APHY-312 Nanomaterials and Device Fabrication

Course Description

Basic concepts, underlying principles, and techniques of nanomaterials and device fabrication. Topics include semiconductor materials and devices processing technologies, vacuum technologies, nanomaterails growth techniques, nanomaterial functionalization and device fabrication, materials and surface characterizations, and survey of various nanomaterials systems. Experimental techniques taught include semiconductor sample cleaning and preparations, magnetron sputtering for metal depositions, reactive ion sputtering for oxides, plasma enhanced CVD for carbon nanotubes growth, thermal CVD growth of thin films, wet and plasma etching, surface and materials characterization with scanning electron microscopy, and electron emission measurement. (3 credit hours)

Prerequisite: PHYCS 122, PHYCS 260.

Course Objectives

The Nanomaterials and Device Fabrication course will introduce students basic concepts, and underlying principles of nanomaterials growth and device fabrication. It will also provide students hands-on experience and opportunities to learn basic experimental techniques of the field. Upon completion of this course the student will gain the knowledge and experimental skills for basic semiconductor processing and nanomaterials growth and characterizations.

Course Rationale

The Nanomaterials and Device Fabrication is an experimental course offered for the undergraduate physics and chemistry majors and minors as well as graduate students. It is a one-semester, four credit hour course. It provides an overview of semiconductor technologies and the emerging field of nanotechnology. It also provides hands-on training of basic materials processing and device fabrication techniques. The knowledge and skills gained in this course are particularly beneficial to students who wish to do experimental work in a science or engineering field.

Course Content, Format, and Bibliography

Content

Part I Fundamentals for Materials Processing (week 1 – 6)

- Semiconductor materials and devices processing
- Vacuum technology
- Sample cleaning and preparations
- Magnetron sputtering
- Plasma enhanced CVD
- Thermal CVD

- Dry and wet Etching
- Materials characterization and property measurements (SEM etc.)

Part II Nanomaterials (Carbon Nanotubes) Growth and Devices Fabrication (Week 5 – 10)

- Growth of Carbon Nanotube thin films
- Carbon nanotubes growth with various catalysts or substrates
- Morphological control for carbon nanotube thin film growth
- Carbon nanotubes growth conditions
- Functional carbon nanotubes
- Electron emission properties and applications of functional carbon nanotubes

Part III Survey of Nanomaterial Systems and their Growth and Device Fabrications (9- 16)

- Survey of nanomaterials growth techniques
- Other nanomaterials systems
- Student project researches
- Student presentations

Format

Labs, group lab reports, assigned readings, individual research papers, group research projects and presentations.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

Bibliography

Handouts