Universitat Autònoma de Barcelona

**2023/2024**

# Polymeric Materials and Biomaterials

Code: 102510
ECTS Credits: 6

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2502444 Chemistry | OT | 4 | 1 |

## Contact

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## Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

## Teachers

Carles Jaime Cardiel

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## Prerequisites

It is advisable to have passed the subjects "Fundamentals in Chemistry I" and "Structure and Reactivity of Organic Compounds".

The subject is taught entirely in English, thus it is almost essential to have a good knowledge of this language.

## Objectives and Contextualisation

In "Polymeric materials and biomaterials" we will study the properties, both physical and chemical, and the preparation methods of the most important polymers, as well as their main uses. Also, basic ideas about different analytical methods will be given.

The objectives of the course are:

1 Identify the synthetic polymers.

2 Be familiar with the main methods of preparation and characterization of the polymeric materials and biomaterials.

3 Determine and represent the structure of organic polymers and biomaterials.

4 Find out the properties of polymeric materials depending on their structure.

5 Knowing the main applications of polymeric materials and biomaterials based on its structure.

## Competences

- "Interpret data obtained by means of experimental measures, including the use of IT tools; identify their meaning and relate the data with appropriate chemistry, physics or biology theories."
- Apply knowledge of chemistry to problem solving of a quantitative or qualitative nature in familiar and professional fields.
- Be ethically committed.
- Communicate clearly in English.
- Communicate orally and in writing in one's own language.
- Develop synthesis and analyses studies in chemistry from previously established procedures.
- Evaluate the health risks and environmental and socioeconomic impact associated to chemical substances and the chemistry industry.
- Handle chemical products safely.
- Handle standard instruments and material in analytic and synthetic chemical laboratories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Manage, analyse and synthesise information.
- Obtain information, including by digital means.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show initiative and an enterprising spirit.
- Show motivation for quality.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Use the English language properly in the field of chemistry.
- Work in a team and show concern for interpersonal relations at work.

## Learning Outcomes

1. Analyse the composition, structure and molecular weight of polymeric materials using the most common measurement and characterisation techniques.
2. Be ethically committed.
3. Communicate clearly in English.
4. Communicate orally and in writing in one's own language.
5. Describe the kinetics, mechanisms, polymerisation techniques and most relevant examples of polymerisation reactions by stages and in chain.
6. Distinguish the main types of soft matter and their properties.
7. Identify the environmental impact of the use of polymeric materials and recycling demands.
8. Identify the main parameters used to describe the thermomechanical behaviour of polymers, as well as other physical and chemical properties of interest.
9. Justify the results obtained in the laboratory from processes of synthesising and characterising solid, soft and nano materials on the basis of knowledge of their structure and properties.
10. Learn autonomously.
11. Manage the organisation and planning of tasks.
12. Manage, analyse and synthesise information.
13. Obtain information, including by digital means.
14. Predict the product formed in polymerisation reactions.
15. Prepare and characterise nanomaterials.
16. Prepare and characterise polymeric materials and other types of soft matter.
17. Properly handle the chemical products required to prepare solid, soft and nano materials.

18. Properly use the required material and instruments to prepare and characterise solid, soft and nano materials.
19. Propose creative ideas and solutions.
20. Propose the best processing methods and additives for polymeric materials in accordance with their end applications.
21. Read, analyse and extract information from texts in the English language on the different areas of the field of material chemistry.
22. Reason in a critical manner
23. Recognise the English names of terms in the field of material science.
24. Recognise the English names used in the field of preparing and characterising solid and soft materials, as well as in nanochemistry and nanomaterials.
25. Resolve problems and make decisions.
26. Show initiative and an enterprising spirit.
27. Show motivation for quality.
28. Show sensitivity for environmental issues.
29. Synthesise and characterise solid materials with electrical, magnetic or optical properties, and measure said properties.
30. Use IT to treat and present information.
31. Work in a team and show concern for interpersonal relations at work.

## Content

1. Introduction: composition and structure of polymer (chains and types of isomers, copolymers, intermolecular forces), characterization techniques (IR, Raman, NMR, XRD, solubility and viscosity, molecular weight).

2. Synthesis and applications of polymers: classification of polymerization reactions (step-growth and chain polymerization, polymer curing and other reactions), inorganic-organic polymers and carbon polymers.

3. Rheology and macroscopic properties of polymers: macroscopic properties.

4. Formulation, processing and environmental aspects: composites, fillers and additives, polymerization and environmental issues, polymer technology.

5. Biomaterials and natural polymers: introduction, biomedical materials, main tissues and polymers as construction biomaterials; natural polymers from plants and animals.

6. Soft Matter: definition, colloids (sols, gels, foams, emulsions), surfactants and liquid crystals.

Laboratory practices
Synthesis and characterization of polymers.
Analysis and determination of polymer properties.

WARNING ON SECURITY IN THE LABORATORY
Any student seen involved in an incident that may have serious security consequences may be expelled from the laboratory and fail the course.

## Methodology

Students will develop different types of activities throughout this course:

a) Directed activities: In the classroom, lectures/flipped classrom on the contents of the subject. In addition, questions and exercises will be solved. Students will also carry out laboratory sessiong, consisting of the synthesis and characterization of macromolecular and polymeric materials. These sessions are part of the

compulsory laboratory sesssions of the Chemistry of Materials itinerary (mention). Therefore, if a student completes the mention later, he/she will carry out the itinerary practices in that academic year.

b) Supervised activities: There will be tutorials to monitor the progress of students with different aspects of the subject.

c) Autonomous activities: Students will study the contents of the course and solve exercises on their own. They will also read related texts and perform laboratory experiments following protocols. They will write reports on their experimental results.

Teaching material

Students will have access to the slides used during lectures. These materials should ideally be complemented by students using the suggested bibliographic resources.

Face-to-face classes

The face-to-face classes will be dedicated to the following aspects:

- To present and discuss the most difficult concepts of the subject, and to solve the doubts that may appear in lectures.

- To comment exercises propossed by the professors, that must have been previously solved by the students.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

## Activities

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Lectures | 34 | 1.36 | 1, 3, 4, 26, 27, 5, 6, 8, 21, 2, 28, 14, 20, 19, 23, 24 |
| Practical exercises | 18 | 0.72 | 1, 3, 27, 5, 16, 11, 12, 8, 7, 9, 17, 18, 28, 22, 23, 24, 29, 31 |
| Type: Supervised | | | |
| Tutoring | 4 | 0.16 | 10, 3, 26, 27, 21, 28, 19, 22, 23, 24 |
| Type: Autonomous | | | |
| Reading of texts and recipes, and writing reports | 23 | 0.92 | 3, 11, 12, 9, 21, 13, 22, 23, 24, 31, 30 |
| Studying and exercises solving | 64 | 2.56 | 1, 10, 4, 26, 27, 5, 6, 12, 8, 21, 28, 13, 14, 20, 19, 23, 24, 25, 30 |

## Assessment

The assessment will be based on two modules, each having a specific weight in the final grade:

Practical module: this module is compulsory to pass the subject for all the students. The lab will be evaluated based on the ability and commitment demonstrated during laboratory sessions (30%), in the correctness of the

laboratory notebook (10%), and in the contents of a brief report (60%) to be submitted electronically in English on the date indicated by the lab supervisors. The mark obtained in this practical module is equivalent to 20% of the final grade for the course.

From the second enrollment for the course, students who have achieved the skills of the practical module in previous years (get a rating equal to or greater than 5.0 out of 10) they do not need to do that again.

If, for organizational reasons, some students do not carry out these practices, they will be asked to make only one report related to the subject, written in English and that should be presented orally; this report will be also equivalent to 20% of the final grade.

This lab is mandatory for students following the Materials Chemistry itinerary (mention). If a student completes the mention later, and he/she had not made these practices, the/she will need to carry out them at that course.

Written test module: it will consist on two partial tests with a weight of 40% each. The subject is considered passed when the average of the modules grades is equal to or greater than 5.0 points out of 10, provided they have obtained a minimum of 4.0 out of 10 in each of the two written tests in both tests. If the final mark of the written test module is lower than 5.0 out of 10.0, it will be necessary to retake one or both failed exams (with a scorelower than 5.0 out of 10).

Passing the subject: To pass the subject it is necessary to have an average of 5.0 out of 10.0 of the two modules and to have completed the practical module.

Recovery exam: To undertake the recovery exam, the student should have previously been evaluated of all the continuous evaluation activities (two written exams and the laboratory sessions).

Students who do not pass the minimum scoring in the first and/or second written test and those with an average of less than 5.0 out of 10.0 for the overall subject can make a recovery exam, of the failed test or tests, after the second written test. The completion of this test involves giving up the qualification obtained in the firts and/or second written tests, but will keep the scoring and the weight of the practical module (20%), which can't be retaken.

When the number of assessment activities carried out is less than 50% of the planned for the course (the practical module and two written tests), the grade will be "Not assessable".

Single assessment: The single assessment is only applicable to the written tests module, and will consist of a single test in which the contents of the whole subject program will be evaluated using different types of exercises (test type, problem solving , concept development, etc.). The grade obtained in this test will account for 80% of the final grade of the subject. The minimum grade to pass the subject is a 5.0 out of 10 for this single test. The written tests module test for the single assessment modality will take place on the same day, time and place as the last continuous assessment test for the subject. The single evaluation of the written tests module can be recovered on the day set for the recovery of the subject, provided that the student has completed both the laboratory sessions and the written test.

## Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---|---|---|---|---|
| Laboratory module | 20% | 1 | 0.04 | 1, 3, 26, 27, 5, 16, 15, 12, 8, 7, 9, 17, 18, 28, 19, 23, 24, 29, 31 |
| Writing exams module | 80% | 6 | 0.24 | 10, 3, 4, 26, 27, 5, 6, 11, 12, 8, 7, 21, 2, 28, 13, 14, 20, 19, 22, 23, 24, 25, 30 |

## Bibliography

*Polymer Chemistry*, Carraher, C. E., Jr. 10th edition, CRC 2017 (or any other previous edition). Disponible en línia: https://bibcercador.uab.cat/permalink/34CSUC_UAB/avjcib/alma991000616389706709

*Polymer Chemistry*, S. Koltzenburg, M. Maskos, and O. Nuyken, 1st edition, Springer, 2017. Disponible en línia: https://bibcercador.uab.cat/permalink/34CSUC_UAB/1eqfv2p/alma991010401285506709

*Introduction to Soft Matter: Synthetic and Biological Self-Assembling Materials*, Hamley, I. W., Wiley,2007. Disponible en línia: https://bibcercador.uab.cat/permalink/34CSUC_UAB/1eqfv2p/alma991010342937206700

## Software

Ther is no recommended computer program for this subject.