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# Fatigue and Fracture Mechanics

37th Volume



***JAI Guest Editors:***  
Sreeramesh Kalluri  
Michael A. McGaw  
Andrzej Neimitz

**Journal of ASTM International  
Selected Technical Papers STP1526  
Fatigue and Fracture Mechanics:  
37th Volume**

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# Foreword

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THIS COMPILATION OF THE *JOURNAL OF ASTM INTERNATIONAL (JAI)*, STP1526, on *Fatigue and Fracture Mechanics: 37th Volume*, contains only the papers published in JAI that were presented at the Ninth International ASTM/ESIS Symposium on Fatigue and Fracture Mechanics (37th National Symposium on Fatigue and Fracture Mechanics) held during May 20–22, 2009 in Vancouver, BC, Canada. The Symposium was jointly sponsored by ASTM International Committee E08 on Fatigue and Fracture and the European Structural Integrity Society (ESIS).

Dr. Sreeramesh Kalluri, Ohio Aerospace Institute, Brook Park, OH, USA, Dr. Michael A. McGaw, McGaw Technology, Fairview Park, OH, USA, and Prof. Andrzej Neimitz, Kielce University of Technology, Kielce, Poland co-chaired the Symposium and served as JAI Guest Editors.



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## Overview

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This special technical publication (STP1526) is a compilation of papers presented by several authors at the Ninth International ASTM/ESIS Symposium on Fatigue and Fracture Mechanics (37th National Symposium on Fatigue and Fracture Mechanics) and published in the Journal of ASTM International (JAI) after successful peer reviews. The International Symposium was jointly sponsored by ASTM Committee E08 on Fatigue and Fracture and the European Structural Integrity Society. The Symposium was held during May 20–22, 2009 in Vancouver, British Columbia, Canada, in conjunction with the May 18–19, 2009 standards development meetings of ASTM Committee E08.

The opening Jerold L. Swedlow memorial lecture was delivered at the Symposium by Professor Dr.-Ing. Karl-Heinz Schwalbe on analytical models for fatigue crack propagation and fracture. The symposium focused on three major tracks of fatigue and fracture of structures and materials under 1) thermomechanical conditions, 2) multiaxial loading conditions, and 3) application of cohesive zone models to fracture problems. In addition, several papers were presented at the Symposium in the traditional areas of fatigue behavior, fracture mechanics and mechanisms, fatigue crack propagation, and effects of residual stresses on fatigue and fracture.

In the last decade, physics- and mechanics-based approaches gained prominence in assessing fatigue and fracture related design lives of structures used in aerospace, surface transportation, power generation, biomedical, and petroleum industries. Advanced structures in these industries utilize specially engineered materials with heterogeneous properties (for example, materials with coatings as thermal barriers or to resist wear and corrosion) that serve multiple purposes and require application of mechanics at both micro- and macro-scales to estimate the damages associated with fatigue and fracture. In particular, estimating the remaining lives of such structures under prototypical loading conditions poses significant challenges during the operation of those structures. Complexities associated with the challenges increase significantly when the advanced structures are subjected to loads in multiple directions and nonisothermal loading conditions. Papers presented at the Symposium and compiled in this STP (after publication in JAI) address some of these challenging areas.

A total of 33 papers, including the Jerold L. Swedlow memorial lecture paper, are compiled in this STP. The remaining 32 papers are grouped into the following categories: 1) elastic—plastic fracture mechanics and fracture mechanisms, 2) fatigue behavior and life estimation, 3) fatigue crack growth, 4) multiaxial fatigue and fracture, 5) residual stress effects on fatigue and fracture, 6) fatigue and fracture under thermomechanical conditions, and 7) application of fracture mechanics and cohesive zone models. It is our sincere hope that papers compiled in this STP advance the state-of-

the-art in analytical methods and testing techniques for fatigue and fracture mechanics. In addition, some of the papers documented in this STP are expected to promote the development of fatigue and fracture related standards within ASTM Committee E08.

We would like to thank all the authors for their valuable contributions to the STP and all the reviewers for their thorough reviews, which substantially improved the quality of published papers. We are grateful to Ms. Dorothy Fitzpatrick and Ms. Hannah Sparks at ASTM International for their meticulous organization of the Symposium, Ms. Susan Reilly at ASTM International for her help with the STP, and Ms. Linda Boniello at the American Institute of Physics (AIP) for her excellent coordination of peer reviews for all the papers and publication of the manuscripts in JAI.

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