

# PhD in PhD in Materials Science and Engineering

## Research Title: Ceramic and composite materials for advanced applications

Funded by	Ateneo
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Context of the research activity	<p>There have been several recent developments in joining, surfacing and associated fabrication processes. These are often driven by the continuous demand for higher productivity and quality, lower costs and the use of advanced materials in manufacturing.</p> <p>Advances in materials and coatings technologies are important to strategic sectors, such as the energy and transport ones, because of increasingly challenging environments and the aging and life extension of components.</p> <p>The joining and coating of advanced materials were identified as a key enabling technology to innovative and sustainable manufacturing. Lightweight and high performance structures and components integrating a large number of functions can be obtained only by combining various materials into a multi-material structure. Surface protection, including corrosion protection and permeation barrier have been the main functions of coatings in the past. In more recent years, many new opportunities have arisen for coatings to provide products with innovative new functionalities.</p> <p>Chemical and thermo-mechanical incompatibilities between the different materials to be joined and coated (thermal expansion, ductility, fatigue/fracture mechanics, elastic modulus etc.) can create problems both for the joining and coating process itself, but also for the structural integrity of the components during their use. The joining and coating materials and processes must be designed to minimise these differences. In this research, new joining and coating materials and techniques for advanced materials will be investigated, together with other innovative</p>
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	<p>techniques (such as advanced surface engineering).</p> <p>The current research programme concerns the design, fabrication and characterization of oxide and non-oxide glasses, innovative glass ceramics (also nanostructured) and their composites with metallic or ceramic reinforcement. The characterization techniques include:</p> <p>Thermal analysis and mechanical tests. The study is also including morphological investigations by optical and electronic microscopy. The studied materials include bulk samples, joining materials, porous material , in the form of thin films and fibres. Industrial field application of the above materials with preparation of prototypes will be studied together with the simulation of their performance by means of adequate software. Cost analysis and potential patent applications will be investigated as well.</p>
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<b>Objectives</b>	<p>The main objectives of the research are the development of:</p> <ul style="list-style-type: none"> <li>• the development of new joining and coating materials and techniques for advanced materials;</li> <li>• the study of advanced surface engineering to maximise adhesion at the interfaces</li> <li>• the characterization of joined and coated materials in relevant conditions</li> </ul>
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<b>Skills and competencies for the development of the activity</b>	<p>Synthesis and characterization of metallic and glass/glass-ceramic systems; glass design and manufacturing, melting, mixing, casting. Optical microscopy (heating microscopy, wettability of glasses and metals on solid surfaces); electron microscopy and compositional analysis: SEM, FESEM, EDS; Calorimetry: DSC, TGA, DTA; X-Rays Diffraction (standard and micro XRD analysis) . Mechanical testing: macro and micro-hardness, standard mechanical tests. Software program for managing of experimental data (X-Pert HighScore, Sci-Glass, INCA). Planning and implementation of the research activity, coordination of the experimental activity and discussion of the results</p>
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