University of Puerto Rico
Mayagüez Campus
College of Engineering
Department of General Engineering
Master of Science and Engineering

Course Syllabus

1. General Information:

Alpha-numeric codification: CIIM 6017
Course Title: FUNDAMENTALS OF MATERIALS CHEMISTRY
Number of credits: 3
Contact Period: 3 hours of lecture per week

2. Course Description:

English: Study of the scientific foundations of the chemical origin of materials properties and the structure of solids, in order to apply these concepts in the analysis of homogeneous and heterogeneous systems. The physicochemical principles of dissolution, precipitation, and crystal growth processes are presented and discussed on mechanistic and practical application bases. The theory and applications of mechanochemistry and mechanoactivation of materials, as well as the chemistry of surfaces and interfaces in sols, gels, colloids, and nanoparticle systems, self- assembly and film formation, will be discussed.

Spanish: Estudio de los fundamentos científicos del origen químico de las propiedades de los materiales y la estructura de sólidos, para aplicar los mismos en el análisis de sistemas homogéneos y heterogéneos. Los principios físico-químicos de los procesos de disolución, precipitación y crecimiento de cristales son presentados y discutidos sobre bases mecanísticas y de aplicación práctica. Se discutirá la teoría y aplicaciones de la mecanoquímica y activación mecánica de los materiales, así como la química de superficies e interfaces en sistemas de soles, geles, coloides y nanopartículas, el auto-ensamblaje y la formación de películas.

3. Pre/Co-requisites and other requirements:

Graduate student with permission of the Program Coordinator.

4. Course Objectives:

By the end of the course students will:
- Analyze the physical and chemical principles in materials synthesis at low and high temperatures.
- Review the concepts of interfacial equilibria.
- Distinguish the characteristics and features of particulate materials.
- Apply electrochemical principles in materials synthesis
- Recognize the mechanisms of mechano- chemical processing routes.
- Propose conceptual interpretation of interfacial reactions.
- Discuss conditions to control particle growth and stabilize particles in suspension and thin films.
- Identify the critical physical and chemical conditions leading to film formation.
- Identify the conditions for processing and parameters that control the synthesis of materials at high temperature.

5. Instructional Strategies:

☒conference ☐discussion ☐computation ☐laboratory

☐seminar with formal presentation ☐seminar without formal presentation ☐workshop

☐art workshop ☐practice ☐trip ☐thesis ☐special problems ☐tutoring

☐research ☐other, please specify:

6. Minimum or Required Resources Available:

No specific resources are required

7. Course time frame and thematic outline

Outline	Contact Hours
- Physical and chemical principles of materials synthesis at low and high temperatures.	6
- Structure and bonding. Electronic structures of atoms and molecules. Solids, liquids and gases.	3
-Equlibria and rate processes: Dissolution, precipitation and crystal growth. Particulate sols, gels, colloids and nanoparticles. Electrochemical systems.	7
- Mechanochemistry and mechanoactivation of materials.	5
- Thermodynamics of surfaces. Interfacial chemistry. Adsorption desorption phenomena. Electrical double layer. Colloids stability.	6
- Electrostatic and steric stabilization. Self assembly. Electrocapillary and electrokinetic measurements. Other surface characterization techniques.	4
- Film formation. Deposition conditions. Thin films. Chemical bath deposition (CBD), chemical vapor deposition (CVD), etc.	5
- High Temperature synthesis. Solid state reactions. Kinetics vs thermodynamic control of products. Synthesis of metastable materials. Topotactic reactions. Synthesis processes at high temperature.	8
-Exam	1
Total hours: (equivalent to contact period)	45

8. Grading System

☒ Quantifiable (letters) ☐ Not Quantifiable

Standard Curve:

100-90 A; 89-80 B; 79-70 C; 69-60 D; 59-0 F

9. Evaluation Strategies

	Quantity	Percent
☒ **Exams**	**1**	**20**
☒ **Final Exam**	**1**	**20**
☐ **Short Quizzes**		
☒ **Oral Reports**	**2**	**30**
☒ **Monographies**	**2**	**30**
☐ **Portfolio**		
☐ **Projects**		
☐ **Journals**		
☒ **Other, specify:**		
TOTAL:		**100%**

10. Bibliography:

Textbook:

Gersten, J. I., & Smith, F. W. (2001). *The physics and chemistry of materials*. New York: Wiley. There is no newer version. [Available at the Circulation Collection (QD478 .G47 2001), UPRM General Library]

Other resources:

Benjamin, M. M. (2002). *Water chemistry*. Boston: McGraw-Hill. There is no newer version. [Available at the Circulation Collection (GB855 .B46 2002), UPRM General Library]

Brinker, C. J., & Scherer, G. W. (1990). *Sol-gel science: The physics and chemistry of sol-gel processing*. Boston: Academic Press. There is no newer version. [Available at the Circulation Collection (TP810.5 .B75 1990), UPRM General Library]

Fahlman, B. D. (2011). *Materials chemistry ()2nd edition)*. New York: Springer. [Available at the Circulation Collection (QD131 .F33 2007), UPRM General Library]

Gersten, J. I., & Smith, F. W. (2001). *The physics and chemistry of materials*. New York: Wiley. There is no newer version. [Available at the Circulation Collection (QD478 .G47 2001), UPRM General Library]

Selected articles from specialized journals available in: *ACS* (http://pubs.acs.org) [Available online via ACS Journals , UPRM General Library]

11. According to Law 51: Students will identify themselves with the Institution and the instructor of the course for purposes of assessment (exams) accommodations. For more information please call the Student with Disabilities Office which is part of the Dean of Students Office at (787) 265-3864 or (787) 832-4040 extensions 2040 or 3372.

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