List of Abstracts of QIRT 1994 (Sorrento, Italy)

Spatial resolution enhancement of an IR system by image restoration techniques

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Abstract

The spatial resolution of infrared systems is one of the major limitations in the use of IR thermography for temperature measurements, mainly in the case of small objects of size [1]. The use of digital image restoration techniques for spatial resolution enhancement is a very powerful method to reduce this limitation. Two restoration filters are examined in this paper. The accuracy of these two methods is based on the accurate determination of the Optical Transfer Function (OTF) and of the noise spectral density.

Studies of catalysts and catalytic reactions by infrared thermography

By MARENGO S. and COMOTTI P.

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Abstract

This communication shows that infrared thermography can be a valuable technique for catalyst characterization and for the study of catalytic processes. The possibility of drawing detailed thermal maps of catalytic systems under working conditions, associated with the growing availability of image analysis methods, allows a range of applications in the study of acid- base properties of solid materials and in the description of thermal effects produced in chemical reactors by exothermic catalytic reactions.

Statistical analysis of computer-generated thermal images based on overall modeling of line-scanning process

By MILOVANOVIC D., MARINCIC A., BARBARIC Z. and PETROVIC G.

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Abstract

Using our previously developed computer model of line-scanner on moving platform, several synthetic thermal images of a terrain background were produced. The geometrical image deformations, spatial radiance filtration and influence of the model scene parameters on statistical properties of simple terrain image are analyzed. The change of the mean value, standard deviation, histogram and pixel-to-pixel correlation of computer-generated thermal images with a scanning angle, indicate a possibility for adaptive reduction of the data redundancy for an efficient digital image transmission.

High power microwave antenna design using infrared imaging techniques

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Abstract

An infrared (IR) imaging technique is used to design a high power microwave (HPM) antenna. IR thermograms of the electric field distributions of the internal modes in several cross sections of the waveguide feed line to the antenna and the radiation patterns of a 30° beveled-cut circular waveguide microwave aperture antenna are measured. A thin, lossy detector screen is placed in the plane of measurement. The absorbed heat energy in the screen is re-radiated as electromagnetic (EM) "blackbody" energy, which is detected with an IR camera. Due to the absorbed energy, the temperature of the detector screen rises above the ambient temperature of the waveguide by an amount proportional to the local electric field intensity (energy) at each point in the screen material. The temperature distribution in screen material is correlated to the intensity of the electric field absorbed in the screen and is presented as a false-color image of the electric field distribution.

The antenna is fed with a coaxial TM_{01} mode, which does not radiate in the bore-sight direction of an open-ended cylindrical waveguide; therefore, a combined mode converted/radiator is used to convert the TM_{01} mode into the dominant circular waveguide TE_{11} mode, which does have a main beam radiation pattern. A 30° beveled-cut radiator is used for mode conversion. The far-field radiation pattern of the beveled-end aperture antenna is also measured.

Direct detection of temperature maps on electronic devices surface by using an infrared radiometric microscope

By PICA S. and SCARPETTA G.

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Abstract

In this paper the advantages of using infrared radiometry for temperature measurements on semiconductor devices are presented. The choice of using a radiometric microscope with an automatic scanning and elaboration system, instead of thermal imaging, is discussed. Some peculiar problems of thermal measurements on electronic devices, and their solutions are also presented. Finally, preliminary results of our system are shown, consisting in dynamic temperature maps obtained on two different devices, with a brief discussion on their different thermal instability.

Temperature measurement by infrared thermography in a lubricated contact : radiometric analysis

By REUNGOAT D. and TOURNERIE B.

Abstract

A method of surface temperature measurement by infrared thermography in a lubricated contact has been developed. The capabilities of the camera are examined. The analysis, which needs the determination of global radiometric coefficients and leads to radiometric equations is presented. The calibration of emissivity and transmittivity coefficients of the involved materials is reported. The validity of the method is tested and discussed.

Problems commonly encountered in quantitative thermographic electrical inspections

By SNELL R., Jr.

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Abstract

The primary benefit of using infrared thermography to inspect electrical systems is qualitative in nature, i.e. locating problems. As reliable portable quantitative imaging systems have become available, thermographers have also begun relying almost entirely on radiometric temperature data as the primary means of prioritizing the severity of a problem. The validity of these methods is suspect due to the lack of standardization in data collection methods, the often poor understanding of radiometric measurements by maintenance thermographers, field conditions that vary widely enough to defy standardization, and the almost total lack of scientific research on the relationships among heat, time and failure in regard to the components being inspected.

Peculiarities of thermal inspection of materials with short observation time

By VAVILOV V. P. *, GRINZATO E. #, BISON P. G.# and MARINETTI S.#

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Abstract

Modem thermal NDT tends to deal with millicentigrade temperature signals occurring for tens of milliseconds. This concerns inspection of either high-conductive materials, such as steel, aluminium etc., or thin materials where heat processes are fast. The paper highlights the correlations between heat pulse duration, life time for signal over defect and frame time of an IR imager.

Accuracy analysis of measuring thermal imaging systems

By CHRZANOWSKI K. and JANKIEWICZ Z.

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Abstract

A theory of the influence of measurement conditions and system parameters on the accuracy of remote temperature measurements with thermal imaging systems has been developed. An analysis of the influence of disturbances (such as: incorrectly assumed emissivity, radiation reflected by the object, radiation emitted by the optics of the system, limited transmittance of atmosphere and limited temperature resolution of the system) on the accuracy of temperature measurement has been made. The results have shown that the accuracy clearly differs in 3-5μm and 8-12μm spectral band under typical measurement conditions.

Influence of changes of object-system distance on accuracy of remote temperature measurement

By CHRZANOWSKI K. and JANKIEWICZ Z.

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Abstract

A study has been made to determine the influence of the difference between the distance object-system under calibration and the one at real work conditions on the accuracy of the temperature measurement with infrared systems. A theory of the influence of this difference on the errors of the temperature measurement for any measurement condition and system parameter has been developed. The results of the following calculation have shown that the errors of the remote temperature measurement due to this source can be significant.

Rescaling of thermographic camera readouts based on the results of contact measurements during unsteady process

By PREGOWSKI P. *

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Abstract

This paper gives practical advice based on experience gained by the author's company during the investigations of soldering in the vacuum chamber with the use of external and contact type reference sources. The conditions of these measurements were far from optimum ones. The main elements of the applied simple procedures are discussed.

Advanced image processing in thermography

By WIECEK B. and GRECKI M.

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Abstract

In the paper the thermal and visual camera systems working in parallel are presented. The proposed extension of widely used thermal video systems by visual camera is very helpful to identify the object elements and localise precisely hot spots on the surface. The visual camera is linked with the computer through an interface, which is based on the modern video processor in order to provide enough power to compute images in real-time. Additionally, the most suitable image processing methods for mixing images are described. The integrated software for both cameras is briefly discussed to present the potentialities of the whole system. Some experimental results confirm the useability of the developed system.

A procedure to measure thermal conductivities of anisotropic laminates by infrared thermography

By BERARDI P. G.* and CUCCURULLO G.*

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Abstract

In this paper an experimental procedure to determine the thermal conductivities of CFRP thermoplastics laminates sheets is presented. The method is based on Laser heating and Infrared Scanning Radiometer System. The thermal conductivities are estimated by matching the experimental data with the analytical solution, previously derived for temperature field of heated specimens.

Discussion of different numerical models applied to air infiltration measurement in external walls.

By DUC E.*

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Abstract

When computing heat loss or temperature fields in external wall joints, with existing cracks, numerical mesh layout is chosen depending upon crack type. In practice, analytic approach can be used only in case of uniform walls or sandwich wall (with no head leakage bridge) with a straight crack coming through. The paper summarizes comparison of results developed according to numerical outcome of the balance analysis for different practical mesh layouts. The results can be applied to in situ research of external wall joint air tightness using thermal - pressure method [1], where thermovision equipment (880 LWB + TIC 8000) is used.

Thermomechanical coupling as a criterion of the yield point of spheroidal graphite cast iron

By SCHMIDT J.*

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Abstract

The determination of the critical levels of stresses in the form of the yield point for materials with quasiparabolic course of the tension curve is based on the conventional determination of remaining strain. The development of remaining strain, determined through observation of an increase in temperature on the surface of a specimen during the growth of stress σ_{ii}, confirmed by an increase in the values of the factors of acoustic emission, allows the physical determination of the place of occurrence of the yield point. The experiment was made for the spheroidal graphite cast iron, grade Zs 60002.

IR thermography and heat treatment of metals

By SVAIC S. and SUNDOV I.*

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Abstract

In quenching the essential point is the knowledge of the temperature distribution in the body during the quenching period. In the work the mathematical model for determination of the temperature distribution and calculation of the heat transfer coefficient is given when the probe surface temperature versus time is known. The goal of the project was to find if thermography could be a successful tool in such a case for the surface temperature measurement.

Infrared polarization thermometry using an imaging radiometer

By BALFOUR L. S.*

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Abstract

This paper describes a method to determine absolute temperatures of surfaces based on the thermal infrared polarization of the radiant beam emanating from the surface. No

knowledge of the surface emissivity is required but a known source of radiation is required to be reflected off the surface. Results of measurements from two samples are presented.

The measurement of emissivity of charring ablative materials

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Abstract

Normal emissivity of ablative thermal insulators at different temperatures is determined comparing the radiation emitted and the surface temperature for a cylindrical sample. A microthermocouple (diameter 50 μm) is carefully inserted under a very thin sublayer of the surface sample and a CO_2 laser is used to heat it at different temperatures. The sample is observed by an infrared camera which allows the determination of the radiating energy emitted from its surface in the wavelength interval of 3.0 - 5.4 μm.

Determination of uncertainties for emissivity measurements in the temperature range [200°C - 900°C]

By HAMEURY J.*

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Abstract

A new test apparatus for the measurement of spectral emissivity of good conductive opaque materials is described. Spectral emissivity is measured in the infrared spectral range [2.5 μm - 14 μm] and in the temperature range [200°C - 900°C]. A comprehensive study of uncertainties has been made. Uncertainties of each parameter and influence of each assumption are quantified. The final combined standard uncertainty is calculated by combination of all the uncertainties. The first results of a comparison validate the calculated level of uncertainty.

Thermal analysis at very high temperature

By JEGOU C. and BRENIER Y.*

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Abstract

In the field of severe accident prevention concerning Pressurised Water Reactors, the CEA (*French Atomic Energy Commission*) is conducting the VULCANO program to

analyze the behavior of the melted core of the reactor inside and outside the reactor vessel. The estimated temperatures to be measured are of the order of 1500 to 3000 K. Several technologies are conceivable and one of these is *infrared thermography*.

Technical methods of emissivity correction in thermography

By WIECEK B.* and PACHOLIK J.*

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Abstract

This article presents some chosen methods of temperature correction while the emissivity factor of the investigated object is nonuniform on its surface. An approach of application of reflection method (RM) for emissivity factor evaluation is emphasised in comparison with others based on alternate temperature measurement or covering object surface by thin layer with known emissivity factor. The practical possibilities as well as the limits of these methods are discussed. The examples of temperature map correction are presented.

Infrared thermography study of a thermal anti-icing system

By BUCHLIN J-M.*, PRÉTREL H. *, PLANQUART H. *,
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Abstract

This paper deals with the mapping of the convective heat transfer in a multijet anti-icing system by application of the quantitative infrared thermography technique. The experiments are conducted on a full-scale mock-up of the leading edge section of a jet aircraft wing. A steady state infrared thermography technique combined with the heating foil method is developed and successfully applied to recover the complete distribution of the thermal exchange coefficient on the concave surface of the skin. The heating performance of such a multijet system depends on the jet Reynolds number, the stand-off distance of the supply duct and the spanwise and chordwise jet arrangement. Tridimensional numerical simulations are performed with the FLUENT code. Despite the complexity of the flow phenomena and the stiff character of the boundary conditions involved, satisfactory agreement is fond between the predictions and the IR data.

IR measurements of hypersonic viscous interaction

By CARDONE G. *, DE LUCA L. *, ASTARITA T.*
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Abstract

Heat transfer measurements performed by means of an Infrared Scanning Radiometer in a blowdown hypersonic wind tunnel are discussed. In particular, the formation of Goertler-type vortices in the reattaching flow region over the flap following a flat plate is investigated, as well as its influence on the wall heat transfer distribution. Tests are carried out within the European Community Hermes space program to develop the first european space shuttle.

IR heat transfer measurements on a rotating disk

By CARDONE G., ASTARITA T. and CARLOMAGNO G. M.

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Abstract

Heat transfer measurements on a rotating disk are performed, for a wide range of Reynolds number values in the laminar, transitional and turbulent regimes, by making use of the *heated-thin-foil* technique and by measuring temperature maps with an infrared scanning radiometer. The use of the IR radiometer is advantageous on account of its relatively good spatial resolution and thermal sensitivity and because it allows one to perform measurements down to very low Reynolds numbers. Heat transfer results are presented in terms of Nusselt and Reynolds numbers based on the local radius and show a substantial agreement with previous experimental and theoretical analyses. Transition to turbulent flow is found at about RE = 250,000. A discussion about the role played by the adiabatic wall temperature is included.

Comparative application of two infrared scanners to heat transfer measurements in a Mach 6 wine tunnel

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Abstract

The performances of two infrared scanning radiometers (Inframetrics 525 & Agema 900 systems) used in the VKI H-3 Mach 6 wind tunnel are presented and discussed. The spatial resolution characteristics of the two scanners are evaluated using in-house calibrations. Modeling of the SRF and MTF are validated against measurements. Finally, a restoration technique based on the MTF response is applied for the quantification of the striation heating on a compression ramp in hypersonics.

Steady and unsteady wall heat transfer mapping by active infrared thermography at the mean aerodynamic reattachment point behind a backward-facing step

By DUMOULIN J., REULET P., GRENIER P., PLAZANET M. and MILLAN P.

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Abstract

Knowledge of the thermal behaviour of materials submitted to turbulent flows, is essential in many industrial problems, in particular when designing combustion chambers. So, experimental work is needed to gain a physical understanding of the steady and unsteady wall heat transfer. CERT - ONERA / DERMES has built an experimental method, with the financial support of DRET, in order to characterise the intensity and distribution of heat transfer coefficient (Hcv), around the mean aerodynamic reattachment point behind a backward-facing step. The infrared Thermography, coupled with anemometric and pressure measurements allows us to build-up mean wall laws required for numerical simulations. The synchronization of measurements is exploited to show the possibility of building instantaneous wall heat transfer laws. A first analysis of unsteady results is proposed for an inlet velocity of 12 m/s, and compared to tomographic visualisations.

Study of heat transfer enhancement on surface protuberances using infrared technique

By R. C. HENRY (*), R. J. HANSMAN (**) and D. L. BALAGEAS (*)

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Abstract

In order to determine the effect of ice protuberances on local convective heat transfer coefficient, enhancement of heat transfer coefficient on small (2mm to 6 mm diameter) hemispherical elements on a flat plate has been studied in a wind tunnel using an infrared camera. The influence of size and density of protuberances and velocity are investigated for laminar and turbulent boundary layers on the flat plate. Maximum heat transfer is observed on the upstream face of protuberances and values increase strongly with roughness size and velocity for laminar conditions on the flat plate. For turbulent conditions, heat transfer enhancement is relatively constant with velocity, but increases with the size of protuberances. Results are also given for multiple elements configurations.

Thermography measurement of the local heat transfer distribution for flow around a surface-mounted obstacle

By LYBAERT P., FELDHEIM V. and LEBRUN I.

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Abstract

This paper deals with the use of infrared thermography to measure the convective heat transfer coefficient distribution at the surface of a plate around a surface-mounted prismatic obstacle, placed in a turbulent flow. Complex longitudinal profiles of the coefficient are obtained, showing minimum values upstream from the obstacle, minimum and maximum values downstream. The heat transfer data are analyzed with recent results from the literature concerning the fluid flow around the obstacle. The measured values are then compared with values obtained by numerical simulation, using the standard (κ, ε) model of turbulence. The comparison shows that the model overpredicts the reattachment length and underpredicts the heat transfer coefficients.

Thermal measurements in a single axisymmetric jet impinging normal to a flat plate

By MEOLA C., DE LUCA L. and CARLOMAGNO G. M.

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Abstract

Measurements on convective heat transfer coefficient between a flat plate and an air jet impinging perpendicular to it are made to account for the influence of some governing parameters in order to gain some new understandings for a data correlation. Particular attention is focused on the influence of the recirculation effects within the exhaust area and the temperature difference between the jet and the ambient. Measurements of surface temperatures (adiabatic wall and wall temperature) are made by means of an infrared scanning radiometer applied to the *heated thin foil* technique.

Infrared thermography on testing an anti-icing device

By MEOLA C. *, CARLOMAGNO G. M. *, RIEGEL E. [+] and SALVATO F.[+]

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Abstract

An infrared scanning radiometer, applied to the *heated thin foil* technique, is employed to test the performance of an anti-icing device, which consists of a hot air spray-tube inside aerodynamic surfaces as leading-edge wing sections. Experimental tests are made in order to determine the convective heat transfer coefficients between the surface of the wing section and the air jets impinging on it. The influence of several parameters such as the Mach number, the impingement distance, the diameter of the holes of the spray-tube and the spacing between holes is considered.

3D sensing: Overview with a thermal non-destructive testing perpective

By MALDAGUE X.

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Abstract

In this paper, we present a review of tridimensional sensing techniques which have a potential for the automatization of the thermal non-destructive testing (TNDT) task, for instance to inspect large curved specimens. The underlying ideas are two-fold. First knowledge of the shape of the inspected component allows correction of the recorded corresponding thermal images for the quantitative analysis and improved TNDT diagnosis. Second when inspecting large size components, a robotic approach to carry the TNDT head over the specimen is of interest to save cost (higher throughput) and insure reproducibility.

The methods which are reviewed in this paper fall into two different categories: *intrinsic and extrinsic*. *Intrinsic* methods depends essentially on the infrared inspection apparatus to perform the 3D survey while *extrinsic* techniques rely on dedicated hardware for the 3D task. Considered *intrinsic* techniques are: *point source heating, videothermal stereovision, direct thermogram correction and shape from heating*. Considered *extrinsic* techniques are: *stereopsis, photometric stereo, shape from shading, texture, motion occluding contour, optical flow, moirè, focusing, active triangulation, time of flight and shape from spatial encoding.* These techniques will be briefly reviewed. Other *extrinsic* techniques have been developed but seem to have less interest for TNDT applications and were non included in this review although an annotated bibliography is included at the end of this paper and presents a mix of 3D sensing techniques and developments. Considerations on diffractive optical elements for structured light projection are included as well as a case study illustrating the use of robotic in a TNDT inspections system.

Thermal NDE of delaminations in plastic materials by neural network processing

By BISON P. G. *, BRESSAN C. *, DI SARNO R. *, GRINZATO E. *, MARINETTI S. * and MANDUCHI G.°

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°Consiglio Nazionale delle Ricerche, Istituto Gas Ionizzati (IGI), 35123 Padova, Italy.

Abstract

Neural networks are applied to the problem of detecting and classifying voids inside an opaque material at different depths. A classic one-side dynamic thermographic testing procedure is applied to artificial defects buried in 14 mm specimens of PVC. Experimental data are automatically processed, extracting the maximum and the corresponding time of thermal contrast profile versus time. A two steps procedure was developed and tested using an intentionally uneven heating of the sample. The obtained results are presented, demonstrating the robustness and accuracy of the developed technique.

Thermal defectometry using the temperature decay rate method

By DELPECH P. M. *, KRAPEZ J. C. and BALAGEAS D. L.

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Abstract

The pulsed stimulated infrared thermography NDE method has been used to evaluate the integrity of thin structures in highly conductive materials. An inversion procedure for the thermal images is obtained from an analytical solution of the 1D heat transfer through a bilayer including a thermal resistance at the interface with third kind conditions on its external boundaries. A simplified analytical model is suitable for long time inspection and allows the identification of both the depth location and the thickness of the defects without any previous experiment on a reference sample. 2D effects are studied by inversion of numerically calculated thermograms. Experimental analysis of samples made of metallic materials used in aircraft construction are presented.

Photothermal infrared radiometry applied to textile materials - General characterization and determination of moisture content

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Abstract

The potential of photothermal methods for the characterization of textiles is investigated systematically. It has been shown that the moisture content in fabrics can be determined by IR detection of thermal waves. Measurements on moving fabrics have been done to demonstrate the possibility of application potential in continuous industrial production processes.

Investigations of subsurface structures and buried inhomogeneities by photothermal inspection

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Abstract

Among optical methods the photothermal radiometry offers a new metrological technique for the successful investigation of subsurface defects, buried inhomogeneities and structures beneath an optical opaque surface. In these investigations, the thermal waves reflect several sets of information about the inner and outer structures, about optical, thermal and mechanical properties.

The purpose of this contribution is the presentation of theoretical calculations for simulation of measuring signals and reconstruction of buried inhomogeneities from measured amplitude and phase signals. Hence, experimental results can yield a reliable defect identification and identification of surface and subsurface thermal features.

Numerical modeling of the defect response in pulsed video thermography on samples with finite optical penetration

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Abstract

The results of one- and tow-dimensional finite volume (FV) model calculations, based on the instationary heat diffusion theory, are applied to pulsed video thermography. A special regard is given to the optical absorption of light at the specimen surface and to the finite optical penetration depth in polymers.

The maximum temperature at surface is found to decrease significantly compared to opaque samples. The temperature contrast of a defect of finite size is affected to a depth of about four times the optical penetration depth.

Edge-effects and defect sizing by transient thermography

By ALMOND D. P. *, SAINTEY M. B. ** and LAU S. K.*

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Abstract

Thermal edge-effects for crack-like defects have been calculated using the Wiener-Hopf technique. These lead to an experimentally verified prediction that transient thermographic defect images shrink systematically with elapsed time. A simple method of defect sizing is proposed based on accounting for defect shrinkage. Finite difference modeling is used to investigate the dependence of image shrinkage on defect size and depth.

Analytical simulation of a multi-dimensional temperature field produced by planar defects of any shape; application to non-destructive testing

By DEGIOVANNI A., BENDADA A., BATSALE J.C. and MAILLET D.*

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Abstract

Thermal interface resistance are associated with bad contact between two materials. In the case where this interface takes place between two rectangular slabs of the same material, a heat pulse experiment with recording of the slab surface temperature evolution, gives information about the space distribution of this resistance. The inverse problem is considered here, using an explicit analytical solution of the direct problem and a stochastic approach, in the case of a non uniform interface resistance distribution. Experimental inversion of frames produced by an infrared camera is implemented.

Early detection of thermal contrast in pulsed stimulated infrared thermography

By KRAPEZ J.-C. and BALAGEAS D.

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Abstract

Pulsed stimulated infrared thermography is a powerful technique for the detection of thermally resistive defects in materials. Time-resolved analysis of the surface temperature field can then be used for the identification of the defect characteristics (mainly its depth, its lateral size and its thermal resistance). Several such inversion procedures were proposed in the past. They are based either on a 1-D or on a 2-to-3D modeling of thermal transfer in the inspected material. In this paper we describe a new 1-D procedure for the defect geometry characterization (depth and lateral size). Compared to previous 1-D methods, it is less sensitive to lateral diffusion. It however retains their high speed.

Reconstruction of thermal defects from photothermal images

By LAN T.T.N., HAUPT K., SEIDEL U. and WALTHER H.G.

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Abstract

The paper reports on 2 methods to get depth dependend information about thermal properties from photothermal measurements. First, an inversion technique is suggested to calculate the depth profile of either κ or $c_{Q.}$ Second, a deconvolution technique making use of the photothermal point spread function is presented to estimate depth, size and strength of buried localized thermal defects.

Inversion of experimental data and thermal tomography using "Termo.Heat" and "Termidge" software

By VAVILOV V.P.*, KOURTENKOV D.G.*,
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#ITEF-CNR, Corso Stati Uniti, 4, 35020-Padova, Italy.

Abstract

Modern analysis of thermal NDT data involves solving direct and inverse heat transfer problems. This paper presents methodology in determining relationships between parameters in thermal test and identifying experimental data for defects characterization purpose.

Depth profiling of orientation in laminates with local lockin thermography

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Abstract

Fibre reinforced materials are inspected with thermal waves. We show how orientation fields of carbon fibres can be probed both along the surface and in depth at low modulation frequencies and in short time. This technique is applicable for remote analysis and prediction of material properties.

Lock-in infrared thermography applied to the characterization of electromagnetic fields

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Abstract

Lock-in infrared thermographic systems developed since more than ten years allow the measurement of both amplitude and phase of periodic temperature fields. They have been essentially used for mechanical testing, mainly for stress field analysis, and for NDE. The present system is applied to the quantitative characterization of electromagnetic fields. The modulated amplitude of the temperature leads to the intensity of the fields. The purpose of such a system is to eliminate both radiato-convective and conductive effects which produce a blurring of the thermal image and hence degrade the accuracy of the measurement. Experiments demonstrate the real enhancement of the technique when compared to classical steady state measurements. The interest of the thermal phase image is also presented.

Photothermal detection of surface defects and thermal changes in near-surface layers

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Abstract

When mechanical or structural changes on surfaces and in near-surface layers are correlated with alterations of thermal properties, they become detectable by means of photothermal microscopy. We applied this approach to the detection of variations in ceramic materials (Si_3N_4, Widianit N2000) induced by Vickers indentations of several loads. The photothermal images show remarkable changes near the marked areas depending on the different loading strengths. Certainly cracks, but probably also alterations of the microcrystalline structure are responsible for this behavior. This statement is confirmed by thermal diffusivity measurements and it agrees with estimations known from the photothermal defect identification.

Lockin thermography for defect characterization in veneered wood

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Abstract

The technique of lockin thermography combines the advantages of both conventional thermal wave methods and thermography using a commercial IR-camera. It allows for shorter imaging time and depth profiling. Inhomogeneous illumination and optical surface structures can be suppressed in phase images. Several examples show applicability of lockin thermography to detect and locate hidden flaws in layered material.

Infrared monitoring system for urban solid waste landfills: experimental activities for biogas outflow modelling

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Abstract

The present work concerns preliminary testing activities for the application of a ground based infrared system with spectral sensitivity in the 8-12 μm band to the detection of environmental risk conditions due to anomalous outflows of biogas and leakage in urban solid waste landfills. Calibrated surface temperature maps which outline anomalous areas affected by biogas release in the atmosphere were used for biogas outflow estimations through a thermal balance modeling. An experimental approach for thermal data calibration and model validation was followed as well.

Selective infrared thermography. Application to detection of humidity in buildings

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Abstract

Humidity is one of the main problems affecting building materials, specially in historical monuments. Its sources can be multiple and, in some cases, very difficult to be determined. Very often, the environmental conditions (high levels of humidity and CO_2 in the atmosphere) make difficult to obtain true results through Infrared Thermography. With the object of solving these problems the "Selective Infrared Thermography Method" has been developed. This technique is based on the use of interferencial filters (developed by the authors) for determining the interferencial areas to analyze. The foremost tests in these studies have been carried out using prisms of gypsum subjected to capillarity processes with different salt dissolutions.

IR detection limit of underground structure by thermal image technique

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Abstract

A thermal image technique had been developed to detect internal flaws of industrial structural elements as a remote sensing device. This method was applied to detect the underground and obscured structural elements, like piping, vessel, concrete and ancient tomb, by solar and artificial heating. Detection limit of underground test pieces was represented by the experiment. Numerical calculation was carried out to analyses heat flow mechanism around the test piece.