Nondestructive Evaluation Of Adhesive Bonds Using 20 Mhz And 25 Khz Ultrasonic Frequencies On Metal And Polymer Assemblies

After decades of work to develop bonded primary structures for DoD and NASA applications, there has been little use of adhesive-bonded joints in critical structures. A primary barrier to application of adhesive-bonded structures is a perception of poor reliability. To meet current and future requirements, a review and evaluation of the current state-of-the-art of the NDE knowledge base and hardware for assessing the quality, reliability and integrity of adhesive bonds has been performed by NTIAC with the results documented in this report.

Focusing on visual and optical inspection, ultrasonics, acoustic emission, dynamic techniques, X-ray radiography, material characterization, industrial applications and qualification programmes, this book is intended for engineers and researchers, as well as teachers and graduate students.

Both solid knowledge of the basics as well as expert knowledge is needed to create rigid, long-lasting and material-specific adhesions in the industrial or trade sectors. Information that is extremely difficult and time-consuming to find in the current literature. Written by specialists in various disciplines from both academia and industry, this handbook is the very first to provide such comprehensive knowledge in a compact and well-structured form. Alongside such traditional fields as the properties, chemistry and characteristic behavior of adhesives and adhesive joints, it also treats in detail current practical questions and the manifold applications for adhesives.

In the current volume, consisting of Parts A and B, edited vers ions of most of the papers presented at the annual Review of Progress in Quantitative Nondestructive Evaluation held at Bowdoin College, Brunswick, Maine on July 28-August 2, 1991 have been collected. The Review was organized by the Center for NDE at Iowa State University and the Ames Laboratory of the USDOE in cooperation with a number of organizations including the Air Force Materials Directorate, Wright Laboratory, Wright Patterson Air Force Base, the American Society for Nondestructive Testing, the Center for NDE at Johns Hopkins University, Department of Energy, Federal Aviation Administration, National Institute of Standards and Technology, National Science Foundation IndustryjUniversity Cooperative Research Centers, and the Office of Naval Research. The 1991 Review of Progress in QNDE was attended by approximately 450 participants from the US and many foreign countries who presented over 360 papers. Divided into 36 sessions, with as many as four sessions running concurrently, the meeting covered all phases of NDE development from basic research to engineering applications and all methods of inspection science from acoustics to x-rays. Over the past ten years, the participants of the Review have seen it grow into one of the largest and most significant gatherings of NDE researchers and engineers anywhere in the world. By sharing their work at this conference, they deserve much credit for its success.

Examines the initiation and growth of fatigue cracks and the fracture toughness of advanced materials such as silicon nitride, special alloys and steels, thermoplastics, and graphite-epoxy composites; and explains several non-destructive techniques to evaluate such materials for manufacturing defect

This single-source reference is designed for anyone who is responsible for selecting the bestsurface treatment and a compatible adhesive for a particular design.Filled with over 300 photos, figures, and tables, Adhesive Bonding of Aluminum Alloyspresents clear analytical methods for examining the adequacy of bonded joints ... methodsfor chemical analysis of an adhesive and primer ... specific instructions on how to anodizealuminum alloys for three different surface treatments .. . recommended primers foranodized alloys ... examples that help you verify fail-safe capacity ... and more.In addition, this guide gives you the latest chemical analysis methods for control, proventest procedures for mechanical durability properties, a wide selection of nondestructive inspectionprocedures, and numerous surface analysis methods.Adhesive Bonding of Aluminum Alloys can be of immediate assistance to materials, mechanical,design, process, manufacturing, automotive, aeronautical, corrosion, and maintenanceengineers; designers and manufacturers of primary and secondary aluminum structures;adhesive scientists; testing and material specialists; and upper-division undergraduateand graduate-level researchers in materials, aeronautical design, and adhesive science.

Surface Treatment in Bonding Technology provides valuable advice on surface treatment methods, modern measuring devices, and the appropriate experimentation techniques that are essential to create strong joints with a reliable service life. The book's focus is on the detailed and up-to-date analysis of surface treatment methods for metallic and polymer substrates. An analysis of factors affecting the surface preparation stage, together with advice on selection, is also provided. Essential theory is combined with experimentation techniques and industry practice to provide a guide that is both practical and academically rigorous. Including a general introduction to bonding, as well as coverage of mechanical, chemical and electrochemical methods, this book is the ideal primer for anyone working with or researching adhesive bonding. Provides detailed descriptions of surface treatments and their mechanisms that will help readers build a deep understanding of these fundamental techniques Includes a thorough survey of recent advances in research in surface treatments of metals and polymers Provides technical advice on experimental testing methods throughout the book

Advanced composite materials are widely used for many structural applications in the aerospace/aircraft industries today. Joining of composite structures using adhesive bonding offers several advantages over traditional fastening methods. However, this technique is not yet employed for fastening the primary structures of aircrafts or space vehicles. There are several reasons for this: There are not any reliable non-destructive evaluation (NDE) methods that can quantify the strength of the bonds, and there are no certifications of quality assurance for inspecting the bond quality. Therefore, there is a significant need for an effective, reliable, easy to use NDE method for the analysis of composite adhesive joints. This research aimed to investigate an adhesively bonded composite-aluminum joints of variable bond strength using digital image correlation (DIC). There are many future possibilities in continuing this research work. As the application of composite materials and adhesive bond are increasing rapidly, the reliability of the composite structures using adhesive bond should quantified. Hence a lot of similar research using various adhesive bonds and materials can be conducted for characterizing the behavior of adhesive bond. The results obtained from this research will set the foundation for the development of ultrasonic DIC as a nondestructive approach for the evaluation of adhesive bond line.

Nondestructive Evaluation of Adhesive BondsNondestructive Evaluation of Adhesive BondsNondestructive Evaluation of Adhesive Bonds Using 20 MHz and 25 kHz Ultrasonic Frequencies on Metal and Polymer AssembliesAuthor House

This report describes the results of a successful effort to demonstrate the feasibility of using leaky Lamb waves to detect and delineate flaws in the bond surface of metal/rubber laminates, even when adherends remain in intimate contact. It is shown that the leaky Lamb wave method can detect and image a poorly bonded surface when conventional pulse-echo method failed

even to detect the flaw. A new technique was implemented for preparing partially bonded surfaces by varying the percentage of adhesive coverage, and results are provided that illustrate the sensitivity of the leaky Lamb wave method in detecting different surfaces prepared by this technique. An analytical model of the leaky Lamb wave phenomenon in homogenous, isotropic metal/rubber laminates is described. Numerical results for a metal/rubber laminate immersed in water are included.

This volume comprises papers presented at the 2nd International Conference on Advanced Nondestructive Evaluation (ANDE 2007) held in Busan, Korea, on October 17-19, 2007. Many of the excellent papers included in this book show the current state of nondestructive technologies, which are experiencing rapid progress with the integration of emerging technologies in various fields. As such, this volume provides an avenue for both specialists and scholars to share their ideas and the results of their findings in the field of nondestructive evaluation./a

The Mechanics of Adhesion shows that adhesion science and technology is inherently an interdisciplinary field, requiring fundamental understanding of mechanics, surfaces, and materials. This volume comprises 19 chapters. Starting with a background and introduction to stress transfer principles; fracture mechanics and singularities; and an energy approach to debonding, the volume continues with analysis of structural lap and butt joint configurations. It then continues with discussions of test methods for strength and constitutive properties; fracture; peel; coatings, the case of adhesion to a single substrate; elastomeric adhesives such as sealants. The role of mechanics in determining the locus of failure in bonded joints is discussed, followed by a chapter on rheology relevant to adhesives and sealants. Pressure sensitive adhesive performance; the principles of tack and tack measurements; and contact mechanics relevant to wetting and surface energy measurements are then covered. The volume concludes with sections on fibermatrix bonding and reinforcement; durability considerations for adhesive bonds; ultrasonic non-destructive evaluation of adhesive bonds; and design of adhesive bonds from a strength perspective. This book will be of interest to practitioners in the fields of engineering and to those with an interest in adhesion science.

This volume documents the proceedings of the International Symposium on Adhesive Joints: Formation, Characteristics and Testing held under the auspices of the Division of Polymer Mater ials:Science and Engineering of the American Chemical Society in Kansas City, MO, September 12-17, 1982. There is a myriad of applications (ranging from aerospace to surgery) where adhesives are used to join different materials, and concomitantly the understanding of the behavior of adhesive joints becomes very important. There are many factors which can influence the behavior of adhesive joints, e.g., substrate preparation, in terfacial aspects, joint design, mode of stress, external environ ment, etc., and in order to understand the joint behavior in a holistic manner, one must take due cognizance of all these germane factors. So this symposium was planned to address not only how to make acceptable bonds but their characterization, durability and testing were also accorded due consideration.

This book comprises the proceedings of the Conference and Exhibition on Non Destructive Evaluation, (NDE 2019). The contents of the book encompass a vast spectrum from Conventional to Advanced NDE including novel methods, instrumentation, sensors, procedures and data analytics as applied to all industry segments for quality control, periodic maintenance, life estimation, structural integrity and related areas. This book will be a useful reference for students, researchers and practitioners.

An in-situ corrosion sensor based on electrochemical impedance spectroscopy (EIS) has been used to detect moisture ingress into aluminum-aluminum and aluminum-composite adhesive bonds. Both wedge tests and tensile button tests (aluminum-aluminum bonds only) were performed. Upon moisture absorption, the impedance spectra change shape with the low-frequency region becoming resistive. The low-frequency impedance decreases by several orders of magnitude, depending on the adhesive and the experimental conditions. For bonds with stable interfaces, such as phosphoric acid anodized (PAA) aluminum, the absorbed moisture causes an initial weakening of the adhesive resulting in reduced strength or small crack propagation. A substantial incubation time prior to substrate hydration and bond degradation allows warning of potential joint deterioration and enables condition-based maintenance. For bonds with smooth interfaces with little or no physical bonding (mechanical interlocking), crack propagation can proceed inter-facially with minimal moisture absorption. A comparison of the incubation times for Forest Products Laboratory (FPL) surfaces both bonded to epoxy adhesives and freely exposed to water or humidity at different temperatures shows that hydration occurs with the same activation energy, independent of whether or not the surface is covered with adhesive. However, the pre-exponential factor in the rate constant is dependent on the concentration of free moisture at the interface' so that the hydration rate varies by several orders of magnitude. The results of this study demonstrate that the electrochemical sensor technology can detect the ingress of moisture into an adhesive bond and should be further developed to provide a means to warn of potential degradation of adhesive joints and enable condition-based maintenance.

This volume presents original research in the broad areas of technical design and nondestructive testing procedures. It provides critical information for managers, materials scientists, quality control specialists and engineers who must stay abreast of rapidly advancing methods for the detection and measurement of the performance capabilities for parts, equipment and structures. Papers of special interest to the aircraft, nuclear and automotive industries include adhesive bonding of lap joints, nuclear radiography, nuclear tomography, use of hte leaky lamb wave technique to determine the dynamic elastic moduli of a fiber-reinforced composite, and a comparison of the resonant technique with the impact-echo technique.

Non-Destructive Evaluation (NDE) is now playing an increasing role in our modern global economy; in security sensitive industries, for instance. The complexity of the inspection task and either large or limited lot runs now require more operator-assisted or fully- automated signal processing. This book deals with both fields of expertise: NDE and signal processing. On the signal processing side, in the particular context of NDE applications, the following topics are discussed: sensor fusion, signal knowledge representation, artificial intelligence, fuzzy logic, computer vision, integration of numeric and non-numeric informations, parallel decomposition, noise processing and calibration of sensor devices as well as reliability of detection. Some hardware considerations are introduced as well, to discuss platforms on which processing is done. On the NDE side, applications include advances in holographic interferometry, microwave resonance or shearography and also on more traditional NDE techniques such as ultrasonics, infrared techniques, X-ray, computed tomography, Eddy currents. Inverse problems are also discussed. This book is required reading for those who already have some experience in one or both fields (signal processing and/or NDE).

The increased use of polymer matrix composites in structural applications has led to the growing need for a very high level of quality control and testing of products to ensure and monitor performance over time. Non-destructive evaluation (NDE) of polymer matrix composites explores a range of NDE techniques and the use of these techniques in a variety of application areas.

Part one provides an overview of a range of NDE and NDT techniques including eddy current testing, shearography, ultrasonics, acoustic emission, and dielectrics. Part two highlights the use of NDE techniques for adhesively bonded applications. Part three focuses on NDE techniques for aerospace applications including the evaluation of aerospace composites for impact damage and flaw characterisation. Finally, the use of traditional and emerging NDE techniques in civil and marine applications is explored in part four. With its distinguished editor and international team of expert contributors, Non-destructive evaluation (NDE) of polymer matrix composites is a technical resource for researchers and engineers using polymer matrix composites, professionals requiring an understanding of non-destructive evaluation techniques, and academics interested in this field. Explores a range of NDE and NDT techniques and considers future trends Examines in detail NDE techniques for adhesively bonded applications Discusses NDE techniques in aerospace applications including detecting impact damage, ultrasonic techniques and structural health monitoring

This book is open access under a CC BY 4.0 license. It presents the results of the ComBoNDT European project, which aimed at the development of more secure, time- and cost-saving extended non-destructive inspection tools for carbon fiber reinforced plastics, adhered surfaces and bonded joints. The book reports the optimal use of composite materials to allow weight savings, reduction in fuel consumptions, savings during production and higher cost efficiency for ground operations.

A technique which uses the reflected waveform data to obtain the fundamental ultrasonic parameters (transit time, reflection coefficient and attenuation coefficient) of an adhesive bond has also been presented.

This volume comprises papers presented at the 2nd International Conference on Advanced Nondestructive Evaluation (ANDE 2007) held in Busan, Korea, on October 17-19, 2007. Many of the excellent papers included in this book show the current state of nondestructive technologies, which are experiencing rapid progress with the integration of emerging technologies in various fields. As such, this volume provides an avenue for both specialists and scholars to share their ideas and the results of their findings in the field of nondestructive evaluation.

This state-of-the-art report describes the bonding process, the destructive methods used to measure bond strength, and the various NDE methods that have been evaluated for determining the quality of a bond. These NDE methods include sonics, ultrasonics, acoustic emission, nuclear magnetic resonance, x-ray and neutron radiography, optical holography, and thermography. Each of these methods has shown some limited success in detecting debond conditions. At the present time, however, it appears that only the sonic, ultrasonic, and nuclear magnetic resonance methods have the potential capability to differentiate qualitatively the gradations between a good bond and a debond and thus provide a correlation to bond strength. Nondestructive testing; Adhesive bonds; Adhesive bond testing; Adhesive bond strength; Sonic testing; Ultrasonic testing.

For several years, I have been responsible for organizing and teaching in the fall a short course on "Fundamentals of Adhesion: Theory, Practice, and Applications" at the State University of New York at New Paltz. Every spring I would try to assemble the most pertinent subjects and line up several capable lecturers for the course. However, there has always been one thing missing-an authoritative book that covers most aspects of adhesion and adhesive bonding. Such a book would be used by the participants as a main reference throughout the course and kept as a sourcebook after the course had been completed. On the other hand, this book could not be one of those "All you want to know about" volumes, simply because adhesion is an interdisciplinary and ever-growing field. For the same reason, it would be very difficult for a single individual, especially me, to undertake the task of writing such a book. Thus, I relied on the principle that one leaves the truly monumental jobs to experts, and I finally succeeded in asking several leading scientists in the field of adhesion to write separate chapters for this collection. Some chapters emphasize theoretical concepts and others experimental techniques. In the humble beginning, we planned to include only twelve chapters. However, we soon realized that such a plan would leave too much ground uncovered, and we resolved to increase the coverage. After the book had evolved into thirty chapters, we started to feel that perhaps our mission had been accomplished.

Demands for improvements in aerospace and automotive energy-efficiency, performance, corrosion resistance, body stiffness and style have increased the use of adhesive bonds to help meet those demands, by providing joining technology that accommodates a wider variety of materials and design options. However, the history of adhesive bond performance clearly indicates the need for a robust method of assuring the existence of the required consistent level of adhesive bond integrity in every bonded region. The Quality Assurance of Adhesive Bonds by Ultrasonic Nondestructive Testing technology put forth in this book meets that need by describing two new, complementary ultrasonic techniques for the evaluation of these bonds, and thus provide improvements over previous methods. The development of a 20 MHz pulse-echo method for nondestructive evaluation of adhesive bonds will accomplish the assessment of bond joints with adhesive as thin as 0.1 mm. This new method advances the state of the art by providing a high-resolution, phase-sensitive procedure that identifies the bond state at each interface of the adhesive with the substrate(s), by the acquisition and analysis of acoustic echoes reflected from interfaces between layers with large acoustic impedance mismatch. Because interface echo amplitudes are marginal when the acoustic impedance of the substrate is close to that of the adhesive, a 25 kHz Lamb wave technique was developed to be employed in such cases, albeit with reduced resolution. Modeling the ultrasonic echoes and Lamb-wave signals was accomplished using mathematical expressions developed from the physics of acoustic transmission, attenuation and reflection in layered media. The models were validated by experimental results from a variety of bond joint materials, geometries and conditions, thereby confirming the validity of the methodology used for extracting interpretations from the phase-sensitive indications, as well as identifying the range and limits of applications. Results from the application of both methodologies to laboratory specimens and to samples from production operations are reported herein, and show that bond-joint integrity can be evaluated effectively over the range of materials

and geometries addressed.

Following the successful first, the second edition is a complete guide to all that is required to successfully bond materials. It is both a reference and a source for learning the basics for those involved in the entire product value chains. Basic principles of adhesion such as surface characterization, types of adhesive bonds, and adhesion failure topics are covered in addition to a description of common adhesive materials and application techniques. Provides the end user practitioners of adhesion technology with a complete guide to bonding materials successfully Covers most substrates, including plastics, metals, elastomers and ceramics, explaining basic principles and describing common materials and application techniques Arranges information so that each chapter can be studied selectively or in conjunction with others

Electromagnetic Non-destructive Evaluation (ENDE) is an invaluable, non-invasive diagnostic tool for the inspection, testing, evaluation and characterization of materials and structures. It has now become indispensible in a number of diverse fields ranging from biomedics to many branches of industry and engineering. This book presents the proceedings of the 24th International Workshop on Electromagnetic Nondestructive Evaluation, held in Chengdu, China from 11 - 14 September 2019. The 38 peer-reviewed and extended contributions included here were selected from 45 original submissions, and are divided into 7 sections: eddy current testing and evaluation; advanced sensors; analytical and numerical modeling; material characterization; inverse problem and signal processing; artificial intelligence in ENDE; and industrial applications of ENDE. The papers cover recent studies concerning the progress and application of electromagnetic (EM) fields in the non-destructive examination of materials and structures, and topics covered include evaluations at a micro-structural level, such as correlating the magnetic properties of a material with its grain structure, and a macroscopic level, such as techniques and applications for EM NDT&E. Recent developments and emerging materials such as advanced EM sensors, multi-physics NDT&E, intelligent data management and maintaining the integrity of structures are also explored. The book provides a current overview of developments in ENDE, and will be of interest to all those working in the field.