UCL Université catholique de Louvain

LMAPR2012

2013-2014

Macromolecular Nanotechnology

5.0 credits	45.0 h + 15.0 h	2q

Teacher(s) :	Demoustier Sophie ; Nysten Bernard ; Glinel Karine ; Gohy Jean-François ;
Language :	Français
Place of the course	Louvain-la-Neuve
Main themes :	After a general introduction on nanosciences and nanotechnologies, the fabrication and characterisation techniques of organic thin films are presented. This part is also dedicated to the study of particular properties such as dewetting or self-assembly of monomolecular films for the functionalization of various surfaces. A second part is dedicated to "soft" nano-fabrication techniques, particularly "soft" nanolithography and nano-fabrication through self-assembly. The third part aims at sensitize students to the phenomena of phase separation in block copolymers. The various morphologies obtained in the solid state with di- and tri-block copolymers are discussed in more details. Phase separation is then discussed in the case of thin films or in a good solvent of one of the block (micellar structures). A special emphasis is placed on the recent applications in nanotechnology and the present state-of-the-art. In the fourth part, the synthesis, the properties and the applications of nanowires and nanotubes are presented. This part particularly describes the different techniques to fabricate such nanostructures with an accurate control of their size, geometry, composition and surface properties. Structures based on conjugated polymers are presented together with some of their applications in nano-electronics. The applications of these nanostructures in biomedicine are also discussed. The last part is dedicated to the presentation of the principles of scanning probe microscopies (STM and AFM) and of certain applications of these techniques in macromolecular nanotechnology: the use of scanning tunnelling spectroscopy for the characterisation of the electronic properties of conjugated polymers, the characterisation of block copolymers by phase detection microscopy, single molecule force spectroscopy, manipulation of atoms or molecules and nano-fabrication by SPM.
Aims :	The objective of this set of lectures is to introduce students to the main applications and functions of organic and polymer materials for micro- and nanotechnologies. The interdisciplinarity of the field will be specially emphasized, as well as recent applications in the fields of electronics, optics, biosensors, biomedicine, ... This course also aims at introducing some characterisation techniques especially suited for the study of the structure and of the properties of macromolecular nanostructures. At the end of their classes students are expected to be able: - to propose fabrication methods to realise a given nanostructure presenting specified properties (electrical, biochemical, optical,...); to compare and discuss their advantages and drawbacks; to propose characterisation techniques; - to propose methods for the (bio-)functionalization of surfaces; to compare and discuss their advantages and drawbacks; - to understand and apply the phase separation phenomenons in block copolymers in order to propose polymer nanomaterials for specified applications; - to understand the basic working principles of scanning probe microscopies; - to apply these techniques to characterise the structure/morphology and/or the properties of a given macromolecular nanostructure, or to fabricate a macromolecular nanostructure. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Content :	I. Introduction to nanosciences, nanomaterials and nanotechnologies II. Organic thin films and self-assembled layers II.1. Self-assembled layers: thiol and silane monolayers, polyelectrolyte multilayers, Langmuir-Blodgett films II.2. Organic thin films: fabrication techniques, use and stability (dewetting) II.3. Optical characterisation methods of the structure of organic films: ellipsometry, X-ray and neutron reflectometry III. " Soft " methods of nano-fabrication III.1. " Soft " nanolithographies and related techniques III.2. Nano-fabrication by directed self-assembly IV. Block copolymers and micellar structures IV.1. Solid state phase separation: macro- and micro- phase separation, phase diagrams IV.2. Various morphologies in block copolymers IV.3. Amphiphilic copolymers and micellar systems IV.4. Self-assembly of block copolymers in thin films and surface effects IV.5. Examples of applications of copolymers in nanotechnology V. Synthesis, properties and applications of nanowires and nanotubes with controlled size, shape and surface properties V.1. " Templated nanostructures " V.2. Nanostructures based on conjugated polymers V.3. Polymer brushes: surface-immobilized macromolecules V.4. Biomolecules immobilization V.5. Biomedical applications of one-dimensional nanostructures VI. Scanning probe microscopies in macromolecular nanotechnology

	VI.1. Principles and techniques of scanning probe microscopies VI.2. Scanning tunneling spectroscopy and electrostatic force microscopy VI.3. Vibrating atomic force microscopies and phase detection VI.4. Single molecule force spectroscopy VI.5. Nano-fabrication with SPM Méthods: Various teaching methods will be used. They will be presented at the beginning of the semester. They could consist of, for instance, lectures illustrated by examples extracted from the recent litterature and/or with exercices, seminars prepared by the students, laboratories or small projects.
Other infos :	Nil
Cycle and year of study :	> Master [120] in Chemistry > Master [120] in Chemical and Materials Engineering > Master [120] in Biomedical Engineering > Master [120] in Physical Engineering > Master [120] in Electro-mechanical Engineering > Master [120] in Electrical Engineering
Faculty or entity in charge:	FYKI