Residual Stresses In Composite Materials Measurement Modeling Amp Effects On Thermo Mechanical Behavior-residual Stress Measurement By Diffraction And Interpretation

#residual stress in composite materials #composite stress measurement #diffraction residual stress #thermo mechanical behavior composites #modeling residual stress composites

Explore the critical area of residual stresses in composite materials, covering essential measurement techniques, with a focus on diffraction and its interpretation. This content also delves into advanced modeling approaches for these stresses and their significant effects on the thermo-mechanical behavior of composites, providing a comprehensive understanding for researchers and engineers.

Residual Stresses in Composites

This volume contains the proceedings of a conference on the residual stresses in composites. It offers three interrelated objectives: present developments in the measurement of residuals composites; present analytical predictions of residual stresses and their impact on composite properties; and documents the role of the residual stresses during thermo-mechanical excursions of the composites.

Residual Stresses in Composites

Intermetallic matrix composites develop residual stresses from the large thermal expansion mismatch (delta-alpha) between the fibers and matrix. This work was undertaken to: establish improved techniques to measure these thermal stresses in IMC's; determine residual stresses in a variety of IMC systems by experiments and modeling; and, determine the effect of residual stresses on selected mechanical properties of an IMC. X ray diffraction (XRD), neutron diffraction (ND), synchrotron XRD (SXRD), and ultrasonics (US) techniques for measuring thermal stresses in IMC were examined and ND was selected as the most promising technique. ND was demonstrated on a variety of IMC systems encompassing Ti- and Ni-base matrices, SiC, W, and Al2O3 fibers, and different fiber fractions (Vf). Experimental results on these systems agreed with predictions of a concentric cylinder model. In SiC/Ti-base systems, little yielding was found and stresses were controlled primarily by delta-alpha and Vf. In Ni-base matrix systems, yield strength of the matrix and Vf controlled stress levels. The longitudinal residual stresses in SCS-6/Ti-24Al-llNb composite were modified by thermomechanical processing. Increasing residual stress decreased ultimate tensile strength in agreement with model

predictions. Fiber pushout strength showed an unexpected inverse correlation with residual stress. In-plane shear yield strength showed no dependence on residual stress. Higher levels of residual tension led to higher fatigue crack growth rates, as suggested by matrix mean stress effects. Wright, P. K. and Sensmeier, M. D. and Kupperman, D. S. and Wadley, H. N. G. Unspecified Center MECHANICAL PROPERTIES; METAL MATRIX COMPOSITES; MICROSTRUCTURE; NEUTRON DIFFRACTION; RESIDUAL STRESS; STRESS MEASUREMENT; THERMAL STRESSES; ULTRASONICS; X RAY DIFFRACTION; CONCENTRIC CYLINDERS; CRACK PROPAGATION; FATIGUE (MATERIALS); FIBER STRENGTH; FRACTURE STRENGTH; SHEAR STRENGTH; TENSILE STRENGTH; THERMAL EXPANSION; YIELD STREN...

Thermomechanical fatigue behavior of materials

Engineering Applications of Residual Stress represents one of eight volumes of technical papers presented at the Society for Experimental Mechanics Annual Conference on Experimental and Applied Mechanics, held at Uncasville, Connecticut, June 13-16, 2011. The full set of proceedings also includes volumes on Dynamic Behavior of Materials, Mechanics of Biological Systems and Materials, Mechanics of Time-Dependent Materials and Processes in Conventional and Multifunctional Materials, MEMS and Nanotechnology; Optical Measurements, Modeling and, Metrology; Experimental and Applied Mechanics, and Thermomechanics and Infra-Red Imaging.

Thermal Stress Effects in Intermetallic Matrix Composites

The European Conference on Residual Stresses (ECRS) series is the leading European forum for scientific exchange on internal and residual stresses in materials. It addresses both academic and industrial experts and covers a broad gamut of stress-related topics from instrumentation via experimental and modelling methodology up to stress problems in specific processes such as welding or shot-peening, and their impact on materials properties. Chapters: Diffraction Methods; Mechanical Relaxation Methods; Acoustic and Electromagnetic Methods; Composites, Nano and Microstructures; Films, Coatings and Oxides; Cold Working and Machining; Heat Treatments and Phase Transformations; Welding, Fatigue and Fracture: Stresses in Additive Manufacturing.

Engineering Applications of Residual Stress, Volume 8

The complex geometry of cylinder heads in heavy-duty diesel engines makes grey iron or compact graphite iron a preferred material choice due to its price, castability, thermal conductivity and damping capacity. Today’s strict emission laws have increased the demands on engine performance and engine efficiency. This means that material properties such as fatigue resistance need to be improved. Shot peening is often used to improve the fatigue resistance of components and the benefits of shot peening are associated with the induced compressive surface stresses and surface hardening. How different shot peening parameters can affect fatigue strength of grey and compact graphite iron has been investigated within the project underlying this thesis. To do this, X-ray diffraction (XRD) was utilized for residual stress measurements, scanning electron microscopy (SEM) for microstructural characterizations and mechanical fatigue testing for mechanical quantifications. The ultimate aim of this work has been to increase the fatigue resistance of cast iron by residual stress optimization. XRD measurements and SEM examinations revealed that the shot peening parameters shot size and peening intensity significantly influence residual stresses and surface deformation. Residual stress profiles, similar to the one general considered to improve the fatigue strength in steels, were obtained for both grey and compact graphite iron. Uniaxial push-pull fatigue testing on grey iron with these shot peening parameters reduced the fatigue strength with 15–20 %. The negative effect is likely related to surface damage associated with over peening and relatively high subsurface tensile residual stresses. With very gentle shot peening parameters, the uniaxial fatigue strength were unaltered from the base material but when subjected to bending fatigue an increase in fatigue strength were observed. An alternative way to increase the fatigue strength was to conduct a 30 min annealing heat treatment at 285 XC which increased the fatigue strength by almost 10 % in uniaxial loading. The improvement could be an effect of favourable precipitates forming during the annealing, which could hinder dislocation movement during fatigue. Measuring residual stresses using XRD and the sin2 -method demands accurate X-ray elastic constants (XEC) for meticulous stress analysis. The XEC referred to as 1~2s2 should therefore always be calibrated for the specific material used. The experiments conducted revealed that the XEC value is independent of the testing method used in this work. A small correction from the theoretical value should be applied when the material contains small amounts of residual

stresses. The amount of residual stresses has a great impact on the XEC and thus on the stress analysis. Concluding that proper analysis of residual stresses in cast iron is not straight forward.

Residual Stresses 2018

Includes papers on the effects of residual stress on materials properties. Measurement methods and techniques are covered in a number of papers that describe applications of X-ray diffraction, Barkhausen noise, ultrasonic velocity and neutron diffraction. Prediction of residual stresses described include applications to metal welding, forging and forming as well as ceramic matric composites and those developed by manufacturing processes.

Residual stresses, fatigue and deformation in cast iron

Papers presented at the March 1994 symposium are organized into five sections that progress from basic understanding of mechanical damage mechanisms and environmental effects to life prediction methodology. Five papers discuss the interplay between interfacial strength, residual thermal stresses, an

Practical Applications of Residual Stress Technology

Of interest to researchers and practitioners in materials science, especially in the aerospace industry, 16 papers from a symposium in Atlanta, Georgia, November 1988 discuss the analysis, modeling, and behavior of both continuous and discontinuous ceramic and metal matrix composites, and methods of

Life Prediction Methodology for Titanium Matrix Composites

"Commercially available finite element modeling software (ABAQUS) was used to investigate the internal residual stresses that develop as a result of cooling from processing temperatures in ZrB2-SiC ceramics. The size and shape of the SiC particles were varied to evaluate their effect on the residual stresses. Results were compared to experimental data and showed similar trends, where increasing SiC particle size increased tensile stress and also decreased strength. Models were used to analyze benefits of novel shaped SiC inclusions and also better understand the short comings of the composites. An attempt to validate the models using neutron diffraction to measure residual stress led to the fabrication of ZrB2-SiC composites made using isotopically pure 11B and a reaction hot pressing technique. Natural boron in conventional ZrB2 ceramics had to be replaced with the 11B (0.0055 barns) due to the high thermal neutron absorption of natural boron (767 barns). Neutron diffraction experiments were successfully performed at Argonne National Laboratory, however, stress free reference samples for ZrB2 and SiC must still be measured to complete the residual stress analysis. ZrB2-SiC ceramics made from 11B were characterized to confirm a complete reaction and full density. The microstructure was compared to natural B ZrB2-SiC ceramics to confirm equivalent grain size. Effects on the thermal properties by the 11B isotope were studied by measuring thermal diffusivity of both natural boron and 11B containing ZrB1-SiC specimens at Oak Ridge National Laboratory. The thermal conductivity and thermal expansion were both determined to be lower for the 11B containing materials--Abstract, leaf iv

Thermal and Mechanical Behavior of Metal Matrix and Ceramic Matrix Composites

The purpose of this effort was to develop and demonstrate a method of experimentally determining both elastic and plastic strain distributions in metallic materials. This was accomplished by recording minute temperature changes on the surface of the material as it was subjected to various loading conditions. Mathematical relationships relating these changes to the strain in the material was developed and verified. Much of the success of this effort was due to the development of thermocouple attachment and readout technique that recorded minute temperature changes (0.1 degree centigrade) at ten millisecond sample intervals. This small time period sampling assures that heat has not been conducted away from the thermocouple attachment point. The thermocouples consisting of two .13 mm dissimilar metal wires were attached to the surface 0.1 mm apart by discharging a large capacitor grounded to the specimen. The small size permits the mounting of several thermocouples in a small area. The determination of plastic zone outlines is thereby facilitated.

Modeling and Measurement of Thermal Residual Stresses and Isotope Effects on Thermo Physical Properties of ZrB2-SiC Ceramics

We extended a previous model due to the PIs for the evolution of the properties of curing thermoset resins to the BMI/SOC resins of interest to the Air Force. The model was used to estimate the cure stresses in this system in an ideally and isotropically constrained system. The results were surprising in the large magnitude of the stresses predicted and showed that judicious selection of polymer materials for low values of the then%al pressure coefficient will reduce thermal stresses by as much as a factor of three. Also, two distinct methods for measuring isotropic residual stresses were developed and demonstrated. A spherical "bomb" geometry was developed and provided a method of measuring isotropic stresses during cure when stresses remained below approximately 35 MPa. A thick-willed cylindrical geometry combined with lock-in amplifier electronics to excite the strain gages was developed for high stress measurements%-pressures as high as 300 MPa were readily achieved, which is not possible with conventional thin- walled cylinders or with the thin-walled sphere just mentioned. More importantly, in the process of developing the thick-walled cylinder method, we demonstrated that the classical thin-walled tube method of constraining resins in an isotropic state of stress does not actually produce the isotropy expected. Measurements tend to be incorrect and are biased by the fact that the stresses are anisotropic. Hence, the thick-walled cylinder is a true improvement in measurement technology. Using this geometry, we performed the entire cure and post-cure under compression and observed over two hundred MPa cure stresses for model thermosetting resinsconsistent with our model predictions. Our work leads us to conclude that reduction of isotropic residual stresses in them%osetting composites must focus on the reduction of thermal stresses through a reduction in the thermal pressure coefficient rather than focusing on reducing cure shrinkage.

Temperature Based Stress Analysis of Notched Members

Selected, peer reviewed papers from the 8th European Conference on Residual Stresses, ECRS8, Riva del Garda, Italy 26-28 June 2010

Residual Stresses in Thermosetting Resins for Polymer Matrix Composites: Modeling and Effects on Long Term Performance

The field of Residual Stresses is surprisingly large, and also highly interdisciplinary in nature, both with regard to its applications and to its scientific and technological fundamentals. Volume is indexed by Thomson Reuters CPCI-S (WoS).

Residual Stresses VIII

A three-dimensional finite element program called VISCOPAC was developed and used to conduct a micromechanics analysis of titanium metal matrix composites. The VISCOPAC program uses a modified Eisenberg-Yen thermo-viscoplastic constitutive model to predict matrix behavior under thermomechanical fatigue loading. The analysis incorporated temperature-dependent elastic properties in the fiber and temperature-dependent viscoplastic properties in the matrix. The material model was described and the necessary material constants were determined experimentally. Fiber-matrix interfacial behavior was analyzed using a discrete fiber-matrix model. The thermal residual stresses due to the fabrication cycle were predicted with a failed interface. The failed interface resulted in lower thermal residual stresses in the matrix and fiber. Stresses due to a uniform transverse load were calculated at two temperatures, room temperature and an elevated temperature of 650°C. At both temperatures, a large stress concentration was calculated when the interface had failed. The results indicate the importance of accurately accounting for fiber-matrix interface failure and the need for a micromechanics-based analytical technique to understand and predict the behavior of titanium metal matrix composites.

Residual Stresses VII, ICRS7

"ASTM Stock Number: STP1428. - "Fourth Symposium on Thermomechanical Fatigue Behavior of Materials, held in Dallas, Texas on November 7-8, 2001. The Symposium was sponsored by ASTM Committee E08 on Fatigue and Fracture and its Subcommittee E08.05 on Cyclic Deformation and Fat. - Includes bibliographical references and indexes. ASTM International; 2011.

Thermo-mechanical Fatigue Behavior of Materials

This book presents the proceedings of the International Conference on Residual Stresses 10 and is devoted to the prediction/modelling, evaluation, control, and application of residual stresses in engineering materials. New developments, on stress-measurement techniques, on modelling and prediction of residual stresses and on progress made in the fundamental understanding of the relation between the state of residual stress and the material properties, are highlighted. The proceedings offer an overview of the current understanding of the role of residual stresses in materials used in wide ranging application areas.

Residual Stress Effects in Fatigue

This book presents the proceedings of the International Conference on Residual Stresses 9 and is devoted to the prediction/modelling, evaluation, control, and application of residual stresses in engineering materials. The state of the art is presented by the contributions of researchers from both academia and industry. New developments, on stress-measurement techniques, on modelling and prediction of residual stresses and on progress made in the fundamental understanding of the relation between the state of residual stress and the material properties, are highlighted. Focal points of interest are: simulation of stress profiles, depth-resolved stress analysis using synchrotron radiation and phase transformations in welded structures. This book offers an indispensable overview of the current understanding of the role of residual stresses in materials used in wide ranging application areas, such as, for example, microelectronic devices, sensors and actuators and machine parts, as in the automotive industry. Volume is indexed by Thomson Reuters CPCI-S (WoS).

Time-dependent Deformation of Titanium Metal Matrix Composites

Conference held May 1986 in Charleston, South Carolina. Twenty-seven papers represent the following areas; analysis; impact and compression; materials characterization; failure mechanisms; nondestructive evaluation; filament wound and woven composites. Annotation copyrighted by Book News, Inc., Portland, OR.

Thermomechanical Fatigue Behavior of Materials

Challenges in Mechanics of Time-Dependent Materials and Processes in Conventional and Multifunctional Materials, Volume 2 represents one of seven volumes of technical papers presented at the Society for Experimental Mechanics SEM 12th International Congress & Exposition on Experimental and Applied Mechanics, held at Costa Mesa, California, June 11-14, 2012. The full set of proceedings also includes volumes on: Dynamic Behavior of Materials, Imaging Methods for Novel Materials and Challenging Applications, Experimental and Applied Mechanics, 2nd International Symposium on the Mechanics of Biological Systems and Materials 13th International Symposium on MEMS and Nanotechnology and, Composite Materials and the 1st International Symposium on Joining Technologies for Composites.

Proposed Framework for Thermomechanical Life Modeling of Metal Matrix Composites

Hard coating’s thermal stability is essential due to the high temperature environment of high-speed cutting applications, while the phase and microstructure evolution induced by exposing the coating to high temperature affects the mechanical properties. In this thesis, the mechanical stability of arc-evaporated, hard, transition metal nitride coatings annealed at high temperature is analyzed and related to the phase and microstructure evolution. In addition to hardness, fracture toughness is evaluated by surface and cross-sectional investigations by scanning/transmission electron microscopy of damage events following mechanical tests. The crack resistance of Ti1?xAlxN with a range of Al content (x = 0.23-0.82) was studied by contact fatigue tests, where the differences in the microstructure were found to play a major role. Superior mechanical properties were found in Ti0.63Al0.37N; in the as-deposited state as a result of a favorable grain size, and after annealing at 900o C due to the microstructure formed during spinodal decomposition. The mechanical and high-temperature properties of hard coatings can be enhanced by alloying or multi-layering. Within this work, quaternary Ti-Al-X-N (X = Cr, Nb and V) alloys were studied and superior toughness was found for TiAl(Nb)N in both the as-deposited and annealed (1100? C) states. The hexagonal (h)-AlN formation in cubic (c)-TixAl0.37Cr1?0.37?xN (x = 0.03 and 0.16) was analyzed by in-situ x-ray scattering during annealing. The energy for h-AlN formation was found to be dependent on the microstructure evolution during annealing, which varies with the coating composition. High Al content h-ZrAlN/c-TiN and h-ZrAlN/c-ZrN multilayers were investigated through scratch tests followed by focused ion-beam analysis of the crack propagation. A c-Ti(Zr)N

phase forms in h-ZrAlN/c-TiN multilayers at high temperatures and that contributes to enhanced hardness and fracture toughness by keeping the semi-coherent sub-interfaces. Finally, an in-situ analysis of coatings by x-ray scattering during a turning process was carried out. It demonstrates the possibility of observation of stress evolution and thermal expansion of the coatings or the work piece material during machining. This experiment provides real-time information on the coating behavior during cutting. Hårda skikts högtemperaturstabilitet är viktig på grund av den höga temperaturskikten utsätts för under skärande bearbetning, och den utveckling av faser och mikrostruktur som då sker påverkar skiktets mekaniska egenskaper. I den här avhandlingen har den mekaniska stabiliteten hos arcförångade, hårda metallnitridskikt som värmebehandlats vid höga temperaturer studerats. Förutom hårdhet har även skiktens seghet utvärderats genom yt- och tvärsnittsstudier av den sprickbildning som uppstår vid mekanisk provning med hjälp av svep- och transmissionselektronmikroskopi. Segheten hos Ti1?xAlxN skikt med varierande Al-halt (x = 0.23-0.82) studerades genom utmattningsprovning och resultaten visar att förändringar i mikrostrukturen spelar en stor roll. Ti0.63Al0.37N skikten hade överlägsna mekaniska egenskaper; på grund av en fördelaktig kornstorlek i de obehandlade skikten och efter värmebehandling som ett resultat av det spinodala sönderfall som skett. De mekaniska egenskaperna och högtemperaturegenskaperna hos hårda skikt kan förbättras genom legering eller genom multilagring. I den här avhandlingen har kvarternära Ti-Al-X-N (X = Cr, Nb eller V) skikt studerats och TiAl(Nb)N skikten hade en överlägsen seghet i både obehandlat och värmebehandlat (1100oC) tillstånd. Bildandet av h-AlN i TixAl0.37Cr1?0.37?xN (x = 0.03 and 0.16) skikt studerades genom in situ röntgenspridning under värmebehandling. Den energi som krävs för att bilda h-AlN beror av mikrostrukturutvecklingen under värmebehandling vilken i sin tur beror av skiktens kemiska sammansättning. h-ZrAlN/c-TiN och h-ZrAlN/c-ZrN multilager med hög Al-halt undersöktes genom reptester följda av tvärsnittsstudier av sprickbildningen genom en analys med en fokuserad jonstråle (FIB). En c-Ti(Zr)N fas bildas vid höga temperaturer i h-ZrAlN/c-TiN multilagren och det bidrar till förhöjd hårdhet och förbättrad seghet på grund av en bibehållen koherens mellan lagren. Slutligen har in situ röntgenspridningsstudier av ytskikt utförts vid svarvning. Studien visar på möjligheten att observera spänning och värmeutvidgning av skikten eller arbetsmaterialet under bearbetning. Experimenten ger information om skiktens beteende under bearbetning i realtid. La estabilidad térmica del recubrimiento es esencial debido a que estos recubrimientos durante su aplicación son utilizados a elevada temperatura y a alta velocidad. Durante dicho proceso, la evolución microestructural afecta a las propiedades mecánicas. En dicha tesis, la estabilidad mecánica de los recubimientos duros base nitruro producidos mediante arco y recocidos a elevada temperatura son analizados y se correlacionado con su transformación de fase. La dureza, la resistencia a la fractura son evaluados mediante la observación tanto superficial como transversal mediante microscopia electrónica de barrido. La resistencia a la propagación de grieta de Ti1?xAlxN con un contenido en Al que fluctúa entre 0.23-0.82 se estudia mediante ensayos de fatiga por contacto, donde la diferencia microstructural juega un papel importante. Las mejores propiedades mecánicas se encentran en las muestras con un 0.63 de Ti donde se ha realizado un proceso de recocido a 900o C debido a la descomposición espinoidal. Las características mecánicas y de alta temperatura de recubrimientos duros pueden ser mejoradas si tenemos un recubrimiento multicapa. Aleaciones cuaternarias de Ti-Al-X-N (X = Cr, Nb y V) son estudiada, y una mejor tenacidad de fractura se encuentra para la muestra TiAl(Nb)N sin tratamiento de recocido como recocida a 1000ºC. La formación del AlN con una estructura hexagonal en la muestra TixAl0.37Cr1?0.37?xN (x = 0.03 y 0.16) son analizadas mediante ensayos in-situ de difracción de rayos X durante el proceso de recocido. Cabe mencionar que la energía cinética para la formación de la AlN con una estructura hexagonal depende del proceso de recocido, la cual hace variar la composición química del recubrimiento. Multicapas de h (hexagonal)-ZrAlN/c (cúbica)-TiN con un elevado contenido de Al son estudiadas mediante ensayos de rayado y la generación de daño es observado mediante la técnica del haz de iones focalizados. Las formas de la fase de c-Ti(Zr)N en las multicapas de (h)-ZrAlN/c-TiN formadas a elevadas temperaturas contribuyen a mejorar la dureza y la tenacidad de fractura manteniendo la semicoherencia en las intercaras entre cada capa. Finalmente, se realiza un análisis in-situ de los diferentes recubrimientos me diante dispersión de rayos X durante un proceso de torneado. En este caso, se demuestra la posibilidad de observar la evolución de las tensiones residuales y de la expansión térmica durante el proceso de conformado. Dicho experimentos proporciona información en tiempo real sobre el comportamiento del recubrimiento en condiciones de servicio.

Residual Stresses 2016

The authors explain the changes in the thermophysical and thermomechanical properties of polymer composites under elevated temperatures and fire conditions. Using microscale physical and chemical concepts they allow researchers to find reliable solutions to their engineering needs on the macroscale. In a unique combination of experimental results and quantitative models, a framework is developed to realistically predict the behavior of a variety of polymer composite materials over a wide range of thermal and mechanical loads. In addition, the authors treat extreme fire scenarios up to more than 1000?C for two hours, presenting heat-protection methods to improve the fire resistance of composite materials and full-scale structural members, and discuss their performance after fire exposure. Thanks to the microscopic approach, the developed models are valid for a variety of polymer composites and structural members, making this work applicable to a wide audience, including materials scientists, polymer chemists, engineering scientists in industry, civil engineers, mechanical engineers, and those working in the industry of civil infrastructure.

International Conference on Residual Stresses 9 (ICRS 9)

These facsimiles of 16 contributions from the symposium held in May 1996 in Orlando provide information on the behavior of materials and structures. The authors describe novel ways to measure point to point deformation (or strain, when normalized), procedures for measuring crack length and the stres

Composite Materials

Emphasizing fiber-matrix adhesion and its characterization in composite materials, reports results from applying the most commonly used test methods, such as fragmentation, pull-out, and indentation, to high-performance composites and their constituents. The 13 papers were presented at a symposium i

The Effect of Interface on Thermo-mechanical Properties of Composites

The global energy consumption is increasing and together with global warming from greenhouse gas emission, create the need for more environmental friendly energy production processes. Higher efficiency of biomass power plants can be achieved by increasing temperature and pressure in the boiler section and this would increase the generation of electricity along with the reduction in emission of greenhouse gases e.g. CO2. The power generation must also be flexible to be able to follow the demands of the energy market, this results in a need for cyclic operating conditions with alternating output and multiple start-ups and shut-downs. Because of the demands of flexibility, higher temperature and higher pressure in the boiler section of future biomass power plants, the demands on improved mechanical properties of the materials of these components are also increased. Properties like creep strength, thermomechanical fatigue resistance and high temperature corrosion resistance are critical for materials used in the next generation biomass power plants. Austenitic stainless steels are known to possess such good high temperature properties and are relatively cheap compared to the nickel-base alloys, which are already operating at high temperature cyclic conditions in other applications. The behaviour of austenitic stainless steels during these widened operating conditions are not yet fully understood. The aim of this licentiate thesis is to increase the knowledge of the mechanical behaviour at high temperature cyclic conditions for austenitic stainless steels. This is done by the use of thermomechanical fatigue- and creepfatigue testing at elevated temperatures. For safety reasons, the effect of prolonged service degradation is investigated by pre-ageing before mechanical testing. Microscopy is used to investigate the microstructural development and resulting damage behaviour of the austenitic stainless steels after testing. The results show that creep-fatigue interaction damage, creep damage and oxidation assisted cracking are present at high temperature cyclic conditions. In addition, simulated service degradation resulted in a detrimental embrittling effect due to the deterioration by the microstructural evolution.

Challenges in Mechanics of Time-Dependent Materials and Processes in Conventional and Multi-functional Materials, Volume 2

The fabrication of metal matrix composites poses unique problems to the materials engineer. The large thermal expansion coefficient (CTE) mismatch between the fiber and matrix leads to high tensile residual stresses at the fiber/matrix (F/M) interface which could lead to premature matrix cracking during cooldown. Fiber coatings could be used to reduce thermal residual stresses. A simple closed-form analysis, based on a three-phase composite cylinder model, was developed to calculate thermal residual stresses in a fiber/interphase/matrix system. Guidelines, in the form of simple equations, for the

selection of appropriate material properties of the fiber coating were also derived to minimize thermal residual stresses in the matrix during fabrication.

Mechanical and thermal stability of hard nitride coatings

Book is organized around new experiments in and modeling of fatigue and its effects over a range of composite materials subjected to multiple mechanical and thermal stresses. An objective of the investigations discussed is to explain failure mechanisms and improve long-term loading prediction and performance. Chapters in the book are edited and refereed presentations made at the most recent ICFC5 conference, held in Nanjing, China.TABLE OF CONTENTS Preface •Fatigue Life Assessment via Ply-By-Ply Stress Analysis Under Biaxial Loading F. Schmidt, T. J. Adam and P. Horst •A Residual Stiffness—Residual Strength Coupled Model for Composite Laminate Under Fatigue Loading W. Lian •Damage in Thermoplastic Composite Structures: Application to High Pressure Hydrogen Storage Vessels C. Thomas, F. Nony, S. Villalonga and J. Renard •Cyclic Interlaminar Crack Growth in Uni-directional and Braided Composites S. Stelzer, G. Pinter, M. Wolfahrt, A. J. Brunner and J. Noisternig •Experimental Analysis and Modelling of Fatigue Behaviour of Thick Woven Laminated Composites P. Nimdum and J. Renard •Fatigue Behaviour of Woven Composite p Joint J. Zhang, Y. Fu, L. Zhao, X. Liang, H. Huang and B. Fei •Monotonic and Cyclic Deformation Behavior of Ultrasonically Welded Hybrid Joints Between Light Metals and Carbon Fiber Reinforced Polymers (CFRP) F. Balle and D. Eifler •Fatigue-Driven Residual Life Models Based on Controlling Fatigue Stress and Strain in Carbon Fibre/Epoxy Composites J. J. Xiong, J. B. Bai and C. Y. Luo •An Energy-Based Fatigue Approach for Composites Combining Failure Mechanisms, Strength and Stiffness Degradation H. Krüger, R. Rolfes and E. Jansen •Fatigue Life Prediction Of Off-Axis Unidirectional Laminate F. WU and W.-X. YAO •Thermal Fatigue of AX41 Magnesium Alloy Based Composite Studied Using Thermal Expansivity Measurements Z. Drozd, Z. Trojanová and P. Luká •Fabrication of TI/APC-2 Nanocomposite Laminates and Their Fatigue Response at Elevated Temperature M.-H. R. Jen, C.-K. Chang, Y.-C. Sung and F.-C. Hsu •Fatigue and Fracture of Elastomeric Matrix Nanocomposites C. Bathias and S. Dong •Fatigue Delamination of Carbon Fiber Fabrics Reinforced PPS Laminates J. Bassery and J. Renard •Damage Mechanism and Fatigue Behaviour of Uniaxially and Sequentially Loaded Wound Tube Specimens F. Schmidt and P. Horst •Influence of Thermal and Mechanical Cycles on the Damping Behaviour of Mg Based-Nanocomposite Z. Trojanová, A. Makowska-Mielczarek, W. Riehemann and P. Luká •Delamination Detection in CFRP Laminates Using A0 and S0 Lamb Wave Modes N. Hu, Y.-L. Liu, H. Fukunaga and Y. Li •Calorimetric Analysis of Dissipative Effects Associated with the Fatigue of GFRP Composites H. Sawadogo, S. Panier and S. Hariri •Correlation Between Crack Propagation Rate and Cure Process of Epoxy Resins V. Trappe, S. Günzel and M. Jaunich Author Index

Swedish Symposium on Residual Stresses

This report reviews the most important studies undertaken of the compressive failure mechanisms encountered in modern composite materials. It considers first the behaviour of unidirectional laminates, followed by unnotched and notched multidirectional structures. It then considers existing theoretical models. An additional indexed section containing several hundred abstracts from the Rapra Polymer Library database provides useful references for further reading.

High Temperature Performance of Polymer Composites

The seventh European Conference on Residual Stresses (ECRS7), was held in Berlin, Germany, on the 13-15th September 2006. These rapidly published proceedings contain the oral and poster contributions which were presented at the conference. They have been grouped into topic areas covering: measurement techniques, generation of residual stresses by manufacturing, processing of materials, modelling and computation of residual stresses, residual stresses in thin layers, residual stresses in multiphase materials , micro and intergranular residual stresses, andesidual stresses and phase transformation.

Nontraditional Methods of Sensing Stress, Strain, and Damage in Materials and Structures

Composite material systems are the basis for much of the natural world around us and are rapidly becoming the basis for many modern engineering components. A controlling feature for the general use of such systems is their damage tolerance, durability and reliability. The present book is a comprehensive cross section of the state of the art in the field of the durability of polymer-based, composite, and adhesive systems. As such, it is of special value to researchers concerned with the

frontier of the field, to students concerned with the substance of the subject, and to the applied community concerned with the finding methodologies that make it possible to design safe and durable engineering components using material systems.

Fiber, Matrix, and Interface Properties

Simulation of the Thermomechanical Behavior of Fiber Reinforced Thermoset Composites