ME/MSE 556 3(3,0,0)
NANO CRYSTALLINE MATERIALS
Muhammad Farzik Ijaz, PhD
Second Semester 1443[2021-2022]

Instructor Contact Information:

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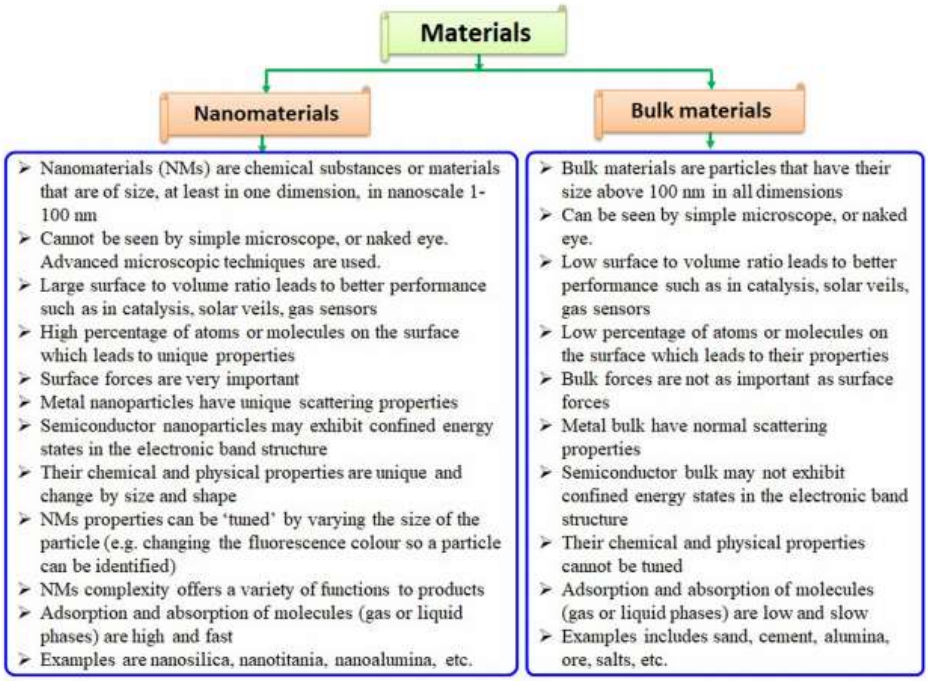
Class schedule: 5:00-7:30 pm (**TUESDAY**)

This course aims to present a number of topics in nanotechnology and science, with emphasis on the role of size on mechanical, optical, thermal and electrical properties of materials. The course also introduces various modern techniques developed to produce Nanostructures and Nano devices and to characterize them.



2. Learning outcome

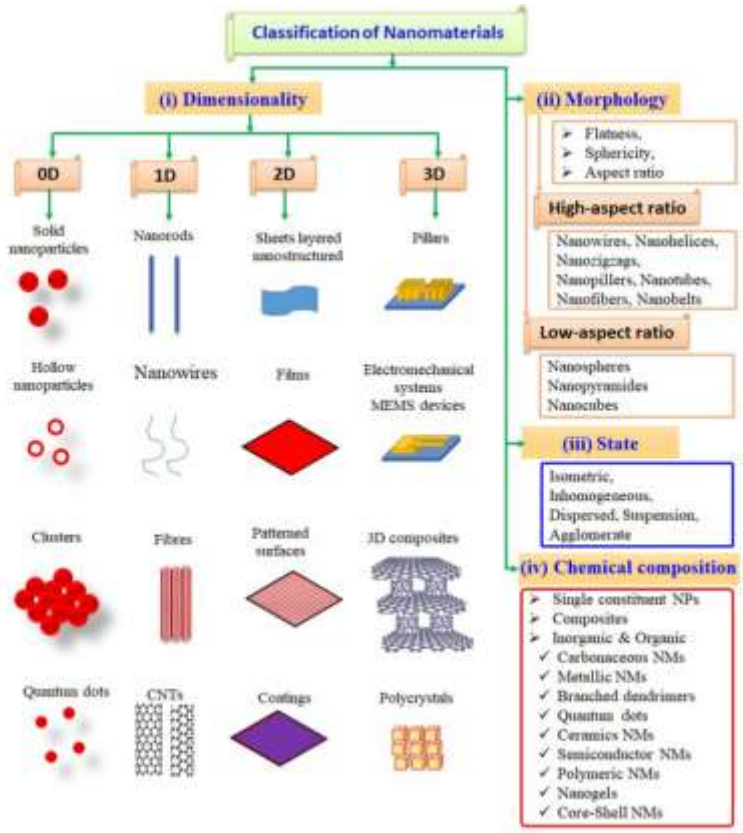
After completion of this course, you should be able to:

1.To have an updated knowledge of the state-of-the-art in nanomaterials and their applications

2.To understand why nanoscaled materials have different properties from their bulk counterparts and how

Course Topics (Preliminary Schedule):

1. Introduction to Nanotechnology: The future of Moore's law, what is nanotechnology, why nanotechnology, existing applications of nanotechnology, nanocrystals, different dimensions of nanocrystals and properties of nanocrystals.
2. Nanofabrication: "top-down" and bottom-up" nanofabrication, optical lithography techniques, electron beam lithography (EBL), focused ion beam (FIB), limitations of "top-down" lithography", nanoimprint, self-assembly, Nano-manipulation, charge writing, dip-pen nanolithography, physical vapor deposition (PVD) and chemical vapor deposition (CVD). Printing and coating. Electrospinning.
3. Characterization at the nanoscale: Different nanomaterials characterization techniques such as Scanning electron microscope (SEM), Transmission electron microscope (TEM), Scanning tunneling microscope (STM) X-ray diffraction (XRD), Energy dispersive X-ray (EDX), Thermogravimetric analysis (TGA), Fourier Transform infrared analysis (FTIR), X-ray photo-electron spectroscopy (XPS), Atomic force microscopy (AFM), and Photoluminescence (PL).
4. Carbon Nanostructures: Diamond, Graphene, Carbon Nanotubes and Fullerenes.
5. Metal oxide Nanostructures: ZnO nanomaterials, Advantages, Properties, Fabrication, Dimensions, Limitations and Applications.Functionalization and modification of nanocrystals: Self-assembly, Self-assembled Monolayer (SAMs), Thiols, Siloxanes, Electrostatic attraction.Recent advances in nanotechnology research: A focus on uses of nanotechnology in Bio-applications, Electronics, Mechanical applications and Water Treatment Technologies.



Grading Policy

Homework (2×5)---------- 10
Two Major Exams (15×2) ---------- ---------- 30
Project and presentation ---------- 20
Final Exam ---------- 40

Exam Schedule

Midterm1……26th October,2021[5:00-6:30 PM]
Midterm 2…… 7th December,2021[5:00-6:30 PM]

Reference Texts:

- Introduction to Nanoscale Science and Technology", M. Di Ventra et al. (Ed.), Springer
- "Nanoscale Science and Technology", R. Kelsall et al. (Ed.), Wiley

Articles

(1) H. Gleiter, ―Nanocrystalline Materials‖, Progress in Materials Science Vol. 33, pp. 223315, 1989
(2) C. C. Koch, ―Nanostructured Materials: Processing, Properties and Applications‖, 2nd Edition, Ed.:2007
(3) Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects, D. Michael Ashby , Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009
(4) J. R. Weertman, in Nanostructured Materials: Processing, Properties and Applications, edited by C. C. Koch (Andrews, Norwich, 2002), p. 397