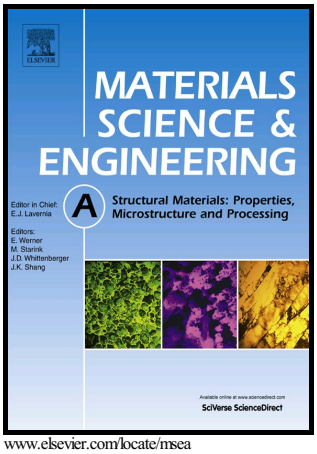
Effect of laser shock on tensile deformation behavior of a single crystal nickel-base superalloy

G.X. Lu, J.D. Liu, H.C. Qiao, Y.Z. Zhou, T. Jin, J.B. Zhao, X.F. Sun, Z.Q. Hu



www.elsevier.com/locate/msea

PII: S0921-5093(17)30047-3
DOI: http://dx.doi.org/10.1016/j.msea.2017.01.039
Reference: MSA34601

To appear in: *Materials Science & Engineering A*

Received date: 25 July 2016
Revised date: 11 January 2017
Accepted date: 12 January 2017

Cite this article as: G.X. Lu, J.D. Liu, H.C. Qiao, Y.Z. Zhou, T. Jin, J.B. Zhao, X.F. Sun and Z.Q. Hu, Effect of laser shock on tensile deformation behavior of a single crystal nickel-base superalloy, *Materials Science & Engineering A* http://dx.doi.org/10.1016/j.msea.2017.01.039

Effect of laser shock on tensile deformation behavior of a single crystal nickel-base superalloy

G.X. Lu[a,b], J.D. Liu[a*], H.C. Qiao[c], Y.Z. Zhou[a], T. Jin[a**], J.B. Zhao[c], X.F. Sun[a], Z.Q. Hu[a]

[a]Institute of Metal Research, Chinese Academy of Sciences, 72 Wenhua Road, Shenyang 110016, China

[b]University of Chinese Academy of Sciences, 19 Yuquan Road, Beijing 100049, China

[c]Shenyang Institute of Automation, Chinese Academy of Sciences, 114 Nanta Road, Shenyang 110016, China

[*]jdliu@imr.ac.cn

[**]tjin@imr.ac.cn

Abstract

This investigation focused on the tensile deformation behavior of a single crystal nickel-base superalloy, both in virgin condition and after laser shock processing (LSP) with varied technology parameters. Nanoindention tests were carried out on the sectioned specimens after LSP treatment to characterize the surface strengthening effect. Stress strain curves of tensile specimens were analyzed, and microstructural observations of the fracture surface and the longitudinal cross-sections of ruptured specimens were performed via scanning electron microscope (SEM), in an effort to clarify the fracture mechanisms. The results show that a surface hardening layer with the thickness of about 0.3~0.6 mm was gained by the experimental alloys after LSP treatment, but the formation of surface hardening layer had not affected the yield strength. Furthermore, fundamental differences in the plastic responses at different temperatures due to LSP treatment had been discovered. At 700℃, the slip deformation was held back when it extended to the surface hardening layer and the ensuing slip steps improved the plasticity; however, at 1000℃, surface hardening layer hindered the macro necking, which resulted in the relatively lower plasticity.

Keywords: Nickel based superalloys; Laser shock treatment; Hardening; Fracture; Plasticity

1. Introduction

Nickel-base superalloys have excellent mechanical properties, especially at medium and high temperatures. These properties make the material widely used in aero-engine applications, such as turbine disks and blades[1]. Nevertheless, superalloys are required to withstand higher stresses and operating temperatures to meet the current demands for increased gas-turbine efficiency and superior damage tolerance[2]. The challenges imposed on the service performance improvement not only relate to the bulk microstructure, but also to microstructures altered by