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

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Nondestructive Evaluation Of Adhesive Bonds Using 20 Mhz And 25 Khz Ultrasonic Frequencies On Metal And Polymer Assemblies ***OMB No. 0826935062359 edited by***

RICHARD GEMMA

Evaluation of Composite Adhesive Bonds Using Digital Image Correlation Springer Science & Business Media
Commercial and military use of adhesive fastening is wisespread and continues to grow rapidly. This growth is indicative of the significant advantages of adhesive bonding over other fastening methods, in that it proceeds in the face of many disadvantages. Current adhesive systems are designed to be forgiving of some latitude in processing, but substandard bonds do occur, and these cannot be tolerated in critical applications. The extent of controls and tests necessary to assure highly reliable adhesive bonds does not appear to be generally appreciated in that many presently available procedures are often ignored. Nondestructive testing can contribute to the production of more reliable adhesive bonds by (1) providing rapid, economical tests for in-process measurement and control to supplement and replace some of the lengthy destructive procedures now required, and (2) providing a non-contaminating means to evaluate the suitability of surfaces for bonding. Based on bonding theory, it appears that this latter may best be done through development of a rapid means to determine the work function of surfaces compatible with production requirements. (Author).

NONDESTRUCTIVE TESTING OF ADHESIVE BONDS.

Springer
This project addressed durability and damage and fracture development and monitoring in adhesive composite joints for aerospace structural applications. Experimental and theoretical studies of static and fatigue behavior of single lap adhesive joints were performed on joints with unidirectional (UD) and cross-ply (CP) adherends made from a graphite-epoxy composite and an adhesive used in the Air Force. Joints with and without deliberately introduced cracks and delaminations were analyzed. Instrumented testing was performed by a digitally controlled servohydraulic testing machine. Damage and fracture evolution and mechanisms were analyzed by acoustic emission (AE), video microscopy, and off-line optical, scanning electron, and atomic force microscopies. A new method of acoustic emission analysis of histories of damage and fracture mechanisms was developed (patent pending). The method was shown to be especially effective for fatigue damage and fracture evolution studies. Nonlinear finite element analysis was used to compute mixed mode energy release rates for the bond cracks and delaminations as functions of crack lengths. The results showed that both UD and CP joints subjected to fatigue exhibited gradual crack propagation over a substantial portion of fatigue life. Static fracture mechanics characterization of joints under pure Mode 1,11, and mixed mode loadings was also performed and exploratory results on fatigue fracture under pure mode loads are also discussed. Overall, the project provides better understanding of static and fatigue behavior of adhesive composite joints. The results can be used in the development of intelligent nondestructive evaluation approaches with predictive capabilities.
Proceedings of the Second Annual Symposium for Nondestructive Evaluation of Bond Strength
Author House
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.
Nondestructive Evaluation of Adhesive Bond Thickness Using Infrared Thermography CRC Press
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.
International Advances in Nondestructive Testing CRC Press
The intention of this book is that it should contain everything an engineer needs to know to be able to design and produce adhesively bonded joints which are required to carry significant loads. The advan tages and disadvantages of bonding are given, together with a sufficient understanding of the necessary mechanics and chemistry to enable the designer to make a sound engineering judgement in any particular case. The stresses in joints are discussed extensively so that the engineer can get sufficient philosophy or feel for them, or can delve more deeply into the mathematics to obtain quantitative solutions even with elasto plastic behaviour. A critical description is given of standard methods of testing adhesives, both destructively and non-destructively. The essen tial chemistry of adhesives and the importance of surface preparation are described and guidance is given for adhesive selection by me ans of check lists. For many applications, there will not be a unique adhesive which alone is suitable, and factors such as cost, convenience, produc tion considerations or familiarity may be decisive. A list of applications is given as examples. The authors wish to increase the confidence of engineers using adhesive bonding in load-bearing applications by the information and experience presented. With increasing experience of adhesives en gineering, design will become more elegant as weH as more fitted to its products.

Nondestructive Evaluation of Structural Silicone Adhesive Joints in Building Evelope Systems

CRC Press
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.
Nondestructive Testing of Adhesive-bonded Joints Springer Science & Business Media
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.

Development of Nondestructive Tests for the Evaluation of Bonded Materials Nondestructive Evaluation of Adhesive Bonds Using 20 MHz and 25 kHz Ultrasonic Frequencies on Metal and Polymer Assemblies

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

Nondestructive Evaluation of Adhesive Bond Quality: State of the Art Review CRC Press

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.

Ultrasonic Spectral Analysis for Nondestructive Evaluation Springer

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.

Ultrasonic Nondestructive Evaluation of Adhesive Bond Degradation Springer Science & Business Media

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

Handbook of Aluminum Bonding Technology and Data Elsevier

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.

Proceedings of the First Annual Symposium for Nondestructive Evaluation of Bond Strength

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.

A New Technique for Ultrasonic Nondestructive Evaluation of Adhesive Joints

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.

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

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.

Ultrasound NDE of Adhesive Bond Integrity

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.

Nondestructive Evaluation of the Adhesive Bond Strength in Laminated Safety Glass

A reference that offers comprehensive discussions on every important aspect of aluminum bonding for each level of manufacturing from mill finished to deoxidized, conversion coated, anodized, and painted surfaces and provides an extensive, up-to-date review of adhesion science, covering all significa

Electrochemical Sensors for Nondestructive Evaluation of Adhesive Bonds

This volume documents the proceedings of the Second International Symposium on Adhesive Joints: Formation, Characteristics and Testing held in Newark, NJ, May 22-24, 2000. Since the first symposium, held in 1982, there had been tremendous research activity dealing with many aspects of adhesive joints. This volume contains a total of 21 papers, which were all properly peer reviewed, revised and edited before inclusion. Therefore, this book is not merely a collection of unreviewed manuscripts, but rather represents information which has passed peer scrutiny. Furthermore, the authors were asked to update their manuscripts, so the information contained in this book should be current and fresh. The book is divided into three parts: 1) General Papers; 2) Evaluation, Analysis and Testing; and 3) Durability Aspects. The topics covered include: molecular brush concepts in enhancing strength of adhesive joints; factors affecting performance of adhesive joints; substrate preparation and modification; interfacial/interphasial aspects; determination of locus of failure; analysis and evaluation of adhesive joints using various techniques; testing of adhesive joints; stress analysis; application of fracture mechanics; durability aspects; accelerated environmental degradation of adhesive joints; solvent uptake; and adhesives with special characteristics. This volume represents a commentary on the current R&D activity in this arena and it should be of great value and interest to anyone interested in adhesive bonding / adhesive joints. Furthermore, this volume contains a number of excellent review/overview articles, which should be of particular value.

NON DESTRUCTIVE TESTING

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 (NDE) of Adhesive Bonds

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