MATERIALS ENGINEERING AND NANOTECHNOLOGY (LM56)

(Lecce - Università degli Studi)

Teaching CERAMICS MATERIALS

GenCod A003797

Owner professor ANTONIO ALESSANDRO LICCIULLI

Reference professors for teaching SANOSH KUNJALUKKAL PADMANABHAN, ANTONIO ALESSANDRO LICCIULLI

Teaching in italian CERAMICS MATERIALS

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SSD code ING-IND/22

Reference course MATERIALS ENGINEERING AND

Course type Laurea Magistrale

Credits 6.0

Teaching hours Front activity hours: 54.0

For enrolled in 2020/2021

Taught in 2021/2022

Course year 2

Language ENGLISH

Curriculum PERCORSO COMUNE

Location Lecce

Semester First Semester

Exam type Oral

Assessment Final grade

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

BRIEF COURSE DESCRIPTION	https://sites.google.com/unisalento.it/ceramics/home
REQUIREMENTS	Student is requested to aware of chemistry, physics, materials fundamentals
COURSE AIMS	* Identify the role of ceramic materials in technological devices and in everyday life. * Identify the functional and structural properties of ceramic materials and learn how to recognize their properties starting from sensory perceptions ending up to analytical testing. * Quantify the engineering performance of ceramics: strength, stiffness, toughness, transparency, opacity, refractoriness, thermal and electrical conductivity and certify their suitability for specific uses. * Acquire a working method for the identification of the material and combination of materials capable of offering the best engineering solution.
TEACHING METHODOLOGY	The course provides a thorough understanding of ceramic and glassy materials. The student will be able to assess whether, when and how to suggest the use of ceramic materials in different application contexts. The criteria for the engineering design and affidabilistic aproach on ceramic materials will be disclosed.
ASSESSMENT TYPE	The student is evaluated by the commitment and interest with which he follows the theoretical lectures and laboratory experiences. The student at the end of the course will prepare a monograph or a report on experiences of laboratory. A final oral examination will give the final vote.

FULL SYLLABUS

Traditional ceramics, glasses, advanced ceramics: taxonomy and classes.
Description of the microstructure of the main ceramics: wurtzite, zin blende, cesium chloride, corundum, fluorite perovskite, garnet, graphite, diamond, amorphous carbon and carbon fibers. Silicates: tectosilicates and feldspars, phyllosilicates, zeolites clays and their properties: intercalation and chemical reactivity and their properties. Ceramics and porcelain from silicates: the ternary phase diagram. Density, microporosity mesoporosity and macroporosity, evaluation and applications.
Mechanical properties of ceramics, theoretical strength, Griffith model of fracture for brittle materials, toughening mechanisms in monolithic and ceramic composites. Weibull probabilistic approach to the mechanical performace of ceramics.
Electrical and magnetic properties of ceramic: dielectric constant, contributions to the polarizability, electrical conductivity in ceramic conductors and semiconductors. Solid state gas sensors, fuel cells, piezoceramics, ferroelectric and ferromagnetic ceramics.
Sintering: definition, types and stages of sintering. Solid state sintering: densification from diffusion transport from grain boundaries, lattice, surface diffusion and vapor. Viscous sintering and Frenkel model. The sintering diagram.
Ceramic powders: Bayer process for the preparation of alumina, and Atchenson process for the preparation of silicon carbide. Methods for sieving, sizing calcining ceramic powders. Properties of ceramic suspensions: zeta potential, viscosity, flocculation deflocculation.
Forming of ceramic by wet and dry methods: slip casting, uniaxial and isostatic pressing, injection moulding. Rapid prototyping techniques: selective laser sintering, laminated object manufacturing, laser stereolithography.
Ceramic matrix composites: ceramic fibres and classification of reinforcements and preforms. The role of fiber-matrix interface.
Materials in the glassy state: models and prediction of amorphous solid formation. The furnaces for glass melting and raw materials selection. Production of glass fibers and cables. Glass processing techniques: etching, fusing, blowing, pressing, drawing.
Flat glass: production processes, thermal and chemical tempering and surface hardening. Safety glass, tempered glass. Special glasses: low-emissivity, solar glass, anti-reflective, fireproof glasses.
Color: Definition absorption phenomena, emission, reflection and luminescence. The color in the ceramic and in the glasses, vibrational model in ionic solids, the transition metals, the rare earths.
Applications and markets for structural ceramics, electroceramics, coatings, bioceramics, ceramics for energy, membranes, ceramic filters, ceramics for aerospace, telecommunications materials.
Bioceramics and biological tissue response: definitions and classifications. The biogenic materials, and the "ceramic" materials of natural origin. Implants, prosthesys, scaffolds, films the range of ceramic biotechnological solutions.

REFERENCE TEXT BOOKS

[1] Fundamentals of Ceramics, Michel Barsoum, M.W Barsoum, 2002 CRC Press
[2] Modern Ceramic Engineering, D. W. Richerson, M. Dekker inc., 1990
[3] Mechanical properties of ceramics, J. Wachtman et al, Wiley e Sons 2009
[4] Introduction to the principles of ceramic processing, J.S. Reed J. Wiley e Sons 1988
[5] Electroceramics, A.J. Moulson, J.M. Herbert, Chapman and Hall 1990
[6] Tecnologia ceramica, vol. 1-3, G.P.Emiliani, F.Corbara Faenza ed., 1999