materials proceedings

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Abstract

Tantalum Doped Bioactive Glass: Towards a Pro-Regenerative and Antibacterial Response †

Ana Sofia Pádua [1,*], Sílvia R. Gavinho [2], Manuel Pedro F. Graça [2], Isabel Sá-Nogueira [3,4] and Jorge C. Silva [1,*]

1 I3N-CENIMAT, New University of Lisbon, 2825-097 Caparica, Portugal
2 I3N and Physics Department, Aveiro University, 3810-193 Aveiro, Portugal; silviagavinho@ua.pt (S.R.G.); mpfg@ua.pt (M.P.F.G.)
3 Associate Laboratory i4HB—Institute for Health and Bioeconomy, NOVA School of Science and Technology, NOVA University Lisbon, 2819-516 Caparica, Portugal; isn@fct.unl.pt
4 UCIBIO—Applied Molecular Biosciences Unit, Department of Life Sciences, NOVA School of Science and Technology, NOVA University Lisbon, 2819-516 Caparica, Portugal
* Correspondence: as.padua@campus.fct.unl.pt (A.S.P.); jcs@fct.unl.pt (J.C.S.)
† Presented at the Materiais 2022, Marinha Grande, Portugal, 10–13 April 2022.

Keywords: bioactive glass; tantalum pentoxide; cytotoxicity; antibacterial activity; bone regeneration

The use of synthetic implants for bone restoration is associated with the risk of bacterial colonization, resulting in implant failure. Bioactive glasses (BG) are among the most used materials in bone regeneration applications. However, this material does not have an effective antibacterial activity capable of maintaining an infection-free wound for long. A material that could respond to this need is tantalum (Ta), as it is biocompatible, has antibacterial properties, promotes osseointegration, and has hemostatic capacity. This work aims to improve the performance of BG-coated implants by doping BG with metal ions known for their excellent anti-microbiological activity. To achieve this goal, 45S5 Bioglass™ was doped with Ta, prepared using the melt quenching technique, and then characterized both physically and biologically. The biological analysis focuses on cell responses and microbiological assays. Cell responses were analyzed by cytotoxicity assays, using both osteoblasts and macrophages, and macrophage polarization. The microbiological assays allow minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) determination. The incorporation of Ta ions does not show a significant change in the glass structure at low concentrations; however, for the highest Ta concentration, Ta-doped BG presented characteristic peaks of the Ta2O5 crystal. Furthermore, an increase of Ta in BG led to an increase in cell viability for both types of cells tested (Saos2 and THP-1). In what concerns the anti-bacterial activity, the effect of incorporating 4 mol% Ta in BG led to an effective bactericidal activity against both Gram-negative (*Escherichia coli*) and Gram-positive bacteria (*methicillin-resistant Staphylococcus aureus*). These results show that Ta-doped BG is a promising material for accelerating tissue regeneration and preventing bacterial infections.

Author Contributions: Conceptualization, A.S.P., M.P.F.G. and J.C.S.; methodology, A.S.P. and S.R.G.; validation, M.P.F.G., I.S.-N. and J.C.S.; formal analysis, A.S.P.; investigation, A.S.P. and S.R.G.; resources, M.P.F.G., I.S.-N. and J.C.S.; data curation, A.S.P.; writing—original draft preparation, A.S.P.; writing—review and editing, M.P.F.G. and J.C.S.; supervision, M.P.F.G., I.S.-N. and J.C.S. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded by FCT—Portuguese Foundation for Science and Technology (UI/BD/151287/2021), CENIMAT/i3N (UID/CTM/50025), UCIBIO (UIDP/04378/2020 and UIDB/04378/2020) and Associate Laboratory i4HB (LA/P/0140/2020).

Institutional Review Board Statement: Not applicable.

Citation: Pádua, A.S.; Gavinho, S.R.; Graça, M.P.F.; Sá-Nogueira, I.; Silva, J.C. Tantalum Doped Bioactive Glass: Towards a Pro-Regenerative and Antibacterial Response. *Mater. Proc.* **2022**, *8*, 51. https://doi.org/10.3390/materproc2022008051

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

Published: 30 May 2022

Informed Consent Statement: Not applicable.

Data Availability Statement: Data may be obtained from authors upon reasonable request.

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