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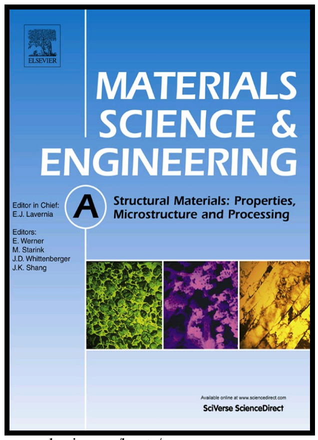

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PII: S0921-5093(16)31430-7
DOI: http://dx.doi.org/10.1016/j.msea.2016.11.066
Reference: MSA34392

To appear in: *Materials Science & Engineering A*

Received date: 19 October 2016
Accepted date: 18 November 2016

Cite this article as: Moustafa El-Tahawy, Yi Huang, Hyelim Choi, Heemar Choe, János L. Lábár, Terence G. Langdon and Jenő Gubicza, High temperatur thermal stability of nanocrystalline 316L stainless steel processed by high pressure torsion, *Materials Science & Engineering A* http://dx.doi.org/10.1016/j.msea.2016.11.066

High temperature thermal stability of nanocrystalline 316L stainless steel processed by high-pressure torsion

Moustafa El-Tahawy[1,2], Yi Huang[3], Hyelim Choi[4], Heeman Choe[4], János L. Lábár[1,5], Terence G. Langdon[3] and Jenő Gubicza[1,*]

[1]Department of Materials Physics, Eötvös Loránd University, Budapest, P.O.B. 32, H-1518, Hungary
[2]Department of Physics, Faculty of Science, Tanta University, 31527 Tanta, Egypt
[3]Materials Research Group, Faculty of Engineering and the Environment, University of Southampton, Southampton SO17 1BJ, UK
[4]School of Advanced Materials Engineering, Kookmin University, 77 Jeongneung-ro, Seongbuk-gu, Seoul 136-702, Republic of Korea
[5]Institute for Technical Physics and Materials Science, Centre for Energy Research, Hungarian Academy of Sciences, Budapest, Hungary
[*]Corresponding author: Tel: + 36-1-372-2876, Fax: +36-1-372-2811, e-mail: jeno.gubicza@ttk.elte.hu

Abstract

Differential scanning calorimetry (DSC) was used to study the thermal stability of the microstructure and the phase composition in nanocrystalline 316L stainless steel processed by high-pressure torsion (HPT) for ¼ and 10 turns. The DSC thermograms showed two characteristic peaks which were investigated by examining the dislocation densities, grain sizes and phase compositions after annealing at different temperatures. The first DSC peak was exothermic and was related to recovery of the dislocation structure without changing the phase composition and grain size. The activation energies for recovery after processing by ¼ and 10 turns were ~163 and ~106 kJ mol^{-1}, respectively, suggesting control by diffusion along grain boundaries and dislocations. The second DSC peak was endothermic and was caused by a reverse transformation of α'-martensite to γ-austenite. The hardness of annealed samples was determined primarily by the grain size and followed the Hall–Petch relationship. Nanocrystalline 316L steel processed by HPT exhibited good thermal stability with a grain size of ~200 nm after annealing at 1000 K and a very high hardness of ~4900 MPa.

Keywords: activation energy; differential scanning calorimetry; high-pressure torsion; phase transformation; stainless steel