JUNIOR EUROMAT
19 - 22 JULY 2022
COIMBRA, PORTUGAL

Hydrothermal Ageing Behavior of Bioinspired Material with Piezoelectric Functions for Implant Applications

João Pinto[1]*, Michael Gasik[2], Óscar Carvalho[1], Filipe Samuel Silva[1]
1 CMEMS-University of Minho, Guimarães, 4800-058, Portugal
2 Dep. of Chemical and Metallurgical Engineering- Aalto University, Espoo, 02150, Finland

Implant-bone fixation loss can occur 10-15 years after surgery. This is related to bone resorption and consecutive biofilm formation in the generated gap, which could lead to tissues inflammation and implant loss [1]. Current solutions are focused on primary osseointegration for implant early survival rate. In long term, they lose effectiveness due to implant foreign body reaction once bone metabolism is challenged by a non-part of the body. Bone is composed of piezoelectric materials with production of biological electricity due to collagen deformation and displacement of the local electric field [2]. Barium titanate is a lead-free piezoelectric bioceramic without toxicological risk and absence of foreign body reactions that can mimic natural bone piezoelectricity and inhibit bacterial adhesion [3]. The focus of this work is design, produce, and characterize a smart, bio-inspired, and multi-functional composite material to improve implant long-term bone regeneration and antibacterial effect. In this sense, a composite with BaTiO3 particles and bioinert ZrO2 was produced. 5%BaTiO3-ZrO2 composites were mixed in isopropanol alcohol and ultrasonicated for total dispersion, followed by press (200MPa) and sintering technic (1300-1500ºC). The different samples were characterized with SEM (Fig1.(a)), that present two distinct phases, XRD analysis, and subjected to hydrothermal ageing (Fig1.(b)), to evaluate the stability of the tetragonal zirconia phase. After 5h of accelerated ageing (≈10 years), monoclinic phase is more evident with the sintering temperature increment, but always lower than 25%, staying in according with ISO 13356:200, promising to be promising a potential replacement material for implant applications.

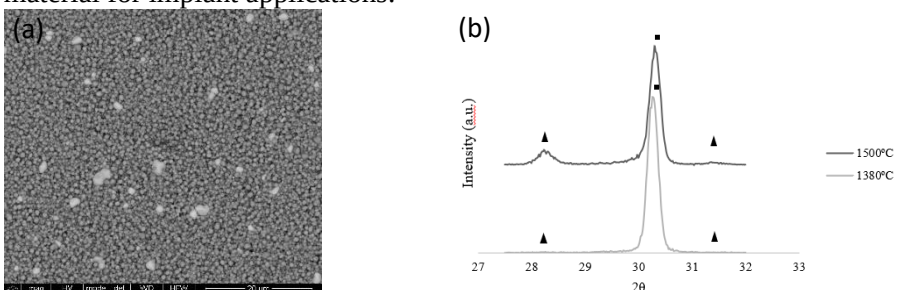

Figure 1 (a) Top view recorded on as sintered 5wt% BaTiO3 – ZrO2 composite sintered at 1500ºC; (b) XRD X-ray diffractograms spectra for the composites sintered at 1380ºC (1.7% monoclinic phase) and 1500ºC after 6h hydrothermal ageing with monoclinic phase percentage of 1.7 and 14.3, respectively.

Acknowledgments: This work was supported by FCT national funds under the national support to R&D units grant, through the reference project UIDB/04436/2020, UIDP/04436/202, FunImp POCI-01-0145-FEDER-030498 and through the grant 2021.09001.BD.

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*Presenting author: Universidade do Minho, Dep. Engenharia Mecânica, CMEMs, id8102@alunos.uminho.pt