

Testing at the Microscale



BRITISH SOCIETY FOR
STRAIN MEASUREMENT

Wednesday 11 June 2008

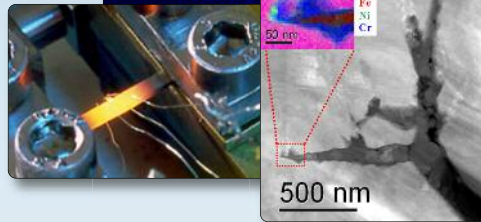
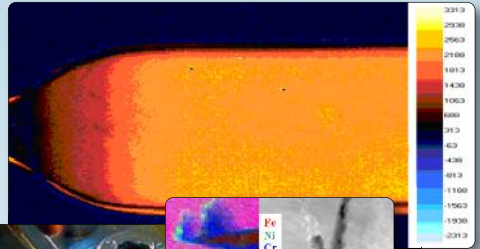
The National Physical Laboratory (NPL), London, UK

Seminar chairman: Dr Jerry Lord,
National Physical Laboratory.

Aims and Scope

With increasing emphasis on miniaturization, downsizing and in-situ measurement, a range of novel and innovative test methods are being developed to meet the demands of the materials and engineering industries. The physical and mechanical aspects of testing at this scale present significant measurement challenges. Systems and test pieces are on a similar scale to the microstructure and are small compared with conventional techniques. Local variations in surface properties, material behaviour and microstructure can significantly influence the measurements.

The seminar will showcase some of the latest developments and techniques for the characterization of material properties and performance at the microscale level. Presentations will cover different aspects of mechanical testing on miniaturized test pieces for generating lifetime and performance data relevant to power generation and high temperature materials development; a novel scratch test method for developing the understanding of the wear mechanism in tool steels; and the characterization of electronic devices,



composite interfacial properties and biomedical devices using photoelastic and thermoelastic techniques. Techniques for measuring local deformation, strain and crack tip processes based on in-situ Digital Image Correlation in the SEM, NanoSIMS, (S)TEM, and Atom probe FIB tomography will also be covered. Where relevant, validation of the methods with conventional test techniques will be presented, and examples given relevant to a wide range of applications and industries.

The seminar is the latest in a series of focused BSSM workshops and aims to bring together experts from academia and industry to showcase recent progress and applications in the field of experimental mechanics, and stimulate discussion, development and the uptake of the methods by engineers and scientists.

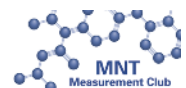
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Programme Timetable

10.00 – 10.30 Registration and coffee

10.30 – 11.00 Micro-scratch Testing of WC/Co Tool Materials

Professor Mark Gee, National Physical Laboratory

WC/Co tool materials are widely used in many applications where abrasion resistance is important. This talk describes model experiments carried out using a cost effective micro-scratch test system at NPL on a range of WC/Co materials with different grain sizes and compositions. The tests showed many of the mechanisms of wear that have been seen in macroscopic and field testing, and show potential for developing a detailed microstructurally based understanding of the mechanisms of abrasive wear for these materials.

11.00 – 11.30 Small Scale Sampling and Impression Creep Testing of Aged CrMoV Steam Pipework

Dr Steve Brett, RWEpower

The majority of the UK's aged coal-fired power stations have CrMoV steam pipework systems that have now operated for well beyond their original design life. As a result there is an increasing need for inspection programmes to prevent in-service failure. Small scale sampling of pipework material with subsequent impression creep testing, to rank materials in terms of creep strength, is being used to help establish inspection priority.

11.30 – 12.00 Strain Measurement in a Miniature Uniaxial Test System

Dr Bryan Roebuck, National Physical Laboratory

A small scale testing system developed at NPL (ETMT) is being extensively used for characterising the mechanical behaviour of metallic and metal composite materials at room and elevated temperature. The testpiece generally has rectangular cross-sectional dimensions of about 2 by 1 mm and at typical test temperatures the zone of uniform temperature is about 2-3 mm in length. This is too small to attach conventional extensometry and consequently a method for measuring plastic strain has been developed that requires changes in electrical resistance to be measured. The advantages and disadvantages of this technique are discussed using case studies associated with the deformation of Ni-base superalloys, stainless steels and metal composites.

12.00 – 12.30 Multi-scale characterization of crack tips

Dr Sergio Lozano-Perez, University of Oxford

The presentation will give an overview of recent work in the characterization of stress corrosion cracking of stainless steels from nuclear reactors. Data will show that it is possible to analyze crack tips with a wide range of techniques, including NanoSIMS, (S)TEM, Atom probe FIB tomography – a multi-scale approach that has proven very useful in understanding the mechanisms controlling crack initiation and propagation.

12.30 – 14.00 Lunch & Lab Tours

14.00 – 14.30 Strains in Grains - Metal Deformation at the Microscale

Dr João Quinta da Fonseca, University of Manchester

Surface strain mapping techniques such as image correlation now allow us to quantify the deformation of metals at the microscale. Time lapsed images obtained during in-situ straining reveal the truly heterogeneous nature of deformation and its links to the underlying microstructure. However, interpreting the results is fraught with difficulties, starting with data filtering and image corrections to linking the behaviour at the surface to that in the bulk. In this talk we will present recent work aimed at overcoming these challenges and present examples of how studying deformation at this scale really matters.

14.30 – 15.00 Studying the Reliability of Electronic Interconnects: Challenges and Methods

Dr Davide Di Maio, National Physical Laboratory

Moore's law, originally used as a forecast, is now used more as a goal and a road map for the electronics industry. This forces the devices to shrink at a very fast pace. Whilst their performance seem to easily keep up with such a development speed, the mechanical reliability is challenged in several ways. Here an overview is given on these challenges and how reliability research is trying to keep up at ever smaller scales.

15.00 – 15.30 Interfacial Characterisation of Polymer Fibre Composites

Professor Frank R Jones, University of Sheffield

The presentation will review the techniques for quantifying the interfacial response between fibres and resins in composites. The difference between an interface and interphase will be identified. It will be shown that the failure locus will change as the bond strength increases so that optimum adhesion is difficult to describe. Recent work on 4 phase stepped photoelasticity to measure interfacial shear stresses will be used to illustrate the role of residual thermal stresses on fragmentation micromechanics. Most recent studies using plasma polymer functionalisation of fibres will be used to show how the results of single filament and high volume fraction composites tests can be correlated.

15.30 – 16.00 Thermoelastic Stress Analysis of Intravascular Devices

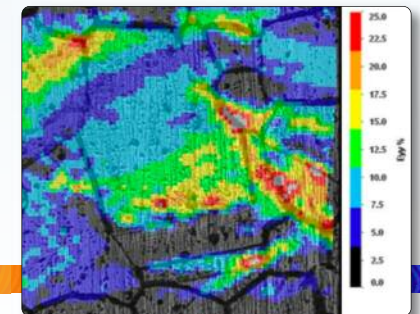
Dr James Eaton-Evans, University of Oxford

Experimental stress analysis of small, intravascular medical devices using Thermoelastic Stress Analysis (TSA) is presented. Important considerations for obtaining quantitative data at small scales are discussed and a case study on the application of TSA for the analysis of angioplasty balloons is presented.

16.00 – 16.30 Discussion Session

Dr Jerry Lord, National Physical Laboratory

16.30 Tea and Close



Registration Form

Please complete, photocopy and return to: John Edwards, BSSM Society Administrator
22 St Georges Road, Bedford MK40 2LS, Tel/Fax: 01234 347778
e-mail: johnedwards@bssm.org

Name: _____

Address: _____

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| Fees (VAT is not applicable) | Member | £120 | <input type="checkbox"/> | Non-member* | £175 | <input type="checkbox"/> |
| | Student Member | £55 | <input type="checkbox"/> | Student Non-member* | £80 | <input type="checkbox"/> |

*Non member rates include membership until 31 December 2008
Members of co-sponsoring bodies qualify for members' rates

Payment by cheque, credit/debit card (not AMEX) or invoice

Please make cheques payable to British Society for Strain Measurement;
for payments by invoice please quote a purchase order reference number.

Please invoice: Purchase order reference:

Card No:

Start date: / Expiry date: / Issue No. (Switch/Maestro only):

Security code (last three digits on back of card):

Venue information

NPL is the United Kingdom's national standards laboratory, an internationally respected, world-leading independent centre of excellence in research, development, and knowledge transfer in measurement and materials science.

For more than a century, NPL has developed and maintained some of the world's primary measurement standards - the heart of an infrastructure designed to ensure accuracy,

consistency and innovation in physical measurement.

The laboratory is located in Teddington, approximately 15 miles south west of central London, on the edge of Bushy Park and close to historic Hampton Court Palace, Kew Gardens and the main London tourist attractions. It is easily reached by road, rail (from London Waterloo) and air (London Heathrow Airport).

For more information visit www.npl.co.uk/location