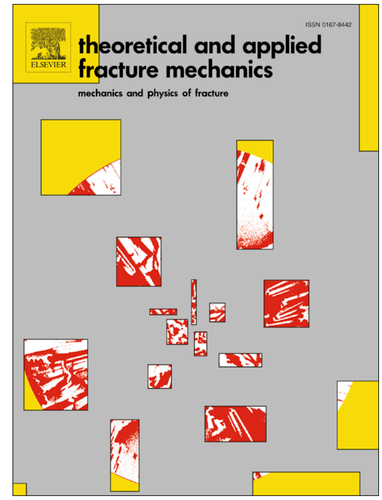
Accepted Manuscript



Prediction of texture evolution and crack growth rate of nickel based superalloys in thermo-mechanical fatigue by ultrasonic technique

M. Esmaeilzadeh, H. Arabi, F. Qods, B.M. Sadeghi

PII: S0167-8442(17)30471-8
DOI: https://doi.org/10.1016/j.tafmec.2018.07.003
Reference: TAFMEC 2071

To appear in: *Theoretical and Applied Fracture Mechanics*

Received Date: 9 October 2017
Revised Date: 30 June 2018
Accepted Date: 2 July 2018

Please cite this article as: M. Esmaeilzadeh, H. Arabi, F. Qods, B.M. Sadeghi, Prediction of texture evolution and crack growth rate of nickel based superalloys in thermo-mechanical fatigue by ultrasonic technique, *Theoretical and Applied Fracture Mechanics* (2018), doi: https://doi.org/10.1016/j.tafmec.2018.07.003

Prediction of texture evolution and crack growth rate of nickel based superalloys in thermo-mechanical fatigue by ultrasonic technique

M.Esmaeilzadeh [a], H.Arabi [b], F.Qods [a,*], B.M.Sadeghi [b]

[a] Faculty of Metallurgical and Materials Engineering, Semnan university, Semnan, IRAN.
[b] School of Metallurgy and Materials Engineering, Iran University of Science & Technology, Tehran, IRAN.

ABSTRACT

In this research, texture evolution and crack growth rates were investigated by ultrasonic technique in Hastelloy X during thermo mechanical fatigue (TMF) and also in Inconel 718 during isothermal fatigue. For this purpose, TMF tests were performed at various modes, i.e. constant temperature, in-phase (IP) and out of phase (OP) in addition to application of linear elastic fracture mechanics (LEFM) and elastic-plastic fracture mechanics (EPFM). The existing ultrasonic model for predicting the texture evolution was modified and a model on the base of the relationships between ultrasonic wave velocity, elastic constants and texture parameters was developed. For predicting the TMF crack growth rate, an integrated ultrasonic model was proposed on the base of dislocation density and cyclic J-integral for ultrasonic wave velocity. The validation tests for texture evolution and TMF crack growth rates show a good correlation between experimental results and those predicted by ultrasonic method. For predicting the initiation and growth of unstable cracks up to failure of the specimen during TMF, a new parameter in the form of critical ultrasonic wave velocity has also been introduced in this research.

Keywords- Thermo-mechanical fatigue, Ultrasonic tools, Texture, Crack growth rate, Hastelloy X, Inconel 718

1. Introduction

Thermo mechanical fatigue (TMF) can be viewed as a process under simultaneous changes in temperature and mechanical loads. Since gas turbine engine components are exposed to TMF at high temperatures, they should composed of a combination of good tensile strength, fatigue life, creep resistance and rupture strengths, in addition to high resistances to oxidation and stress-corrosion cracking [1, 2].

Crystallographic texture, microstructure and secondary phases have vital effects on the fatigue crack initiation and growth during TMF. Some studies reported the slip system transfer via plastic strain accumulation across grain boundaries [3]. This phenomenon can affects micro-crack formation in Hastelloy X [4] .The role of local texture and heterogeneous plastic strain on crack initiation and propagation during TMF has also been investigated in Ref. [5]. In addition, High temperature fatigue in the advanced nickel based superalloy [6], effects of induction heating during TMF on Hastelloy X on fatigue life [7] crack growth simulation in thermo

* Corresponding author. Tel.: +98 912 831 77 89.
E-mail addresses: qods@semnan.ac.ir (F. Qods), m-esmaeilzadeh@semnan.ac.ir (M.Esmaeilzadeh), arabi@iust.ac.ir (H.Arabi), bmsadeghi@iust.ac.ir (B.M.Sadeghi)