1. Carbon Nano Tubes and Applications

Course Objectives:

The objective of this course is to provide the students the basic understanding of carbon nanotubes and their applications. This course will introduce to the student about the Nano diamond particles synthesis, classifications of diamond like carbon films and their physical properties. The course will also focus on the properties of Nano crystalline diamond films and their applications. The student will be introduced to the structure of carbon nanotubes and their application in chemical sensors, computer, optical and telecommunication applications.

Course Outcomes:

Upon completion of this course, the student will be able to

1. Describe Nano diamond particles and diamond like carbon films.
2. Illustrate the synthesis of carbon nanotubes
3. Analyze the properties of carbon nanotubes
4. Illustrate the applications carbon Nano tubes

Course Contents:

1. Nano diamond particles,
2. Nano diamond particles synthesis
3. Applications of Nano diamond particles.
4. Diamond-like Carbon films (DLC),
5. DLC/graphite transformation
6. deposition techniques of DLC films.
7. Nanocrystal line diamond (NCD) films,
8. Carbon nanotube (CNT),
9. Structure of CNT,
10. Synthesis of CNT,
11. Properties of CNT
12. Functionalization of Carbon Nanotubes
13. Applications of Carbon Nanotubes.

Reference Books:

1. Charles P. Poole Jr and Frank J.Owens, “Introduction to Nanotechnology,” Wiley-Interscience publication, USA.
2. W. R Fahrner, “Nanotechnology and Nano Electronics – Materials, devices and measurement techniques,” Springer publications.
3. Michael J. O'Connell, “Carbon Nanotubes: Properties and Applications.”, Taylor and Francis Group.

2. Graphene Nanoelectronics: From synthesis to device applications

The course aims to introduce graphene nanoelectronics from science and technology perspectives. It covers the fundamental processes that are involved in the synthesis of graphene, which will include chemical synthesis and chemical vapour deposition. Discussion will be focused on the effect of different processing technique on the structure of graphene. The course will also introduce on various characterisation tools that can be used to characterise graphene structures such as Raman Spectroscopy, High Resolution Tranmission Electron Microscope (HR-TEM and Scanning Tunneling Microscopy. In addition, the discussion will focus on electronic properties of graphene and device applications.

Course Outcomes:

1. Develop a broad understanding of graphene and application in devices
2. Evaluate the various chemical and non-chemical approach in production of graphene
3. Examine graphene structures through various characterization tools
4. Compare and contrast the properties of graphene and graphene nanoribbons
5. Relate graphene structure with the performance of devices

Course Contents:

Introduction to graphene nanoelectronics
Chemical approaches to produce graphene oxide and graphene
Graphene growth by chemical deposition method
Raman Spectroscopy: Characterization of Edge, Defects and Structure
Scanning Tunneling Microscopy of Graphene
Formation of Epitaxial Graphene
Epitaxial Graphene on Metals .
Electronic transport properties of graphene
Electronic Properties of Multilayer Graphene
Graphene transistors
Graphene nanoribbons: Structure and Electronic Properties
Graphene pn Junction: Electronic Transport and Devices

Reference Books:

1. Graphene: Fundamentals, Devices and Applications by Serhii Shafraniuk (2015) Pan Standford.
2. An introduction to Graphene and Carbon Nanotubes by John E. Proctor, Daniel Melendrez Armada, Aravind Vijayaraghavan (2017) CRC Press
3. Raman Spectroscopy in Graphene related Systems by Ado Jorio, Mildred Dresselhaus, Riichiro Saito and Gene F, Dresselhaus (2011) Wiley VCH