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/SiCp composite and found that the composite and the
unreinforced matrix alloy showed cyclic hardening behavior (Koh et al., 1999).