Lectio Materia

Newsletter of the

ACADEMIA NDT INTERNATIONAL

Science, Technology and Diagnostics in Non-Destructive Testing

Academia NDT International scientific meetings at WCNDT

ACADEMIA NDT International, the organisation for science, technology and diagnostics in non-destructive testing with the aim of advancing the science of NDT, is proud to host a series of two scientific meetings to take place within the programme of the 18th World Conference on NDT being held in Durban, South Africa, from 16-20 April 2012. Both meetings are to feature keynote lectures by Nobel Laureate Sir Harold Kroto.

The programmes for the meetings, which are both open to all, are shown below.

Sir Harold (Harry) Walter Kroto, FRS, is a British chemist and one of the three recipients to share the 1996 Nobel Prize in Chemistry along with Robert Curl and Richard Smalley.

In the 1970s, he launched a research programme at the University of Sussex to look for carbon chains in the interstellar medium. The work led to the discovery of the C60 molecule – the spherical fullerene molecule known as the Buckminsterfullerene (or Buckyball). Buckminsterfullerene is the largest material to have been shown to exhibit wave-particle duality. Its discovery led to the exploration of a new field of chemistry, involving the study of fullerenes.

Because the ACADEMIA NDT scientific meetings are integrated into the programme of the World Conference and are free for participants, persons planning to attend the scientific meetings arranged by the ACADEMIA should communicate their intention to the Executive Secretary of the ACADEMIA, Dr Irena Pushkina, by email: pushkina@spektr-group.ru

In the time since its birth, the ACADEMIA NDT has achieved a great deal – most notably its membership has grown considerably and four memorable special lecture meetings have been held: the first in Shanghai, coinciding with the 17th World Conference on NDT; the second and fourth in Brescia, Italy, the official seat of the organisation; and the third alongside the 10th European Conference on NDT, held in Moscow in 2010.

The idea of the ACADEMIA NDT International emerged a few years ago, reflecting a need within the NDT community to have a body that is evidence of the science in the NDT field at the highest level. A Steering Committee was formed and met for the first time on 25 May 2007 in Opatija, Croatia. An official decision to establish the ACADEMIA was taken on 10 March 2008, in Moscow. The overall objective of the ACADEMIA is to foster research, development and education in the NDT field by engaging NDT professionals in a combined effort, thus attaining the goal of always seeking progress.

Giuseppe Nardoni, President of the ACADEMIA NDT International, has referred to the organisation as “the greatest gift we can make to the new generation of NDT.”

ACADEMIA NDT International Scientific Meetings

International Convention Centre, Durban

Session 1: Tuesday 17 April 2012, 14:00-17:00, Room MR22

Session 2: Wednesday 18 April 2012, 18:00-19:00, Room 1A/B

Session 1: Tuesday 17 April 2012

Chairmen: Giuseppe Nardoni (President, ACADEMIA NDT) and Dr Baldev Raj (Vice President, ACADEMIA NDT)

14:00 – 14:30 Welcome and Introduction

14:30 – 15:00 1. Lecture: ‘Non-linear ultrasonic time-reversal mirrors in NDT’
Dr Zdenek Prevorovsky, Czech Academy of Science

15:15 – 16:00 2. Lecture: ‘Carbon in nano and outer space’
Sir Harold Kroto, Florida State University, USA

16:00 – 16:30 3. Lecture: ‘Nanosensors’
Dr Marc Kreutzbruck, BAM, Germany

16:30 – 17:00 4. Lecture: ‘Potential of terahertz radiation in NDT’
Professor Uwe Ewert, BAM, Germany

Session 2: Wednesday 18 April 2012

Chair: Giuseppe Nardoni (President, ACADEMIA NDT)

18:00 – 19:00 1. Lecture: ‘Scientific research as a key stimulus of socio-economic development’
Sir Harold Kroto, Florida State University, USA

Programme at time of going to press. Please note there may be last-minute unavoidable alterations.

Giuseppe Nardoni
President, ACADEMIA NDT International
Carbon in nano and outer space adds into the overall carbon equation its uniquely profuse chemistry, molecules and dust particles, as well as some highly puzzling material that life could be based on any other element. The most recent big discovery of a new form of carbon, for which he, together with Robert Curl, Richard Smalley, received the 1996 Nobel Prize in Chemistry.

In 1995, he launched the Vega Science Trust (www.vega.org.uk) to create science films of sufficiently high quality for broadcast on UK network television. He is now heavily involved with GEOSET, the Global Education, Science, Engineering and Technology programme (www.geoset.info and www.geoset.fsu.edu), which he initiated after moving to Florida State University. GEOSET (Spanish for “global education”) exploits the revolutionary creative dynamics the internet (which Harry calls the Goorulawi-Woolf) to improve the general level of science understanding and awareness worldwide. Numerous universities in the US, the UK, Japan, Croatia and Spain are now contributing to GEOSET’s resources, globalising, global-catch science educational material in modular form designed to help teachers. An exciting aspect of this initiative has been the realisation that graduate and undergraduate students are often exceptionally good at creating educational modules.

Harry has numerous awards, including the Copley Medal, the Faraday Lectureship of the Royal Society as well as the Tilden Lectureship and staff Medals of the Royal Society of Chemistry. Other awards include the Louis Vuitton – Most Hennessy Science pour l’Art Prize and the Italgas Prize for Innovation. He holds some 36 honorary degrees, has published over 800 papers, and is currently the Freeman of the City of Torino. From 2004, he has been on the Board of Scientific Governors at Scripps Institution. He was elected a Foreign Associate of the National Academy of Sciences in 2007.
Since his university studies, Dr Prevorovsky has been engaged in the Czech Academy of Science (CAS) in the field of physical and mechanical engineering, specialising in NDT/NDI/NDE and fracture mechanics of materials and structures. His research interests and published papers are mainly oriented on acoustic emission and ultrasonic methodology, including the latest non-linear and time-reversal spectroscopy and tomography, and NDE of all kinds of materials, including biological tissues. His activities in NDT and SHM cover diverse structures, ranging from aircraft to nuclear power plants. Signal analysis, elastic waves and industrial diagnostics with NDT are the main subjects of his university lectures. He is currently with the Institute of Thermomechanics, CAS.

Non-linear ultrasonic time-reversal mirrors in NDT

Dr Zdenek Prevorovsky, Institute of Thermomechanics, CAS, Prague, Czech Republic

Standard ultrasonic NDT methods use for damage detection characteristics of elastic wave propagation – like reflections, time-of-flight, attenuation, spectra, mode conversion etc. Recently developed non-linear elastic wave spectroscopy (NEWS) methods play on local material non-linearity caused by microcracks, bond weakening and corrosion, for example. Observed non-linear (NL) effects provide more sensitive detection and imaging of defects even smaller than the acoustic wavelength used. However, most NEWS methods require structure excitation with relatively large amplitudes. The necessary excitation energy can be substantially reduced combining NEWS with a technique referred to as time reversal mirror (TRM). The time reversal (TR) procedure consists of forward propagation of waves from the source, which are detected using one or more receivers, and then the recorded signals are reversed in time and rebroadcasted back by receivers inverted to transmit mode. In linear media, interchanging the source and receiver does not change the resulting wave-field (reciprocity principle), which can be used for unknown source reconstruction. If the medium contains a higher order non-linearity, the spatial reciprocity may be broken. The TR process enables to focus the wave energy in time and space on a scatterer (non-linearity) without a priori knowledge of its location. TRM enables detection and, in some modifications, also localisation of defects like cracks and other local damages.

Various NDT techniques based on NL TRM were developed during the last few years and have already been utilised in practice. Different modifications involve, for example, pulse inversion, frequency intermodulation, harmonic filtration, time shifting, decomposition of TR operator (DORT), excitation with symmetry analysis (ESAM) or chirp coding. Piezoelectric transducers are mostly used as both wave transmitters and receivers, and multiplexers switch between modes. Also, the non-contact receiving is realised using laser interferometers or air-coupled transducers. In that case, the reciprocity principle is again applied – an array of transmitters is used as a source of both forward and TR waves. Ultrasonic NL TRM techniques are today under intensive development and are becoming very promising in the NDT and structural health monitoring fields.

Dr Marc Kreutzbruck

Dr Marc Kreutzbruck received his PhD and the habilitation degree in applied physics from the University of Giessen in 1998 and 2005, respectively. His interests in fundamental research are magnetotransport effects in nanoscale heterostructures, for which he investigated unusual linear and high magnetoresistance effects based on the distribution on the nanoscale. His applied research began in 1995 within the field of superconductivity, where he studied the use of SQUID (Superconducting Quantum Interference Device) as an utmost sensitive magnetic field sensor for non-destructive testing applications, where very deep or small defects could be detected with a SQUID integrated as an eddy current sensor. Later on his research also dealt with the acoustic, thermal or coupled NDT techniques. This also involved signal processing, pattern recognition, and solving the inverse problem to transfer the detected physical properties into the mechanical condition of the component.

Dr Kreutzbruck is now the head of the non-destructive testing division 8.4 at BAM, Berlin, focusing on the acoustic, electromagnetic and thermal methods in non-destructive testing applications. He is member of many NDT-related advisory boards and technical committees and also a lecturer at the Technical University of Berlin.

Nanosensors

Dr Marc Kreutzbruck, BAM Federal Institute for Materials Research and Testing, Division 8.4

Sensors are increasingly pervading many aspects of modern living, such as information technology, transportation, medical devices, automation and safety applications. Usually the miniaturisation trend is motivated to meet the sensor requirements in terms of invisibility and low power consumption. However, entering the nano-world not only offers better sensor integration or the determination of materials properties on the nanoscale, but also opens up the use of a new detection mechanism based on unusual behaviour in terms of quantum mechanical effects at atomic dimensions. In this respect, a nanosensor is a sensing device in which some of its portion operates at the nanoscale, improving its functionality, such as enhanced reactivity, optical absorption or superparamagnetism.

This talk will provide an introduction into the field of nanosensors, allowing for the detection of a bunch of physical properties such as distances, forces, electronic charges or magnetic fields. The topic will also be highlighted from a NDT-perspective, where nanosensors can already be used or at least have the potential to be used in future NDT applications. Particularly, we draw attention to magnetic nanoscaled thin film devices based on the giant magnetoresistance effect (GMR), consisting of a stack of alternating nm-thick magnetic and non-magnetic layers whose electrical resistance is sensitively influenced by external magnetic fields. Because of their high field sensitivity and their small size down to the sub μm-regime, GMR sensors can support the detection of surface-breaking defects in metallic components applying stray field or eddy current testing. As a further example a thermoacoustic device is shown, in which the mm-dimension enables us to generate and to detect airborne ultrasound up to 1 MHz. Carbon nanotubes are driven with an AC-current resulting in a periodic joule heating of the nanowire. Due to its 2D nanodimensions, the heat can be transferred fast enough into the surrounding air to cool the wire within one excitation cycle. The expansion of the heated air then generates the sound wave. This example will show that nanomaterials have the potential to generate strong broadband sound pulses, which are key for future airborne impulse-echo applications.