FISI 6995-182: RESEARCH SEMINAR- SPINTRONICS MATERIALS & DEVICES

DEPARTMENT OF PHYSICS
UNIVERSITY OF PUERTO RICO, RIO PIEDRAS CAMPUS
DR. RATNAKAR PALAI

Course: FISI 6995-182: Research Seminar-Spintronics Devices and Materials
Instructor: Dr. Ratnakar Palai
Credits: 1-3 credit per semester
Class hours: Monday & Friday 4.30pm-5.30pm
Office: FB 219 Facundo Bueso Bldg
Email: r.palai@upr.edu
Tel: 787 764 0000 Ext: 88465
Teaching Assistant: N/A

Prerequisites:
FISI 6426- Solid State Physics, FISI 6432- Electrodynamics, and FISI 6451- Quantum Mechanics or equivalent and permission of the investigator in laboratory or the Director of the Department.

Course Description:
The course focuses on science and engineering of different spintronic materials and magnetic tunnel junctions (MTJs). The course will cover growth mechanisms of thin films by different techniques such as, molecular beam epitaxy (MBE), pulsed laser deposition (PLD), atomic layer deposition (ALD), and sputtering. The course will also discuss different characterization techniques for the better understanding of film properties and device parameters.

Course Objectives

The main course objective of the spintronics materials and devices seminar course are as follow:

- To understand different thin film growth and characterization techniques
- To learn more about the spintronics materials and their applications
- To deepen the understanding of physics of spintronics materials through discussion of current research
- To gain an understanding of the concept of experimental uncertainties and their importance in the design and analysis of experiments
- To communicate experimental results through clear scientific/technical writing and oral presentation
- To become proficient in the use of computers and software tools for analyzing and representing data for communication, etc.

Content Outline and Time Distribution:

Weeks	No. Hours	Topics
weeks 1-5	15	Review of literature and discussion about the importance of spintronic materials (magnetoelectric multiferroicsd and diluted magnetic semiconductors) and their applications. Vacuum science and technology- covering physics of vacuum and different pumps. Presentation by PI and student
weeks 6-10	15	Thin film growth mechanisms and principle of different thin film growth techniques molecular beam epitaxy (MBE), pulsed laser deposition (PLD), atomic layer deposition (ALD), and sputtering. Characterization of thin films using different analytical techniques (photoluminescence (PL), cathodeluminescence (CL), XPS, TEM, RHEED, XRD, magnetic, and electrical. Presentation by PI and student
weeks 11-15	15	Discussion of recent reviews on spintronic materials, magnetoelectric multiferroics, and rare earth based III-nitride semiconductors. Discussion on magnetic tunnel junctions, spin-FET and spin-LED Presentation by students

Instructional Strategies:
The instructional method of the seminar is based on the discussion of current review articles and oral presentations.

Minimum resources available: Audiovisual and conference room projectors.

Evaluation Strategies:
Each student has to give three presentations and discussing relevant scientific data, experimental observation supported by scientific argument.
Active participation- 25%
Oral presentation -50%
Presentation Proficiency-25%

Rating system: Approved or not approved

Suggested Textbook:

- M. Ohring, The Materials Science of Thin Films, Academic Press, Inc., (1992).
- K.L. Chopra, Thin Film Phenomena (1969)

Bibliography:

- B. Lewis and J.C. Anderson, Nucleation and Growth of Thin Films, Academic Press, New York, (1978).
- J.A. Venables, Introduction to Surface and Thin Film Processes, Cambridge University Press, (2000).
- J.S. Horwitz and J.A. Sprague, in Film nucleation and Film Growth in
- Pulsed Laser Deposition of Thin Films (D.B. Chrisey and G.K. Hubler, Editors), John Wiley & Sons, Inc., (1994).
  M. A. Herman and H. Sitter, Molecular Beam Epitaxy- Fundamental and current Status (1996)

Recommended Internet resources:

1. Applied Physics Letters (http://apl.aip.org/apl/),
2. Journal of Applied Physics (http://jap.aip.org/),
3. Physical review B (http://journals.aps.org/prb/)
4. Journal of Physics D: Applied Physics (http://iopscience.iop.org/journal/0022-3727)
5. Nature (http://www.nature.com/index.html),
6. Science (http://www.sciencemag.org/)
7. http://iopscience.iop.org/journal/0022-3727

Reviews:

1. http://physics.aps.org/articles/pdf/10.1103/Physics.2.20 (Classifying multiferroics Mechanisms and effects)
2. http://journals.aps.org/prb/pdf/10.1103/PhysRevB.78.012104
3. http://physics.aps.org/articles/pdf/10.1103/Physics.5.16
4. http://x-ray.ucsd.edu/mediawiki/images/7/7a/AwschalomD_SpintronicsReview_NPhys_2007.pdf (Challenges for semiconductor spintronics)
5. http://journals.aps.org/rmp/pdf/10.1103/RevModPhys.76.323 (Spintronics: Fundamentals and applications)

Rights of Students with Disabilities:

The University of Puerto Rico complies with state and federal laws and regulations concerning discrimination, including Law 51 of the Commonwealth of Puerto Rico and the federal law known as the 1990 Americans with Disabilities Act (ADA). Students who receive vocational rehabilitation services or require any assistance should inform the teacher (a) in charge of the course about this situation for reasonable accommodation to have equal access to education and services offered by the University of Puerto Rico accordance with the recommendations Affairs Office for Persons with Disabilities (OAPI) the Dean of Students.