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PII: S1751-6161(17)30563-5
DOI: https://doi.org/10.1016/j.jmbbm.2017.12.020
Reference: JMBBM2623

To appear in: *Journal of the Mechanical Behavior of Biomedical Materials*

Received date: 23 October 2017
Revised date: 18 December 2017
Accepted date: 21 December 2017

Cite this article as: Qifeng Jiang, Jewan Ismail, Fahmi Zaïri, Zhengwei Qu, Xiaobing Liu and Fahed Zaïri, Damage mechanisms in bioactive glass matrix composites under uniaxial compression, *Journal of the Mechanical Behavior of Biomedical Materials,* https://doi.org/10.1016/j.jmbbm.2017.12.020

Damage mechanisms in bioactive glass matrix composites under uniaxial compression

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Abstract

The damage and crack resistance improvement of bioactive glass is of prime importance, particularly when applied to the repair of load-bearing bones. The present contribution is focused on the prediction of damage mechanisms and crack resistance under uniaxial compression of bioactive glass matrix composites reinforced with a particulate phase. In order to characterize the effects of voids and particles on the damage mechanisms and the macro-response, a two-step homogenization is performed by considering the two phases existing at two different scales: micro/meso through the homogenization of the porous matrix and then meso/macro through the periodic micro-field approach. The damage in the bioactive glass matrix is computed via an anisotropic stress-based damage model, implemented into a finite element program. Failure resulting of excessive damage accumulation in the bioactive glass matrix is predicted by a critical damage criterion combined with a vanishing element technique. The implication of particles in the toughening mechanism as well as the damage and crack resistance improvement in this class of porous biomaterials is highlighted via a parametric study using the proposed numerical model.

Keywords: bioactive glass; composites; computational homogenization; continuum damage mechanics; damage mechanisms.