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 6010
Course Title: MATERIALS MICROPROCESSING AND ENGINEERING
Number of credits: 3
Contact Period: 3 hours of lecture per week

2. Course Description:

English: Discussion of synthesis routes applied to the microprocessing of engineering materials, including epitaxial growth in ion beam processing. The processing conditions for thin films of semiconductors and other functional materials for superconducting, magnetic, and tribological applications are also discussed. The students will be able to propose and explain the most suitable microprocessing route for a specific engineering application.

Spanish: Discusión de las rutas de síntesis aplicadas al microprocesamiento de materiales de ingeniería, incluyendo el crecimiento epitaxial en el procesamiento con haz de iones. Las condiciones de procesamiento de películas delgadas de semiconductores y otros materiales funcionales para aplicaciones superconductoras, magnéticas y tribológicas también son discutidas. Los estudiantes podrán proponer y explicar la ruta de microprocesamiento más adecuada para un uso específico en ingeniería.

3. Pre/Co-requisites and other requirements:

Graduate students: with permission of the Program Coordinator.

4. Course Objectives:

By the end of the course students will:
- Describe the making of single crystals.
- Differentiate metallurgical grades (MGS) from electronic grade Si (EGS).
- Identify means of accomplishing transport phenomena.
- Explain the scientific bases for selection and application of phenomena in the fabrication process.
- Describe pattern design and selection criteria.
- Identify limitations on the bases of integrated circuits (IC) fabrication.
- Distinguish purely physical and purely chemical etching processes.
- Explain the thermodynamics of vapor phase growth.
- Describe techniques employed in the deposition of materials.
- Explain evaporation processes as applied to different materials systems.
- Identify deposition processes based on substrate temperatures.
- Analyze surface phenomenon of film deposition.
- Characterize defects inherent to epitaxial growth.
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- Characterize defects inherent to epitaxial growth.

Describe some applications, e.g., tribology and superconducting and magnetic materials.

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
- Single crystal substrates.	3
- Review of diffusion. Thermal oxidation. Rapid thermal processing	9
- Optical and non-optical lithography (including photoresists)	11
- Vacuum science and plasmas etching processes	9
- Physical vapor deposition. Chemical vapor deposition. Ion implantation.	9
- Applications of Techniques. Epitaxial growth	3
- 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**	**20**
☒ **Monographies**	**2**	**40**
☐ **Portfolio**		
☐ **Projects**		
☐ **Journals**		
☒ **Other, specify:**		
TOTAL:		**100%**

10. Bibliography:

Textbook:

Banks, D. (2006). *Microengineering, MEMS, and interfacing: A practical guide*. Boca Raton, FL: CRC/Taylor & Francis. http://dx.doi.org/10.1201/9781420015416 There is no newer version. [Available via CRCNetBASE, UPRM General Library]

Other resources:

Adams, T. M., & Layton, R. A. (2010). *Introductory MEMS: Fabrication and applications*. New York: Springer. http://dx.doi.org/10.1007/978-0-387-09511-0 [Available via Springer eBooks, UPRM General Library]

Campbell, S. A. (2001). *The science and engineering of microelectronic fabrication*. New York: Oxford University Press. There is no newer version. [Available at the Circulation Collection (TK7871.85 .C25 2001), UPRM General Library]

Chakraborty, S. (Ed.). (2010). *Microfluidics and microfabrication*. New York: Springer. http://dx.doi.org/10.1007/978-1-4419-1543-6 [Available via Springer eBooks, UPRM General Library]

Jackson, M. J. (2006). *Microfabrication and nanomanufacturing*. Boca Raton, FL: Taylor & Francis. http://dx.doi.org/10.1201/9781420028270 There is no newer version. [Available via CRCNetBASE, UPRM General Library]
Madou, M. J. (2012). *Fundamentals of microfabrication and nanotechnology* (3rd ed.). Boca Raton, FL: CRC Press. [Available at the Circulation Collection (TK7836 .M33 2002), UPRM General Library]
Powers, M. T., Lavernia, E. J., Groza, J. R., & Shackelford, J.F. (Eds.). (2007). *Materials processing handbook*. Boca Raton, FL: CRC Press. There is no newer version. http://dx.doi.org/10.1201/9781420004823 [Available via CRCNetBASE, UPRM General Library]
Selected articles from specialized journals available in: *IEEE* (http://ieeexplore.ieee.org/xplore/dynhome.jsp) [Available online via IEEE, 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.

Prepared by:

Dr. Marcelo Suárez
Coordinator

Approved by:

Dr. Aidsa I. Santiago Román
Department Chair

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