

ChE 375 – Structure, Properties and Processing of Materials Spring 2018

Instructor: Dr.Irina Molodetsky **Office:** 350 Tiernan Hall

Email: Irina.Molodetsky@njit.edu

Office Hours: **Monday:** 1:00 PM-2:30 PM; **Wednesday:** 3:00 PM – 5:00 PM

Text: Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition, W.D. Callister, Jr., and D.G. Rethwisch, John Wiley and Sons, Inc. (2008). ISBN 978-1-118-06160-2

Class: Monday, 11:30 AM – 12:55 AM; Room: Cullimore Hall 1
Wednesday, 1:00 PM – 2:25 AM; Room: Cullimore Hall 1

Course: Tailoring materials properties by engineering their microscopic/macrosopic structures via processing is central to product design and development in the chemical industry. This course introduces the principles of materials engineering from the perspective of structure-property-processing relationships. Instead of covering different types of materials separately, this course will use the principles common to engineering of the most important materials as an underlying theme. These are atomic/molecular structure, nanoscale, morphology, principles of phase transformation, structure development during processing, and property dependence on structure. Besides single component systems, advanced materials such as multiphase and/or multi component systems, (e.g. composites and gels) and nanomaterials will be discussed based on these principles. An integral part of this course will be introduction to principles of the materials characterization and selection of the techniques for creative problem solving (failure analysis and troubleshooting). We will discuss examples of materials selection from the actual industrial applications.

Pre-Requisites: Chem 236, (or Chem 235), Mech 320 (can be taken as co-requisite).

Homework: Homework assignments will include problems from the textbook. A similar problem will be assigned in class (closed book).

Exams: There will be three exams and one final exam.

GRADING

3 Exams [closed or open book]	60%
Final	30%
Assignments/quizzes	<u>10%</u>
	100%

Note: NJIT Honor Code will be upheld and any violations will be brought to the attention of the Dean of Students.

Students will be informed regarding modifications or deviations from the syllabus.

Course Objectives: Students will be able to:

- Understand the different properties and applications of metals, ceramics, polymers and composites.
- Identify a set of analytical methods to characterize the material macro- and microstructure
- Describe the differences in atomic/molecular structure between crystalline and non-crystalline materials
- Read binary phase diagrams and apply them to specific examples
- Describe the general types of polymer molecular structures and relate properties to structures
- Gain knowledge of imperfections including defect structures and grain boundaries and dislocations of materials.
- Apply acquired knowledge on diffusion properties, thermal properties, mechanical properties in materials failure mechanisms

Topics

Section I:

Structure and Morphology

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| 1. Introduction | Chapter 1
Chapter 2 |
| 2. Review of the analytical methods for materials characterization | |
| 3. Metallic/Ceramic Structures | Chapter 3 |
| 4. Phase Diagrams | Chapter 10;
Chapter 11; |
| 5. Phase Transformations | |

Exam 1 Wednesday, February 21

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| 6. Polymer Structures | Chapter 4 |
| 7. Imperfections in Solids (composition) | Chapter 5 |
| 8. Diffusion | Chapter 6 |

Section II: Macrostructure-Properties Relationship

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| 9. Mechanical Properties | Chapter 7 |
| 10. Imperfection in solids | Chapter 5 |
| 11. Deformation/Strengthening Mechanism | Chapter 8 |
| 12. Materials with advanced macrostructure and their application. | |
| 13. Nanomaterials | |

Exam 2 Wednesday, April 4

Section III: Types and Fabrication of Materials

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| 14. Types and application of materials | Chapter 13 |
| 15. Introduction to fabrication of materials-
Synthesis and fabrication of polymers
Ceramic processing and synthesis of advanced ceramics
Property modification with composite materials | Chapter 14

Chapter 15 |

Section IV: Material Selection for Product Design

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| 16. Corrosion in metals and ceramics-
Polymer Degradation | Chapter 16 |
| 17. Thermal Properties | Chapter 17 |

Exam 3 Wednesday, April 25

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| 18. Economic, Environmental and Social Issues | Chapter 20 |
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Final Exam May 7-9