Thermal characterization techniques, mechanical and thermomechanical

Academic Year: (2020 / 2021) **Review date: 16/07/2020 15:28:08**

Department assigned to the subject: Materials Science and Engineering and Chemical Engineering Department

Coordinating teacher: GONZALEZ BENITO, FRANCISCO JAVIER

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is recommended to have been successful in basics subjects associated to science and engineering degrees such as: licenciaturas, grados o ingenierías tales como:

- General Chemistry.
- Physics.
- Mathematics.
- Chemical-Physics.
- Thermodynamics.
- Materials Science.

OBJECTIVES

COMPETENCES:

CB6, To have with understanding knowledge about materials characterization with the use of thermal analysis techniques giving the basis and the opportunity of being original in the development and application of ideas, mainly in a scientific and researching context.
CB7, Students must apply their acquired knowledge on the techniques of thermal analysis and their skills for solving thermal characterization problems on new environments or little known within wider contexts (multidisciplinary) related with the field of study.
CB8, students should be able of integrating different knowledge and affronting the complexity of formulating reasons from one information that, although being incomplete or limited, had thoughts about social and ethical responsibilities associated to their knowledge and decisions.
CB9, students should be able to communicate their conclusions so last reasons to specialized and non-specialized public in a clear way without ambiguities.
CB10, Students must possess the learning skills that enable them to continue studying in a way that will be mainly self-directed or autonomous.
CG1, students must understand the need and therefore, the usefulness of thermal analysis techniques in the frame of Materials Science and Engineering within both and industrial and research contexts.
CG2, students must know the best methods in order to perform thermal analysis of materials to finally work properly in a laboratory of materials and optimize how to obtain results.
CG3, Students should develop teamwork skills in a research context.
CG6, Students should acquire the necessary skills to defend a results report about thermal analysis in a scientific and industrial environment.
CG7, Students should acquire creative and decision-making strategies to address problems related to thermo-mechanical properties of materials in relation to their subsequent design, manufacturing and performance.
CE6, Students should know how to interpret, discuss and make conclusions from the experimental data obtained using thermal analysis techniques in the world of Materials Science and Engineering.
EC 9, Students must consolidate the specific research skills in the field of Materials Science and Engineering.
CE10, Students must acquire knowledge and skills about mecano-thermal scientific techniques to solve specific problems associated with the working in a research laboratory in the field of designe, development and characterization of materials.

LEARNING OUTCOMES

Students should learned to:

1) Select a technique of thermal, mechanical or thermo-mechanical analysis suitable for obtaining specific information about a material.

2) Know the basics of the different techniques of thermal, mechanical and thermo-mechanical analysis:
- Thermogravimetric Analysis.
- Differential Thermal Analysis.
- Differential Scanning Calorimetry.
- Dilatometry.
- Tensile tests, compression, hardness, impact.
- Creep Testing.
- Dynamic-mechanical-thermal analysis.

3) Know the most appropriate methods for sample preparation when using the thermomechanical techniques considered.

4) Know the most appropriate methods for the analysis of the results obtained from the performance of the tests associated with thermo-mechanical techniques.

5) Know the best way to present the results of thermal, mechanical and thermo-mechanical analysis.

6) Infer and get general conclusions from the thermo-mechanical properties of materials from the correct interpretation of the results.

DESCRIPTION OF CONTENTS: PROGRAMME

This course should provide an overview of the techniques of thermal analysis of materials most used today, showing their potentialities and possible limitations. Therefore, the contents consider a brief description of the theoretical basis of the techniques, a description of the most characteristic tests and how to prepare the samples. This point is always strengthened by the student's work in the laboratory. In addition, a proper training will be given so that students are able to interpret simple results independently obtained from different techniques and discuss their meaning in a context of researching.

Program:

Topic 01.- Introduction to the techniques of thermal, mechanical and thermo-mechanical analysis.

Topic 02.- Thermogravimetric Analysis
* Fundamentals of thermogravimetric analysis.
* Case Studies thermogravimetric analysis.

Topic 03.- Differential Thermal Analysis
* Fundamentals of differential thermal analysis.
* Case studies of differential thermal analysis.

Topic 04.- Differential Scanning Calorimetry
* Fundamentals of differential scanning calorimetry. Working methods.
* Study of thermal transitions and processes by differential scanning calorimetry.

Topic 05.- Dilatometry
* Fundamentals of dilatometry (methods). Dilatometric study of materials.
* Case studies of dilatometric studies.

Topic 06.- Mechanical characterization of materials

Topic 07.- Creep tests
* Fundamentals, testing and applications.
* Case Studies for creep tests.

Topic 08.- Dynamic-thermal-mechanical analysis
* Fundamentals of dynamic-mechanical-thermal analysis.
* Case studies of thermal-mechanical-dynamic analysis.

LEARNING ACTIVITIES AND METHODOLOGY

TRAINING ACTIVITIES
AF1, Theoretical and practical lectures.
AF2, Lab.
AF3, Tutoring.
AF4, Work in group.
AF5, Individual work.
TEACHING METHODS.
MD1, Presentations or lectures in class with audiovisual media supports, in where the main concepts of the topics are exposed giving examples and solving exercises or case studies.
MD2, Critical reading by the students of recommended texts by Professor (scientific publications and books).

- Before accessing the laboratories, all students should watch some videos on safety in chemistry laboratories and, after that, they have to pass some virtual questionnaires (Aula Global) in order to demonstrate the contains of the videos are understood.

MD3, Resolution by the student (individually or in groups) of case studies, problems and exercises proposed by the teacher.
MD5, Obtaining experimental results in the laboratory. handling of equipments and research techniques under the guidance of the teacher.
MD6, Development of papers and reports individually or in groups.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

1) Participation in theory lectures and laboratory practices. (SE1) 0-5
2) Ability to demonstrate he acquisition of critical thinking skills about the contains of the subject. (SE1) 0-5

Weight (20% of the final mark).

3) To carry out works so as their corresponding presentations (exercises, individual or collective memories done throughout the course) (SE2) 20 to 30

Weight (10% of the final mark).

4) Participate in the laboratory practices, preparation, presentation and discussion of reports so as detailed questionnaires about the techniques used and experimental results. (SE3) 25 - 35

Weight (20% of the final mark).

5) Final exam of the course that have to be done individually, in writing or orally. (SE4) 40 - 50

Weight (50% of the final mark).

Note: in order to be considered the the above mentioned it is required to obtain in each of the parts at least a mark of 4 over 10 points.

BASIC BIBLIOGRAPHY

- James W. Dodd and Kenneth H. Tonge. Thermal Methods, John Wiley & Sons, 1987

- Zhang, Sam Materials characterization techniques , CRC Press, 2009

- Bernhard Wunderlich Thermal Analysis, ACADEMI C PRESS , INC, 1990

- F. Paulik Special trends in thermal analysis, John Wiley and Sons, 1995

- Höhne, Günther, Hemminger, Wolfgang F., Flammersheim, H.-J. Differential Scanning Calorimetry, Springer, 2003

- Lifshin, Eric Characterization of materials, VCH , cop. , 1994

- null Standard test method for linear thermal expansion of solid materials by thermomechanical analysis, ASTM, 2006

- Peter J. Haines. Thermal Methods of Analysis. Principles, Applications and Problems, Blackie Academic & Proffesional, Glasgow, 1995

- Speyer, Robert F. Thermal analysis of materials, Marcel Dekker, INc, 1994

- Turi, Edith A. Thermal characterization of polymeric materials , Academic Press, 1997

ADDITIONAL BIBLIOGRAPHY

- A. W. Coats and J. P. Redfern Thermogravimetric analysis. A review, Publishing, Analyst, 1963,88, 906-924