NPL National Physical Laboratory

Engineering *Precisely*

A National Measurement Newsletter

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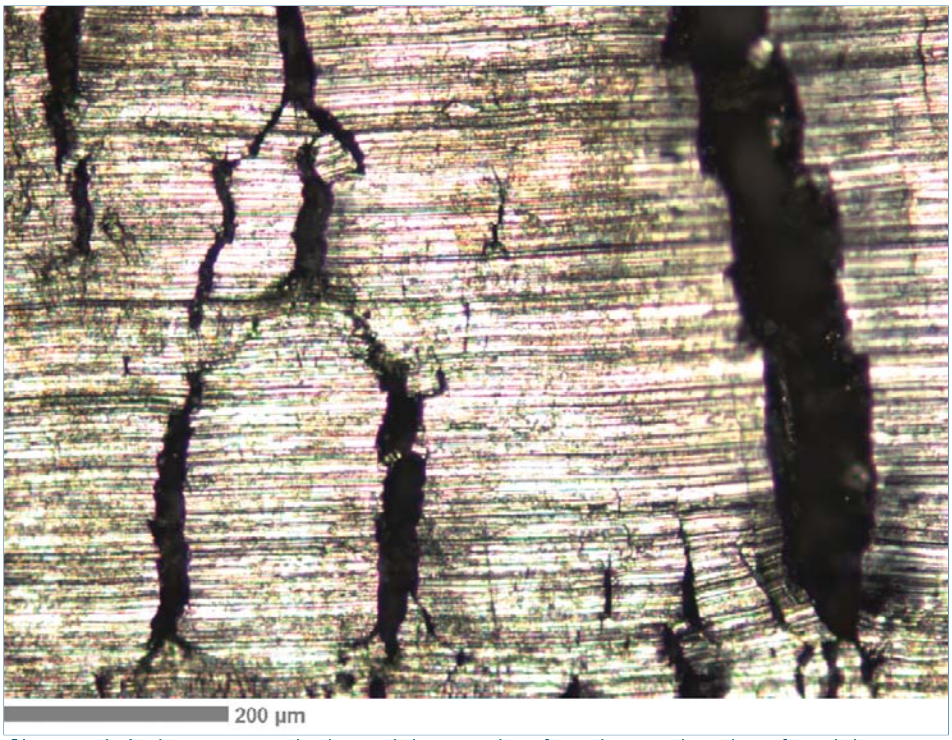


Characteristic damage on a duplex stainless steel surface close to the edge of a salt layer, where multiple cracks coalesce and eventually lead to fracture

Contents:

Oil and gas producers to revise guidelines for pipework

Oil and gas producers are revising guidelines for the installation of duplex stainless steel in marine environments following new measurements at NPL.

Failure due to stress corrosion cracking of topside pipework is a major concern and can be induced by concentrated salts formed by evaporation of seawater from spray, washing, splashing and dripping on the hot metal surface. This can be controlled by coating the pipework for applications above the perceived critical temperature for cracking. Based on the widely adopted NORSOK standard for material selection in marine environments, this would be above 100 °C for duplex stainless steels and above 110 °C for superduplex stainless steels.

Simulating the operational conditions in a laboratory is a challenge, but by using a new approach NPL has recently shown that these materials can crack at temperatures as low as 80 °C. The results were obtained using a modified drop evaporation test with improved control of specimen temperature and stress, and with evaporation conditions designed to create a three-phase boundary on the specimen. At an applied stress of 90% of the material proof stress, a threshold temperature for cracking between 70 °C and 80 °C was identified for both 22 Cr duplex and 25 Cr superduplex stainless steel.

Although the risk of failure in service is low, since it relies on the coincidence of high stress (e.g. at a weld) with the edge of a salt deposit, NPL has recommended that for conservative reasons the threshold temperature for coating should be reduced to 70 °C for both materials.

For further information, please contact Gareth Hinds on 020 8943 7147 or e-mail gareth.hinds@npl.co.uk

Real thermographic inspection solutions for real coated components

NPL, with the assistance of Tecvac Ltd, has investigated the use of non-destructive thermographic inspection methods for turbine blade coatings, demonstrating great potential for use with real components.

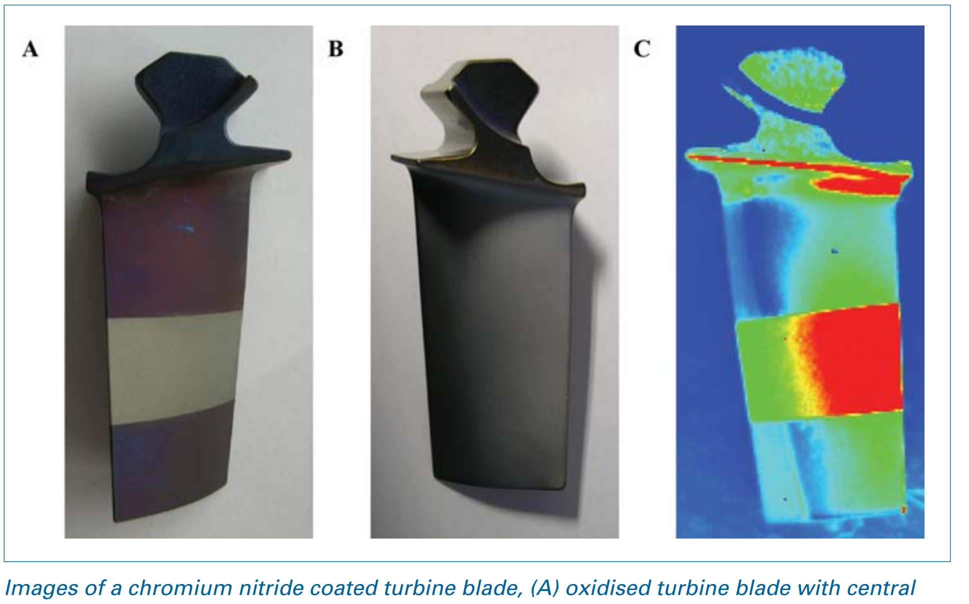
Turbine blades are coated with hard and durable coatings, through physical vapour deposition (PVD), which provide protection during use and reduce the risk of catastrophic failure arising from damage. Contamination of surfaces during the coating process can lead to poor adhesion of the coating and in-service delamination is a risk. Inspection of individual components reduces this risk. However, many types of defect are difficult to detect, and a robust non-destructive inspection method for assessing adhesion quality is needed.

Thermography methods, which use thermal imaging cameras to detect the disruption of heat flow through the sample caused by sub-surface defects, have great potential for evaluating coatings. These methods were evaluated for inspecting coated turbine blades as part of the Non-Destructive Adhesion Measurements project (run by TWI and NPL with funding from the National Measurement System Directorate - NMSD); the turbine blade coatings were tested using a conductive heating thermography method, where the substrate is heated. Defects are visible on the thermal image as cold spots (blue/green) on the coating surface, where heat does not transfer as effectively from the component to the coating. A blade sample with poor surface preparation was made by oxidising a grit blasted titanium turbine blade. The middle section of the blade was then again grit blasted to return it to its original state (A). The blade was then coated (by Tecvac Ltd) with chromium nitride using physical vapour deposition (PVD), to produce a visibly uniform coating (B).

A thermographic image (C) of the blade obtained following conductive heating visualises differences in temperature. The poor and well-bonded areas of the coating are easily distinguished, despite the shape of the blade, suggesting this method has a use as a reliable inspection tool for real components.

For further information, please contact Bruce Duncan on 020 8943 6795

Materials Enquiry Point
Tel: 020 8943 6701
Fax: 020 8943 7160
E-mail: materials@npl.co.uk



Images of a chromium nitride coated turbine blade, (A) oxidised turbine blade with central region grit blasted, (B) PVD coated blade, (C) thermographic image of coated blade

Industrial insulation measurements to meet European standards

European product standards for industrial insulation will be issued sometime in 2008/2009 and will require the thermal resistance of these products to be provided as part of a CE mark. However, only very few measurement facilities are currently available at either cryogenic or elevated temperatures. After more than a decade of development, NPL will soon be able to provide measurements of thermal resistance/conductivity covering the temperature range required by these standards (-170 °C to 800 °C).

Following the implementation of mandatory requirements for declaring thermal performance values of insulation used in buildings, manufacturers of insulation for industrial applications will also soon face a mandatory CE (European Conformity) mark requirement for their products for sale or export within Europe. The types of product included in these new standards will include insulation used in furnaces, steam pipes, cryogenic storage and industrial plant processes. The CE mark indicates that a product conforms to legally required minimum safety characteristics, and that the product standards will include definitions of how thermal performance data should be measured by an independent, notified body.

The NPL Thermal Performance Laboratory is one of the few laboratories in Europe that has the expertise and facilities for measuring the thermal resistance and thermal conductivity of industrial insulation over the required temperature range, and is currently the only laboratory in the UK that will be able to provide this service. NPL has developed a range of National Standard facilities that can measure the thermal performance of industrial insulation: Low Temperature Guarded Hot-Plate (-170 °C to 50 °C); Vacuum Guarded Hot-Plate (-50 °C to 70 °C); High Temperature Guarded Hot-Plate (100 °C to 800 °C); and High Temperature Pipe Insulation Tester (50 °C to 250 °C).

One of the main reasons for the small number of laboratories able to provide these measurements is that accurately determining thermal resistance becomes even more challenging at more extreme temperatures. For example, in the higher temperature range there is a requirement for the temperature sensors to be precise, stable and robust, but this is in direct conflict with the need to limit paths for extraneous heat flow by using the thinnest possible sensors. Additionally, radiant heat transfer becomes far more significant in both the specimen and the interfaces between components.

NPL is currently leading a working group within CEN Technical Committee 89 to develop a new European measurement standard for thermal resistance at elevated temperatures (prEN15548-1). The aim is to address the technical challenges and to improve on the currently poor level of agreement between the existing laboratories. Until a measurement infrastructure can be established within Europe, NPL will be one of the few laboratories able to provide the measurements of thermal resistance and conductivity to meet mandatory requirements for industrial insulation.

For further information, please contact Jiyu Wu on 020 8943 6045 or e-mail jiyu.wu@npl.co.uk

Vibration testing of solder joints

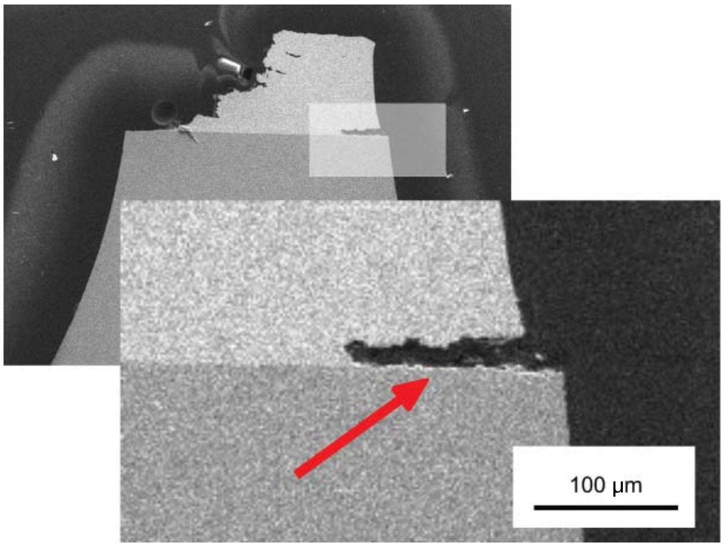
The behaviour of solder joints in a high frequency environment is now better understood as a result of the development of a new test method that permits the solder behaviour to be characterised. Research recently conducted at NPL has highlighted that the high frequency response of lead-free alloys falls behind that of conventional SnPb alloy.

There are many applications in which electronic devices are subjected to vibration, but while there has been much research into the effects of low-cycle fatigue, there has been very little regarding high-cycle fatigue. A recent NPL research project addressed this imbalance, generating data on SnAgCu (SAC) lead-free joints, using conventional SnPb solder as a benchmark. The NPL work adopted a general approach using a model solder joint, to which controlled vibrations (400 Hz and 800 Hz) were applied, whilst recording joint lifetimes and the materials' responses to the vibration.

The test method was found to be a valuable tool for studying solder performance under high frequency vibration, and particularly useful for ranking various alloys in terms of vibration performance. During testing, the SnPb alloy performed better than lead-free alloys, especially at 800 Hz, while within the lead-free solders group, those with higher concentrations of silver performed better at 400 Hz than lead free solders with lower silver concentrations.

In testing, the lifetime of solder alloys and their ranking were frequency-dependent, and different crack propagation modes were found to operate at different frequencies. The team also discovered that annealing degrades performance at both 400 Hz and 800 Hz.

The method has the advantage of tests being easily repeatable in a range of conditions, which can be targeted at specific industrial applications. The equipment is also easy to modify for testing at high temperatures. More details can be found in High Frequency vibration tests of *SnPb and lead-free soldering joints,* NPL Report MAT2.



SEM image of a crack on the interface on a SAC sample vibrated at 800 Hz

For further information or for a copy of the report, please contact Ling Zou on 020 8943 6065 or e-mail ling.zou@npl.co.uk

Piezo brought into the mainstream

Europe's first organisation dedicated to piezoelectric materials and devices, the Piezo Institute, has been launched by a multidisciplinary consortium of researchers and industrialists. The National Physical Laboratory (NPL) is a founding member.

The European Institute of Piezoelectric Materials and Devices (Piezo Institute) was created by the EU-funded MIND Network of Excellence and incorporates expertise from countries including the UK, France, Italy, Denmark, Slovenia, Switzerland, Spain and Latvia. Companies involved include Fiat and piezo-ceramics manufacturer Ferroperm in Denmark. Members are currently being recruited from Europe and beyond.

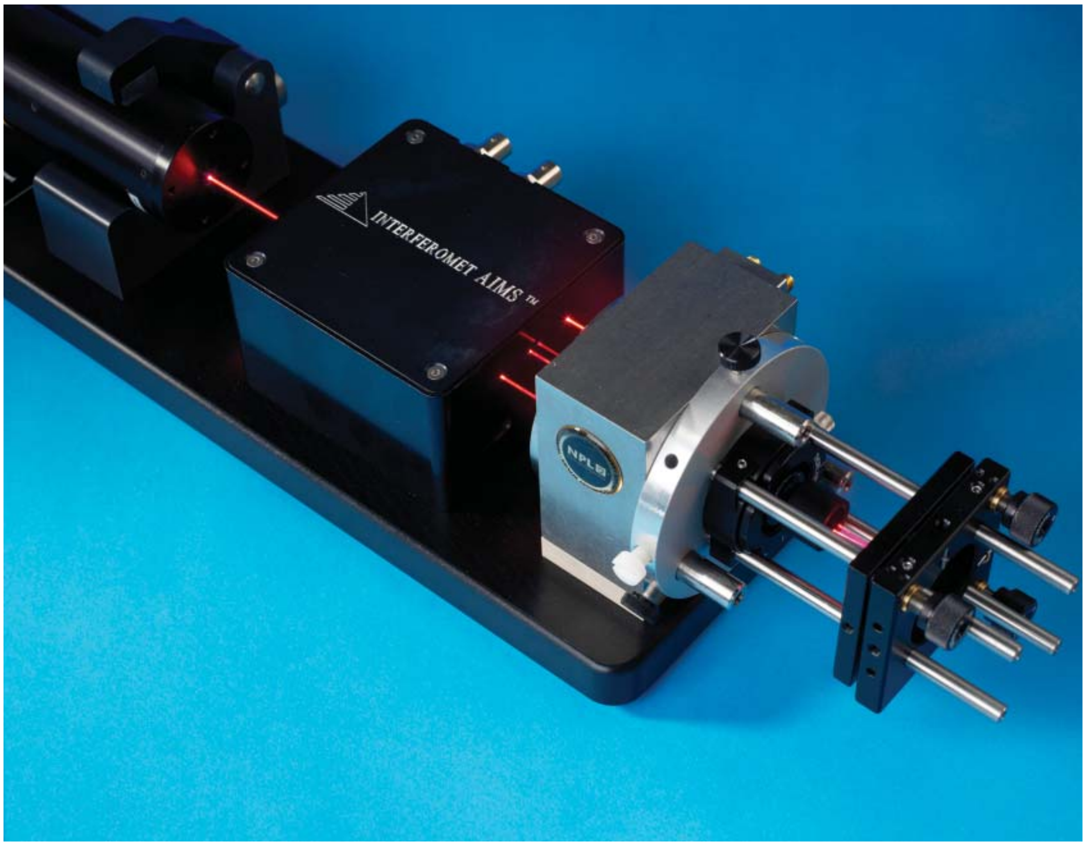
The Piezo Institute will develop piezo-based sensors and other applications. It will be the European hub of expertise and resources in piezo technologies, offering research, resources, education and training. Its expertise include ferroelectricity, electrostriction and pyroelectricity in materials including ceramics, single crystals, polymers and composites.

"The science of piezoelectricity has been known for more than a century," notes Dr Markys Cain, a principal research scientist and knowledge leader at NPL. "The Institute is Europe's recognition that there is now a far greater potential for piezo applications in healthcare, transport, energy harvesting and environmental protection. It will help us to keep up with the rapid pace of piezo development in Asia and North America."

The Piezo Institute offers research and consultancy in chemistry and process engineering, solid state physics, materials characterisation, metrology, standards and the manufacture and testing of piezo devices.

Applying piezo phenomena

The aims of the new institute include miniaturisation and integration of piezo structures into multifunctional devices, such as sensors for monitoring radiation, temperature and biological threats. New transducers for medical imaging, underwater acoustics and telecommunication systems are improving sensing performance and environmental efficiency. Innovative piezo-based devices enable implants for health monitoring and targeted drug delivery, and disposable probes to inspect and treat cardiovascular disease.



NPL/Interferomet system for measurement of properties of piezoelectric materials

Transport

Piezoelectric materials are the basic component of many automotive sensors, including accelerometers and infra-red detectors. Improvement of sensor performance will reduce fuel consumption and improve safety. Piezoelectricity is becoming a leading technology in diesel fuel injection. The high pressures generated by piezo injectors improve the efficiency of engines and reduce pollution. The Piezo Institute aims to develop self-testing structures with embedded sensors to monitor the effects of age such as micro-defects, cracks, delaminations and fatigue-related flaws.

Piezoelectricity is the ability of certain materials to generate an electric charge in response to mechanical stress. They also have the opposite ability – the application of electric voltage produces mechanical strain in the materials. This makes piezoelectric materials effective in sensors and transducers used in the automotive and healthcare industries, and for environmental monitoring.

Education and training in piezo

Education and training are among the core functions of the new Piezo Institute, which will help to enhance UK and European competitiveness by preparing students for scientific and industrial leadership in the field.

Europe's first Masters degrees in piezoelectric materials and devices will be offered by the Institute and its partner universities, which include Cranfield University. More than 15 Masters programmes in nine countries have already been identified by the Piezo Institute joint education programme. Students with a Bachelors or equivalent degree in a field related to materials science, chemistry, physics or engineering are eligible, and there are opportunities to work as interns at leading European companies.

Piezo INSTITUTE
The European Institute of Piezoelectric Materials and Devices

Supporting PhDs and beyond

Piezo doctorates are being created at leading universities, with supervision from Piezo Institute scientists as well as part time employment and funding opportunities.

The Institute is committed to continuous development of piezo-related skills, and provides industrial training once students enter the workforce. The training covers ferro and piezoelectric fabrication, micro and nanotechnology and piezo applications – all essential skills for scientists and engineers working in materials science, chemistry, physics, electronics, mechanics and systems engineering.

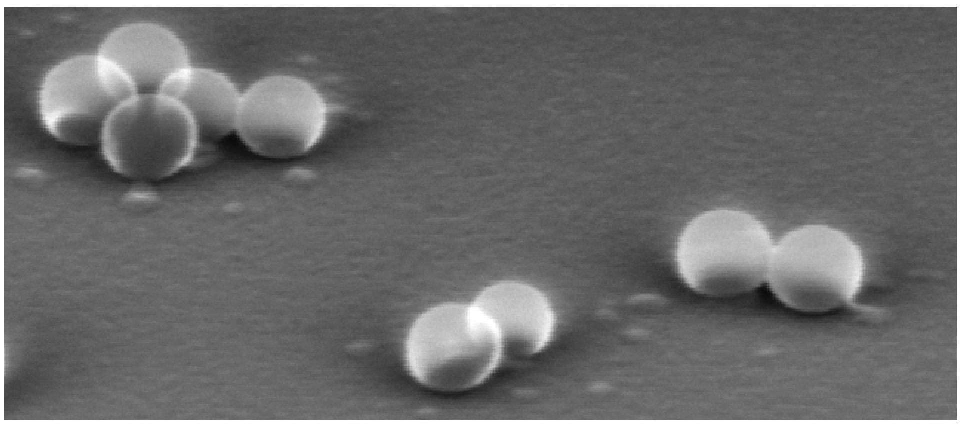
www.piezoinstitute.com

For Piezo Institute membership enquiries e-mail membership@piezoinstitute.com

Europe wide project looks at nanoparticles

The NPL nanomaterials team is now able to measure nanoparticles between 0.5 nm and 1 µm, and is coordinating a European project to provide traceable standards for nanoparticles, with an accuracy of better than 1 nm.

When sizes of particles and more complex structures reach the nano-dimension, new properties can be observed. These properties can be used to develop new products or optimise existing ones. An important aspect is the increased surface to volume ratios of nanoparticles, which are used to boost the efficiency of existing catalysts or powder-based products. The nanomaterials team at NPL is working on a series of projects to improve the reliability of nanoparticle-based products and is developing the essential underpinning metrology needed for quality control. Characterisation and standardisation of nanoparticles are absolutely critical for regulatory purposes and to sustain innovation.



Scanning electron microscopy image of 50 nm polystyrene beads

Nanoparticles have unique properties that can be exploited commercially, for example as highly concentrated suspensions in the ink industry, as drug delivery agents for the pharmaceutical industry, or in novel composite materials for the transport industries. Well-documented toxicological concerns highlight the need for strict and well-defined standards to be applied. Currently no recognized traceable calibration of nanoparticles exists below 50 nm, and as nanoparticle properties are strongly dependent on size, new metrological capabilities are required in order to ensure consistency in quality and innovation. The NPL nanomaterials team has recently developed the metrology expertise to measure nanoparticles (dry or in liquid suspension) in the size range between 0.5 nm and 1 µm. NPL can now provide transmission electron microscopy, atomic force microscopy and dynamic light scattering measurements for nanoparticles. The team is also coordinating a European project to provide new, traceable standards and procedures to determine the size, shape and distribution of nanoparticles, with an accuracy of better than 1 nm. This will be correlated with preparation methods and the end-product environments (on a surface or in suspension), and will be offered as a new measurement service to industry.

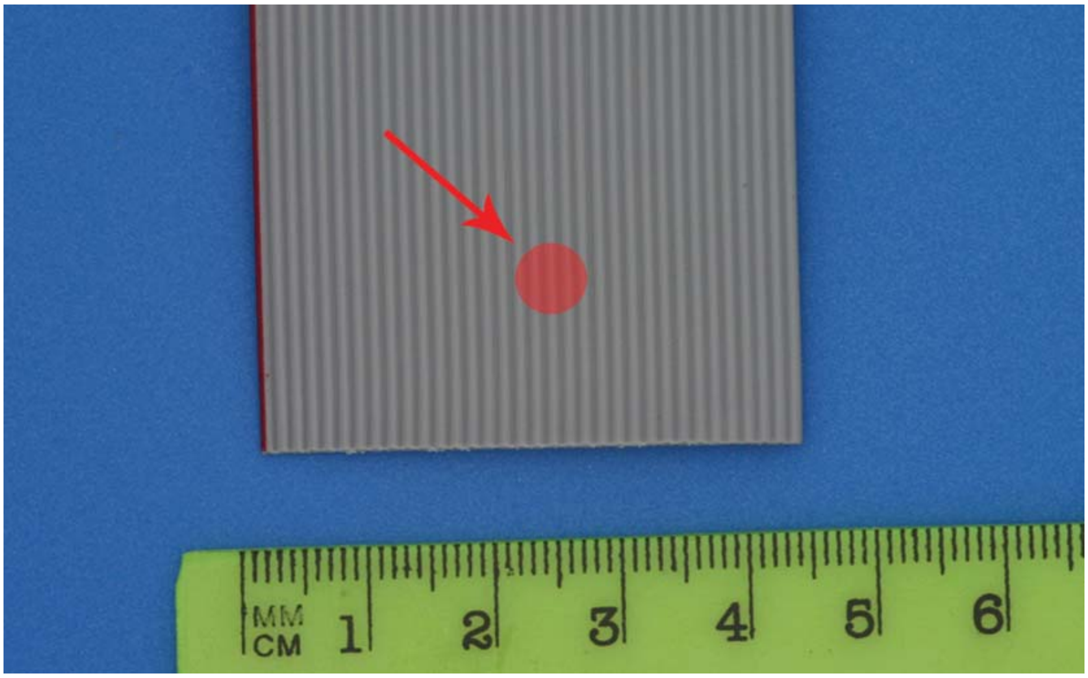
Nano-scale materials currently dominate the markets for nanotechnology products, representing around 70% of sales. In 2001 these markets were equivalent to worldwide sales of around £22bn, with approximately 33% being associated with nanoparticles. By 2010 overall nanomaterials sales are expected to approach £88bn, with nanoparticles accounting for over 40% of this figure. Better characterisation methods will help to support this market growth, particularly for the highly engineered, high added value materials market.

For further information please contact Alexandre Cuenat on 020 8943 8627 or e-mail alexandre.cuenat@npl.co.uk

XRF – proven RoHS compliance screening tool

A significant step towards RoHS (Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) compliance is to ensure only RoHS-compliant materials are used, and a potential frontline inspection tool is XRF (X-ray fluorescence) spectroscopy. The results of a short NPL-industry study to benchmark commercial instruments have now provided some cautionary findings for engineers in the industry.

The results indicate that XRF systems offer a viable method of screening RoHS compliance and tin whisker mitigation. The systems offer low unit cost, low running costs, fast results and small sample requirements. However, care should be exercised in the choice and use of these systems. Also, in order to prevent incorrect interpretation of the data, they require skilled operators with a thorough knowledge of the instrument and a good understanding of the structures and materials of the test samples.



Typical PVC IDC cable, with area of analysis shown

Fifteen XRF systems (11 benchtop; 4 portable) were evaluated using 40 typical components and assemblies, ranging from contaminated plastic components, through bulk solder alloys, to solder joints and solder-terminated components. The study found that PIN (semiconductor diode) and SiLi detector based systems are suitable for RoHS compliance measurements in plastics and solders, but proportional counter systems are not. Systems using PIN or SiLi detectors can distinguish non-compliant components from compliant components. For intermediate levels, the use of additional techniques is required for discrimination.

The PIN and SiLi detectors could distinguish compliant and non-compliant components containing more than 1000 ppm cadmium.

Whilst proportional counter based systems could detect RoHS-banned elements at levels of more than 3%, such as found in plastics, below this level the results were questionable, and their use for such applications is not recommended.

For tin whisker mitigation, lead levels of more than 4% are required to be present in solders. All the systems could detect lead at or below this level, provided the sample was large enough to fill the measurement window.

More details can be found in *XRF Measurement of Residual Materials in Electronics*, NPL Report MAT4.

For further information or for a copy of the report please contact Ling Zou on 020 8943 6065 or e-mail ling.zou@npl.co.uk

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Formulation of Engineering and Flow programme for 2008

The Department for Innovation, Universities & Skills (DIUS, formally the DTI) National Measurement System (NMS) combined programme for Engineering and Flow is being formulated for 2008 and beyond.

The Engineering Measurement part of this programme is managed on behalf of DIUS by NPL. Consisting of Dimensional, Mass and Force Measurement, the Engineering Measurement programme is one of the main science programmes within the National Physical Laboratory's (NPL) Division for Industry and Innovation.

The Flow measurement part of the programme supports and develops the infrastructure for flow measurement and is delivered on behalf of DIUS by TUV National Engineering Laboratory (TUV-NEL, see www.flowprogramme.co.uk for more details).

NPL and NEL's programme formulators are actively seeking consultation with user communities, industry and academia to identify and prioritise stakeholder needs. This provides the opportunity for participation in the formulation process, and collaboration in the development of the programme or in projects.

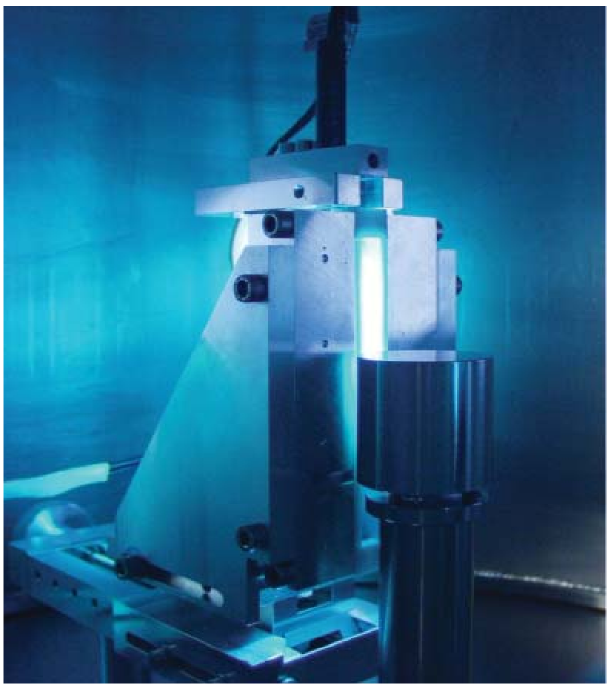
If you wish to participate, NPL and NEL would be pleased to receive your comments.

For further information, please contact Rob Simpson, Impact and Formulation Leader, NPL on 020 8943 6438 or e-mail rob.simpson@npl.co.uk, or contact TUV-NEL on 01355 593870 or fp@tuvnel.com

How clean is our kilogram?

Periodically the UK's national mass standard, along with those of about forty other countries, is sent back to the Bureau International des Poids et Mesures (BIPM) for re-verification. As part of this exercise the BIPM cleans the kilograms using a process known as nettoyage-lavage (cleaning and washing). This involves manually rubbing the weight with an alcohol soaked chamois leather, followed by washing in a jet of steam. The process is effective in removing the organic contamination that builds up on all mass standards, but relies on the skill of the operator and has proved to be difficult to replicate by other users at various National Measurement Institutes.

NPL, in collaboration with BIPM, is developing a novel technique for the cleaning of primary mass standards which promises to be at least as effective as the nettoyage-lavage technique, but much more reproducible. The technique involves the use of ultra violet light in an ozone rich atmosphere. The UV "activates" the ozone by producing atomic oxygen and also excites the organic molecules on the weight surface. The carbonaceous and hydrocarbon contamination reacts with the atomic oxygen to produce CO_2 and H_2O which can be easily desorbed from the surface of the mass standard. The process can be applied to mass standards of most materials (platinum-iridium, gold, stainless steel, silicon etc.) and is extremely controllable by varying the UV intensity, ozone concentration and exposure time.



A cylindrical primary mass standard undergoes UV/Ozone cleaning

Preliminary results have been very encouraging; several monolayers of contamination have been removed from the test pieces in a controllable and repeatable way. An artificially contaminated platinum-iridium kilogram artefact has also been cleaned and over 70 µg of contamination removed, showing that the technique is able to cope with even badly contaminated mass standards. The next stage of the work will be a direct comparison between the new technique and the nettoyage-lavage cleaning procedure. This comparison will take place in January and February when James Berry from the Engineering Measurement Team at NPL will be seconded to BIPM to carry out the work in collaboration with Richard Davis, the head of the BIPM Mass Group.

For further information, please contact 020 8943 6224 or e-mail stuart.davidson@npl.co.uk

New torque standard to have worldwide appeal

A new version of British Standard BS 7882 - *Method for calibration and classification of torque measuring devices* - is about to be published. The changes draw on the research and developments made at NPL and the latest best practices in UK industry.

The previous standard (1997) has proved to be a very popular publication and has been used worldwide from the USA and China to Australia and South East Asia. The new standard has introduced changes that include a higher classification – now possible because of the NPL torque standard machine – and the mandatory use of symmetric mounting positions for the two highest classifications. One of the challenges faced was to balance the demands for higher accuracies, now achievable due to improvements in torque measurement technology, with the pragmatic approach that made the previous standard so popular. Other additions include worked examples – which are particularly useful for validating software – and a method for calculating measurement uncertainty.

With the recent publication of a new revision of the DIN (the German Institute for Standardisation) standard (DIN 51309), it is hoped that there is enough common ground to eventually work towards a single European standard.

The publication of BS 7882 now paves the way for a new standard – which is already underway – for continuous torque calibration (BS 7996). Continuous torque calibration is a fast (although less accurate) procedure taking only a fraction of the time of a traditional static calibration, potentially leading to huge savings for industry.

For further information, please contact Andy Robinson on 020 8943 6194 or e-mail andy.robinson@npl.co.uk

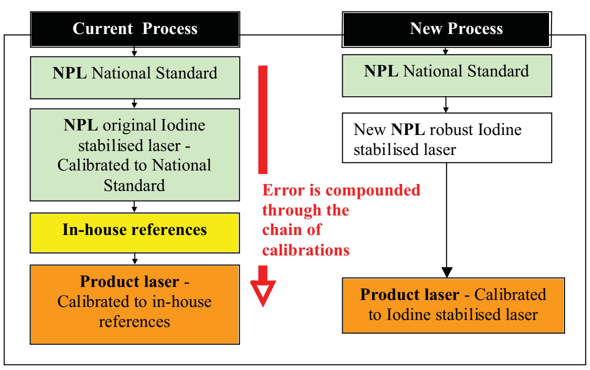
NPL expertise improves Renishaw's production measurements

A recent DIUS-funded joint industry project (JIP) between NPL and Renishaw has the potential to cut costs and increase efficiency of Renishaw's production line of frequency-stabilised lasers, through the development of a robust reference laser that can be used in a busy production line environment.

Renishaw's Laser and Calibration Products Division (LCPD) manufacture instruments used to calibrate machine tools, co-ordinate measuring machines, and other precision positioning systems. These instruments are based on interferometric technology and use HeNe lasers as the light source. Precision measurements cannot be achieved without knowing the optical frequency of the laser in question. Renishaw therefore measures and calibrates the frequency of all its calibration product lasers to ensure they are traceable to national standards.

Renishaw tests its product lasers against an NPL iodine stabilised HeNe laser indirectly through a system of in-house reference lasers. This is necessary because the NPL laser, originally designed in the 1980s, could be affected by acoustic noise, vibration and other production environment disturbances.

However, as a result of this project,



Manufacturing improvement due to new NPL robust laser

all new product lasers can be tested directly against the new robust iodine stabilised reference laser without having to leave the production line, therefore giving superior measurement accuracy without the need for a highly skilled operator. The new iodine stabilised reference laser is insensitive to its environment, and therefore requires no special vibration or acoustic noise isolation equipment, and brings together Renishaw's product technology and NPL's iodine spectroscopy stabilisation technology.

Several product lasers can be simultaneously tested against an iodine reference in this new system, due to the higher power of the new reference laser, thus achieving greater production environment accuracy and efficiency.

The new process developed as a result of the JIP will decrease potential error in measurements, reduce rework and improve efficiency. It will also allow Renishaw to claim more direct traceability to National Standards within their manufacturing facilities.

For further information on this project or the NPL iodine stabilised HeNe laser, please contact Geoff Barwood on 020 8943 6032 or e-mail geoffrey.barwood@npl.co.uk For further information on how your business can benefit from a collaboration with NPL, please contact Val Ralph on 020 8943 6477 or e-mail val.ralph@npl.co.uk

NPL combing the field for dimensional metrology solutions

A new transportable femtosecond optical frequency comb developed at NPL is opening doors to a wide range of applications from dimensional metrology to molecular spectroscopy.

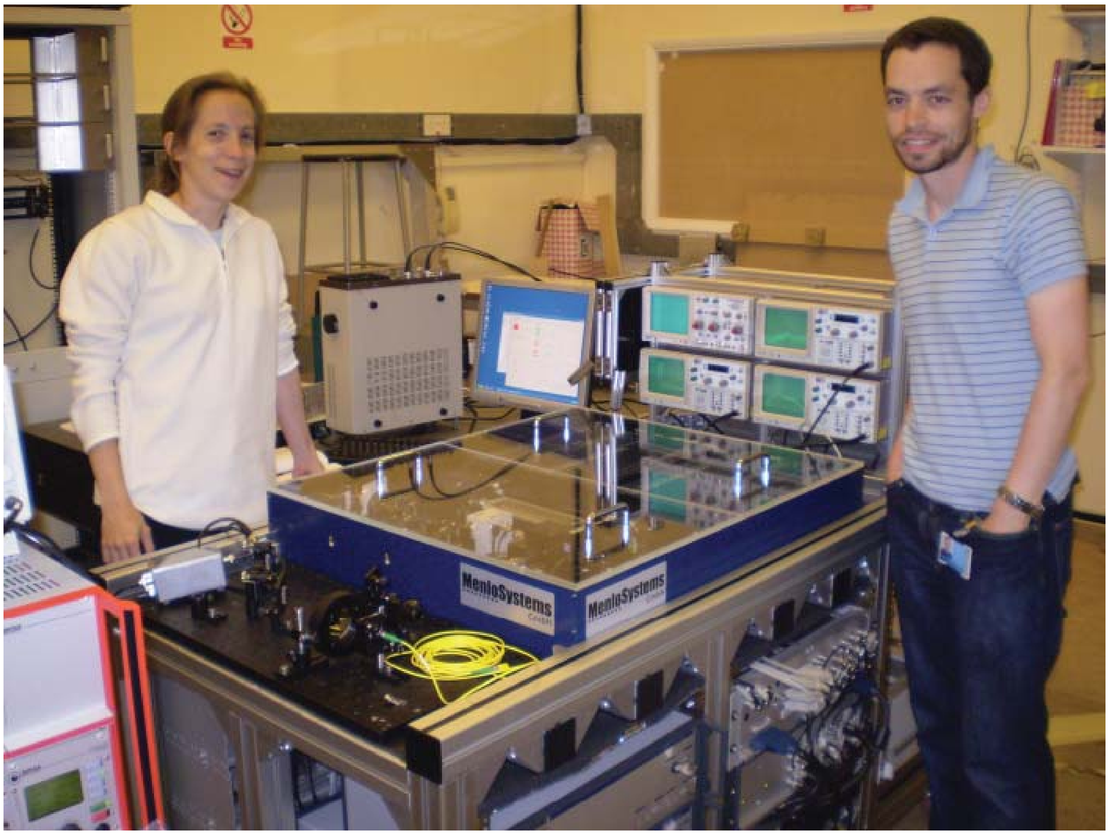
Femtosecond combs are an emerging technology designed for highly precise frequency metrology and optical atomic clocks. A femtosecond comb is based on a tightly stabilised pulsed laser system, the output of which consists of millions of equally spaced and accurately known frequency modes. This comb of modes forms an optical frequency "ruler" which can be used to determine any unknown laser frequency within the spectral range covered by the comb.

These combs have already led to a revolution in the field of optical frequency metrology, enabling optical frequencies to be linked in a single step to the primary caesium microwave frequency standard. The NPL transportable comb can be used to measure laser frequencies anywhere in the range between 500 nm and 2.1 µm. An on-board GPS-disciplined oscillator provides a reference frequency which gives traceability to the SI second at any location.

Femtosecond optical frequency combs have unique spectral properties, combining extremely broad spectral coverage with ultra-high resolution. A huge amount of spectroscopic information can therefore be gathered simultaneously, which makes the combs useful for spectroscopic applications such as molecular fingerprinting for environmental monitoring or explosives detection. Combs also have potential applications in dimensional metrology where their unique properties may be used to develop new techniques for absolute long distance determination with higher resolution than competing techniques.

The new NPL transportable comb will enable research and product development in a number of application areas. NPL welcomes enquiries from potential partners who have an interest in exploiting this technology to improve existing products, or to develop new products and services in industry.

For further information, please contact Helen Margolis on 020 8943 6113 or e-mail helen.margolis@npl.co.uk



NPL scientists Helen Margolis and Barney Walton with their newly developed transportable optical frequency comb

Guide for developers of measurement software

NPL and PTB are collaborating on a guide to developing and assessing measurement software, to ensure it is fit-for-purpose.

Software is an intrinsic part of measurement. It is used in instruments to control experiments, store and process measurement data, analyse and display results and to implement many mathematical techniques. A great number of innovations in measurement have been enabled through the use of software for simulations or complex analysis. For example, the international temperature scale ITS90 requires the processing of high order polynomials and can only be implemented using software. Improving the quality of software and reducing the cost of its development are vital to the effective delivery of metrology.

Due to the increasing complexity and dependency on software, there are considerable concerns over its quality. A study by NIST in 2000 stated that "Software bugs, or errors, are so prevalent and so detrimental that they cost the US economy an estimated $59.5 billion annually". There is every reason to believe that Europe suffers in a similar way. NPL's recent audits of instrument manufacturers, based on Software Support for Metrology Best Practice Guide 1, Validation of Software in Measurement Systems (BPG1), and several examinations of measurement software carried out by the PTB's (Physikalisch-Technische Bundesanstalt, the German National Metrology Institute) Software Testing Laboratory, have indicated that software engineering techniques are not widely used.

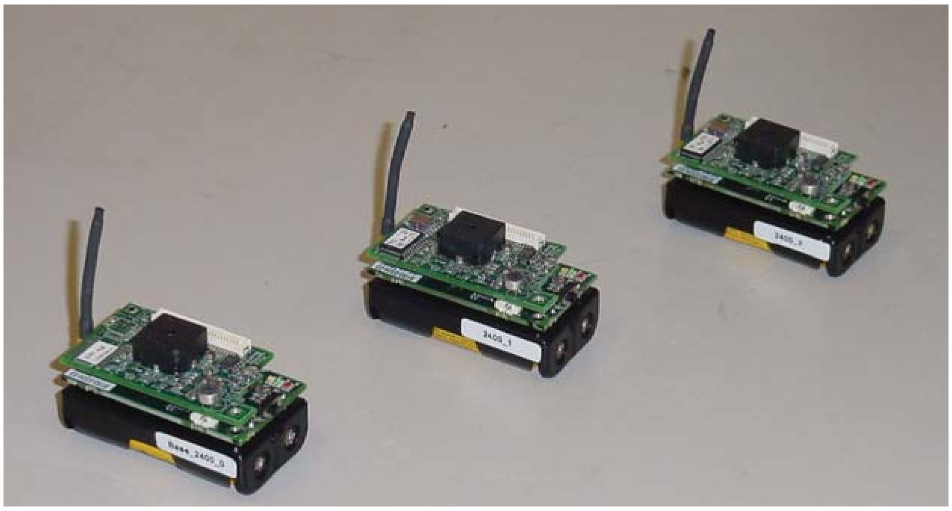
A software guide that has been developed and accepted by leading NMI's would be more widely used and effective in the measurement community. For this reason NPL and PTB are currently collaborating on a guide to allow developers of measurement software to know what is required to produce fit-for-purpose software. This guide will also allow assessors of measurement software to confirm that the developed software meets these standards.

__For more information, please contact Graeme Parkin on 020 8943 7104 or e-mail graeme.parkin@npl.co.uk__

Wireless Sensor Networks - new measurement capabilities and new challenges

Wireless Sensor Networks (WSNs) are used in measurement, security and structural health monitoring. NPL is breaking down the remaining barriers to the adoption of WSNs in new applications.

Advances in microchip production have enabled the development of Wireless Sensor Networks (WSNs); distributed sensing systems with processing and radio communications. WSNs are a significant enabling technology in many areas of measurement, security, structural health and environmental monitoring. They are becoming increasingly sought after to enable many military, health and civil monitoring and control applications. NPL is breaking down a key barrier to the adoption of these systems - the difficulty in quantifying the reliability and confidence in their outputs. Without this, it is impossible to perform a cost-benefit analysis, and therefore justify investment in any system.



MICAz motes from Crossbow, which make up part of the NPL WSN testbed. The matchbox-sized devices include temperature, light, acceleration, magnetic field strength and acoustic sensors, as well as processing and radio communications

WSNs pose many new challenges. Their distributed nature means that calibration of the sensors themselves is complex. NPL has been developing validation techniques that improve the confidence of an output by fusing data from many complementary sensors. By coupling this with models of the system it is possible to predict what an individual sensor should be reading. NPL are also investigating synchronisation over the wireless links as a method of propagation of time and location calibration.

Typically, users will want a higher-level output, such as an automated control, rather than raw data. These higher-level outputs rely on numerous sensors, making it challenging to quantify the reliability and correctness of the output. NPL has developed techniques to quantify the confidence available in some higher-level outputs.

The robustness of the radio links is a key factor in the adoption of WSNs. Interference from other wireless systems and position-dependent fading can cause communication degradation or loss. NPL is measuring and modelling the performance of wireless systems in real environments to understand the extent and impact of these issues, in order to advise on the best deployment strategies for given applications.

If you would like to find out more about NPL's work in this area please visit:

www.npl.co.uk/wireless_communications

For further information please contact Michael Collett on 020 8943 6771 or e-mail michael.collett@npl.co.uk

NPL Training framework

Do you use measurement equipment or rely on measurements within your processes?

Are you aware that knowing how to use a measurement tool is not the same as knowing how to use measurement as a tool?

How confident are you in challenging a measurement as being fit for purpose?

Measurement is a science to be applied with skill, not a manual.

The NPL Training framework is the only independent, hands-on measurement-focused training course. Understanding the principles of measurement can lead to better decisions in product purchasing, a reduced need for expensive technical support and fewer operational mistakes with expensive consequences. A better understanding of measurement will reduce the risks to your business.

Dates of Level 1 Dimensional courses are now available for 2008 - Find out more at www.npl.co.uk/training

Structured surfaces meeting

A lively DMAC (Dimensional Measurement Awareness Club, a Special Interest Group of NPL's Engineering Measurement Awareness Network) meeting, held on 11 September 2007, covered topics ranging from the mathematical classification of structured surfaces to their applications in the glass and plastic films industry.

On 11 September 2007, a DMAC meeting – 'Structured surfaces - applications and control' - was held at Cranfield University Management Development Centre. Modern nano- and micro-scale manufacturing techniques often involve the deterministic structuring of a surface to change its functionality and its physical effect on its surroundings. Current research and development is allowing new effects and processes to be exploited in products. Examples include engineering a surface so that it acts as a key or hindrance to biological cells, DNA or proteins; self cleaning glass; MEMS (Micro-Electro-Mechanical Systems); heat transfer mechanisms; gas sensing; numerous tribological/rheological applications; optical control; carbon nanotube growth and self assembling structures.

The DMAC meeting started with Prof Xiang (Jane) Jiang from University of Huddersfield who described research into the mathematical classification of structured surfaces. This included surfaces ranging from repeated structures, to MEMS-type structures, to freeform surfaces. Prof Alistair Forbes of NPL then spoke about the structuring of a surface to encourage the adhesion of biological cells, and local methods for characterising such surfaces. Dr Claire Jones from Pilkington and Dr Karl Rakos from DuPont Teijin Films UK described applications of structured surfaces in the glass and plastic films industries using a range of instrumentation. The measurement of large samples with only a small number of defects allowed is an important issue in both these areas. Dr Paul Moranz (Cranfield University) and Dr Nick Walker (Microsharp) talked about the metrology and fabrication issues of microstructured optical films, and expressed the need to measure such films in-line. This was a lively meeting with much discussion and showed that the DMAC Surface Texture Special Interest Group is very much alive and kicking.

For further information or to join the Surface Texture Special Interest Group please contact Richard Leach on 020 8943 6303 or e-mail richard.leach@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

Industry and Innovation Division
National Physical Laboratory | Teddington | Middlesex | United Kingdom | TW11 0LW
Helpline: 020 8943 6880 | **Fax:** 020 8614 0446 | **E-mail:** enquiry@npl.co.uk

Forthcoming events

How best to qualify a material for resistance to hydrogen assisted cracking

12 February 2008
NPL, Teddington
Contact: paul.mcintyre@npl.co.uk

Metrology Data Analysis: One Day Course

13 February 2008
NPL, Teddington
http://www.npl.co.uk/server.php?show=ConWebDoc.2178

NPL / EMAN @ Mtec 2008

13 - 14 February 2008
NEC, Birmingham
Mtec is the only UK show dedicated wholly to Sensors, Measurement, and Instrumentation.
http://www.mtecukshow.com

Regional Measurement Surgery

14 February 2008, 11 am - 6 pm
Coventry Metrology Centre, Coventry University Technology Park
Contact: engineering@npl.co.uk

Regional Measurement Surgery Innovation Forum 2008

19 February
Tamar Science Park, Plymouth
Contact: engineering@npl.co.uk

ANAMET Meeting RF and Microwave Metrology Club

6 March 2008
Rohde & Schwarz UK, Fleet, Hampshire
Contact: chris.eio@npl.co.uk

NPL Training level 1 courses: Dimensional

10 - 13 March 2008
1 - 4 April 2008
Hexagon Metrology, Telford

19 - 22 May 2008
16 - 19 June 2008
Hexagon Metrology, Swindon

Contact: helen.white@npl.co.uk
http://www.npl.co.uk/training

NPL / EMAN @ MACH 2008

21 - 25 April 2008
NEC, Birmingham
MACH is the UK's premier manufacturing technologies event
http://www.mach2008.com/

EURAMET 732 Workshop 2008

Towards more accurate fixed points
3 - 4 June 2008
NPL, Teddington
Contact: npl_clubs@npl.co.uk
http://conferences.npl.co.uk/euramet732/

Micro and Nano Scale Characterisation of Fibres

3 July 2008
University of Ulster, Jordanstown, Belfast
http://www.npl.co.uk/fibresworkshop

Standards for hearing aids

13 February 2008 (11:00 hrs)
Jill Barrie – NPL
(Interwise Event Number 212449)
Join this online meeting via mset.org.uk

Overview of Ultrasound Research at NPL

21 February 2008 (11:00 hrs)
Bajram Zequiri – NPL
(Interwise Event Number 123139)
Join this online meeting via mset.org.uk

A Node Discovery Service for Partially Mobile Sensor Networks

22 February 2008 (15:00 hrs)
Vladimir Dyo - University College London
(Interwise Event Number 348235)
Join this online meeting via mset.org.uk

Measurement and modelling tools being developed by NPL for the Fuel Cell industry

27 February 2008 (11:00 hrs)
Gareth Hinds – NPL
(Interwise Event Number 450389)
Join this online meeting via mset.org.uk

New perspectives on the evolution of stress corrosion cracks from corrosion pits

4 March 2008 (11:00 hrs)
Alan Turnbull – NPL
(Interwise Event number 240603)
Join this online meeting via mset.org.uk

Surgery by soundbeam - the use of high intensity focussed ultrasound to treat cancer

5 March 2008 (11:00 hrs)
Adam Shaw – NPL
(Interwise Event Number 756380)
Join this online meeting via mset.org.uk

Nanoscale surface analysis for the characterisation of fibres

19 March 2008 (11:00 hrs)
Joanna Lee – NPL
(Interwise Event Number 308065
Join this online meeting via mset.org.uk

Power Harvesting for MEMS

26 March 2008 (11:00 hrs)
Markys Cain – NPL
(Interwise Event Number 361045)
Join this online meeting via mset.org.uk

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

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