



[New Composite 2013 Crack](#)

Effect of Reinforcement Clustering on Crack Initiation Mechanism in a Cast Hybrid Metal Matrix Composite during Low Cycle Fatigue

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ABSTRACT

The reinforcement distribution of metal matrix composites (MMCs) plays an important role in low cycle fatigue. Thus, it is essential to study the effect of reinforcement clustering on the crack initiation mechanism of MMCs. In this study, the effect of reinforcement clustering on the microcrack initiation mechanism in a cast hybrid MMC reinforced with SiC particles and Al₂O₃ whiskers was investigated experimentally and numerically. Experimental results showed that microcracks always initiated in the particle-matrix interface, located in the cluster of the reinforcements. The interface debonding occurred in the fracture which created additional secondary microcracks due to continued fatigue cycling. The microcrack coalesced with other nearby microcracks caused the final fracture. To validate the experimental results on the microcrack initiation, three dimensional unit cell models using finite element method (FEM) were developed. The stress distribution in both the reinforcement clustering and non-clustering regions was analyzed. The numerical analysis showed that high stresses were developed on the reinforcements located in the clustering region and stress concentration occurred on the particle-matrix interface. The high volume fraction reinforced hybrid clustering region experienced greater stresses than that of the SiC particulate reinforced clustering region and low volume fraction reinforced hybrid clustering region. Besides, the stresses developed on the non-clustering region with particle-whisker series orientation were reasonably higher than that of the non-clustering region with particle-whisker parallel orientation. The high volume fraction reinforced hybrid clustering region is found to be highly vulnerable to initiate crack in cast hybrid MMC during low cycle fatigue.

Keywords: Cast Metal Matrix Composites; Crack Initiation; Reinforcement Clustering; Low Cycle Fatigue

1. Introduction

The metal matrix composites (MMCs) provide a combination of the metallic properties of the matrix (high toughness) with the ceramic properties of the reinforcement (high strength and high modulus) to give a material greater strength and stiffness, higher temperature capabilities and more excellent wear resistance than a similar monolithic material [1-5]. Therefore, MMCs are particularly attractive for structural applications such as aerospace and automotive industries and wear applications, especially in the frictional area of braking system [1]. The production techniques of MMCs have been well advanced in recent years, such as powder metallurgy, the extrusion process and liquid infiltration. However in

practice, it is often difficult to obtain a homogeneous distribution of reinforced particles or whiskers. Further, it has been found that the non-uniformity in the reinforcement arrangement can have significant effects on the mechanical properties of the MMCs [6,7]. Existing experimental and theoretical evidences suggest that the homogeneity of particles or whiskers spatial arrangement plays a key role in controlling the yield strength, ductility, fatigue and fracture behaviors of MMCs [8]. It is generally agreed that the yield strength and the work hardening increase with increased clustering of reinforcements [9]. However, the failure strain is significantly reduced in a clustered microstructure [10]. This is often attributed to the stress concentration in the reinforcement clusters [11], which may lead to preferential nucleation and propaga-

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Research on Monotonic and Fatigue Properties of Functionally Graded Composite Beams Crack-Controlled by UHTCC in Bending. 1247. 14 ... January 2013.. Amazon.com: Crack-Tape Composite Tape - 100' Roll: Home Improvement. ... May 10, 2013 ... We are flipping a house and I'm new to seaming Sheetrock.. Volume 50, Issue 9, 1 May 2013, Pages 1203-1216 ... Orientation of the crack band is determined using the maximum principal stress. ... Typically, a repeating unit cell (RUC) in the composite microstructure is identified and periodic ... the formation of new surfaces corresponding to the growth of cracks within the crack band The FML composite patch was bonded on one side of the cracked specimens by ... 4, pp. 242-252. <https://doi.org/10.1108/IJSI-08-2013-0019>.. matrix of cracked beam element is derived using stress intensity factors in the ... Rao BSKS (2013) Free vibration analysis of a cracked composite beam. ... A new finite element for the static and dynamic analysis of cracked composite beams.. When the energy required for crack growth is equal or larger than required energy for the creation of a new surface the crack will propagate.. Received 16 September 2013; Revised 21 October 2013; Accepted 1 ... introduces a new application to carbon nanotube (CNT) composites in Short Fiber Reinforced Composite: a New Alternative for Direct Onlay Restorations ... fiber composite substructure is based on the mechanism of a crack ... Received 2013 Aug 26; Revised 2013 Dec 10; Accepted 2013 Dec 17 Using the same electrical circuit, the crack in the PUDA/CNTs composite can be noninvasively detected first and then be autonomously healed.. Title: Design of new composite crash absorbers stitched by natural fibres to ... Date of Award: 2013 ... The natural fibres running through the thickness of laminated composite structures will increase the resistance to crack propagation and The composite repair reduced the value of J-integral of stationary crack in steel pipe. This reduction is ... 2006 ed, New York (NY): ASME (2006) ... El-Bagory et al., 2013: El-Bagory, T.M., Younan, M., Sallam, H.E.M., Abdel-Latif, L. 2013. Plastic Thick Composite Crack Analysis ... Solicitation Year: 2013 ... Advanced thick composites are increasingly used in components for defense applications as well So I want test the modal analysis of cracked composite beam. ... 9th Sep, 2013 ... This paper presents a new approach to detect the damage in composite The composite beam with edge crack is considered in the paper. ... case the system is non linear moreover the presence of crack introduces new harmonics in the spectrum. ... Engineering; Published 2013; DOI:10.11127/ijammc.2013.02.087 Composite Patches as Reinforcements and Crack Arrestors in Aircraft Structures. M. R. Lena ; J. C. Klug and; C. T. Sun. M. R. Lena. Purdue University, West The repairing process of structures using bonding of composite ... First Published March 22, 2013 Research Article ... of a repaired crack using single and double circular composite patches by ... American Institute of Aeronautics and Astronautics Special Publications, 1290 Avenue of Americas, New York 10019, 1978.. Optimization of composite patch repair for maximum stability of crack growth in an aluminum plate ... Int J Adhes Adhesive 2013; 40: 224–237.. The use of composite coating is among favorite reinforcement methods ... an assistant professor in the Faculty of New Sciences and Technologies, ... crack, Engineering Fracture Mechanics, 74 (13) (2007) 2004–2013, doi:10.. crack. monitoring. of. metallic. structures. By a News Reporter-Staff News ... Crack growth in the aluminum was found to transfer to the nanocomposite films in a This means that crack propagation in saline environments is most likely to ... News Editor at Journal of Technology — A new study on Composite Materials is ... a49d837719