



# Small Fatigue Cracks

**BM King**



## Small Fatigue Cracks:

**Small Fatigue Cracks** K.S. Ravichandran, Y. Murakami, R. O. Ritchie, 1999-09-30 This book contains the fully peer reviewed papers presented at the Third Engineering Foundation Conference on Small Fatigue Cracks held under the chairmanship of K S Ravichandran and Y Murakami during December 6 11 1998 at the Turtle Bay Hilton Oahu Hawaii This book presents a state of the art description of the mechanics mechanisms and applications of small fatigue cracks by most of the world s leading experts in this field Topics ranging from the mechanisms of crack initiation small crack behavior in metallic intermetallic ceramic and composite materials experimental measurement mechanistic and theoretical models to the role of small cracks in fretting fatigue and the application of small crack results to the aging aircraft and high cycle fatigue problems are covered *Initiation, Growth, and Coalescence of Small Fatigue Cracks* Alten F Grandt (Jr), PURDUE UNIV LAFAYETTE IN SCHOOL OF AERONAUTICS AND ASTRONAUTICS., 1985 The objective of this effort was to determine the manner in which small fatigue cracks initiate at notches extended by cyclic loading interact with adjacent flaws and coalesce into a single dominant crack which controls final fracture The desired product was a predictive scheme capable of analyzing the early stages of fatigue crack growth which are characterized by the growth and link up of small cracks Research toward this goal was directed at the following tasks 1 Crack Growth Predictive Algorithm A computer program was developed to predict the growth and coalescence of multiple cracks located at notches 2 Crack Interaction Analysis Stress intensity factors solutions were computed for multiple cracks located at an open hole These solutions were required for the multiple crack growth algorithm 3 Crack Coalescence Experiments Fatigue tests were conducted with multiply cracked specimens to provide a data base to evaluate the predictive model The model was verified with large crack results directed toward coalescence aspects of the problem as well as small crack experiments which focused on the initial stages of fatigue crack growth and 4 Characterization of Small Cracks This phase of the effort was directed toward the growth and coalescence of physically small cracks which were expected to behave differently than large cracks *Small-crack Test Methods* James M. Larsen, 1992 Reviews the most recent methods for testing small cracks in a variety of materials providing detailed quantitative information on necessary procedures for data acquisition Emphasizes the characterization of small three dimensional fatigue cracks initiated either naturally or artificially The ei *The Growth of Naturally-generated Small Fatigue Cracks in a Nickel-base Single-crystal Superalloy* Scott Andrew Yandt, Carleton University. Dissertation. Engineering, Aerospace, 2010 *Small Fatigue Cracks and Damage Tolerant Design* Mohammad Tasleem, 1993 **A Study on the Influence of Microstructure on Small Fatigue Cracks** Gustavo Marcelo Castelluccio, 2012 In spite of its significance in industrial applications the prediction of the influence of microstructure on the early stages of crack formation and growth in engineering alloys remains underdeveloped The formation and early growth of fatigue cracks in the high cycle fatigue regime lasts for much of the fatigue life and it is strongly influenced by microstructural features such as grain size twins and

morphologica and crystallographic texture However most fatigue models do not predict the influence of the microstructure on early stages of crack formation or they employ parameters that should be calibrated with experimental data from specimens with microstructures of interest These post facto strategies are adequate to characterize materials but they are not fully appropriate to aid in the design of fatigue resistant engineering alloys This thesis considers finite element computational models that explicitly render the microstructure of selected FCC metallic systems and introduces a fatigue methodology that estimates transgranular and intergranular fatigue growth for microstructurally small cracks The driving forces for both failure modes are assessed by means of fatigue indicators which are used along with life correlations to estimate the fatigue life Furthermore cracks with meandering paths are modeled by considering crack growth on a grain by grain basis with a damage model embedded analytically to account for stress and strain redistribution as the cracks extend The methodology is implemented using a crystal plasticity constitutive model calibrated for studying the effect of microstructure on early fatigue life of a powder processed Ni base RR1000 superalloy at elevated temperature under high cycle fatigue conditions This alloy is employed for aircraft turbine engine disks which undergo a thermomechanical production process to produce a controlled bimodal grain size distribution The prediction of the fatigue life for this complex microstructure presents particular challenges that are discussed and addressed The conclusions of this work describe the mechanistic of microstructural small crack In particular the fatigue crack growth driving force has been characterized as it evolves within grains and crosses to other grains Furthermore the computational models serve as a tool to assess the effects of microstructural features on early stages of fatigue crack formation and growth such as distributions of grain size and twins

The Growth of Small Corrosion Fatigue Cracks in Alloy 2024 Robert S. Piascik,1993 *Small Fatigue Cracks.*

*Proceedings of the Engineering Foundation International Conference/ Workshop // Engineering Foundation (US) ; 2 ,1986*

Small Fatigue Cracks ,2001 Damage tolerant design and life prediction methodologies have been practiced for metallic structures for decades although their application to brittle materials such as ceramics and intermetallic alloys still poses particular problems primarily because of their extreme flaw sensitivity

**On the Initiation and Growth of Small Fatigue Cracks in Gamma-based Titanium Aluminides** Jamie Joseph Kruzic,1998 **Tests and Interpretation of Small Fatigue Crack Growth in Metallic Rotorcraft Structures with Emphasis on the Statistical Characteristics**

Marcus D. Cappelli,Robert L. Carlson,George A. Kardomateas,United States. Federal Aviation Administration. Office of Aviation Research and Development,Georgia Institute of Technology. School of Aerospace Engineering,2008 This report presents the results of an experimental program on the growth of small multisite fatigue cracks on smooth surfaces in 7075 T7351 aluminum It was shown that the resulting population of measured cracks was bimodal That is it consisted of primary cracks that can grow until failure by fracture in each specimen and secondary cracks that ultimately arrest An experimental procedure for separating the two distributions was developed and used to obtain confidence intervals for crack length versus

loading cycles A microstructurally based transition point between small and long crack behavior was also developed and used Topics for additional research that need to be further developed and applied to the bimodal model of cluster small crack growth are presented Report documentaion page

**The Behaviour of Small Fatigue Cracks, and Some Basic Modelling Approaches for the Phenomenon** Vaclav Strof,2007 *Small Fatigue Cracks* Robert O. Ritschie,J.

Lankford,1986 *A Study of Fatigue Cracks in Car Axles* Alfred Copeland Callen,Carl Herbert Casberg,Cloyde Moffett Smith,Harold Eaton Babbitt,Herbert Fisher Moore,Harry Edward Schlenz,Stuart Wellington Lyon,William H.

Spencer,Norville James Alleman,1929 **The Effects of Slip Character and Crack Closure on the Growth of Small Fatigue Cracks in Titanium-aluminium Alloys** James M. Larsen,1990 An investigation was performed to study the effects of slip character and crack closure on the propagation of small fatigue cracks in titanium aluminum alloys The materials examined were solution treated Ti 4Al and Ti 8Al as well as aged Ti 8Al The propagation of naturally initiated surface cracks of depths as small as 25 micrometers was compared with the behavior of large through thickness cracks An extensometer was used to monitor crack closure throughout the large crack tests and the closure behavior of the small cracks was measured using a computerized laser interferometric displacement gage having a displacement resolution of 0.01 micrometer The measurements of crack closure were used to compute an effective stress intensity factor range In all three alloys and for all test conditions which included a range of stress levels and stress ratios small cracks propagated faster than large cracks subjected to an equivalent  $\Delta K$  and the small cracks propagated under conditions that were significantly below the large crack threshold  $\Delta K_{th}$  Although the character and distribution of slip in Ti Al alloys may have a dramatic influence on fatigue crack initiation and on the propagation of large cracks this effect was minimal for small cracks

**Fatigue Crack Initiation and Small Crack Growth in Several Airframe Alloys** ,1990 Small Fatigue Cracks Robert O. Ritchie,James Lankford,1986 Small fatigue cracks Robert O. Ritschie,1986 Crack Opening Displacement Measurements on Small Cracks in Fatigue JM. Larsen,Jira, JR.,T. Weerasooriya,1988 A computerized interferometric displacement gage was used to monitor the crack mouth opening behavior of naturally initiated small fatigue cracks in the high strength alloy Ti6Al 2Sn 4Zr 6Mo Complete load versus crack opening displacement curves were obtained for naturally initiated semicircular cracks of surface length as small as 50  $\mu$ m For a crack of this size the maximum crack mouth opening displacement was less than 0.5  $\mu$ m and the precision of the individual displacement measurements was approximately 0.01  $\mu$ m An excellent correlation between crack mouth opening compliance and surface crack length was demonstrated and the data were shown to agree with an analytical expression for part through surface cracks A matrix of experiments was performed for a range of loading conditions and crack growth data were plotted versus the nominal  $K$  and  $K_{eff}$  which was defined using crack closure measurements Experimental measurements obtained for a small crack indicated that closure often develops discontinuously as the crack initially extends This behavior was speculated to result from the formation of individual

asperities on the fracture surface In general the interferometric method proved to be very effective and demonstrated a unique capability to monitor the behavior of very small fatigue cracks **Growth-arrest Behavior of Small Fatigue Cracks** David Lawrence Steadman,1997

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