactions on polymers.

286AA-ZZ **Special Topics in Inorganic Materials**
This course will be offered on an irregular basis and will concern in-depth discussions of advanced topics in inorganic materials.

287 AA-ZZ **Special Topics in Macromolecular Materials (3 Units)**
This course will be offered on an irregular basis and will concern in-depth discussions of advanced topics in macromolecular materials.

288 AA-ZZ **Special Topics in Electronic Materials (3 Units)**
This course will be offered on an irregular basis and will concern in-depth discussions of advanced topics in electronic materials.

289 AA-ZZ **Special Topics in Structural Materials (3 Units)**
This course will be offered on an irregular basis and will concern in-depth discussions of advanced topics in structural materials.

290 **Research Group Studies (1-3 Units)**
In this course students or instructors present recently published papers and/or results relevant to their own research.

501 **Teaching Assistant Practicum (1-4 Units)**
Practical experience in the various activities associated with teaching including: lecturing, supervision of laboratories and discussion sections, preparation, and grading of homework and exams.

596 **Directed Reading and Research (2-4 Units)**
Individual tutorial. Instructor usually student’s major professor. A written proposal for each tutorial must be approved by the department chair.

598 **Master's Thesis Research and Preparation (1-12 Units)**
For research underlying the thesis and writing of the thesis.

599 **Ph.D. Dissertation Research and Preparation (1-12 Units)**
Research and preparation of the dissertation.

MATERIALS
UC Santa Barbara

Appendix

COMPUTING FACILITIES

Computers are located in all Materials Department student offices. Additionally, students are allowed to bring in personal laptops and workstations for use on Materials networks. To register a computer for network access, fill out the online IP address request form at:

http://www.materials.ucsb.edu/request_ip.php

Please be aware that system and network security is strictly enforced. The departments Computing and Network Security Policy can be found at:

http://www.materials.ucsb.edu/policies/computer_security.php

All students are eligible for College of Engineering email accounts through the Engineering Computing Infrastructure (ECI). To open an account, please follow the link below.

https://accounts.engr.ucsb.edu/create

The Department employs a part-time system administrator, Mike Edwards, and a full-time system administrator, Budd Jamieson, to maintain computers and answer any questions about the computing services. For computing and network assistance, please email mats-help@engineering.ucsb.edu.

ON-LINE RESOURCES

The Materials Department Web Site (www.materials.ucsb.edu) is a valuable source of departmental and university information. At the web site, you will find:

- Quarterly schedule of Materials courses
- Listings of Materials personnel (faculty, staff and students) with email addresses
- Links to faculty web pages
- List of available facilities within the department
- List of related research centers and groups (with links to their web pages)
- Health and safety information, including the Department Emergency Plan, Lab Safety Manuals, and links to important MSDS information and EH&S sites
- Travel policies and procedures manual


Transportation and Parking Services
UNIVERSITY OF CALIFORNIA, SANTA BARBARA
MAP & DIRECTORY
Parking Regulations
• UCSB Parking Permits required at all times.
Purchase permits from permit dispensers, located throughout campus, or from the Parking Sales Office located in Building #381, off Stadium Road. To vend permit, please follow instructions on the dispenser. Payment options are Visa, MasterCard, cash or campus Access card. Please observe all parking signage as parking violations are subject to citation.
• Monday-Friday from 7:30AM to 5:00PM, visitor permits are valid in "Visitor/Student" spaces and parking lots.
• Saturday and Sunday all day, visitor permits are valid in "Faculty", "Staff" and "Visitor/Student" spaces and parking lots except spaces marked "Enforced At All Times", Reserved" or "Restricted".
For updated parking information please visit our web site @ www.tps.ucsb.edu or call our customer service line at 805-893-5388
Central Stores, Receiving, Mail Services
Public Safety
Harder Stadium
PARKING SERVICES
Facilities Management
Environmental Health & Safety
Caesar Uyesaka Stadium
Storke Field
Future site of San Clemente Housing
Stadium Road
Recreation Center
Pool
INFORMATION KIOSK
Athletic Fields
Intercollegiate Athletics
Robertson Gym
VISITOR CENTER
Student Affairs & Admin. Services
Mesa Road
Mosher Alumni House
Campbell Hall
Phelps Hall
Cheadle Hall
Coral Tree Cafe
North Hall
Ellison Hall
Buchanan Hall
Physical Sciences North
Physical Sciences South
Chemistry
Engineering Science
Engr II
California Nanosystems Institute (CNSI)
EAST GATE
Kohn Hall
Ward Memorial Blvd.
Cervantes Road
El Colegio Road
El Greco Road
Picasso Road
Segovia Road
Cordoba Road
Pardall Road
Madrid Road
Embarcadero Hall
Seville Road
Isla Vista Theater
Trigo Road
Sabado Tarde Road
El Nido Lane
Del Playa Drive
Student Health
Ocean Road
Future site of ESSB
Old Gym
Kerr Hall
South Hall
Davidson Library
Broida Hall
MRL
Harold Frank Hall
Bren Hall
Lagoon Road
Events Center
Humanities and Social Sciences
Counseling & Career Services
Girvetz Hall
Webb Hall
Noble Hall
Life Sciences
Bio II
Marine Science Research
Student Resource
Theater and Dance
Hatlen Theater
Arts
Art Museum
Storke Tower
Music
Lotte Lehmann Concert Hall
Psych
Faculty Club
University Center
Corwin Pavilion
UNIVERSITY CENTER
UCEN Road
Anacapa Hall
Santa Rosa Hall
Santa Cruz Hall
San Miguel Hall
San Nicolas Hall
San Rafael Hall
Manzanita Village
University House
Channel Islands Road
Office of Technology & Industry Alliances
Marine Biotechnology Laboratory
REEF/Aquarium
UCSB Lagoon
SPEED LIMIT 25
Enforced by Radar
Emergency
• For fire, police or medical emergency assistance call 9-911 or use emergency phones (in red boxes).
• UCSB Police Department, Public Safety Building, non-emergency 805-893-3446 (24 hours).
• CSO Escort Service is available by calling 805-893-2000.
FEBRUARY 2007
PARKING DESIGNATIONS
Permits required at all times.
A Faculty
B1 Residential Students
B2 Residential Students
B3 Residential Students
C Students, Commuters and Visitors
S Staff
R Reserved
V Vendors
Accessible Parking
Motorcycles
Bus Stop
Coastal Access
Residence Halls
Traffic Light
Parking Meters (available to general public)
Parking Dispensers
Parking