UC SANTA BARBARA
Chemistry and Biochemistry

UC SANTA BARBARA
MATERIALS

FIVE YEAR COMBINED BS-CHEMISTRY / MS-MATERIALS PROGRAM

Revised Fall 2018

BS CHEMISTRY/MS MATERIALS PROGRAM

CONTACT INFORMATION

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DCB= Department of Chemistry and Biochemistry

***Important**: There will be an informational session for all students during the spring quarter of their sophomore year. Please notify your departmental undergraduate advisor staff of your interest in attending this session. If afterward you are interested in joining the program you must (i) notify the Department of Chemistry and Biochemistry Undergraduate Office and the Materials Department Graduate Office of your interest before the end of the spring quarter of your sophomore year, (ii) enroll in Matrl 100A for the Fall quarter of your Junior year, and (iii) arrange a meeting with Professor Seshadri, the Materials BS/MS Program Advisor for DCB to start planning your academic program. Students who do not comply with this requirement will find it difficult to join the program.*

Why should chemists be interested in materials science?

- The study of materials covers a broad and highly interdisciplinary area at the interface of physics, chemistry, life science, and engineering. The discipline addresses the development of new materials and the improvement of established materials for applications in technology and society that can range from the somewhat mundane (better ceramics cookware) to the very cutting-edge (new semiconductors for more efficient solar cells).
- Chemistry, oft touted as the "central science", is central to Materials Science as well. It is knowledge of the chemistry of metals and alloys, inorganic materials, polymers molecular organics that makes new materials accessible. Improved processing of existing materials also invariably involves knowledge of chemistry. An example of this is a development closely associated with UCSB researchers: of *p*- type gallium nitride, which critically involved not only an understanding of the chemistry of the element magnesium, but the gas-phase chemistry of hydrogen and its interaction with GaN as well. It is this development that has made available efficient white GaN-enabled solid state lighting. Some other examples in the development of new materials, again drawing from UCSB research, include the development of new oxide coatings that allow jet turbines to operate at ever-higher temperatures and therefore more efficiently, research in new materials and new architectures for "plastic" solar cells that convert sunlight to electricity in a manner that is competitive with the better known silicon variants, and new magnetic and semiconducting oxide materials for electronics beyond silicon.
- Chemistry is important to Materials. However, for chemists to truly understand how they can play a role in new and critical materials-based technologies, they must in turn appreciate many aspects of the discipline of Materials. For this, they may require courses that are not usually part of an undergraduate Chemistry degree.

Is this program for you?

This program is designed for students who wish to enhance their undergraduate education in chemistry by adding a strong knowledge base in the understanding of materials behavior, of their synthesis and processing, and of their applications in modern technology.

- The program allows outstanding students to concurrently pursue a Bachelor of Science degree in Chemistry, and a Master of Science degree in Materials, and to complete graduation requirements for both degrees within 5 years (see appendix for timelines and worksheets).
- The graduates of this program retain the breadth and flexibility inherent in chemistry, while their specialized knowledge of materials is expected to give them a competitive edge in the high technology industry.
- The program capitalizes on the emergence of UCSB as an internationally renowned institution in materials research and education. The students involved will interact with faculty working at the cutting edge of technology in a broad range of modern materials, benefiting from their advice and expertise in areas critical to future industrial development.

ADMISSIONS PROCESS

BS/MS Information Session

An informational meeting is typically held during the Spring quarter for all sophomore students who may be interested in applying to the BS/MS program. After the meeting, students interested in the program must inform the DCB Undergraduate Office and the Materials Graduate Office of their intention to pursue the Materials BS/MS program. Students must consult with these offices about the admission procedures and the structure of the program.

BS/MS Program Advisor

Prior to the start of the Junior year (or in the quarter when the student achieves Junior status), candidates should arrange for a meeting with the Materials Department's BS/MS advisor for DCB, **Professor Ram Seshadri,** to discuss their interests, academic goals and program requirements.

The BS/MS advisor helps students plan their Junior and Senior year studies, in coordination with the DCB undergraduate program advisor, and also assist them during the application process for the program. In preparing their academic plan, all students interested in this program must plan on taking MATRL 100ABC during fall, winter, and spring of the Junior year (no exceptions).

Who is eligible to apply?

Applicants must meet the following requirements in order to qualify for admission:

- Eligible applicants are in their third year.
- A minimum overall GPA of 3.2 at the end of the junior year, with a 3.5 minimum GPA in DCB courses
- Receive a B minimum in each of the undergraduate Materials core courses (MATRL 100A, MATRL 100B and MATRL 100C). Grades in physics, chemistry and math courses are particularly important, as are grades in core courses within the discipline.
- A GRE score with a minimum of 85% in the quantitative portion and performance in the verbal and writing sections comparable to the Materials Department entry class in the previous academic year. GRE scores must be submitted with the application, no later than the last working day of July to allow the admissions committee enough time to evaluate the application.

While some exceptions might be made for special circumstances, students must realize that they will be taking courses with Ph.D. oriented students from a very competitive pool in the graduate part of the program, so they must be able to perform academically well in that environment.

Departmental Internal Application

The student must submit a complete application for admission to the MS program in Materials under Plan 2, **no later than the last working day of July** (after the end of Spring quarter of their third year). The complete application should be submitted electronically to the Materials Graduate Program Coordinator (academic@engineering.ucsb.edu), and must include:

- A Statement of Purpose, a Statement of Personal Achievements, and a Resume or CV.
- An official copy of the transcripts from UCSB and all post-secondary institutions.

- Three letters of recommendation from people able to judge the potential of the student for graduate studies. These people should ideally be faculty at UCSB or other higher education institutions who are familiar with the student's academic performance. Letters of recommendation should be mailed by post or electronic means directly by the recommender to the Materials Graduate Program Coordinator by the application deadline.
- Official GRE scores by the application deadline (last working day in July). Request that the official scores be sent to UCSB---Institution code 4835. GRE scores must be submitted by the application deadline (the last working day of July) to allow the admissions committee enough time to evaluate the application. It is strongly recommended that students prepare for the GRE and take it early, in case they need to retake it to improve their scores.
- Proposed BS/MS study plan and have the BS portion approved by the DCB Undergraduate Advisor.

Details on the application requirements can be found in the departmental application packet. You may download the departmental application from the Materials Department website. Direct any questions about the application process to Jocelyn Guzman at academic@engineering.ucsb.edu.

IMPLEMENTATION OF THE PROGRAM

Senior Year

- Notification of an admissions decision before the start of the Fall quarter of the Senior year.
- Submit a proposed MS study plan before the end of the Fall quarter.
- You must select an **emphasis** (Electronic, Inorganic, Macro-/Bio-molecular or Structural) and an MS advisor within the Materials Department (usually different from the BS/MS advisors listed above). The MS advisor will help the student prepare his/her MS study plan and the engineering report required for graduation under Plan 2 (see below).
- Take at least **one** Materials graduate course per quarter to count towards the MS degree from the list of graduate elective courses in Table III. You are allowed to take courses outside your chosen area of emphasis with prior approval of your MS advisor and the departmental Materials Graduate Advisor. Students can petition to take more advanced elective courses outside Table III, with prior approval of his/her MS advisor.
- A final MS study plan must be submitted before the end of Spring quarter. These approvals are required before a BS/MS student is eligible to advance to graduate status (see below) by the start of Fall quarter of the Graduate (5^{th}) year.

Fifth Year

- Fall quarter: Take MATRL 200A, you must receive a B or better in order to graduate. MATRL 200B and 200C are not required for BS/MS students, but could be taken as electives. However, students must also receive a B or better in 200B and 200C.
- Take remaining undergraduate courses for your BS degree, if any.

- Take remaining Materials graduate electives. Up to 6 units of approved undergraduate courses from Table II, not applied already toward the BS degree may be taken as preparation or complement to graduate courses in the MS program (optional)[1].
- Take one (and only one) unit of MATRL 290 (Research Group Studies) per quarter, for a total of 3 units during the MS year. Students must register for MATRL 290 under their MS advisor's code, in order to receive credit for these units. Students must check with their MS advisor the appropriate requirements for earning the credit in MATRL 290, which could involve attending research group meetings and/or area seminars (e.g. the Structural Materials Seminar for students in this emphasis).
- Take 3-6 units of MATRL 596 (Direct Reading and Research). Students must register for these units under their MS advisor's code, as soon as they start working on preparation for their Engineering Report, but not before. Students may have to present evidence of progress to receive a satisfactory grade in the quarter(s) in which these units are taken if their Engineering Report is not submitted by the end of the quarter in which the units are completed.
- Submit your Engineering Report based on the MATRL 596 work by the end of Spring quarter.

Students in this program are neither required nor eligible to be teaching assistants, and thus are not eligible to receive credit for teaching assistant practicum (MATRL 501).

MS DEGREE IN MATERIALS – PLAN 2

All students in the BS/MS program must follow Plan 2 for the M.S. degree.

Plan 2. Students in this plan are required to:

1) Complete 42 units of coursework including:
   a) a minimum of **27-33** units from approved 200 level courses (200-289),
   b) at most 6 units of approved advanced undergraduate courses not used already for credit toward a previous degree (optional)[2]
   c) no fewer than 3 and no more than 6 units of MATRL 596 (Directed Reading and Research),
   d) 3 units of MATRL 290 (Research Group Studies), and
2) Submit an acceptable Engineering Report based on the MATRL 596 units. A committee of two faculty members, including the student's advisor, must approve the report. At least one member of the committee must have a majority appointment in Materials.

[1] Chemistry undergraduate elective courses that are applied to the MS cannot count toward the BS in Chemistry. Non-chemistry courses in Table II will not count towards the BS in Chemistry.

[2] Students are not required to take any undergraduate units toward their MS, but they are given the opportunity to count up to 6 units of courses that may be preparatory for some courses in the Materials MS.

ADVANCING TO GRADUATE STATUS

This change in status must happen prior to the beginning of the Fall quarter of the fifth year in order to satisfy the minimum residency requirements (3 quarters) of the Graduate Division. BS/MS students are therefore advised to change from undergraduate to graduate status as soon as they complete the required undergraduate coursework and units (180+). Once a BS/MS student reaches graduate status, he/she can begin to take the rest of the graduate unit requirements. Students should be aware that the change in status would prompt the registrar to charge Graduate fees for courses taken during this time.

In order to advance to MS (Graduate) status, students must:

- Submit approved final MS study plan to the College of Engineering Undergraduate Office by May 1st and sign the Advancement Request Memo.
- Submit the UCSB Graduate Online application by May 15th, student will receive an email from the Graduate Division with instructions for completing and submitting the application.
- Officially accept your offer of admission by submitting a Statement to Intent to Register (SIR) through the application by June 15th.

Note: In addition to fulfilling the requirements of the BS/MS program discussed above, students must ensure that they follow all the requirements of their individual undergraduate curricula for the Bachelor of Science in Chemistry. Tables are provided in the Appendix to help students in each curriculum understand how they can plan their BS/MS program to satisfy both the BS and the MS requirements within five years. At the end of a BS/MS student's senior year he/she has the option of filling out a BS graduation form and leaving the program with a BS degree, assuming all requirements for the BS have been met.

TABLE I. TIMELINE FOR THE BS-CHEMISTRY/MS-MATERIALS PROGRAM

Year:	Summary of Events:
Second	▪ Spring quarter: Attend BS/MS information session. ▪ Notification to Undergraduate Office in DCB of student's interest in BS/MS program ▪ Meeting with the Materials Department Graduate Program Coordinator to ensure all initial steps have been followed properly.
Third	▪ Meeting with BS/MS program advisor for DCB, Professor Seshadri ▪ Fall: Matrl 100A; Winter: Matrl 100B; Spring: Matrl 100C ▪ Winter: Prepare for, and take GRE. ▪ Spring: Submission of application by the last working day of July, to the Materials Graduate Program Coordinator for admission to the BS/MS Program. ▪ Summer: Departmental admission decision by last working day in August.
Fourth	▪ Submit proposed MS study plan by the end of Fall quarter. ▪ Take one Graduate course each quarter ▪ Select an advisor no later than spring quarter and notify the Materials Department of your choice. He/she must help you prepare and endorse your final MS study plan. ▪ Have final MS study plan approved by their MS advisor and the Department Graduate Advisor. The approved study plan must be submitted to the College of Engineering Undergraduate Office by May 1st and student must sign the Advancement Request Memo. ▪ Submit the Graduate Division electronic application by May 15th ▪ Advance to graduate status at the end of Spring quarter.
Fifth	▪ Remaining Undergraduate Courses, if any. ▪ MATRL 200A (Fall) plus remaining Graduate Electives. ▪ Up to 6 units of additional undergraduate courses not applied already toward the BS degree may be taken in fourth of fifth year as preparation or complement to graduate courses in the MS program. ▪ Research Group Studies, MATRL 290 (3 units, one unit per quarter) ▪ Directed Reading and Research, MATRL 596 (3-6 units) ▪ Deliver Engineering Report based on Directed Reading and Research studies by the end of Spring. Project must be approved by their committee in time for student to file for graduation during the Spring quarter.

APPENDIX A
APPROVED COURSES

TABLE II. APPROVED UNDERGRADUATE COURSES

Fall	U	Winter	U	Spring	U
Undergraduate Core					
MATRL 100A* Structure & Properties I	3	**MATRL 100B Structure & Properties II**	3	**MATRL 100C Structural Evolution**	3
Undergraduate Electives					
		Phys/MATRL 135* Biophysics and Biomolecular Materials	3	Chemistry 145 Computational Biochemistry	3
		MATRL/CH E 160* Introduction to Polymer Science	3	CHEM 175 Physical Inorganic Chemistry	3
ECE/MATRL 162A Quantum Description of Electronic Materials	4	ECE/MATRL 162B Fundamentals of the Solid State	4	ECE 162C Optoelectronic Materials and Devices	4
CHEM 115A Fundamentals of Quantum Chemistry	3			ME 141B: MEMS Semiconductor Processing and Device Characterization	4
ME 167 Structural Analysis	3			ME 166 Advanced Strength of Materials	3
		ME/MATRL 186A Manufacturing and Materials	3	ME/MATRL 186B Introduction to Additive Manufacturing	3
				CHEM 186/286 Structure, Bonding, and Applications	3

Students are not required to take any undergraduate units toward their MS, but they are given the opportunity to take up to 6 units of courses that may be preparatory for some courses in the Materials MS.

(*i) Chemistry undergraduate elective courses that are applied to the MS cannot count toward the BS in Chemistry, (ii) Non-Chemistry courses in this table will not count towards the BS in Chemistry, (iii) MATRL 100B and 100C are required prerequisites for MS program, but they cannot be used to fulfill either BS or MS unit requirements*.

Check for offerings that may not be in this table. You may petition as long as the course is clearly related to Materials. Your petition must be endorsed by your graduate and undergraduate advisors and approved by the academic affairs committee in Materials.

*100A, 135, and 160 may count toward the BS in Chemistry by petition; you must go to the DCB Undergraduate Office for this. However, if you decide to count 135 and/or 160 toward your BS, you cannot count those courses toward you MS or vice versa

TABLE III. APPROVED GRADUATE COURSES

ELECTRONIC/PHOTONIC MATERIALS

Please note course offerings may change from year to year.

Course Number	Course Title	Units
	Main Sequence Courses:	
206A-B	Fundamentals of Electronic Solids I, II	4
209A	Crystallography and Diffraction Fundamentals	3
211A	Engineering Quantum Mechanics	4
215A-B-C	Semiconductor Device Processing (215A is *required for authorization to work independently in clean room*.)	4
268A-B	Semiconductor Lasers I, II	4
	General Courses:	
209B	X-Ray Diffraction	3
209C	Electron Microscopy	3
219	Phase Transformations	3
228	Computational Materials	3
279	First-Principles Calculations for Materials	3
281	Technical Communication and Presentation Design	3
	Specialized Courses:	
204	Introduction to Magnetism and Magnetic Materials	3
211B	Engineering Quantum Mechanics II	4
216	Defects in Semiconductors	3
217	Molecular Beam Epitaxy & Band Gap Engineering	3
226	Symmetry and Tensor Properties of Materials	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

Please note course offerings may change from year to year.

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:	
209B	X-Ray Diffraction	3
209C	Electron Microscopy	3
211A	Engineering Quantum Mechanics	4
219	Phase Transformations	3
222A	Colloids & Interfaces	3
228	Computational Materials	3
241	Structural Inorganic Chemistry	3
281	Technical Communication and Presentation Design	3
	Specialized Courses:	
204	Introduction to Magnetism and Magnetic Materials	3
226	Symmetry and Tensor Properties of Materials	3
251	Processing of Inorganic Materials	3
286AA-ZZ	Special Topics in Inorganic Materials	3
	Background Courses	
Chem 175	Physical Inorganic Chemistry	3

MACROMOLECULAR/BIOMOLECULAR MATERIALS

Please note course offerings may change from year to year.

Course Number	Course Title	Units
	Main Sequence Courses:	
271A	Synthesis 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
228	Computational Materials	3
253	Liquid Crystal Materials	4
273	Experimental Techniques in Macromolecular Materials	3
281	Technical Communication and Presentation Design	3
	Specialized Courses:	
272	Mechanical Forces and Biomolecules	3
276A	Biomolecular Materials I: Structure & Function	3
276B	Biomolecular Materials II: Applications	3
278	Interactions in Biomolecular Complexes	3
280A	Synthesis and Electronic Structures of Conjugated Polymers	3
280B	Organic Electronic Devices	3
287AA-ZZ	Special Topics in Macromolecular Materials	3
	Background Courses	
135	Biophysics and Biomolecular Materials	3
160	Introduction to Polymer Science	3

STRUCTURAL MATERIALS

Please note course offerings may change from year to year.

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
209B	X-Ray Diffraction	3
209C	Electron Microscopy	3
219	Phase Transformations	3
228	Computational Materials	3
281	Technical Communication and Presentation Design	3
	Specialized Courses:	
230	Elasticity and Plasticity	3
232	Plasticity	3
240	Finite Element Structural Analysis	3
251	Processing of Inorganic Materials	3
261	Composite Materials	3
263	Thin Films and Multilayers	3
289AA-ZZ	Special Topics in Structural Materials	3

Notes:

- Students are expected to design a program of study based on the above courses (Tables II and III) with assistance from their faculty advisor.
- Of all departmental courses, only 200A is currently required for the MS.
- Some introductory graduate courses will not be available for credit to students who have taken undergraduate courses covering similar topics, e.g. students cannot get credit toward the MS for ME 166 or ME 162 if they are taking MATRL 207 or vice versa.
- 209A, 218 and 241 are nominally electives and are only recommended courses for the senior year if the student decides to follow the Inorganic emphasis within the MS in Materials.

APPENDIX B

BS/MS CURRICULUM
SAMPLE SCHEDULE

BS-CHEMISTRY/MS-MATERIALS

Fall		Winter		Spring	
Course	Units	Course	Units	Course	Units
Year 1					
Chem 1A/2A	(3)	Chem 1B/2B	(3)	Chem 1C/2C	(3)
Chem 1AL/2AC	(2)	Chem 1BL/2BC	(2)	Chem 1CL/2CC	(2)
Math 3A	(4)	Math 3B	(4)	Math 4A	(4)
GEs	(4+)	Phys 1	(4)	Phys 2	(4)
GEs	(4+)	GEs	(4+)	GEs	(4+)
Year 2					
Chem 109A/109AH	(4)	Chem 109B/109BH	(4)	Chem 109C/109CH	(4)
Phys 3	(3)	Chem 6AL	(3)	Chem 6BL	(3)
Phys 3L	(1)	Phys 4	(3)	GEs/UG Electives	(3+)
Math 4B	(4)	Phys 4L	(1)	GEs/UG Electives	(3+)
Chem 150*	(3)	Math 6A	(4)	Math 6B	(4)
Year 3					
Chem 113A	(4)	Chem 113B	(4)	Chem 113C	(4)
Chem 142A*	(3)	Chem 116AL	(3)	Chem 116BL	(3)
Chem 150† *	(3)	GEs/UD Electives	(3+)	GEs/UD Electives	(3+)
Chem 6CL‡ *	(3)	Matrl 100B	(3)	Matrl 100C	(3)
GEs/UD Electives	(3+)				
Matrl 100A§	(3)				
Year 4					
Chem 173A	(3)	Chem 173B	(3)	Chem 6CL	(3)
Chem 116CL	(3)	GEs/UD Electives	(3+)	GEs/UD Electives	(3+)
GEs/UD Electives	(3+)	GEs/UD Electives	(3+)	GEs/UD Electives	(3+)
Matrl 209A or 241	(3)	**Matrl 218**	(3)	GEs/UD Electives	(3+)
Year 5					
Matrl 200A	(4)	Matrl 290	(1)	Matrl 290	(1)
Matrl 290	(1)	Matrl 596		Matrl 596	
Matrl 596		ΞMatrl Electives		ΞMatrl Electives	
ΞMatrl Electives		(2-3 Matrl courses)		(2-3 Matrl courses)	
(2-3 Matrl courses)					

Ξ Denotes Materials elective course, to be chosen from Table III of approved courses.
Some optional UG electives (Table II): Matrl/ChE 160, Matrl/Phys 135

Note that 209A, 218, and 241 are nominally electives and are only recommended courses for the senior year if the student decides to follow the Inorganic emphasis within the MS in Materials.

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* Chem 142A, 150 and 6CL may be taken in summer quarter before the start of year 3.
† Chem 150 may be taken in Fall quarter of year 2 if the general chemistry series has been completed.
‡ Chem 6CL may be taken Spring quarter of year 4 to help alleviate course workload in Fall quarter of year 3.
§ Student may petition to have Matrl 100A count toward BS in Chemistry. Please see DSB Undergraduate Office.
Matrl 100B and 100C are required prerequisites for the MS program, but they cannot be used to fulfill either BS or MS unit requirements.

MATERIALS DEPARTMENT
MS Plan 2 for BS/MS students

Name: _____ Perm Number: _____

Entrance Year: _____ UG Department: _____

Materials Research Track: _____

Faculty MS Advisor: _____

Program Plan Approval:

Faculty MS Advisor Signature: _____

Dept. Grad Advisor Signature: _____

*Students following Plan 2 must complete **42 units** of coursework*

Graduate Courses (27-33 units):

Matrl 200A	4	**Matrl 290:**	3
		Matrl 596 (3-6 units):	
		Undergrad* (3-6 units):	
		Total Graduate Units:	42

Report Committee (2 faculty members):

_____
Chair (MS advisor)

_____
Member

NOTE: This is a proposed study plan that must be submitted by the end of fall quarter of your fourth year. A final MS study plan must be submitted later for advancement to graduate status.

*This is optional.

Acknowledgment of Having Read
BS/MS Student Manual

(Print this page, sign it after reading the manual and turn it in to the Graduate Program Coordinator)

I, _____ acknowledge that I have carefully read and understood the contents of the BS/MS Student Manual for the Materials Department (Edition Fall 2018). I understand my first point of contact for any questions regarding the BS/MS Manual or the BS/MS Materials Program is the Graduate Program Coordinator* in the Materials Department, who may refer me to the Graduate Advisor** in the Materials Department or the BS/MS advisor for DCB***

_____
Signature

_____
Date

After having read and signed this page, it must be turned into the Graduate Program Coordinator in the Materials Department by the end of the fall quarter of your senior year.

* The current Graduate Program Coordinator is Ms. Jocelyn Guzman

** The current Graduate Advisor is Prof. Anton Van der Ven

*** The current BS/MS advisor for DCB is Prof. Ram Seshadri