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T. Klotz, H.Y. Miao, C. Bianchetti, M. Lévesque, M. Brochu

PII: S0142-1123(18)30141-5
DOI: https://doi.org/10.1016/j.ijfatigue.2018.04.011
Reference: JIJF 4650

To appear in: *International Journal of Fatigue*

Received Date: 5 January 2018
Revised Date: 3 April 2018
Accepted Date: 5 April 2018

Please cite this article as: Klotz, T., Miao, H.Y., Bianchetti, C., Lévesque, M., Brochu, M., Analytical fatigue life prediction of shot peened Inconel 718, *International Journal of Fatigue* (2018), doi: https://doi.org/10.1016/j.ijfatigue.2018.04.011

Analytical fatigue life prediction of shot peened Inconel 718

T. Klotz[a,*], H.Y. Miao[a], C. Bianchetti[a], M. Lévesque[a], M. Brochu[a]

[a]*Département de génie mécanique, École Polytechnique de Montréal, Qc H3T 1J4, Montréal, Canada*

Abstract

High and low cycle fatigue tests performed on shot peened Inconel 718 can result in different crack initiation locations and mechanisms as well as in a wide range of fatigue lives depending on shot peening parameters. A model coupling Navarro and de los Rios crack propagation with Chan's crack initiation models is developed and successfully used to predict crack initiation location and fatigue life of shot peened and unpeened Inconel 718 specimens tested in high and low cycle fatigue at room temperature. Redistributed residual stresses and cold work profiles are added to the propagation model and the crack initiation model is modified to account for the residual stresses. Such a model could lead to significant experimental cost reduction by avoiding the trial and error process currently required to define optimal shot peening parameters.

Keywords: Inconel 718, fatigue life, crack initiation, modeling, shot peening, relaxation

1. Introduction

Inconel 718 is a nickel-based superalloy commonly used in jet engines. Klotz et al. [1] observed that room temperature high cycle fatigue (HCF) life of Inconel 718 can be improved by a factor of 20 when shot peened under optimal conditions. Depending on shot peening parameters, fatigue cracks can nucleate 210 μm beneath the surface, or deeper than 2 mm into the material, which leads to different fatigue lives. In low cycle fatigue (LCF), the relaxation of residual stresses induced by shot peening can lead to tensile surface residual stresses, after the first loading cycle [1]. In these cases, Klotz et al. [1] found that the fatigue life mainly depended on the surface roughness resulting from shot impacts. In these specific LCF cases, shot peening was detrimental to fatigue life.

*I am corresponding author

Email addresses: thierry.klotz@polymtl.ca (T. Klotz), hong-yan.miao@polymtl.ca (H.Y. Miao), charles.bianchetti@polymtl.ca (C. Bianchetti), martin.levesque@polymtl.ca (M. Lévesque), myriam.brochu@polymtl.ca (M. Brochu)