ABSTRACT

The work presented in this paper is a contribution to the lifetime estimate of an aluminium alloy (Au4G type) subjected to complex multiaxial loadings in high cycle fatigue. In order to overcome a purely phenomenological description, a model based on the coupling plasticity-damage in a mesoscopic scale is formulated in the framework of thermodynamics of irreversible processes and by the introducing of the critical approach plan. This model constitutes an improvement of the initial versions proposed in the literature. The confrontation of the results showed the relevance of the model most accurately to capture as closely as possible degradation mechanisms and to predict lifespan in concord with the experimental one.

Keywords: Aluminium, Au4G, high cycle fatigue, mesoscopic scale, damage, critical approach plan.

INTRODUCTION

After decades of work in the field of fatigue of materials and structures, several approaches and models have been proposed and currently they reach a certain level of maturity and allow to effectively address many service situations, although no unified approach for all real situations that may experience a structure or all classes of materials. Current approaches present a wide range of applications and allows in most cases to meet the need sizing for metals. The vast majority of methods of lifespan calculation in High Cycle Fatigue (HCF) are based on the setting in equations of the mechanical quantities calculated on a macroscopic scale. Among the approaches, this type of "multi-scale" (macro - meso / micro) seems to be unanimous where the important role of local plasticity on the appearance of a fatigue limit is widely accepted and fully justifies the using of this approach based on a passage from macroscopic to mesoscopic quantities.

The objective of this work is to contribute to the development of numerical tools for the lifetime prediction of the aluminum alloy Au4G, subject to complex multiaxial fatigue loadings in high number of cycles. To go beyond a purely phenomenological description, we choose to respond to these objectives by basing on a multi-scale type of modeling approach.

RESULTS AND CONCLUSIONS

We have simulated tests available in the literature to determine the lifetime of an aluminum alloy (Au4G type) by the application of the proposed model and compared them with experimental lifetimes and those found by the application of original models. The test loads
are different modes and paths. Note that in the following figures, the F denotes the model of Flacelière- Morel-Dragon, H for the model of Huy-Damien-Yves and finally the proposed model. The signals applied are of constant amplitude sinusoidal type.

Based on existing models in the literature, we have developed a model to estimate lifetime in high cycle fatigue of an aluminum alloy Au4G. This model highlights the crucial role of the coupling mechanisms of plasticity and damage at the local (micro or meso) in the initiation and propagation of cracks. The localized nature of the damage to the micro / meso-scale justifies multi-scale formalism of existing models in this area.

REFERENCES