**INTRODUCCIÓN A LOS MATERIALES NANOESTRUCTURADOS (48 hrs.)**

**Profesor:** Dr. Velumani Subramaniam.

**OBJETIVO:** In this course it is intended to introduce the synthesis, characterization and applications of materials functioning at nano scale - meaning a billionth ($1 \times 10^{-9}$) of a meter. Even though the word nanotechnology is relatively new, the existence of functional devices and structures of nanometer dimensions is not new, and in fact such structures have existed on Earth as long as life itself.. This course basically provides a fundamental understanding of the relationships between physical properties or phenomena and materials dimensions. In the first three parts synthesis of various nanostructured materials are dealt in detail and last two units concentrate on the characterizations technique and the possible applications. Also a thorough review on the recently published articles will be done in order to have an up-to-date knowledge on the synthesis and characterization of nanostructured materials.

Provide an introduction to the synthesis and characterization of various nanostructured materials for its device applications.

**Contenido:**

**TEMA 1: INTRODUCTION AND ZERO DIMENSIONAL NANOESTRUCTURES.**

1.1 Introduction**,** Emergence of nanotechnology, physical chemistry of solid surfaces – surface energy – chemical potential as function of surface curvature – electrostatic stabilization - steric stabilization: Zero dimension nanostructures – Homogeneous Nucleation – synthesis of metallic, semiconductor and oxide nanoparticles, vapor phase segregation, Hetrogeneous nucleation – fundamentals and synthesis-kinetically confined synthesis, epitaxial core shell nanoparticles.

**TEMA 2: ONE DIMENSIONAL NANOESTRUCTURES.**

2.1 One dimensional: Spontaneous growth –evaporation –vapor – stress induced– Template based synthesis – electrochemical – electrophoretic – template filling – electrospinning – Lithography.

**TEMA 3: TWO DIMENSIONAL NANOESTRUCTURES.**

3.1 Two dimensional – fundamentals of film growth – vacuum science – Physical vapor deposition, Chemical vapor deposition- Atomic layer deposition, super lattices – self assembly – electrochemical deposition – Sol-Gel.

**TEMA 4: SPECIAL NANOMATERIALS AND PROPERTIES OF NANOSTRUCTURED MATERIALS.**

4.1 Carbon and fullerene nanotubes, nanoclusters, Quantum wells, Quantum wire and quantum dot structures, Structural characterization –XRD, SAXS, SEM, TEM, SPM –

Chemical characterization – physical properties of nanomaterials – optical, mechanical, electrical.

**TEMA 5: APPLICATION AND RECENT ADVANCES IN NANOESTRUCTURED MATERIALS.**

5.1 Molecular electronics and nanoelectronics – nanobots – biological applikcaitons – bandgap engineered quantum devices – Review of selected and latest articles published on the synthesis of nanostructured materials in peer reviewed international journals.

**Specific objectives covered in each topic and subtopics.**

**1. Introduction and Zero dimensional nanostructures.**

A thorough understanding of the concept of the nanostructured materials on the basis that particles less than the size of 100 nm has different new properties and behavior.
Imparting various terminologies used in the nanostructured materials.
Introduction to zero dimensional nanostructured materials and its various growth phenomenon etc.

**2. One dimensional nanostructures.**

Understanding the concepts and functioning of the nanostructured materials treating it as one dimensional material.
Study on various growth techniques and synthesis of one dimensional structure.

**3. Two dimensional nanostructures.**

Various types of physical and chemical methods to prepare two dimensional nanostructured materials.
Main concentration will be on the synthesis of nanoparticle, nanorods, nanowires, nanotubes by the physical and chemical methods.
Limitations and intricacies involved in the synthesis of the nanostructured materials.

**4. Special nanomaterials and Properties of nanostructured materials.**

Special emphasis on the carbon nanostructures will be given based on its multifaceted applications.
Various nanostructures and its quantum confinement effects will be reviewed.
Various structural and physical properties of the nanostructured materials will be described and the characterizations techniques will be elaborated.

**5. Application and Recent Advances in Nanostructured materials.**

Students will be asked to collect latest research publications appearing in various international and national journals and a survey of the present advancement in the synthesis and characterization of nanostructured materials will be provided.

Recent advances in the various metals, organic and organic semiconductor nanostructured materials for various device applications will be reviewed.
A review on recent advances in the nanofabrication technologies in various fields of applications and its potential competence with many other existing fabrication techniques.

**Suggested Methodology and Activities Of Learning.**

Short expositions of the instructor on key concepts of synthesis various nanostructured materials.
To make understand the functioning of materials at nanoscale by small demonstrations.
Will be trained in synthesis and characterization of selected nanostructured materials in the laboratory scale.
Sessions in the AFM and SEM will be incorporated to have hands on experience and appreciation of the nanostructures.
Bibliografic research project based on recent scientific research in the field.

**Estimated Time to Cover Each Topic.**

**1. Introduction and Zero dimensional nanostructures - 10 hrs.**
**2. One dimensional nanostructures – 10 hrs.**
**3. Two dimensional nanostructures– 10 hrs.**
**4. Special nanomaterials and Properties of nanostructured materials – 10 hrs.**
**5. Application and Recent Advances in Nanostructured materials – 8 hrs.**

**BIBLIOGRAFÍA:**


- Nanostructures and Nanomaterials – synthesis, properties and applications by Guozhong Cao, Imperial college press, London and distributed by World Scientific Publishing Co. Pte Ltd.
- Introduction to Nanotechnology by Charles P.Poole, Jr and Frank J.Owens, 2003, A John Wiley & Sons, Inc.,


**Suggested Evaluation.**
It is recommended to evaluate the students on the basis of his involvement/interaction in the class, the practical work and by means of projects, giving equal responsibilities on any of the individual components/topics of interest involved in the synthesis and characterization of nanoparticles, nanorods, nanotubes etc. Also his/her involvement in collecting the latest informations available from various international and national journals will be taken into account.

**Instructor's profile.**
A professor with Doctorate degree in Materials Science, specialist in synthesis and characterization of various nanostructured materials for device applications. Typically the professor of this subject is engaged in the synthesis and characterization of various semiconductor and metal nanostructured materials.