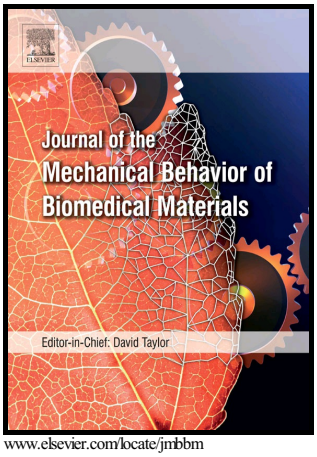
Microscopic full-field three-dimensional strain measurement during the mechanical testing of additively manufactured porous biomaterials

Katia Genovese, Sander Leeflang, Amir A. Zadpoor



www.elsevier.com/locate/jmbbm

PII: S1751-6161(17)30017-6
DOI: http://dx.doi.org/10.1016/j.jmbbm.2017.01.010
Reference: JMBBM2181

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

Received date: 30 August 2016
Revised date: 21 December 2016
Accepted date: 8 January 2017

Cite this article as: Katia Genovese, Sander Leeflang and Amir A. Zadpoor Microscopic full-field three-dimensional strain measurement during th mechanical testing of additively manufactured porous biomaterials, *Journal o the Mechanical Behavior of Biomedical Materials* http://dx.doi.org/10.1016/j.jmbbm.2017.01.010

Microscopic full-field three-dimensional strain measurement during the mechanical testing of additively manufactured porous biomaterials

Katia Genovese[1], Sander Leeflang[2,3], Amir A. Zadpoor[2,3]

[1]*School of Engineering, University of Basilicata, Potenza, Italy*
[2]*Department of Biomechanical Engineering, Faculty of Mechanical, Maritime, and Materials Engineering, Mekelweg 2, Delft 2628CD, The Netherlands*
[3]*Additive Manufacturing Lab, Faculty of Mechanical, Maritime, and Materials Engineering, Mekelweg 2, Delft 2628CD, The Netherlands*

ABSTRACT

A custom-designed micro-digital image correlation system was used to track the evolution of the full-surface three-dimensional strain field of Ti6Al4V additively manufactured lattice samples under mechanical loading. The high-magnification capabilities of the method allowed to resolve the strain distribution down to the strut level and disclosed a highly heterogeneous mechanical response of the lattice structure with local strain concentrations well above the nominal global strain level. In particular, we quantified that strain heterogeneity appears at a very early stage of the deformation process and increases with load, showing a strain accumulation pattern with a clear correlation to the later onset of the fracture.

The obtained results suggest that the unique opportunities offered by the proposed experimental method, in conjunction with analytical and computational models, could serve to provide novel important information for the rational design of additively manufactured porous biomaterials.

Keywords: Digital image correlation, microscopic deformation, additive manufacturing, porous biomaterials, failure.