

# **Abstract list of QIRT Journal 2004, Volume 1 – no 1**

## **Autoregressive algorithms and spatially random flash excitation**

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### **Abstract**

Thermal Non Destructive Evaluation methods to detect cracks perpendicular to the plane of a plate needs to implement in-plane thermal gradients. Instead of a flying spot, a spatially random flash excitation on the front face of a thin plate is here proposed. It allows a very simple and quick experiment. Some processing methods of the resulting infrared images are then discussed and experimental results are shown. The main advantage is to allow the simultaneous process of a huge amount of data, sensitive all over the plane to the thermal conductivity mapping.

### **Keywords**

Thermal Non Destructive Evaluation, Image Processing, Heterogeneous Media, Inverse Methods, Autoregressive Algorithms

# **Lock-in thermography with eddy-current excitation**

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## **Abstract**

A new thermography method is presented where inductive heating by eddy current is used for periodical sample excitation. In conventional eddy current testing damages like cracks in metals are detected with a coil which changes its impedance over defect areas. The disadvantage of this method is its time consuming point-by-point scanning over the surface of the sample. Induction-Lockin-Thermography (ILT), however, uses a thermography camera with a detector array to monitor induction heated areas. Temperature patterns and their time dependence responding to the coded excitation allow for fast phase angle imaging of defects in larger areas.

## **Keywords**

Eddy current, induction heating, lockin-thermography, NDE

# **Thermoinductive investigations of magnetic materials for surface cracks**

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## **Abstract**

Thermoinductive investigations have been carried out on steel work-pieces with the goal of detecting surface cracks. Experimental results show that the method is well suited to find the position of the cracks. Different finite element simulations are used in order to model the temperature distribution in the work-piece and around the cracks, and the derived analytical equations describe the heat transfer process. Results of the numerical simulations and the analytical calculations are compared with the experimental results, and a very good correspondence found. Additionally, the influence of the crack depth on the temperature increase around the flaw is investigated, and a formula derived, which enables the calculation of the crack depth from the measured excess temperatures.

## **Keywords**

Inductive heating, eddy current, infrared, crack detection, thermography

## **Pulsed phase thermography reviewed**

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### **Abstract**

Pulsed Phase Thermography has considerably evolved since it was originally introduced in 1996. In this paper, a general review of the technique is presented. The different types of uncertainties related to data acquisition and processing are identified. Equivalence between discrete and continuous Fourier Transforms when applied to thermographic data is discussed in detail. As will be pointed out, the optimal solution for a Pulsed Phase problem, qualitative or quantitative, arises from a compromise between sampling rate, truncation window size and the available computer power. The theoretical concepts introduced here are reinforced with a variety of experimental results.

### **Keywords**

Pulsed Phase Thermography, sampling, aliasing, truncation, leakage, inversion techniques

# **Determination of the conjugate heat transfer performance of a turbine blade cooling channel**

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## **Abstract**

This contribution presents the experimental investigation of the conjugate thermal behavior of a rib-roughened cooling channel. Previous investigations were mainly focused on the convective aspects of the heat transfer and the channels' models were made out of low conductive materials. To reproduce heat conduction conditions closer to the ones of a real metallic airfoil, a facility with a metallic ribbed wall was designed. The infrared thermography was used to measure the temperature distribution on the wetted surface. Dedicated software was developed to correct the temperature field distortions and to apply the radiation-temperature calibration. The convection coefficient was calculated as a function of the measured wall temperature and computed ed wall heat flux. FLUENT® was used to numerically solve the energy equation into metallic wall, providing the surface heat flux.

## **Keywords**

Conjugate, heat transfer, conduction, convection, cooling

# **Thermographic imaging of free carrier density in silicon for solar cells**

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## **Abstract**

The measurement of free carrier density in silicon is a crucial parameter for the characterisation of silicon solar cell material. Carrier Density Imaging (CDI) is a valuable tool to obtain spatially resolved images of free carrier density distribution. This article describes the experimental setup of CDI for absorption mode and recently developed emission mode measurements. The theoretical dependence of the absorption and emission of infrared radiation on the free carrier density is discussed. Results of absorption and emission mode measurements are presented and the advantages of the new emission mode are elaborated.

## **Keywords**

Free carrier density, silicon, lifetime, solar cells, CDI, emission

# **Analysis of thermoelastic and dissipative effects related to the fatigue of 2024 T3 aluminium alloy**

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## **Abstract**

In this paper the fatigue phenomena of 2024 T3 aluminium alloy were studied in terms of thermal and calorimetric effects during uniaxial cyclic loading. Thermoelastic coupling sources and dissipation were separately estimated by using infrared thermal data and a local simplified form of the heat equation. The simplifications are essentially based on the assumption that the uniaxial fatigue test remains homogeneous until a macroscopic fatigue crack occurs within the gauge section of the specimen. Heat sources were then compared to predictions derived from mechanical data by assuming a linear isotropic thermoelastic behavior of the material and by neglecting the influence of thermomechanical coupling on the hysteresis area of fatigue cycles.

## **Keywords**

Aluminium, fatigue, infrared thermography, thermomechanical couplings, dissipation

# Investigation of nucleation and propagation of phase transitions in TiNi SMA

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## Abstract

The attention of the present paper is focused on the aid provided by infrared thermography, for spectacular investigation of nucleation and further development of the stress induced phase transitions in TiNi shape memory alloy. This is a qualitative analysis aimed to verify the feasibility of further study in the application of IR for studying change phenomena. To this end, the material stress-strain curves, obtained during tension test with various strain rates, were completed by the temperature characteristics. The temperature distributions on the specimen's surface were determined by using an infrared camera. A heterogeneous temperature distribution, related to the nucleation and development of the new martensite phase, were registered and analyzed. A significant temperature increase, up to 30K was registered during the martensite transformation. Similar effects of the heterogeneous temperature distribution were observed during unloading, while the reverse transformation, austenite into martensite, took place. The reverse transformation was accompanied, in turn, by a temperature decrease, of up to 10K.

## Keywords

Shape memory alloy, phase transformation fronts, infrared detection