materials proceedings

MDPI

Abstract

Additive Manufacturing of Bioactive Glass in a Biodegradable Matrix †

Liliana S. O. Pires [1,2,3,*], Maria Helena F. V. Fernandes [2,3] and José Martinho Oliveira [1,2]

[1] EMaRT Group—Emerging: Materials, Research, Technology, School of Design, Management and Production Technologies Northern Aveiro, University of Aveiro, 3720-509 Oliveira de Azeméis, Portugal; martinho@ua.pt
[2] CICECO, Aveiro Institute of Materials, University of Aveiro, 3810-193 Aveiro, Portugal; helena.fernandes@ua.pt
[3] Department of Materials & Ceramic Engineering, University of Aveiro, 3810-193 Aveiro, Portugal
* Correspondence: liliana.pires@ua.pt; Tel.: +351-256-666-960
† Presented at the Materiais 2022, Marinha Grande, Portugal, 10–13 April 2022.

Keywords: additive manufacturing; bioactive glass composites; tissue engineering

Bioactive glass can induce a specific and fast response in the human body that supports tissue regeneration. It is possible to control the design of customized bioapplications with advanced technologies. Although currently used in research, only a few of these technologies have been approved by the FDA to be applied in Tissue Engineering. There is dedicated additive manufacturing equipment to manufacture biomaterials. Since they are emerging technologies in emerging fields of application it is necessary to study and develop formulations with suitable processing characteristics [1].

Formulations of bioactive glass ($CaO{\cdot}P_2O_5{\cdot}MgO{\cdot}SiO_2$ system) in two different biodegradable matrices (polylactide (PLA) and polycaprolactone (PCL)) were prepared and processed by material extrusion process, namely by Fused Filament Fabrication technique.. The polymer (PLA or PCL) involves bioactive particles in biocompatible media and allows to acquire extrudable skills. The formulations with different solid contents (20–50 wt.%) were prepared using a brabender mixer type and were characterized by different techniques (e.g., X-ray diffraction (XRD), differential scanning calorimetry (DSC), melt flow index (MFI)).

The inorganic particles influence the rheological and thermal properties of bioactive glass composites. The viscosity decreases with the increase of bioactive glass content in the polymer matrix. Mechanical standard samples and scaffolds were printed and characterized. Bioactive glass composites until 40 wt.% of solid content can be printed. The bioactive glass improves the mechanical resistance of composites compared to a neat polymer matrix. However, formulations with high bioactive glass solid content (50 wt.%) showed printing limitations by their brittleness and clogging tendency.

Author Contributions: Conceptualization, L.S.O.P., M.H.F.V.F. and J.M.O.; methodology, L.S.O.P.; validation, M.H.F.V.F. and J.M.O.; formal analysis, L.S.O.P.; investigation, L.S.O.P., M.H.F.V.F. and J.M.O.; data curation, L.S.O.P.; writing—original draft preparation, L.S.O.P.; writing—review and editing, M.H.F.V.F. and J.M.O.; supervision, M.H.F.V.F. and J.M.O. All authors have read and agreed to the published version of the manuscript.

Funding: This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020, UIDP/50011/2020 & LA/P/0006/2020, financed by national funds through the FCT/MEC (PIDDAC).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

check for updates

Citation: Pires, L.S.O.; Fernandes, M.H.F.V.; Oliveira, J.M. Additive Manufacturing of Bioactive Glass in a Biodegradable Matrix. *Mater. Proc.* **2022**, *8*, 112. https://doi.org/10.3390/materproc2022008112

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

Published: 5 July 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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

Reference

1. Zafar, M.; Zhu, D.; Zhang, Z. 3D Printing of Bioceramics for Bone Tissue Engineering. *Materials* **2019**, *12*, 3361. [CrossRef] [PubMed]