Advanced Ceramic Materials

Academic Year: (2023 / 2024) **Review date: 17-05-2023**

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

Coordinating teacher: VAREZ ALVAREZ, ALEJANDRO

Type: Compulsory ECTS Credits : 3.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It would be convenient for the student to have taken a general course on Materials Science and Engineering.

OBJECTIVES

COMPETENCIES

CB6, To possess and understand the knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
CB7, That students know how to apply acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
CB8, Students should be able to integrate knowledge and deal with the complexity of making judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with applying their knowledge and decisions.
CB9, That students know how to communicate their conclusions and the ultimate knowledge and reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way.
CB10, That students possess the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.
GC1, To understand the issues involved in Materials Science and Engineering in an industrial and research context.
GC2, To know the appropriate disciplines to work in a materials laboratory and to optimize the achievement of results.
GC3, Develop teamwork skills in a research context
GC4, Develop the ability to apply the acquired knowledge to the research and development of new materials or in technologies for their processing in strategic sectors.
GC5, To combine the interest to innovate and make processes profitable, with the need to do it in an environmentally friendly way.
GC6, Acquire the necessary skills to defend a research project and its results.
GC7, Develop creative and decision-making strategies to face problems related to materials, their design, manufacture, and behavior.
SC1, Know the most current trends in the world of materials in terms of their formulation and identify the potential advantages they can offer over more traditional materials.
SC2, To design ways to optimize the properties of different materials for specific applications through modifications in their structure and composition.
SC3, Know advanced processing and synthesis systems that allow obtaining materials with improved properties.
SC4, To acquire the ability to contribute to the optimization of processing technology for specific applications and problems.
SC5, To know in detail the materials characterization techniques most used in research and acquire the necessary skills to autonomously use the associated instrumentation.
SC6, Interpret, discuss, and draw conclusions from experimental data obtained using complex and common characterization techniques in the world of Materials Science and Technology.

DESCRIPTION OF CONTENTS: PROGRAMME

The subjects of this course complement the basic knowledge in Science and Engineering of Ceramic Materials that the students should have acquired during their previous university education, deepening, essentially, in the following topics:

- Structure and properties of advanced ceramics.
- Advanced ceramic processing techniques.
- Possible advantages and disadvantages of advanced ceramics versus more traditional materials.

Specific topics of advanced ceramic materials:
- Advanced structural ceramics: alumina, zirconia, carbides, nitrides, and diamond. General characteristics and forming techniques.
- Advanced functional ceramics and their properties: dielectric, magnetic, conductive (ionic and electronic), etc. General characteristics, specific characterization techniques, and advanced functional ceramics synthesis methods.
- Synthesis and processing of advanced ceramic materials.
- Structure of advanced ceramic materials: crystalline, nanocrystalline, and amorphous ceramics.
- Characteristic properties of advanced ceramic materials. Structure-properties-performance relationship.

LEARNING ACTIVITIES AND METHODOLOGY

TRAINING ACTIVITIES
TA1Theoretical-practical classes
TA2 Laboratory practices
TA3 Tutorials
TA4 Group work
TA5 Individual student work
TA6 Visits to companies in the sector or to laboratories of research centers other than those of Universidad Carlos III de Madrid.

TEACHING METHODOLOGIES
TM1, Class lectures by the professor with the support of computer and audiovisual media, in which the main concepts of the subject are developed and examples of the resolution of exercises or practical cases are given.
TM3, Resolution by the student (individually or in groups) of practical cases, problems, or exercises proposed by the professor.
TM4, Presentation, and discussion in class, under the moderation of the professor, of topics related to the subject's content.
TM5, Obtaining experimental results in the laboratory, using research equipment and techniques, under the professor's guidance.
TM6, Elaboration of works and reports individually or in groups.

ASSESSMENT SYSTEM

Completion and/or presentation of work, exercises or reports carried out individually or collectively throughout the course (SE2) 20%
Questions and answers of each of the topics of the subject. (SE3) 20%
Mandatory attendance to laboratory practices
Final evaluation exam of the subject carried out individually, in writing or orally (SE4) 60%
The student must obtain a minimum score of 3.5/10 to pass the continuous assessment

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- A.R. West Solid State Chemistry and its Applications,, John Wiley & Sons, 2014
- C. Barry Carter, M. Grant Norton Ceramic Materials: Science and Engineering, Springer Science & Business Media, 2007
- M. Barsoum Fundamentals of Ceramics, International Editions, McGraw-Hill, 1997
- W.D. Kingery; H.K. Bowen and D.R. Uhlman Introduction to Ceramics, John Wiley & Sons, 1976
- W.E. Lee and W. M. Rainforht Ceramic Microstructures, Chapman & Hall, 1994

ADDITIONAL BIBLIOGRAPHY

- Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, John Wiley & Sons,, 2011
- J.M. Fernández Navarro El Vidrio, CSIC - Fundación Centro Nacional del Vidrio, 1991
- N. Brathwaite y G. Weaner Electronic Material, Ed. Butterworths., 1990
- Qingrui Yin, Binghe Zhu, Huarong Zeng Microstructure, Property and Processing of Functional Ceramics, Springer Science & Business Media, 2010