MSE 6402 – Structure and Defects

School of Materials Science and Engineering
Georgia Institute of Technology

Fall Semester 2012

Course Objective	To provide students with a fundamental understanding of crystal structures, symmetry, defects, and microstructure in crystalline materials, and their influence on materials properties.		
Lecture	10-11 M W F in Love 299		
Instructor	Meilin Liu	Naresh Thadhani	Arun Gokhale
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Office Hour	M W F 3-4		
Teaching assistant	TBD		
Homework	Problems will be assigned periodically and solutions will be posted a week later. Homework will not be collected or graded.		
Exam/grading	4 Exams, 25% each Exam 1 – Crystal Structure and Symmetry Exam 2 – Point defects Exam 3 – Dislocations Exam 4 – Surfaces, Interfaces, and Microstructures		

References

1. Lecture notes – to be posted on T-Square
2. Physical Ceramics, Y. M. Chiang, D. Birnie, and W. D. Kinggery, Wiley, 1997.
3. Crystallography, Walter Borchardt-Ott, Springer-Verlag, 1993, QD 905.2.B713
4. Defects in Solids, R.J.D. Tilley, Wiley, 2008, QD921.T53
5. The Chemistry of Imperfect Crystals. Vols. 2&3, F.A. Kroger, North Holland/American Elsevier, 1974, QD478.K76.
6. Introduction of Dislocations, 4th Edition, D. Hull and D.J. Bacon, Pergamon Press
7. Elementary Dislocation Theory, 1992 Edition, Johannes Weertman and Julia R. Weetman, Oxford University Press

MSE 6402: Topical Outline

# of Lectures	Date	Topics	Ref
		Crystal Structure and Symmetry – M. Liu	1,2,3
11	Aug-20 to Sept-14	Geometric principles: Representative structures of important materials: metals, alloys, semiconductors, and ceramics (AX, AX_2, ABX_3, AB_2X_4 compounds: Fluorite, Perovskite, Spinel, Garnet, etc.); Pauling rules Crystal Symmetry: Symmetry operations; Crystallographic point groups; Magnetic (color) point groups; Space groups; Symmetry of force fields and properties: Limit groups; Effect of symmetry on properties of materials	
	Sept-17	**Exam 1: Crystal Structure and Symmetry (25%)**	**5-6:30 P**
		Point Defects – M. Liu	1,2,4,5
10	Sept-19 to Oct-12	Defect Notations Equilibrium Defect Concentrations Defect Reactions Mass-Action Law/Electroneutrality approximation Ionic and Electronic Disorders in materials Brouwer's Approximation Non-stoichiometry: Solid-Gas Interactions Effect of Doping: Donors and acceptors Temperature Effect Charged Surfaces & Space Charge Region, Complex Defects	
	Oct-17	**Exam 2: Point Defects (25%)**	**5-6:30 P**
		Surfaces, Interfaces, and Microstructures – A. Gokhale	1
12	Oct 17 to Nov-9	Structure of Grain Boundaries and Interfaces Geometric Topological Aspect of Grain Structures Mathematical Correlation of Microstructures in terms of correlation functions, near neighbor distributions, morphological orientation distributions, size and shape distributions, metric and topological attributes, etc. Modeling and simulations of microstructural geometry, solutions to inverse problems Effects of microstructural geometry on important classes of material properties	
	Nov-12	**Exam 3: Surfaces, Interfaces, & Microstructures (25%)**	
		Dislocations – N. Thadhani	1,6,7
10	Nov-14 to Dec-7	Line Defects and their Characteristics Movement of Dislocations Elastic Properties of Dislocations Strain Energy of a Dislocation Forces on Dislocations Dislocations in FCC Systems Dislocations in Other Systems Jogs and Intersection of Dislocations Origin and Multiplication of Dislocations Dislocation Arrays and Crystal Boundaries	
	TBD	**Exam 4: Dislocations (25%)**	