PhD in Materials Science and Technology

Research Title: New shaping technologies for functional ceramics

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Context of the research activity

3D printing of ceramics offers new possibilities as compared to traditional manufacturing methods, as it allows more complex shaping as well as the fabrication of customized parts. However, for ceramic materials, 3D printing is still challenging. Among the different technologies currently available to print ceramics, stereolithography is emerging, as it allows the fabrication of materials that – after sintering – present functional and mechanical properties closed to those produced by conventional processes. In the stereolithography technique, the printing process is based on a hybrid ceramic/polymer ink in which a photopolymerizable liquid resin is mixed with a ceramic powder having the composition of the desired final object. During the printing process, overlapping layers of the resin are polymerized when exposed to a UV led or a laser leading to a polymeric structure loaded with a ceramic powder. The printed object is then submitted to a debinding step to remove the resin and to a sintering step to densify the ceramic structure. Among the key features of stereolithography technique are the ability to produce rather fully dense materials after sintering, as well as the accuracy of the printing process which allows to design calibrated porosities in the printed elements.

Objectives

Though different commercial inks based on alumina, silica and zirconia are already available on the market, the objective of this PhD thesis will be to develop new inks based on new ceramic powders in view of new applications. To this aim, an updated state of the art on the 3D shaping...
Technologies for the preparation of dense and porous functional ceramics will be first prepared. Then, different fields of application will be identified and dense and porous, as well as, materials having a gradient of porosity will be manufactured by stereolithography. The development of monolithic and composite ceramics will be investigated, in which both reactive and not reactive systems will be investigated. These materials will be fully characterized from a microstructural and mechanical point of view. Finally, these materials will be compared with materials having the same composition but produced with conventional techniques.

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<th>Skills and competencies for the development of the activity</th>
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<td>Autonomy, ability to perform laboratory experiments alone, including materials synthesis, forming and sintering, materials characterization (physical, microstructural and mechanical characterizations); ability to adapt laboratory facilities for materials synthesis and characterization to the ongoing tasks; knowledge of 3D design softwares; critical data analysis and processing; reports and articles writing.</td>
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