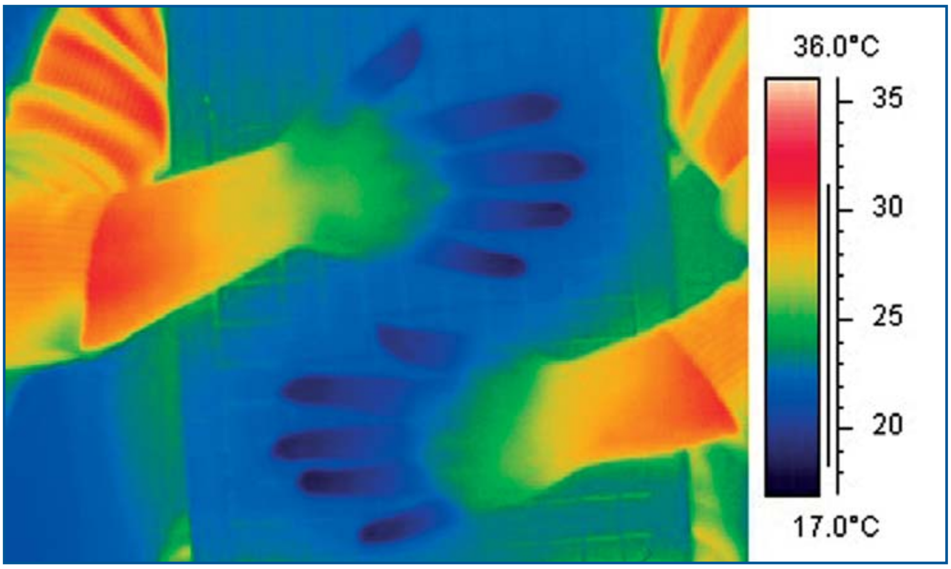
NPL National Physical Laboratory

Engineering *Precisely*

A National Measurement Newsletter

Autumn 2005 | Issue 1



Thermal imaging is being used more regularly in medical diagnosis

Contents:

This issue

Seeing red; but not over calibration

Infrared thermal imagers have become an important part of the medical arsenal, but practitioners need to be confident in their performance. In collaboration with clinical, industrial and university partners, NPL has proposed a new method for calibration.

Over the last decade the cost of thermal imagers has reduced, while the quality has improved greatly. This has led to an increased use in the medical field and the emergence of new applications. Medical thermography can be used for the monitoring and assessment of breast cancer, back pain and scleroderma patients, among others.

Often, images are taken over a period of months or even years and sometimes using different imagers at different hospitals. Any differences in the response of the imagers will hinder the ease with which images can be compared, and could impede the diagnosis.

In order to overcome these problems, medical practitioners need to be sure that the calibration of one camera is equivalent to the calibration of another camera. As a solution, NPL has proposed (in collaboration with the University of Glamorgan, Royal Free & University College Medical School, Isothermal Technology Ltd and Land Infrared) a multiple fixed-point blackbody source to provide an in-image calibration reference.

The collaborative effort to develop this reference source is being supported by the DTI as part of its undertaking to promote innovation by linking industry with the world-class expertise and facilities contained within the UK's National Measurement Institutes.

For further information on the blackbody source please contact Rob Simpson on 020 8943 6438 or e-mail: rob.simpson@npl.co.uk

To find out about current opportunities for collaborative research that can help your organisation develop measurement innovations, visit: ***www.npl.co.uk/measurement_for_innovators***

dti
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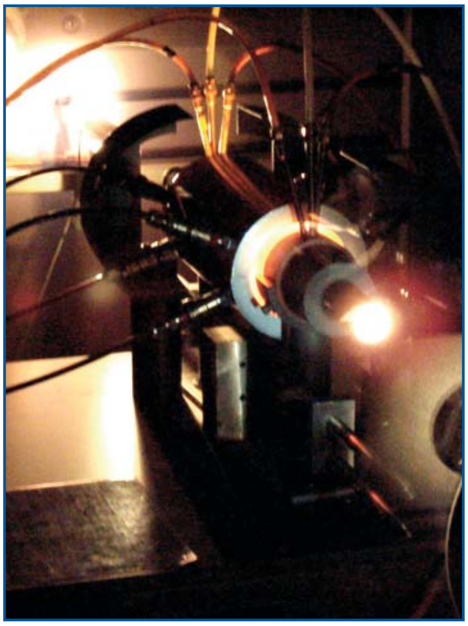
Low cost, low uncertainty, high temperatures

Research at NPL has led to the possibility of a low-uncertainty temperature scale based on novel high-temperature fixed-points of eutectic alloys of metal and carbon. This could give industrial users the ability to generate and apply their own "primary" scale to high temperature processes.



A 2474 °C rhenium-carbon fixed-point being realised at NPL

The International Temperature Scale of 1990 (ITS-90) is the backbone of traceable temperature measurement for much of the world's industry. It offers a practical way to calibrate instruments to a wide range of thermodynamic temperatures. At high temperatures, however, providing low levels of uncertainty can be very expensive.

Above the freezing point of silver (962 °C) ITS-90 specifies the use of a radiation thermometer along with one of the defining fixed-points of silver, gold (1064 °C) or copper (1084 °C). Temperatures above this level are defined by extrapolation, using the Planck radiation law. Every aspect of the thermometer and reference source must be well characterised to keep uncertainties at a reasonable level. This makes providing a primary scale very expensive.

NPL has recently demonstrated that novel high-temperature fixed-points of eutectic alloys of metal and carbon can be used to calibrate radiation thermometers with significant advantages compared to traditional methods of disseminating ITS-90. In this scheme ITS-90 would retain its formal position as the defined scale but these high-temperature fixed-points would become acceptable as a way to realise a low-uncertainty approximation to this scale. At the National Measurement Institute (NMI) level there could be substantial improvements in the reliability of scale realisation with lower uncertainties than are currently possible.

For industrial users benefits include the ability to generate their own "primary" scale with NMI-like uncertainties. Direct application of these fixed-points could greatly improve control of high temperature processes and this should feed through to improved product quality as well as providing environmental benefits such as optimised energy use and reduction in waste product.

For further details please contact Dave Lowe on 020 8943 6312; e-mail: dave.lowe@npl.co.uk or Graham Machin on 020 8943 6742; e-mail: graham.machin@npl.co.uk

Time to act on a residual issue

Anyone interested in improving the measurement of modulus or residual stress is invited to participate in any one of three new projects.

All three projects focus upon providing input for proposed international standards and are being developed by NPL under the auspices of VAMAS, the Versailles Project on Advanced Materials and Standards. NPL is looking to recruit partners ranging from end users, through to material fabricators and research organisations to participate at levels appropriate to their interests and capabilities.

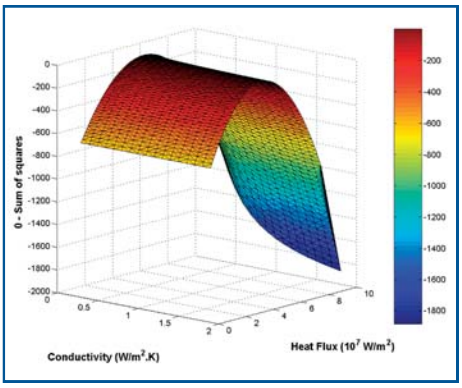
The first project aims to examine and reduce the scatter and uncertainty in the measurement of residual stress in metallic materials by X-ray diffraction. Specific experiments have been designed to examine the repeatability of the measurement, to measure a line profile or surface map across an interface, to examine the effect of surface roughness and to measure the elastic constants of the material. The project will complement the current standards work in CEN/TC138/WG10 through an intercomparison exercise.

The second project will examine the uncertainties associated with room temperature dynamic modulus tests, such as impact excitation, resonance and ultrasonic methods, on a range of materials including ceramics, hardmetals and other metals.

The third project will focus on static methods, examining the techniques and analysis procedures for determining modulus from the tensile test. Recommendations from the recent EU funded TENSTAND project included the development of a separate dedicated tensile test for modulus, but further groundwork is required.

Inverse thinking - calculating model parameters using TherMOL software

A new software tool, TherMOL, has been specifically developed at NPL for generic applications that require inverse modelling of multi-material systems, subjected to transient heat or mass transfer.



The sum of squares difference of oxide surface temperature measured experimentally and TherMOL predictions calculated using the NPL distributed computing system.

Predicting the rate of heat and mass transfer through a material is important in many applications such as insulation, heat exchangers and packaging. Modelling is invaluable in experimental design to make sure that a measurement does not disrupt what is being measured - a particular issue in the measurement of temperature during processing.

Inverse analysis is required when parameters for a direct model are unknown and therefore need to be estimated by "fitting" the model to experimental data. The fitting process may be done computationally by using optimisation routines to determine a parameter or combination of parameters from repeated runs of the model.

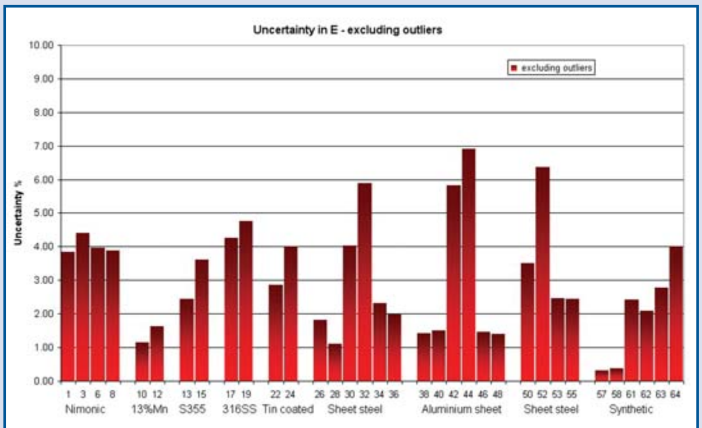
NPL's TherMOL software adopts inverse modelling techniques to reliably determine material and model parameters from experimental data. TherMOL currently has the capability to model rectangular material arrays and has been applied to a range of problems including determining unknown thermal properties, geometry, and boundary conditions by minimising multi-parameter fits to experimental data.

An example of successful application has been in determining the thermal diffusivities of steam grown oxide scales on P92 (a 9 wt% Cr martensitic steel). Temperature measurements were obtained from the NPL laser flash facility, where a laser pulse is directed at the P92 substrate and the temperature rise of the oxide surface over time is recorded. TherMOL was then used to calculate any unknown thermal parameters by numerically fitting the model to the experimental data.

To check results obtained from the optimisation process, TherMOL was also used with NPL's powerful distributed computing system, where the software was run with 40,000 different combinations of oxide thermal conductivity and laser heat flux. The predictions of surface temperature measurements from the run were compared with experimental data to determine the best values of model parameters.

Anyone wishing to harness the power of TherMOL to model their specific heat or mass transfer processes should contact Simon Roberts on 020 8943 6952 or e-mail: simon.roberts@npl.co.uk

http://www.npl.co.uk/materials/thermol.html



Typical scatter observed in modulus values for a range of materials examined in the TENSTAND project

The issue of data analysis has been highlighted as an important factor in modulus measurement as well as in other areas of materials testing. E.g. the K_{IC} and other fracture toughness tests, where fitting of a straight line to the load-COD data has an important influence on the calculated values.

A collaborative project to examine aspects of the procedures and test methodology will meet this requirement.

VAMAS facilitates pre-standards research into materials through international collaborative projects aimed at providing the underpinning technology and information for harmonised measurements, testing, specifications and standards with the objective of facilitating trade.

If you would like to participate in the new modulus and residual stress projects contact Jerry Lord on 020 8943 6340 or e-mail: jerry.lord@npl.co.uk

Details of other international collaborative VAMAS activities can be found at: ***www.vamas.org***

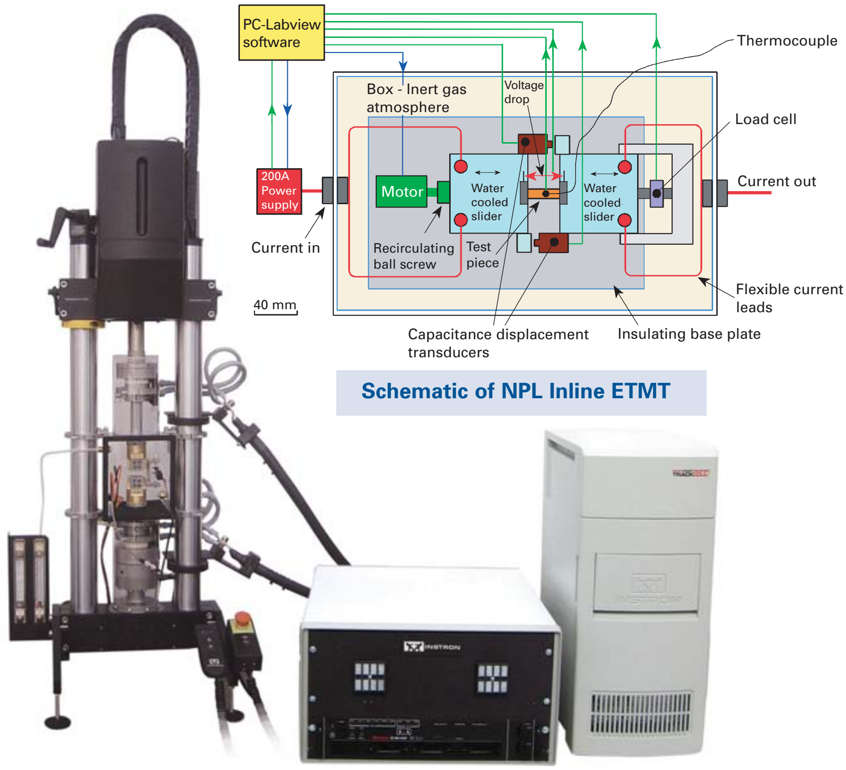
NPL / Instron® partnership delivers advances in electro-thermo mechanical testing

An NPL staff secondment has helped to improve user functionality of the NPL / Instron developed ETMT, making rapid prototype testing of miniature specimens a benchtop reality.

Since 2004 leading materials testing systems manufacturer Instron® and NPL have been jointly redeveloping NPL's ETMT (electro-thermo mechanical tester). The objective was to take the core technological aspects and performance of the original system and map them onto a redesigned small scale Instron test frame that could be commercialised as a stand-alone system. Thanks to a DTI-funded secondment the new ETMT 8800 is now available to purchase. According to Instron's Jeff Morfett, *"Collaboration with NPL on the development of the ETMT system has been invaluable in opening up new market potential in the field of miniaturised TMF testing and thermophysical property evaluation"*.

The ETMT was first designed as a test system capable of performing uniaxial (tension or compression) or fatigue strength tests under isothermal or cyclic temperature conditions on miniature metallic specimens, typically 40 mm x 2 mm x1 mm. The purpose of the instrument is to allow rapid prototype testing thus directly allowing companies to raise productivity by quickly assessing new advanced materials and to use current materials more cost effectively.

The first prototype system was characterised by the use of off-axis servomotor driven loading (±1 kN), and initially one capacitance based displacement probe (0 to 2 mm) mounted to the side of the specimen. Load was measured by an in-axis loadcell and samples were heated via low voltage, high current DC power supply and temperature monitored by type R thermocouples spot-welded to the specimen. The entire mechanical system was encapsulated in a modified electrical switchbox with Perspex lid, allowing operation in an inert atmosphere, whilst allowing the user to observe the sample under test. All



Schematic of NPL Inline ETMT

The NPL Instron ETMT 8800

the associated electronics were bundled up into a bespoke cabinet and the entire system controlled and data saved by bespoke Virtual Instrumentation software written in LabVIEW®.

Concerns about the off-axis loading adding bending moments to the specimen during testing focussed the early development of the system. An additional displacement probe enabled average specimen displacement to be calculated and a redesign brought the servomotor inline with the loading axis. Further enhancements extended the loading capability to 4 kN, employed infrared pyrometers to measure temperature, and used a linescan camera to measure non-contact specimen displacement. The Virtual Instrumentation software was developed to include these capabilities and also new functionality such as Thermo Mechanical Fatigue (TMF) testing in either load or displacement control.

In designing the new ETMT 8800 test system, the decision was taken to base it on a re-designed Instron® 8848 test frame, rated to 3 kN and the FastTrack™ 8800 tower digital control system. The ETMT 8800 test system could then be controlled by either the existing Instron FastTrack2 MAX software, or a new NPL LabVIEW® based Multiproperty application.

The ETMT 8800 test frame is of a twin column design, with an in axis actuator/ drive system which may be mounted in either a vertical or horizontal orientation and can be provided with either a high integrity (vacuum) chamber or a low integrity (atmospheric) chamber for specimen protection. The loadstring is designed to minimise the effective length between the lower base plate of the test frame and the specimen centre while providing a ±5 mm actuation displacement. Direct resistance heating of the specimen has been retained, the power supply having been uprated to a 4 kW, 450 A, DC unit, with 0 to 10 V DC output proportional to current output, suitable for input into an 8800 Signal Conditioning Module (SCM). To avoid an asymmetric specimen temperature profile and prevent significant heating and consequent thermal expansion of the pushrods, both the upper and lower pushrods have been drilled to provide internal water cooling to the entire loadstring, up to and including the specimen grips.

To provide data acquisition and control capabilities to the signals associated with the ETMT 8800, the FastTrack™ 8800 digital control tower is fitted with two Integrated Axis Controllers (IAC's). IAC 1 manages signals associated with the mechanical control of the ETMT and IAC 2 those associated with specimen heating. A remaining free channel on IAC 2 is available for future use by an additional (optional) pyrometer. The 8800 control tower features a 5 kHz maximum data acquisition rate / internal control loop, 19 bit resolution over transducer full range, closed loop control and waveform command generation.

Instron's FastTrack2 MAX software is a well-established software package that enables a user to design and run complex cycling of both specimen temperature and mechanical loading, for example TMF waveforms with periods of up to 6 hours. One of the ETMT's key features though, is that a user can interact with a specimen under test, changing mode of operation on the fly. To develop this functionality, NPL scientist Matt Brooks was seconded to Instron to design and code a new application in Labview. Using a relatively new Labview coding technique, LCOD (Labview Component Orientated Design), and advanced programming features of the 8800 digital control tower, an application was developed that allows independent control of both IACs. The new application caters for the steady state and cycling control modes available in the NPL ETMT, and also a dedicated ramp mode, with selectable end action. It also provides the user with the possibility of transferring control channel, for example load to displacement, or current to temperature, mid-test. Test data can be saved to disk, and once configured, the system will run un-attended until the user next interacts or the specimen fails.
The ETMT 8800 wasn't the only one to benefit from Matt's input. He reports:

"Transferring the existing functionality onto a new system was an exciting product development. It has been immensely satisfying to initially develop an instrument in a laboratory and then also contribute to bringing it to market. An added bonus is that exposure to a commercial manufacturing environment has given me skills I can take forward to other collaborative projects".

For more information on using the ETMT 8800 please contact Matt Brooks on 020 8943 6086; e-mail: matthew.brooks@npl.co.uk

For ETMT sales information contact Instron Limited on 01494 464646; e-mail: Jeff_Morfett@instron.com

Matt's secondment was made possible under the National Measurement Secondment scheme, funded by the DTI. The scheme is designed to encourage closer collaboration between the UK's National Measurement Institutes (NMIs) and other industrial, trade and academic organisations.

To find out how your organisation could benefit from this knowledge exchange, contact Val Ralph on 020 8943 6477 or e-mail: val.ralph@npl.co.uk

New 3D digital non-contact strain measurement

Full field non-contact strain measurement is an important tool in materials testing and for studying component behaviour, failure analyses and validation of finite element models.

NPL has a broad range of strain measurement facilities and expertise. These range from conventional extensometry, strain gauge methods and video extensometry to the higher resolution non-contact line scan systems, Digital Image Correlation (DIC), interferometry techniques and Electronic Speckle Pattern Interferometry (ESPI).

Recent investment in DIC includes a new high-resolution 3D system which, when combined with a new multiaxial testing facility, allows rapid full field 3D strain mapping of a range of materials and components.

The technique works by comparing changes in successive images to build up deformation vector fields and full field 2D and 3D strain maps. Image correlation is superior to most other stationary techniques because it takes into account the movement of the surface points with the sample during deformation. The image correlation method is insensitive to vibrations, large thermal gradients or rigid body motion. It is portable, can be used in an open laboratory without special equipment, and can image large components, up to several metres square.

The DIC technique has already been applied to a range of material testing studies including the examination of strain non-uniformity in testing, flow measurements in polymer processing, thermal expansion studies, dynamic crack growth, failure of adhesive joints and welds, in-situ SEM studies and TMF testing. NPL is currently working with a number of external customers to apply the techniques to a range of industrial problems.

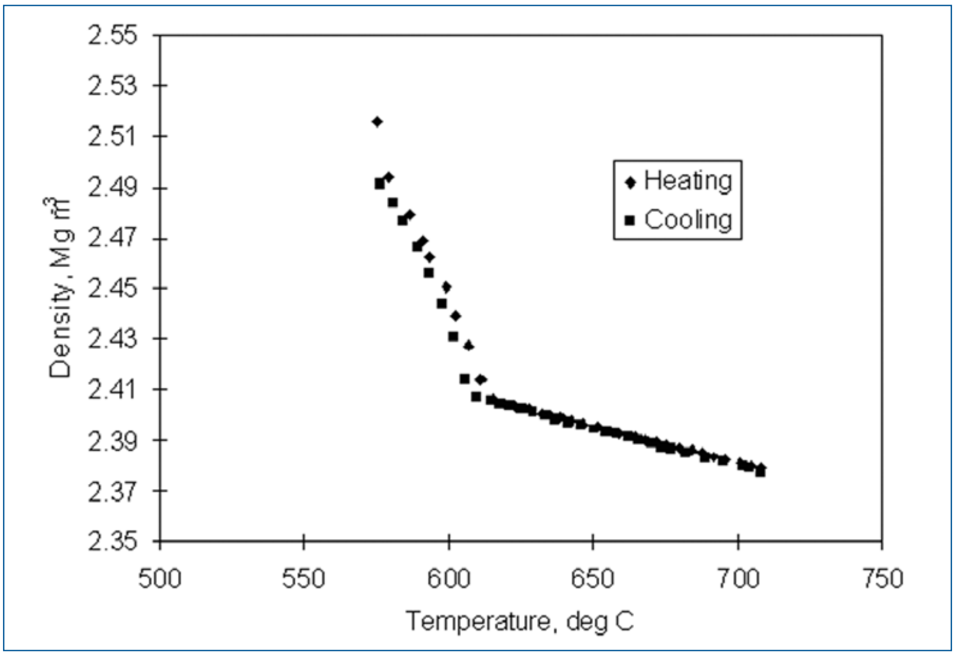
For further information please contact Jerry Lord on 020 8943 6340 or by e-mail: jerry.lord@npl.co.uk

Virtual to reality – piston dilatomtetry results confirm theoretical predictions for aluminium alloys

Recent piston dilatometry tests on a series of aluminium-silicon alloys have produced results for liquid metal density and volumetric expansion coefficient that closely match theoretical predictions produced by NPL's Virtual Measurement System.

The behaviour of metal alloys during cooling is important in optimising the design of casting procedures, much of which is now done by modelling. The rate at which heat is released in a casting depends on the solidification curve. However, the rate at which it can be removed from the casting is determined by the thermal transport behaviour between the casting and the mould, and hence on any gap developing between the casting and the mould. Knowledge of the density of the alloy during melting/solidification is thus of considerable importance to the casting industry. However, existing data based on a variety of direct measurement methods are highly scattered and unreliable.

A method which goes some way to providing this information directly is that of 'piston dilatometry'. A cylindrical sample of the test alloy is placed between ceramic pistons in a ceramic cylinder and is subjected to a small axial compressive force in a conventional mechanical dilatometer normally used for linear thermal expansion measurement of solids. Once the sample melts sufficiently to completely fill the cavity between the pistons, a direct measure of the liquid density as a function of temperature can be made through much of the so-called solid/liquid 'mushy zone' and into the purely liquid condition as the metal expands against the ceramic pistons. On cooling, it may also be possible to follow the process of liquid metal contraction and the first stages of mush solidification. The principal limitation with many metals is the reaction between the metal and the ceramic parts, which can cause the pistons to jam.



Piston cell density results for aluminium alloy LM25, exhibiting a melting range through a 'mushy zone' and a liquidus temperature of 605 °C. Slight undercooling can be detected on freezing.

A combination of pure aluminium run in a hot-pressed boron nitride cell in an argon atmosphere shows minimal wetting, and the process can be followed on both heating and cooling. Pure aluminium shows no melting range, so a very sharp change in volume is seen at the melting point.

Most recently, tests on a series of aluminium-silicon alloys have produced results for liquid metal density and volumetric expansion coefficient that match well with theoretical predictions from NPL's Virtual Measurement System (VMS). The VMS calculations are based upon one of the world's foremost thermochemical modelling packages, MTDATA, developed at NPL for the calculation of phase equilibria from thermodynamic data and a database covering the main components in aluminium alloys.

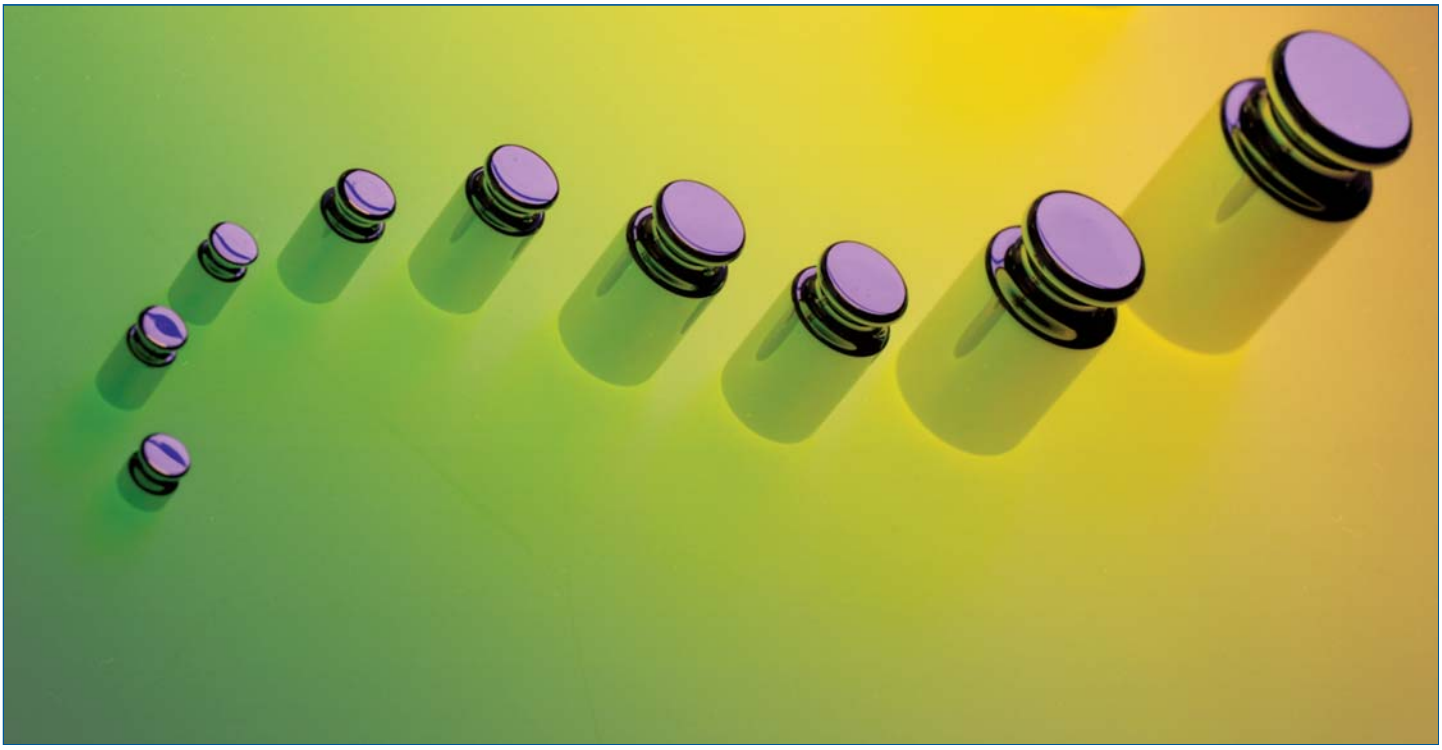
Piston dilatometry has also been successful in acquiring data on cast irons, copper alloys and nickel alloys using an alumina ceramic cell. Success seems to rely on there being sufficient oxide or reaction product being produced on the sample surface to restrict leakage of molten alloy along the pistons. Ironically, it is the very low melting alloys such as those based on lead, tin and antimony that cannot be measured reliably.

To discover how NPL's piston dilatometry technique could help optimise your casting processes or modelling contact
Roger Morrell on 020 8943 6381
or e-mail: roger.morrell@npl.co.uk

For more information on NPL's Virtual Modelling System visit:
www.npl.co.uk/mtdata/vms.html

Magnetism attracts weighty attention

For the first time, recommendations are being made concerning the routine measurement of the magnetic properties (permeability and residual magnetism) of weights by calibration laboratories.



A new version of OIML R 111 (produced by the Organisation of Legal Metrology) makes recommendations for the routine measurement of the magnetic properties of almost all weights used for legal metrology, and most weights used in other calibration and research applications. The document covers weights manufactured from stainless steel, brass or cast iron and is used in the UK as part of the certified calibration of mass standards and mass comparators and balances

Concern has been expressed about the practicalities of mass calibration laboratories making what are quite complex magnetic measurements. A Weighing and Density Network meeting was held at NPL on 25 May to discuss the interaction between balances and weights, technical aspects of performing the magnetic measurements, and the details of the OIML recommendation. The conclusions of the meeting were:

- The interaction between balance and weight is extremely difficult to predict mathematically even when the weight is represented as a dipole. Each model of balance produces a different magnetic field.
- Measuring the magnetic permeability and residual magnetism of a mass standard is not a measurement that can be made routinely by non-specialists.
- Commercial and in-house manufactured "susceptometers" based on microbalances, are available for use in mass laboratories but results depend on the magnetic moment of the magnet used and its distance from the weight being measured. A comparison between National Measurement Institutes has shown a wide scatter of results.
- Susceptometers are expensive and time consuming to use, so making magnetic measurements would significantly add to the cost of routine mass calibrations.
- While the OIML recommendation gives useful guidance on the measurement of magnetic properties of weights, it is unlikely that these measurements will be carried out in mass calibration laboratories. It is likely that the weighing community will rely on manufacturers to provide weights of suitable quality as set out in the recommendation.
- More practical measurements such as the use of a compass to assess the magnetism of a weight or magnetic fields around a balance are often of use. Putting spacers between a (magnetic) weight and the balance pan can reduce the influence of the weight on the balance reading.

Copies of the presentations can be viewed at: ***www.npl.co.uk/mechclubs/wdclub/meetings.html***

The revised OIML R 111 document will be available via the OIML website: ***www.oiml.org/publications***

For more information contact Stuart Davidson on 020 8943 6224 or e-mail: stuart.davidson@npl.co.uk

Critical Mass: timetable and targets set for kilogram redefinition

International agreement has been reached on the required uncertainty for any redefinition of the kilogram to ensure that there is no significant shift in the mass scale.

In July 2005 the Comité Consultatif des Unités (CCU) recommended that a target date of 2011 (the next but one meeting of the Comité International des Poids et Mesures (CIPM)) be set for the redefinition of the kilogram. A level of uncertainty of a few parts in 10^8 has been targeted, in line with the estimated stability of the current kilogram artefact.

Artefact definition

The kilogram is the last of the seven base SI units to be defined in terms of an artefact rather than a fundamental physical constant.

"The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram".

NPL maintains the UK mass scale from 1 mg up to 25 kg disseminating it via a series of working and secondary standards all traceable to kilogram 18. Kilogram 18 is one of the 40 national protoype kilograms compared directly with the International Prototype kept at BIPM, the Bureau International des Poids and Mesures in Sèvres, Paris.

This definition has two intrinsic shortcomings, namely that the mass scale worldwide is dependent on the stability of a single artefact and that all measurements of mass must ultimately be traceable to this artefact. The kilogram is also part of the traceability for the realisation of the ampere, mole and the candela. For over two decades, scientists at National Measurement Institutes (NMIs) around the world have been investigating potential methods for re-defining the kilogram in terms of fundamental constants. While the desirability of replacing the artefact based definition with one relating the kilogram to fundamental physical constants is widely recognised, until now there has been no agreed timetable or indeed consensus on the level of accuracy that the new definition needs to achieve.

While the redefinition of the kilogram is of interest to NMIs and to the scientific community in general, an accuracy level of a few parts in 10^8 has been recommended by the Comité Consultatif pour la Masse et les grandeurs apparentées (CCM) and set by the CCU so that it will have minimal impact on end users. The redefinition of the kilogram could result in a shift in the mass scale of up to 50 µg on a kilogram (5 in 10^8) but it was felt that this represented a level of disruption to the scale which could be accommodated by the worldwide mass community and was at a level appropriate to the stability of the currently used mass artefacts. In practice, the International Prototype is compared with a number of copies to monitor its stability, which can be estimated to be better than 10 micrograms (1 part in 10^8).

Redefinition: the contenders

There are a number of methods being investigated by NMIs for the redefinition of the kilogram in terms of fundamental physical constants. The two leading contenders are the International Avogadro project and the Watt balance approach.

The Avogadro approach involves collecting a given number of silicon atoms (chosen for purity and uniformity of lattice spacing). By measuring the volume, lattice spacing and isotopic composition of a sphere of silicon, its mass can be related to the Avogadro constant (N_A), which is about 6×10^{23}. Several NMIs are involved with this project, each providing a specific area of expertise. NPL provides input on the surface of silicon and on the practical weighing of the sphere.

The Watt balance approach, first proposed by Bryan Kibble of NPL, relates the electrical units of the volt and the ohm to the kilogram via the Planck constant (h). A current running through a coil in a magnetic field is used to generate a force. This force, defined in terms of the current, is used to balance a standard kilogram and thus to define mass in terms of electrical quantities and Planck's constant.

NPL and NIST (USA) have the only two operational Watt balances, but METAS (Switzerland) and LNE (France) are also pursuing the approach. Despite the best efforts of the NMIs involved with these projects, the uncertainties so far achieved are about an order of magnitude away from what is necessary. Interestingly, there is also a discrepancy between the two approaches of about 1 in 10^6. Much work is required if the target uncertainty of 1 in 10^8 is to be realised by 2011.

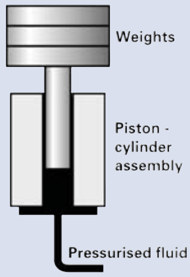
NPL is continuing its efforts to redefine the kilogram via both approaches in the new Engineering Measurement Programme, starting in Autumn 2005.

To find out more about NPL's work on the redefinition of the kilogram via the Avogadro project visit:
www.npl.co.uk/mass/avogadro.html

To find out how NPL will continue its work on the Watt balance visit:
www.npl.co.uk/engmeas/project4_01.html

Are your hydraulic high-pressure systems calibrations correct?

A new research project at NPL aims to help industry by determining the effect of using different types of hydraulic fluid in pressure balances. Users of pressure balances can direct the study by indicating their application requirements.



Within the new Engineering Measurement Programme, NPL will investigate the influence of using different fluids in a pressure balance. What effect does it have on the generated pressure and does it affect the validity of its calibration?

The first stage is to establish the types of hydraulic fluid used in industrial pressure balances and what pressure uncertainties are required. If you use a pressure balance, now is your opportunity to participate in the initial survey and ensure your requirements are taken into account.

High-pressure measurement standards are simple in concept. For demanding applications they consist of a vertical piston in a tightly fitting cylinder. Forces are applied to the cylinder to generate a range of pressures and to a first approximation the pressure generated is the ratio of the applied force to the cross-sectional area of the piston. These instruments are known as pressure balances or piston gauges.

In practice, the pressure generated is influenced by many other factors including the density and viscosity of the fluid used as a pressure transmission medium. In many industrial pressure balances there is a larger radial gap between the piston and the cylinder than in those used in a calibration laboratory. This means that the industrial pressure balances need to be used with more viscous fluids than calibration instruments.

If you are interested in knowing more about the influence of the hydraulic fluid that you are using please contact Ian Severn on 020 8943 6862 or e-mail: ian.severn@npl.co.uk so you can be sent a simple questionnaire that will inform the study.

Quality presentations

Testing, inspection and prediction for quality purposes will be the underlying theme of NPL's seminar presentations at this year's Inspex exhibition (4-6 October, NEC Birmingham).

As part of the educational programme at Inspex, NPL, in conjunction with its EMAN (Engineering Measurement Awareness Network) members, has organised a series of 12 free seminars looking at aspects of materials testing, dimensional measurement and thermal measurement affecting quality issues. In addition, NPL will be running "measurement clinics" where delegates can receive one-on-one consultancy advice from NPL experts. For a full programme of seminars and clinics visit:

www.npl.co.uk/dmac/meetings/inspex_oct_05/index.html

A mass of good practice

NPL's Measurement Good Practice Guides provide valuable advice on calibration and the use of instruments over a large range of measurement areas. Three new mass guides, together with a CD containing basic training modules for mechanical metrology are available free of charge from NPL.

Good Practice Guide No 69: ***The Use and Calibration of Piston-Operated Volumetric Pipettes*** provides information and guidance on the use of micropipettes. It covers both single and multi-channel manual and automatic pipettes, and illustrates good practice through all areas in which they are used. Given the small amounts of liquid dispensed, areas such as weighing accuracy, liquid evaporation and dispensing methods are all of critical importance to calibration accuracy.

Good Practice Guide No 70: ***Weighing in the Pharmaceutical Industry*** provides the user with information to establish best practice in pharmaceutical weighings. This includes the weighing of non-standard loads such as powders and liquids. It includes an overview of the current regulations applicable to pharmaceutical weighing, guidance on legal metrology, and of the US Food and Drug Administration requirement for pharmaceutical calibrations.

Good Practice Guide No 71: ***The Measurement of Mass and Weight*** is intended as a useful reference for all those involved in mass measurement. It introduces the main concepts of mass and weight and the practical techniques involved in their measurement. Of particular importance when weighing is balance assessment, and this is covered in some detail for the different types of balance in regular use.

CD- ROM: Basic Training Modules for Mechanical Metrology contains electronic (pdf file) copies of the Good Practice Guides in the mass, force, pressure and vacuum areas and several Guidance Notes, along with the very useful 'A Beginner's Guide to Uncertainty of Measurement'. The CD also includes a number of training modules covering the basics of mechanical metrology, aimed at staff new to particular areas of mechanical metrology.

For a copy of any of the above Measurement Good Practice Guides or the Basic Training CD please contact the NPL enquiry line on 020 8943 6880 or e-mail: engineering@npl.co.uk

Temperature and humidity – measurement and calibration course

17-20 October 2005, NPL Teddington
A modular four-day course (third and fourth days optional).

This course is suitable for technicians and technical managers closely concerned with temperature and/or humidity measurement and calibration. It will concentrate on those methods of measurement which are of greatest technological and industrial importance.

On days one and two, the emphasis will be on practical aspects of temperature measurement, calibration and traceability, covering the range – 200 °C to 2950 °C. The course will open with an introductory session on temperature scales and standards, including a résumé of the International Temperature Scale of 1990, ITS-90, and the three most important measurement techniques. The five laboratory sessions will be concerned with fixed points, resistance thermometers, thermocouples, radiation thermometers and liquid-in-glass thermometers. These will be supplemented by lectures in calibration techniques, uncertainties, traceability and accreditation.

The optional third day will provide opportunities for more in-depth training and 'hands-on' experience of some of the calibration techniques used in the laboratory.

Day four consists of a stand-alone course on humidity measurement and calibration. Covering dew point, relative humidity and many other humidity quantities, the course will provide an introductory session on humidity terms and definitions. It will also cover measurement techniques and instrumentation, practical use of instruments, calibration, examples of good practice and calculations/conversion between different units. A tour of the humidity laboratory will provide some 'hands-on' experience of the calibration techniques regularly used at NPL. This will be reinforced with talks on calibration techniques, uncertainties, traceability and accreditation. (The humidity course may be attended on its own.)

The course is being jointly run by NPL and the United Kingdom Accreditation Service (UKAS)

For a full programme and registration details visit:
www.npl.co.uk/training/#thermal

Contact Karen Alston on 020 8943 6185 or e-mail: karen.alston@npl.co.uk

Soft touch – hard facts

NPL will be showcasing its work on characterising the feel of thermoplastic elastomers at this year's Interplas exhibition (4-6 October, NEC Birmingham).

The feel of a product plays a critically important role in influencing customers' perception of quality and functionality. From shampoo bottles, to power-tool handles to steering wheels and golf club handles; how an object feels to the human hand is an important factor when customers differentiate products. To reduce the time and resource required in prototyping, NPL is leading research to produce a quantified measure of people's reactions to the feel of thermoplastic elastomers.

At Interplas, visitors to the NPL stand (5153) will be able to experience at first-hand two new approaches to measuring feel:

- a new technology which measures the amount of friction generated when people touch a material.
- a technique (developed in collaboration with City University London) to understand the link between what people think about how objects feel and their true physical properties.

NPL staff will also be available to discuss all your polymer and composite processing and testing needs.

www.interplas-expo.com

Don't let lead weigh your business down

By August 2006, businesses have to remove lead and other materials from their production processes to comply with new European directives. Many small businesses don't know that the new directives could cost them money and put their relationships with suppliers and customers at risk.

NPL is working with the Federation of Small Businesses (FSB) to deliver seminars informing businesses about lead-free manufacturing and the risks involved if they don't comply with the directives. There will be the opportunity for attendees to have a free half-hour consultation with NPL experts to discuss issues directly affecting their company.

The seminars will be held in London (25 October), Manchester (27 October) and Birmingham (28 October).

Speakers will include FSB Environment Chairman John Holbrow, NPL lead-free expert Alan Brewin, and representatives from companies which have already put lead-free manufacturing into practice.

To register please contact Clare Melton at NPL on 020 8943 6327 or e-mail: clare.melton@serco.npl.co.uk

Impact of environment on structural integrity

18th October 2005, NPL Teddington, a FESI-FITNET Workshop

This workshop will reveal the considerable developments that have been made towards procedures for structural integrity assessment in complex circumstances. Leading experts from NPL, Shell, Serco Assurance, Metallurgical Consultants and TWI will present the underlying principles and use case studies to demonstrate how these are applied in practice.

The workshop is aimed at providing guidance to engineers in assessing the risk of failure in service and, where damage is detected, to adopt an informed analysis of its criticality.

In practice, failures do occur unexpectedly for a number of reasons such as:

- altered operating conditions
- unsatisfactory welding
- transient variations in stress, temperature or environment chemistry
- changes in the character of the metal surface with time or "aging" of the material
- local chemistry changes due to crevices or heat transfer.

The presentations will specifically cover the need for optimal engineering design to avoid the occurrence of stress corrosion cracking, corrosion fatigue, and corrosion-induced wall thinning, or to give an acceptable life for the application.

For more information contact Alan Turnbull on 020 8943 7115 or e-mail alan.turnbull@npl.co.uk

If you would like further information on any aspect of **NPL Engineering Precisely,** *please contact:*
Tel: 020 8943 6880 | **Fax:** 020 8943 7160 | **E-mail:** engineering@npl.co.uk

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Helpline: 020 8943 6880 | **Fax:** 020 8943 6458 | **E-mail:** enquiry@npl.co.uk

Be more dynamic!

Improving dynamic measurements can save you time, money and reduce failure rates.

Transducers calibrated statically do not necessarily behave in the same way when subjected to dynamic inputs. This may be due to the frequency response of the instrumentation, creep or drift effects, or to mechanical inertia. Unfortunately, many transducers used to make important industrial measurements are suffering from this problem, more often than not because there are no suitable dynamic calibration facilities available.

Part of the new DTI-funded Engineering Measurement Programme aims to address this major area of concern. A team of NPL scientists will work closely with industry and academia to identify and develop programmes of work in a number of areas, spanning the dynamic regime, including pressure, force, length, torque, and temperature. Suggested project areas so far include blood pressure measurement, aero-engine monitoring, materials testing, automotive data acquisition and on-the-fly transducer calibration.

If you make dynamic measurements using transducers that have been calibrated statically, this is a great opportunity for you to influence this programme of work and reap direct benefits.

If you are concerned that the validity of your measurements may be suffering, your uncertainty budget may not be robust, or that your process could be improved, please contact Andy Knott on 020 8943 6180 or e-mail: andy.knott@npl.co.uk

Forthcoming events

15 September 2005, CLRC Daresbury Laboratory, Cheshire
The Influence of vacuum technology on science & manufacturing
www.npl.co.uk/mechclubs/pressmet/meetings.html
E-mail: npl_clubs@npl.co.uk

20 September 2005, NPL, Teddington
Good measurement practice – Weighing & density network meeting
www.npl.co.uk/mechclubs/wdclub/meetings.html
E-mail: npl_clubs@npl.co.uk

21 September 2005, University of Warwick
Software measurement standards for surface texture software validation
www.npl.co.uk/dmac/meetings/21_sep_2005
E-mail: clare.melton@serco.npl.co.uk

28 September 2005, NPL, Teddington
The measurement of engineered nanoparticles
www.npl.co.uk/metrology_clubs/mnt
E-mail: robert.angus@npl.co.uk

29 September 2005, NPL, Teddington
Time and Frequency Club/Pinpoint Faraday joint meeting
www.npl.co.uk/time/draft_agenda.pdf
E-mail: gill.roe@npl.co.uk

4 - 6 October 2005, NEC Birmingham
Inspex and Interplas exhibitions:
www.npl.co.uk/dmac/meetings/inspex_oct_05
E-mail: npl_clubs@npl.co.uk

12 October 2005, National Metals Technology Centre (NAMTEC), Rotherham
Testing the toughness of materials (Force and hardness network meeting)
www.namtec.co.uk
E-mail: rachael.spooner@namtec.co.uk

12 October 2005, NPL, Teddington
Humidity Masterclass (In association with the Society of Environmental Engineers)
www.npl.co.uk/tman/meetings/meetings_index.html
E-mail: office@environmental.org.uk

17 - 20 October 2005, NPL, Teddington
Temperature measurement and calibration / Humidity measurement and calibration
www.npl.co.uk/thermal/courses/temp_course2005.html
E-mail: kevin.osborne@npl.co.uk

18 October 2005, NPL, Teddington
Impact of environment on structural Integrity FESI-FITNET Workshop
E-mail: alan.turnbull@npl.co.uk

2 November 2005, National Metals Technology Centre (NAMTEC), Rotherham
Technical surgeries
See flyer insert
E-mail: emma.mulligan@npl.co.uk

9 November 2005, NPL, Teddington
Medical thermography & thermometry (hosted by IPEM Medical)
www.npl.co.uk/tman/meetings/meetings_index.html
E-mail: meetings@ipem.co.uk

30 November 2005, NPL, Teddington
Signal processing in metrology
Software Support for Metrology
E-mail: seminar gill.roe@npl.co.uk

For information on Engineering Precisely, event details and contacts visit the website: www.npl.co.uk

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