EXPERIMENTAL AND NUMERICAL STUDY ON THE LOW CYCLE FATIGUE BEHAVIOUR OF A CAST HYBRID METAL MATRIX COMPOSITES

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ABSTRACT

The low-cycle fatigue (LCF) behavior specially the fracture initiation mechanism in a cast hybrid metal matrix composite (MMC) has been studied experimentally and numerically. Conventional three point bending fatigue test has been carried out and factographic analysis has been conducted to observe the fracture initiation site. Experimental results showed that microcracks in LCF initiated at the particle–matrix interface which was located in the hybrid clustering region. Due to continued fatigue cycling, the interface debonding occurred, created additional secondary microcracks and the microcrack coalesced with other nearby microcracks. As far as the numerical study is concerned, three dimensional (3-D) unit cell models of hybrid MMC consists of reinforcement clustering and non-clustering regions were developed by using finite element method (FEM). The stress-strain distribution in both the reinforcement clustering and non-clustering regions were analyzed. The numerical results confirmed that the stress concentration occurred on the reinforcement–matrix interfaces located in the clustering region and provide reasonable agreement with the experimental observations..

Keywords: Low cycle fatigue; Cast metal matrix composites; Fracture initiation; Reinforcement clustering.

INTRODUCTION

Metal matrix composites (MMCs) make-up a category of advanced engineering materials that provide unique advantages over conventional alloys in many high performance applications. These materials have a high specific mechanical strength and a high stiffness, compared to the corresponding unreinforced alloys. Therefore, MMCs have received significant attention for automotive, aeronautical, electrical and military fields (Chen et al., 1995).

Although MMCs have many advantages, problems still remain for their poor damage tolerance properties under monotonic or cyclic loads. Many applications for which these materials can be considered involve cyclic loading, and therefore, fatigue properties are of critical interest. It has been shown that the presence of reinforcement can increase fatigue life (Sasaki et al., 1994). Koh et al. have investigated low cycle fatigue behavior of Al/SiC_p composite and found that the composite and the unreinforced matrix alloy showed cyclic hardening behavior (Koh et al., 1999).