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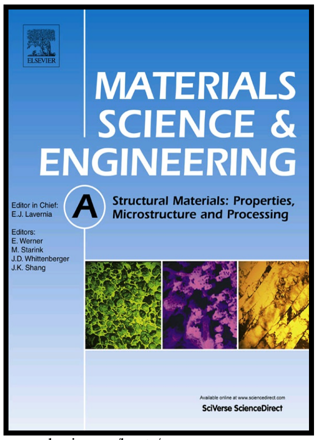

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Micromechanical modeling of fatigue behavior of DP steels

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Abstract

The effect of martensitic phase fraction on the cyclic stress-strain behavior of two DP steels is investigated via a micromechanical model based on a representative volume element (RVE). A dislocation density based model and a Chaboche hardening model are used to identify the isotropic and kinematic hardening behavior of constituent phases, respectively. The Chaboche parameters obtained by fitting flow curves computed from a dislocation density based model for both ferrite and martensite phases of each steel are incorporated into a Finite Element code ABAQUS to simulate the low cycle fatigue with a combined hardening behavior. Based on experimental observations reported in the literature, fatigue crack initiates in ferrite phase. A ductile damage model, therefore, is used to simulate damage initiation in ferrite. The results show that the martensite fraction has a significant influence on cyclic plastic strain accumulation during the cyclic deformation. It is also concluded that with an increase in the martensite volume fraction in DP steel, the elastic component of the total strain amplitude increases and higher fatigue strength is, subsequently, observed.

Keyword: Dual-phase steel, dislocation density model, kinematic hardening, Chaboche hardening model, representative volume element.

1. Introduction

Dual phase (DP) steels having a microstructure consisting of a soft ferrite matrix and metastable hard martensite result in a combination of high strength and high ductility as well as work hardening, which can all be beneficial for industrial applications [1]. High strain hardening and strong bake hardening effects give these steels excellent potential for automotive applications such as in body side, reinforcement and engine cradle [2, 3, 4]. Furthermore, these great