

## COURSE SYLLABUS

### 1. Identification

Code and title: QUP 332 – Nanochemistry: Fundamentals and Applications

Professor: Vladimir Lavayen

Level: Master and Doctorate

Credit hours: 2

Revised: August\_2020

### 2. Summary

This course covers the concepts of nanochemistry, succinct history of nanoscience, surface effects, synthetic strategies for nanorods, nanowires, carbon nanotubes, and based structures, metallic nanoparticles, graphene and their applications.

### 3. Objective

Introduce the student to the field of nanochemistry, starting with the basic concepts, followed by a historical development. The knowledge of the main characterization techniques along with the synthetic strategies of nanotechnology will be taught aiming at the formation of different nanostructured materials under the criteria of nanochemistry.

### 4. Contents

I. Nanochemistry. Concepts and generalities. I understand the nanoscale. Size reduction and impact on properties. Origin of nanochemistry. What studies nanochemistry?

II. Brief history of nanostructures. Introduction. Study of the history of carbon nanotubes and metallic nanoparticles.

III. Surface effects. Surface effects. Dimensionality. Shape, Self-assembly. Self-ordering. Molecular recognition at the nanometric scale. Introduction to small systems thermodynamics.

IV. Physical characterization methods and their interpretation of data. Data interpretation using: Scanning electron microscopy, and transmission electron microscopy.

V. Metallic nanoparticles. Case study of gold and silver particles. Nanoparticle synthesis strategies. Magic numbers and their aggregates. Characterization techniques. Inorganic pigments based on nanoparticles. Applications.

VI. Self-ordering of nanorods, nanotubes, nanowires. Nanomaterials synthesis strategies; nanorods, nanotubes, nanowires. Nanotubes from porous matrices. Vertical growth of nanostructures. "Barcode" composite nanowires. Electronic devices based on tubes, wires, rods. Applications.

VII. Carbon nanotubes, horns, and fullerenes. Introduction. Classification. Synthesis strategies. Characterization tools. Chemical functionalization in horns, fullerenes and nanotubes. applications.

VIII. Graphene. Introduction. Classification Synthesis strategies. Characterization tools. Graphene chemistry. applications.

IX. Soft lithography and chemical self-assembly, Introduction, monolayer self-assembly. Soft lithograph, classification. Polymeric nanoprinting, Applications.

X. Applications of nanochemistry and its updates. New strategies for nanoparticle synthesis. Biopolymer nanostructures. New strategies for forming quantum dots. Structures based on silica and nanoimprinting. Correlation of theoretical calculations with experimental data on nanostructures.

### 5. Assessment

List of exercises, presentation and discussion of scientific articles, theoretical tests and/or directed works. The student, who obtains a final grade of A, B or C, awarded as per the list below, will be considered approved:

A: grade equal to or above 9.0

B: grade equal to or above 7.5 and below 9.0

C: grade equal to or above 5.0 and below 7.5

D: grade below 5

FF: lack of frequency

### 6. Methodology

Lectures, exercises lists, seminars and examinations.

### 7. Bibliography

- G.A. Ozin, A.C. Arsenault, L. Cademartiri – Nanochemistry, A Chemical Approach To Nanomaterials, Ed. RSC Books, 2005.
- H. Watarai, N. Teramae, T. Sawada - Interfacial Nanochemistry, Molecular Science and Engineering at Liquid-Liquid Interfaces - Ed. Springer, 2008.
- C. Bréchnignac, P. Houdy, M. Lahmani - Nanomaterials and Nanochemistry, Ed. Springer-Verlag, 2008.
- A. Jorio, G. Dresselhaus, M.S. Dresselhaus – Carbon Nanotubes: Advanced Topics in the Synthesis, Structure, Properties and Applications – Ed. Springer, 2008.
- L. Cademartiri, G.A. Ozin – Concepts of Nanochemistry, Ed. Wiley-VCH, 2da Edição, 2009.
- W. Zhou - Nanoimprint Lithography: An Enabling Process for Nanofabrication - Ed. Springer-Verlag Berlin Heidelberg 2013.
- Vasilios Georgakilas - Functionalization of Graphene - Ed. Wiley-VCH Verlag, 2014.
- P. Dipanjan - Personalized Medicine with a Nanochemistry Twist: Nanomedicine. Ed. Springer International Publishing, 2016.
- Published papers.