

University of Southern California
Department of Materials Science and Engineering

MASC 505

Crystals and Anisotropy

E. Goo

Course Syllabus

Fall 2015

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Phone: 213 740-4426 This is my USC office phone and it does go to voice mail that I do not check so I do not recommend leaving voice mails.

E-mail: ekgoo@usc.edu E-mail is the preferred method of communication. Please put “MASC 505” in the subject of the e-mail or I may mistake it for junk e-mail. It is also best to use your USC e-mail account to send e-mail to me since I will read all e-mails from an USC account. Request for confidential information such as grades must be from your USC account.

Office Hour: All meetings are by appointment. I have chosen Wednesday 12:45-1:45 pm as my “office hour” but you should still make an appointment. So you must e-mail me to make an appointment even if you are coming during the office hour. If this time does not work you should e-mail me with times that are best for you. I am also generally available after the lecture for brief meetings.

Class Website: Log on to Blackboard at <https://blackboard.usc.edu> for the class website. Various class documents will be posted on Blackboard including the syllabus. E-mails to the class will be sent via Blackboard and sent to your USC e-mail account. Therefore it is important that you read the e-mails in your USC account regularly and that you periodically delete old e-mails so it does not exceed the storage limits. E-mails sent to the entire class will always start with the heading “ MASC 505 class” vs e-mail to a specific student which will have the student’s name.

Lectures: MW 2:00-3:15 pm. Location KAP 156. There will be no lecture on Monday September 7th, Monday November 23rd and Wednesday November 25th.

I. Formal Crystallography - method for classifying crystals based on their symmetry

A. Symmetry Elements

- i. Mirror plane
- ii. Rotation axis

- iii. Inversion point
 - iv. Handedness or Chirality - enantiomorphs
 - v. Orientation vs Position(rotation vs translation)
- B. Combination of Symmetry Elements – Euler’s Rule
- C. Point Groups
- D. Bravais Lattices and Crystal Systems
- E. Space Groups
- II. Physical Properties of Crystals - effect of symmetry on the physical properties of crystals
 - A. 1st Order Tensors
 - i. Polar vectors
 - ii. Axial vectors
 - iii. Coordinate transformations
 - B. 2nd Order Tensors
 - i. Resistivity
 - ii. Coordinate transformations
 - iii. Stress and strain
 - iv. Suffix notation
 - v. Graphical representations – Mohr’s circle and quadric
 - vi. Bifringence – optic axis
 - C. Third Order Tensors
 - i. Piezoelectricity
 - ii. Reduced notion
 - D. Fourth Order Tensors
 - i. Elasticity
 - ii. Reduced notation
 - E. Average properties of polycrystal
- III. Diffraction Theory
 - A. Vector Geometry of Non-cartesian Vectors
 - i. Real and Reciprocal Lattices
 - ii. Dot Product or Scalar Product

- iii. Cross Product
- iv. Metric
- v. Miller Indices, Miller-Bravais Indices
- B. Laue Equations
- C. Bragg's Law
- D. Structure Factor
- E. Effect of Symmetry Elements on Diffraction Pattern
- F. How to Read the International Tables of X-ray Crystallography
- G. Polarization Factor and Lorentz Factor(optional)
- H. Fourier Approach(optional)
- IV. X-ray Diffraction Methods
 - A. X-ray Sources, X-ray Detectors and X-ray Safety
 - B. Laue Method
 - C. X-ray Diffractometer
 - D. Rotation Method
 - E. Fourier Series Methods
 - F. Noncrystalline Solids

Grading

Homework	10% credit/no credit
Three midterms	90%(30% each)(There will be no final)

Midterm I October 7, 2015 Wednesday 2:00 - 3:15 pm

Midterm II November 11, 2015 Wednesday 2:00 - 3:15 pm

Midterm III December 11, 2015 Friday 2:00 – 3:15 pm

Text Covering the Material in MASC 505

None of these texts are required. They provide an alternative source for the material covered in the course.

1. Buerger, M., "Elementary Crystallography" – Buerger uses “repetition patterns” to derive point groups and this will be used in the course in the section on “Formal Crystallography.” Unfortunately this book is out of print but used copies are available on Amazon and it is on reserve in Seaver Science Library QD905.B96 1963
2. Tilley, R., “Crystals and Crystal Structures” – optional text – this would be an alternate source for the material on crystals and crystallography. Available for \$50.11 on Amazon.
3. Nye, J. F., "Physical Properties of Crystals" - recommended text - on reserve in Seaver Science Library QD931.N9 1967 – this will be the text used in the section on “Physical Properties of Crystals.” – Available for \$83.05 from Amazon.
4. Malgrange, C., Ricolleau, C. and Schlenker, M. “Symmetry and Physical Properties of Crystals” – optional text – this text covers both formal crystallography and physical properties of crystal. It is a new book first published in 2011 in French and then in English in 2014 and originally sold for \$28 and I had intended to recommend it but the current price on Amazon is \$113.99 so I put it as an optional text.
5. Warren, B. E., "X-ray Diffraction" – recommended text - on reserve in Seaver Science Library QD945.W33 - \$12.84 from Amazon – this will be the text used for the last two sections on diffraction
6. Gunier, A., “X-ray Diffraction in Crystals, Imperfect Crystals and Amorphous Bodies” – optional text - \$18.02 from Amazon – this is an alternate source of X-ray diffraction and covers diffraction techniques of imperfect crystals and amorphous solids.

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct/>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu/> or to the *Department of*

Public Safety <http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us>. This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu/> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.