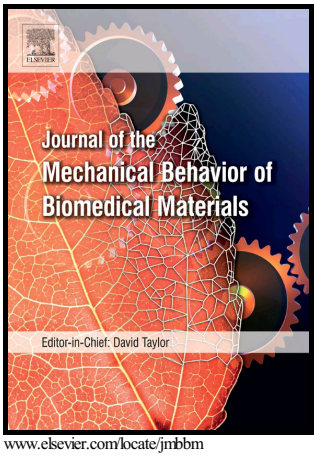
The effect of severe grain refinement on the damage tolerance of a superelastic NiTi shape memory alloy

Thomas Leitner, Ilchat Sabirov, Reinhard Pippan, Anton Hohenwarter



www.elsevier.com/locate/jmbbm

PII: S1751-6161(17)30138-8
DOI: http://dx.doi.org/10.1016/j.jmbbm.2017.03.020
Reference: JMBBM2274

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

Received date: 24 November 2016
Revised date: 16 February 2017
Accepted date: 25 March 2017

Cite this article as: Thomas Leitner, Ilchat Sabirov, Reinhard Pippan and Anton Hohenwarter, The effect of severe grain refinement on the damage tolerance of a superelastic NiTi shape memory alloy, *Journal of the Mechanical Behavior of Biomedical Materials,* http://dx.doi.org/10.1016/j.jmbbm.2017.03.020

The effect of severe grain refinement on the damage tolerance of a superelastic NiTi shape memory alloy

Thomas Leitner [1*], Ilchat Sabirov [2], Reinhard Pippan [3], Anton Hohenwarter [1]

[1] Department of Materials Physics, Montanuniversitaet Leoben, Austria

[2] Madrid Institute for Advanced Studies of Materials, Madrid, Spain

[3] Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, Leoben, Austria

*thomas.leitner@unileoben.ac.at

Abstract

Nickel-titanium (NiTi) shape memory alloys are widely used for medical components, as they can accommodate large strains in their superelastic state. In order to further improve the mechanical properties of NiTi, grain refinement by severe plastic deformation is applied to generate an ultrafine-grained microstructure with increased strength. In this work comprehensive fracture and fatigue crack growth experiments were performed on ultrafine-grained NiTi to assess its damage tolerance, which is essential for the safe use of this material in medical applications. It was found, that equal channel angular pressing of NiTi for 8 passes route B_C increases the transformation stress by a factor of 1.5 and the yield stress of the martensite by a factor of 2.6, without significantly deteriorating its fracture and fatigue crack growth behavior. The fatigue crack growth behavior at high mean stresses is even improved, with lower fatigue crack growth rates and higher threshold stress intensity factor ranges, however, beneficial contributions from crack closure are slightly reduced.

Keywords: Shape memory alloy, NiTi, severe plastic deformation, ECAP, fracture, fatigue crack growth