MATERIALS ENGINEERING AND NANOTECHNOLOGY (LM56)

(Lecce - Università degli Studi)

Teaching SCIENCE AND TECHNOLOGY OF POLYMERS

GenCod A003689

Owner professor Mariaenrica FRIGIONE

Teaching in italian SCIENCE AND TECHNOLOGY OF POLYMERS

Teaching SCIENCE AND TECHNOLOGY OF POLYMERS

SSD code ING-IND/22

Reference course MATERIALS ENGINEERING AND

Course type Laurea Magistrale

Credits 9.0

Teaching hours Front activity hours: 81.0

For enrolled in 2019/2020

Taught in 2019/2020

Course year 1

Language ENGLISH

Curriculum PERCORSO COMUNE

Location Lecce

Semester Second Semester

Exam type Oral

Assessment Final grade

Course timetable https://easyroom.unisalento.it/Orario

BRIEF COURSE DESCRIPTION

The course aims at providing students a comprehensive knowledge of Science and Technology of (natural or synthetic) polymers: from their synthesis, to their processing procedures and techniques, their macroscopic and microscopic properties and characteristics in both solid and liquid states, their durability and their final disposal. Specific examples of natural (i.e. wood, bio-polymers) and technologically advanced polymers, or classes of polymers, will be illustrated. A part of the course is devoted to the characterization methods and techniques for polymers, with related laboratory experiences.

REQUIREMENTS

Knowledge of disciplines belonging to a Bachelor Degree in Industrial Engineering or Materials Science are required to the Students: Chemistry, Physics and Science and Technology of Materials.

COURSE AIMS

Knowledge and understanding. Students must have a solid background with a broad spectrum of basic knowledge related to science and technology of (natural or synthetic) polymers:

- the students must have the basic cognitive tools to think analytically, critically and to correlate information's needed to analyze, characterize, process or select a polymeric material;
- they must have solid knowledge of science and technology of (natural or synthetic) polymers;
- they must be able to find and manage any information required on a specific (natural or synthetic) polymers, or a blend of polymers, on textbooks, handbooks, database.

Applying knowledge and understanding. After the course the student should be able to:
1) Recognize the main differences, characteristics and features of the three classes of polymers, i.e. thermosetting, thermoplastic and elastomers.
2) Select the appropriate technique and processing conditions for a specific polymer, or a blend of polymers.
3) Identify the relationship between chemical-physical, microstructural characteristics and macroscopic properties of different polymers belonging to the three classes of polymers.
4) Select a proper polymeric material, or a blend of polymers, for a specific application.
5) Select the proper range of service temperature for a polymer, or a blend of polymers.
6) Identify the proper methods and techniques required to characterize a specific polymer, or a blend of polymers, in relation to the specific final use.
7) Analyze the results of an experimental test aimed at characterizing a specific property of a (natural or synthetic) polymer/blend of polymers.
8) Propose a method/technique for the recycle of polymers at their end-life in order to prevent landfill.

Making judgments. Students are guided to learn critically everything that is explained to them in class, to select the more appropriate solution (of a polymer/blend of polymers, or of a method/technique to characterize, process or recycle procedure) for any specific application/requisite and to analytically justify any choice in comparison with available alternatives, taking into account also the eco-sustainability concepts involved in the different choices.

Communication. The students must be able to communicate with a varied and composite audience, not culturally homogeneous, in a clear, logical and effective way and with the appropriate terms, using the methodological tools acquired and their scientific knowledge. The course promotes the development of the following skills of the student: ability to expose with the appropriate specialist vocabulary any topic related to science and technology of polymers; ability to describe and analyze the proper solution for any specific application/requisite; ability to illustrate the results of an experimental test performed on a polymeric material.

Learning skills. Students must acquire the critical ability to relate, with originality and autonomy, to the typical problems of science and technology of polymers, in general, cultural issues related to other similar areas. They should be able to develop and apply independently the knowledge and methods learnt with a view to possible continuation of studies at higher (doctoral) level or in the broader perspective of cultural and professional self-improvement of lifelong learning. Therefore, students should be able to switch to exhibition forms other than the source texts in order to memorize, summarize for themselves and for others, and disseminate scientific knowledge.

TEACHING METHODOLOGY	The course consists of theory lessons, seminars, laboratory experiences, exercitations, visits to industrial plants and/or research laboratories. The theory lessons, carried out by using slides of other didactic material made available, always the day before (at least) of the lesson, to students via the intranet of University of Salento (https://intranet.unisalento.it/web/guest), are aimed at improving their knowledge and understanding through the illustration of definitions, assumptions, models and methods; students are invited take part to the lesson with autonomy of judgment, by asking questions and presenting examples. The seminars are aimed at giving an insight on some selected (updated every year) topics on science and technology of polymers. The laboratory experiences are aimed to illustrating the main characterization techniques, testing machines and equipment employed to analyze and characterize polymeric materials. The exercitations in classroom are aimed at illustrating how to analyze, report in a graph/table and critically discuss the results of an experimental test previously performed in the laboratory on a polymeric material. Visits to industrial plants and/or research laboratories are aimed at illustrating the on field application of what the students learn during lessons.
ASSESSMENT TYPE	**Final (oral) exam:** The student is asked to describe for a specific polymer, or a blend of polymers, one or more of the following: synthesis, appropriate processing techniques, main properties and characteristics, characterization measurements and techniques and discussion of relative results, durability feature, "end-life" alternative methodologies. Then, starting from a theme/subject analyzed, the student is asked to supply alternative solutions to a traditional polymeric material, technique or method taking into account a specific goal (application or characterization). In the evaluation of the exam, the final grade of the student will take into account the following elements: the logical route followed by the student in solving the proposed issue; the correctness of the procedure used to address the question and provide a solution; the adequacy of the proposed solution in relation to the competencies that the student is supposed to have acquired; the capacity to make connections among the different topics covered in the course; the use of an appropriate technical language.
OTHER USEFUL INFORMATION	Prof. Frigione receives students upon appointment. Contact her at the end of each lesson or by e-mail: mariaenrica.frigione@unisalento.it. The students can apply for the exam exclusively on Web-VOL system.

FULL SYLLABUS	Theory Lessons (53-57 hs): 1) Polymer's Chemistry. Molecular Structure of polymers. Polymeric solutions: rules for polymer solubility in solvents. Molecular weight and measurements. Gel Permeation Chromatography. Polymerization reactions. Step-growth polymerization. Chain polymerization. 2) Polymer's physics. Classification of polymers with examples. Glassy state of polymers. Characteristic temperatures for polymers. Glass transition temperature. Crystalline state of polymers. 3) Thermal characterization of polymers. Instruments and techniques for thermal analysis of polymers. Properties measured with thermal analysis. 4) Rheology and rheological analysis for polymer characterization. Classification of fluids on the basis of their rheological properties. Viscosity measurements and relative instruments. Rheological instruments employed for characterization of polymers. 5) Mechanical Properties of polymers. Standard tests and instruments for the characterization of the mechanical properties of polymers. Dynamic-mechanical properties. 6) Processing of polymers. Main industrial techniques and instruments for the processing of polymers. Characteristics of final products. 7) Durability and environmental aging of polymers. Chemical Aging. Physical Aging. Weathering. Natural and accelerated aging. Case studies. 8) Wood: a natural polymer (composite). Definitions, characteristics and properties of composite and nanocomposite materials. Wood structure at different levels of magnitude. Influence of water/moisture content on wood properties. Mechanical properties of wood: standard tests, specimens, instruments and results. Durability of wood. 9) Natural and Biodegradable polymers. Biodegradable polymers and biodegradation processes. Natural and synthetic biodegradable polymers: production, properties, applications. 10) End-life of polymers: disposal, recycling. Life cycle analysis of polymers. End-life of polymers: disposal in landfill or recycling methodologies. Advantages and technological limit for recycling. Case studies for thermoplastic, thermosetting and elastomeric polymers, with specific examples. Laboratory Experiences and visits to industrial plants and/or research laboratories (20-22 hs): Thermal, Rheological and Mechanical characterization of polymers. Scanning Electric Microscopy (SEM) to analyze Polymers and Wood, visits to industrial plants and/or research laboratories. Exercitation (4-6 hs).
REFERENCE TEXT BOOKS	L.H. Sperling, 'Introduction to Physical Polymer Science', John Wiley, 2006. F.W. Billmeyer, 'Textbook of Polymer Science', John Wiley & Sons Inc., 1984. S. Bruckner, G. Allegra, M. Pegoraro, F. La Mantia, "Scienza e Tecnologia dei Materiali Polimerici", Edises, 2007. U.W. Gedde, 'Polymer Physics', Chapman & Hall, 1996. F. Rodriquez, 'Principles of Polymer Systems', McGraw Hill, 1989. A.W. Birley, B. Haworth, J. Batchelor, 'Physics of Plastics', Hanser Publishers, 1992. J. Mark, K. Ngai, W. Graessley, L. Mandelkern, E. Samulski, J. Koenig, G. Wignall, "Physical Properties of Polymers", Cambridge University Press. Slides and other didactic material provided by the teacher (via the intranet of University of Salento: https://intranet.unisalento.it/web/guest).