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Abstract

Structural Performance of Dense Alumina-Zirconia Ceramics: An Overview of Conventional versus Additive Manufacturing †

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† Presented at the Materiais 2022, Marinha Grande, Portugal, 10–13 April 2022.

Keywords: alumina; zirconia; conventional processing; powder pressing; colloidal; slip casting; gel casting; additive manufacturing; mechanical properties

Functional ceramics are known to exhibit high performance in certain applications, strictly related to their composition and structural properties. Alumina (Al_2O_3), zirconia (ZrO_2), or even alumina-zirconia composites (zirconia toughened alumina, ZTA, and alumina toughened zirconia, ATZ) are examples of technical ceramics frequently used in several fields (such as aeronautics, refractories industry, and biomedicine), where mechanical performance is a main requirement. Industrially, these ceramics are produced by conventional technologies, including powder pressing or colloidal-based ones, while additive manufacturing (AM) has also been deeply explored at a research level. In fact, additive manufacturing technologies appear as promising alternatives to fabricate these kinds of components with complex designs, shapes, and geometries, although several difficulties have been faced with ceramics due to their specificities.

This work collects the status of dense alumina, zirconia, and their composites fabrication by AM in comparison with traditional methods, relating the most important structural properties with the features of raw materials and other processing variables. This work results from a systematic review covering 344 papers with 1313 different experiments reporting relative density and mechanical properties (flexural strength, elastic modulus, hardness, and fracture toughness) of the final ceramics. A lack of structural quality control is noticed when high-density ceramics are targeted, associated with several drawbacks derived from the printing process conditions and respective feedstock. Challenges and future perspectives in the fabrication of functional ceramics by AM are identified, as is the market overview to guide researchers and commercial players in drawing scientific and industrial novelties in this field.

Author Contributions: Conceptualization: S.O. and S.G.; methodology: S.O., P.M.C.T., J.M.-G., J.B., J.P.-d.-C. and S.G.; data curation: S.O., J.M.-G., J.B. and S.G.; resources: S.O., P.M.C.T., J.P.-d.-C. and S.G.; supervision: S.O. and S.G.; writing—original draft preparation: S.O., S.G., J.M.-G. and J.B.; writing—review and editing: S.O., S.G., P.M.C.T. and J.P.-d.-C.; project administration: J.P.-d.-C., S.O. and S.G.; funding acquisition: S.O., P.M.C.T., J.P.-d.-C. and S.G. All authors have read and agreed to the published version of the abstract.

Funding: This work was supported by the project "TAMAZ3D—Development of a Decision Support Tool for Additive Manufacturing of Alumina-Zirconia 3-D structures" (POCI-01-0145-FEDER-030493). This work was also supported by the projects of CICECO (UIDB/50011/2020 & UIDP/50011/2020),

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Citation: Olhero, S.; Torres, P.M.C.; Mesquita-Guimarães, J.; Baltazar, J.; Pinho-da-Cruz, J.; Gouveia, S. Structural Performance of Dense Alumina-Zirconia Ceramics: An Overview of Conventional versus Additive Manufacturing. *Mater. Proc.* **2022**, *8*, 5. https://doi.org/10.3390/materproc2022008005

Academic Editors: Geoffrey Mitchell, Nuno Alves, Carla Moura and Joana Coutinho

Published: 18 May 2022

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IEETA (UIDB/00127/2020) and TEMA (UID/EMS/00481/2020), all financed by national funds through the FCT/MEC and when appropriate co-financed by the European Regional Development Fund (ERDF) under the PT2020 Partnership Agreement. P. M. C. Torres and S. Olhero acknowledge FCT for CEECIND/01891/2017 and CEECIND/03393/2017 contracts, respectively.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding authors.

Conflicts of Interest: The authors declare no conflict of interest.