NPL
National Physical Laboratory

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Autumn 2010

Metromnia

Sustainability Issue

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National Measurement System

Sustained effort

As the demands on natural resources and the environment increase, the drive and need to develop sustainable, low impact green technologies and systems is becoming critical.

The National Physical Laboratory (NPL), as part of the National Measurement System (NMS) is assisting businesses who are developing innovative solutions to the many sustainability challenges including conserving energy, saving water, recycling materials, reducing waste, limiting pollution, monitoring and trading carbon, and maximising food production.

With the focus on developing a low carbon economy for the UK, areas such as sustainable communities, climate change and sustainable consumption and production are being prioritised. The NMS is working with environmentally focused companies to help develop the technology and measurement systems that are required to make a positive impact in these areas.

We are supporting the UK through the development of measurement and detection techniques for carbon capture and storage in a low carbon economy. NPL and the National Measurement Office are focusing on carbon measurement by providing the standards needed for carbon trading and pricing, and the independent assessment, calibration and validation of low carbon technologies.

Understanding the needs of a sustainable low carbon future is one issue; delivering products and technologies that will actually achieve this brings a new set of challenges. Our measurement scientists are working with the advanced manufacturing sector to understand the challenges that face industry when applying environmentally-conscious solutions.

NPL is also playing a key role in the development of a Quality Assurance system for Earth Observation systems used in monitoring climate to bring greater credibility to climate data.

The Editor, Metromnia

Recognition of NPL's role in the emissions monitoring industry

Rod Robinson has been appointed to the role of Chairman of the Source Testing Association (STA), the trade association for the emissions monitoring industry in the UK, in recognition of NPL's record in improving measurements in the industry.

With 220 Corporate members from the power, chemicals, steel and cement industries, plus instrumentation suppliers and emissions monitoring companies, the STA speaks for the industry in contacts with the Environment Agency, UKAS, SIRA and BSI. NPL has four emission monitoring teams, and is now the 7th largest of the 75 UK emissions monitoring companies listed in the 2010 STA Annual Guide.

For further information, please contact:
Rod Robinson
T: 020 8943 7146
rod.robinson@npl.co.uk

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Advanced Capacitors for Energy Storage – ACES

Domestic transport currently produces about 24% of all UK CO_2 emissions. Despite an overall reduction in UK CO_2 emissions, those from domestic transport are still increasing. The majority of these emissions are from cars. Without new low carbon vehicle technologies, the emissions from this sector are set to continue to increase with improvements in efficiency of conventional technologies being offset by increasing demand for private transport.

One obstacle to the uptake of low carbon vehicles will be the acceptability of performance compromises in a market that is defined by performance and driveability. Hybridised vehicles can meet this challenge by providing reduced CO_2 emissions and enhanced efficiency whilst retaining acceptable levels of performance. Hybridisation combines a downsized, highly efficient petrol or diesel engine with electric boost and regenerative storage of energy used in braking. Hybrid technologies are key to providing the required efficiency improvements in the medium term. It is anticipated that by 2020, the majority of new vehicles will use hybrid technology. Battery and hydrogen-powered vehicles may dominate in the longer term, but are unlikely to make a significant impact in the medium term due to performance issues with the technology and the lack of infrastructure.

A major technological limitation for both hybrid and full electric vehicles is the electrical storage medium. Existing storage technologies (batteries and supercapacitors) are unable to deliver both high power and high-energy capacity in a package size that fits easily in the vehicle. There is therefore a need to develop new storage technologies that can combine high energy density with high power delivery.

This project therefore aims to develop new capacitive boost technology for mass-market hybrid vehicles in the medium term. As well as hybrid vehicles there are potential applications in commercial hybrids, electric vehicles, as well as mass energy storage in the low carbon economy of the near future.

The work is supported by the Technology Strategy Board Low Carbon Vehicles - Integrated Delivery Programme, and the project partners: National Physical Laboratory, Controlled Power Technologies Ltd., Syfer Technology Ltd., NanoForce Technology Ltd., Queen's University Belfast.

For further information, please contact:
Paul Weaver
T: 020 8943 6228
paul.weaver@npl.co.uk

On top of the world

Alpine atmospheric water vapour measurements for improved climate modelling.

A team of NPL scientists have been stationed in the Swiss Alps' Jungfraujoch Research Station, over 3.5 km above sea level, taking measurements of water vapour with the aim of improving climate models.

Water vapour is by far the most important greenhouse gas in the atmosphere. While the basic effect of water vapour is understood, there is a major problem: there is an underlying continuum absorption which is poorly characterised, poorly understood and very important for atmospheric science as the water vapour continuum dramatically affects the energy balance of the climate system.

The NPL and University of Reading team used a high-resolution optical spectrometer to measure the radiative effects of water vapour from the ground, while colleagues from the UK Facility for Airborne Atmospheric Measurements (FAAM), the Met Office and Imperial College London made simultaneous measurements from a research aircraft flying overhead.

This is part of a larger cross-disciplinary team that are researching the water vapour continuum issue using a combination of quantum mechanical modelling, laboratory spectroscopy, atmospheric field instrumentation and radiative modelling to produce improved atmospheric models to provide better climate prediction. The team, led by the University of Reading is called CAVIAR (Continuum Absorption in the Visible and Infrared and its Atmospheric Relevance). In addition to the groups mentioned, CAVIAR also involves the Rutherford Appleton Laboratory, UCL, University of Cambridge and University of Leicester.

Find out more by visiting:
www.npl.co.uk/environmental-measurement/research
www.met.reading.ac.uk/caviar

For further information, please contact:
Tom Gardiner
T: 020 8943 7143
tom.gardiner@npl.co.uk

Pure hydrogen = clean power

NPL is developing a capability to ensure that the purity of hydrogen for fuel cell applications meets stringent target levels.

It is likely that hydrogen will become a crucial part of the UK's future energy matrix as the Government strives to meet challenging targets for reducing greenhouse emissions. One application of hydrogen is to power fuel cell vehicles – such vehicles are emission-free at the point of use, and fossil fuel usage is eliminated if the hydrogen is generated from renewable energy sources. A small number of fuel cell powered vehicles are already in use on the UK's roads.

Greater uptake of hydrogen as a fuel will depend in part on the ability to produce low-cost hydrogen of sufficient purity. These purity requirements are being set out in a series of draft International Standards that are currently under development. Where hydrogen is used to fuel proton exchange membrane (PEM) fuel cells, the recommended limits of impurities permissible to avoid poisoning of the fuel cell catalysts are laid out in two draft standards (ISO/CD 14687-2 and ISO/WD 14687-3). These draft standards identify 14 impurities for which measurement is required, and set some highly challenging limits of detection, for example 1 ppb (part-per-billion) for total sulphur compounds.

NPL is undertaking a project with ITM Power, a Sheffield-based energy storage and clean fuel company, to develop a traceable measurement capability to meet industry's needs for hydrogen purity analysis. Presently, no infrastructure for measurements to such challenging limits of detection is available in the UK.

To establish such a capability, innovative analytical and sampling methods are being developed at NPL, and ITM Power is contributing to the project by providing samples of electrolytic hydrogen as feedstock to the analysis process and hosting sampling tests.

Once developed, these methods will allow the purity of the hydrogen produced by electrolysers or other technologies to be determined to the necessary accuracy to be suitable for use in fuel cell applications. They will also be able to be applied to other industrial applications where purity measurements are critical, for example, the use of hydrogen as a carrier gas in analytical chemistry.

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Find out more by visiting:
www.npl.co.uk/analytical-science/gas-standards/

For further information, please contact:
Andrew Brown
T: 020 8943 6831
andrew.brown@npl.co.uk

Technology Innovation Fund

Draw upon NPL's unique combination of industry knowledge and world-leading scientific expertise to help your business.

NPL's Technology Innovation Fund provides an exciting opportunity to work with NPL for a fraction of the normal cost. NPL has devised a number of products through which you can access its expertise and knowledge base:

- Advice surgeries
- Consultancies
- Research clubs

NPL's cutting edge knowledge, and their interaction with the Science & Technology community helps them provide advice and support that can significantly accelerate the time to market of many products, processes or services. NPL has a broad perspective as a world leader in metrology, and vast experience in understanding the demands and needs of industry. Moreover, NPL is in a position to advise on control and accreditation due to its unique position in developing, and collaborating on, international and national standards.

Find out more by visiting:
www.npl.co.uk/technology-innovation-fund/

For further information, please contact:
Peter Benson
T: 020 8943 8746
peter.benson@npl.co.uk

Hot-box

Thermal measurement scientists are playing an active role in supporting the UK government's policies to combat climate change and secure future energy supplies.

NPL has been responding to an ever-changing background of political and commercial drivers relating to energy use in buildings. These have included the 1973 and 1979 Energy Crisis, EU Construction Products Directive with its associated EU Product Standards, the Kyoto Protocol, Part L of the UK Building Regulations dealing with energy use in buildings, the Government's white paper 'Our energy future - creating a low carbon economy', the EU Energy Performance of Buildings Directive (2006) and finally the Climate Change Act with its commitment for the UK to reduce its CO_2 emissions by 80% of 1990 levels by 2050.

Energy use in buildings accounts for around 50% of these emissions. The government is therefore in the process of introducing and enforcing dramatic carbon reduction targets for buildings. For example, all new homes are to be zero carbon by 2016 and new non-domestic buildings by 2019. All existing dwellings must be made close to zero carbon by 2030 via the 'Great British Refurb' which plans for the low carbon refurbishment of 1.4 million dwellings per annum by 2020. This will involve major and rapid change to the UK built stock. If carbon targets are to be met it is essential that the large investment in refurbishment and new build deliver real low carbon buildings.

The thermal measurement group at NPL are playing an important part in implementing these policies by helping to ensure that the best materials and structures are selected for use in buildings. This selection is based on independent data, and by checking thermal calculation methods used by product manufacturers and building designers. NPL's world class facilities in this area comprise: two hot-box apparatus, one of the world's most accurate guarded hot plate apparatus for measuring thermal conductivity of insulation, a cryogenic guarded hot plate apparatus (to –170 °C) and a high temperature guarded hot plate apparatus (to +800 °C). The most recent addition is a facility for measuring the thermal conductivity of pipe insulation (up to +250 °C).

Of particular use for the evaluation of the thermal performance of building structures is NPL's state-of-the-art, rotatable, wall-guarded hot-box (RWGHB) apparatus. This has been designed to make steady state thermal performance measurements of windows, doors, walls, roofs and floors. The maximum test element size that can be accommodated is 2.4 m x 2.4 m x 0.3 m. The cold-box air temperature can be set between –20 °C and +20 °C and the hot-box air temperature to a maximum of 35 °C. The minimum hot-box temperature is limited by the requirement that the outer wall guard shall be approximately 3 °C above the laboratory air temperature, which is usually held at 18.5 °C ± 1 °C. The apparatus has been designed so that it can be fully rotated, enabling the test element to be set up at any angle, from cold-box horizontally positioned above the hot-box, through the vertical position, to the hot-box positioned horizontally above the cold-box.

With the search for better ways of designing low energy buildings now looking beyond simply adding thicker layers of insulation, there is a growing need to establish measurement facilities to enable the more complex thermal properties encountered in practice to be measured. NPL's considerable expertise in this field is addressing this need, looking at ways of carrying out measurements of building structures in the presence of solar radiation and with bi-directional heat flow.

For further information, please contact:
Ray Williams
T: 020 8943 6510
ray.williams@npl.co.uk

‘NPL in space’ – TRUTHS

NPL is hoping to establish its first ‘branch in space’.

Leading an international team of Earth observation and climate scientists, together with an industrial consortium, NPL has submitted a proposal for a satellite mission called ‘TRUTHS’ (Traceable Radiometry Underpinning Terrestrial- and Helio- Studies).

The TRUTHS mission will establish SI traceable benchmark measurements of solar radiation incident upon and reflected from the Earth at unprecedented accuracies. The key science objective is to establish an unequivocal reference point of a number of key indicators of climate change against which future measurements will enable climate models to be better constrained.

The resultant measurements will significantly reduce uncertainty in climate forecasts enabling policy makers to have robust information to make key infrastructural decisions on mitigation and adaptation strategies in decadal rather than multi-decadal timescales.

The proposed five year satellite mission includes all elements: payload, satellite and operations and is based around concepts and instrumentation developed under NMS programmes, in particular the cryogenic radiometer, the primary standard for optical radiation measurement.

In addition to making its own benchmark measurements, TRUTHS is unique in its ability to transfer its high accuracy to other Earth observation missions, upgrading their performance so that they too can make climate quality measurements. In this way TRUTHS becomes ‘NPL in space’.

Find out more by visiting:
www.npl.co.uk/truths

For further information, please contact:
Nigel Fox
T: 020 8943 6825
nigel.fox@npl.co.uk

Smart & Effective Engineering Manufacturing - SEEM

The shaping or ‘machining’ of components by removing material with a hard, sharp edged tool is one of the most common and well established methods of manufacture in the world today. This form of machining stretches back to at least 1300BC when the Egyptians first developed a two-person lathe, and is still widely used today. For example, the recently launched updated series of Macbook laptop computers from Apple use cases machined to a single complex shape from a solid block of aluminium.

Manufacturers are constantly striving to improve efficiency and quality whilst reducing the environmental impact of their production processes. A cutting tool that requires low energy to cut and that is able to report on its own condition and the condition of the cutting process in real time would provide:

- Improved efficiency and quality by using feedback from the tool on cutting forces, torque and vibration to optimise machining conditions
- Increased tool life, leading to reduced tool replacement costs over time
- Increased machining capacity, due to higher cutter speeds and therefore shorter machining times
- Increased quality of cutting, due to reduced friction in the cutting zone
- Reduced workpiece scrap rate, due to reduced tool failures
- Reduced energy consumption, due to reduced friction in the cutting zone

A ‘smart’ coating that is able to integrate these functions would confer significant benefits to machining businesses and particularly those producing high value machined parts - an important area for UK manufacturing. This project aims to develop a cost-effective ‘smart’ coating to extend tool life, reduce power consumption and permit adaptive control of the production process.

The work is supported by the Technology Strategy Board High Value Manufacturing Programme, and the project partners: Renishaw plc, University of Bristol, Diameter Ltd, Brunel University, and NPL

For further information, please contact:
Paul Weaver
T: 020 8943 6228
paul.weaver@npl.co.uk

The world's most stable commercial microwave oscillator

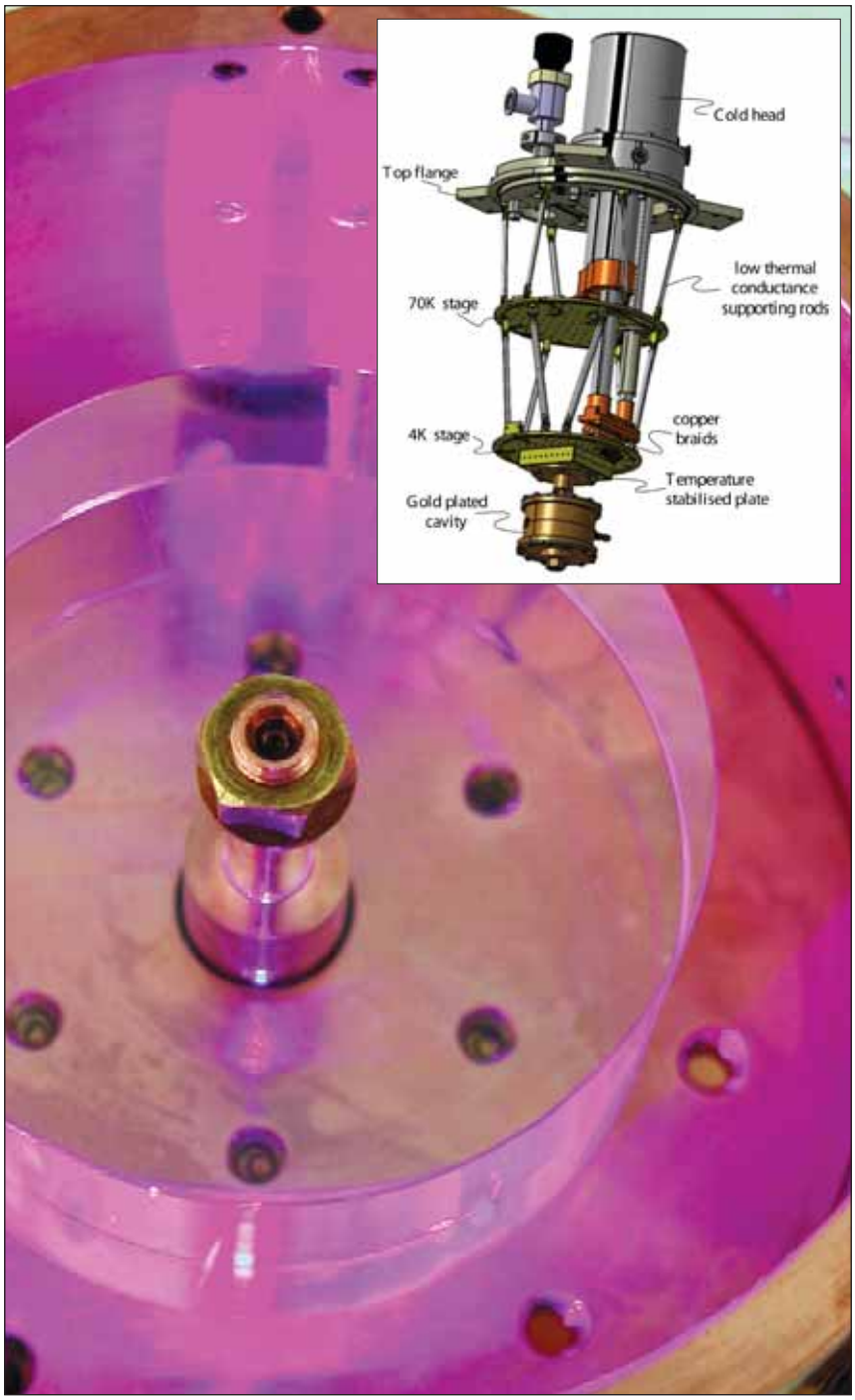
The ever increasing need for better tracking data and scientific return in deep space missions calls for the development of new frequency references of improved stability.

NPL has just completed the manufacture of the world's most stable commercial microwave oscillator, a cryogenic cooled sapphire oscillator better than one part in 10^{14} over time intervals of 1 second to 1000 seconds.

The build, which was funded by the European Space Agency, was carried out by a leading group of quantum physicists from NPL, Femto-ST and TimeTech.

Oscillators based on cryogenic sapphire resonators can supply the levels of microwave phase noise and frequency stability required for advanced time-and-frequency applications such as: Doppler radar, global navigation satellite systems (GNSS), deep space navigation, very-long-base-line interferometry (VLBI), gravitational wave detection, tests of fundamental physics, primary frequency standards and the synchronization of advanced linear particle accelerators and their associated x-ray free-electron lasers.

The stability of this oscillator derives from a cryogenically cooled resonator containing a ring of high-purity mono-crystalline sapphire that supports a 'whispering-gallery' electromagnetic mode with a Q-factor in the order of 1 billion. This mode provides a frequency reference to which the oscillator is locked by way of a Pound servo. The oscillator is cooled and maintained at cryogenic temperatures using a two-stage pulse-tube refrigerator and at these low temperatures, the frequency of the whispering gallery mode exhibits a turning point as a function of temperature. This turning point, combined with the high Q-factor of the whispering gallery mode, provides extreme frequency stability and low phase noise, characterstics that have the ability to greatly improve advanced time and frequency applications.



For further information, please contact:
Robert Elliott
T: 020 8943 6332
robert.elliott@npl.co.uk

Cleanest rooms

In March 2010, the National Measurement System funded refurbishment of NPL's cleanrooms was completed. Operated by the nanomaterials team, these two laboratories (Class ISO 6 and Class ISO 4) are absolutely essential to a huge range of NPL's research in cutting edge applications such as nanotechnology, organic electronics and quantum detection. The cleanrooms are also available for industry/academic use.

Cleanrooms are environmentally controlled rooms designed to enable quick and effective development of new micro or nano-technologies and products. NPL's cleanrooms contain facilities for: micro-photolithography; e-beam deposition, thermal evaporation, wafer dicing and wire bonding.

Find out more:
materials_enquiries@npl.co.uk
www.npl.co.uk/cleanroom

Did you know?

The pressure inside a cleanroom is normally higher than ambient air – this helps to remove particles suspended in the air by pushing them downwards through vents in the floor.

Optical mask

Optical masks are used in microfabrication to perform photolithography, a process by which a pattern is transferred onto a surface.

NPL uses optical masks as a way of depositing very small contacts onto a surface to measure electrical and thermal transport properties.

It is a very delicate procedure – the transfer process' resolution, fidelity and reproducibility are seriously affected by dust particles so it needs to be performed in a cleanroom.

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Did you know?

Cleanrooms are classified according to the maximum number of particles contained in one cubic foot of air – e.g. a Class ISO 4 has no more than 10 particles (≥0.5 micrometres) per cubic foot. By comparison, the air in a typical indoor environment has over 1.5 million particles (≥0.5 micrometres) per cubic foot.

Class ISO 4

The class ISO 4 cleanroom is inside the larger class ISO 6 cleanroom. It is lit with yellow light to allow certain photolithographic techniques to be performed inside.

NPL's nanotechnology, organic electronics, and quantum detection teams regularly use this room for highly sensitive sample preparation.

Originally developed to prepare simple devices to measure transport properties and prepare sensitive nanotechnology samples without contamination, the cleanroom can be used to produce a range of microfabricated devices.

Devices and patterns can be defined on wafer like substrates using photolithography with a resolution of one micrometre. Organic and inorganic thin-films can be deposited using a series of methods, from spin-coating to electron beam physical vapour deposition. The resulting devices can then be isolated by cutting the wafer in small dices and packaged using wire bonding.

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Engineering doctorate on eco-design and the sustainable use of materials

NPL is interacting strongly with the Industrial Doctorate Centre (IDC) at the University of Surrey. In addition to the five Engineering Doctorates (EngD) recruited from the well-established 'Micro- and NanoMaterials and Technologies' scheme, NPL has recruited a further EngD on the 'Sustainability for Engineering and Energy Systems'. This four year research programme will investigate the support and enabling 'tools' needed by industry in terms of validated methodologies and data, case studies and standards, such as BS 8905, to enable designers to use materials sustainably.

For further information, please contact:
Graham Sims
T: 020 8943 6564
graham.sims@npl.co.uk

BSI standard on 'Sustainable use of materials'

NPL is a member of a BSI committee that is preparing a standard under the BS8900 series on the 'sustainable use of materials'. It is important to note that this approach is not about 'sustainable materials', as any material even a natural one can be used unsustainably. Bio-diesel is often quoted as an example of a good idea that was initially poorly and unsustainably applied. The standard, BS 8905, will be available for comment on the BSI website: http://shop.bsigroup.com/ in the latter part of 2010 as part of the balloting procedure.

For further information, please contact:
Graham Sims
T: 020 8943 6564
graham.sims@npl.co.uk

Metering climate change

NPL is working with Camco, a leading UK climate change and sustainable development company, as part of the Carbon Trust's Energy Efficiency Accelerator Programme.

NPL partnered Camco and City Energy Solutions, a specialist instrument installer, for a contract from the Carbon Trust for the installation of metering into businesses in targeted industry sectors. The aim of the project is to improve the process of measuring energy usage in industry through use of appropriate instrumentation and regular monitoring of measured values. This information will be used by appointed experts to help individual companies to understand where they are using energy resources and how they could reduce this requirement. The data will also be used to influence industry sectors through good practice. NPL will provide consultancy where specialist-metering requirements are encountered.

For further information, please contact:
Andy Morris
T: 020 8943 8749
andy.morris@npl.co.uk

Metrology & meteorology

UK scientists helped organise the first ever formal meeting between scientists working on Earth observation and the world's National Measurement Institutes. The workshop focused on 'Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty'.

The World Meteorological Organisation (WMO) co-hosted the workshop with the BIPM (Bureau International des Poids et Mesures) at their Geneva headquarters.

Climate scientists face many measurement challenges, so it makes sense for them to tap into the expertise of measurement scientists from the world's National Measurement Institutes. This workshop was convened to allow these two communities to discuss how they can better collaborate to provide ever more accurate and reliable observations of the Earth's climate.

The workshop was a great success, with Earth observation scientists recognising that they need the support of National Measurement Institutes, such as NPL, to meet future challenges.

The high point of the meeting was the WMO signing the CIPM-MRA (Mutual Recognition Arrangement). This will bring its three designated laboratories into the MRA:

- NOAA Earth System Research Laboratory (USA) for carbon dioxide, methane, carbon monoxide, nitrous oxide and sulphur hexafluoride
- The World Radiation Centre (Switzerland) for solar radiation quantities
- EMPA (Switzerland) for ground level ozone

The other major conclusion was the workshop attendees' endorsement of the importance of establishing robust traceability to SI to meet the needs of climate monitoring, and that in the case of satellites this traceability should ideally be established in space through the development of 'benchmark missions' such as TRUTHS and CLARREO.

The attendees also reached a consensus about meeting the future challenge for greenhouse gas emission verification. This arises because the scope and complexity of mitigation efforts will vary nationally, regionally and locally which is leading to an increase in interest in monitoring ambient greenhouse gases with a consequent massive increase in the number of sites required. It was agreed that the WMO and BIPM communities would collaborate to make best use of established national and international infrastructure, capability and funding to meet these requirements for standards.

Robust climate measurements

Accurate climate change assessment is crucially dependent on low uncertainty, robust measurements of climate variables. It is essential that these measurements comply with the internationally agreed climate monitoring principles of the Global Climate Observing System.

Measurement uncertainties can only be determined, and hence minimised, if proper consideration is given to the metrological traceability of the measurement results to stated standards.

NPL has played a lead role in the development of an international Quality Assurance Framework which has already been endorsed by space agencies and is now evolving to meet the needs of the full Earth Observation community.

The concept of metrological traceability is achieving a higher profile in the planning of climate monitoring systems, but there is still work to be done to ensure that future climate science is based on the most robust measurements available.

Find out more by visiting:

www.npl.co.uk/environmental-measurement

Quality Assurance Framework for Earth Observation

http://qa4eo.org

For further information, please contact:

Nigel Fox

T: 020 8943 6825

nigel.fox@npl.co.uk

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Coating substitution for reduced environmental impact

A consortium of leading UK companies is working with the University of Sheffield and NPL on a project that has the aim of substituting selected coatings in the electricity generation and aerospace industries with new compositions that address concerns with the scarcity of components in the coatings (Co and Cd), and health and environmental issues. The industrial firms in the consortium are Airbus, Alstom and NMB Minebea and Tecvac, who is leading the project. The project will develop a new, innovative suite of coatings with properties that can be tailored to suit many different applications.

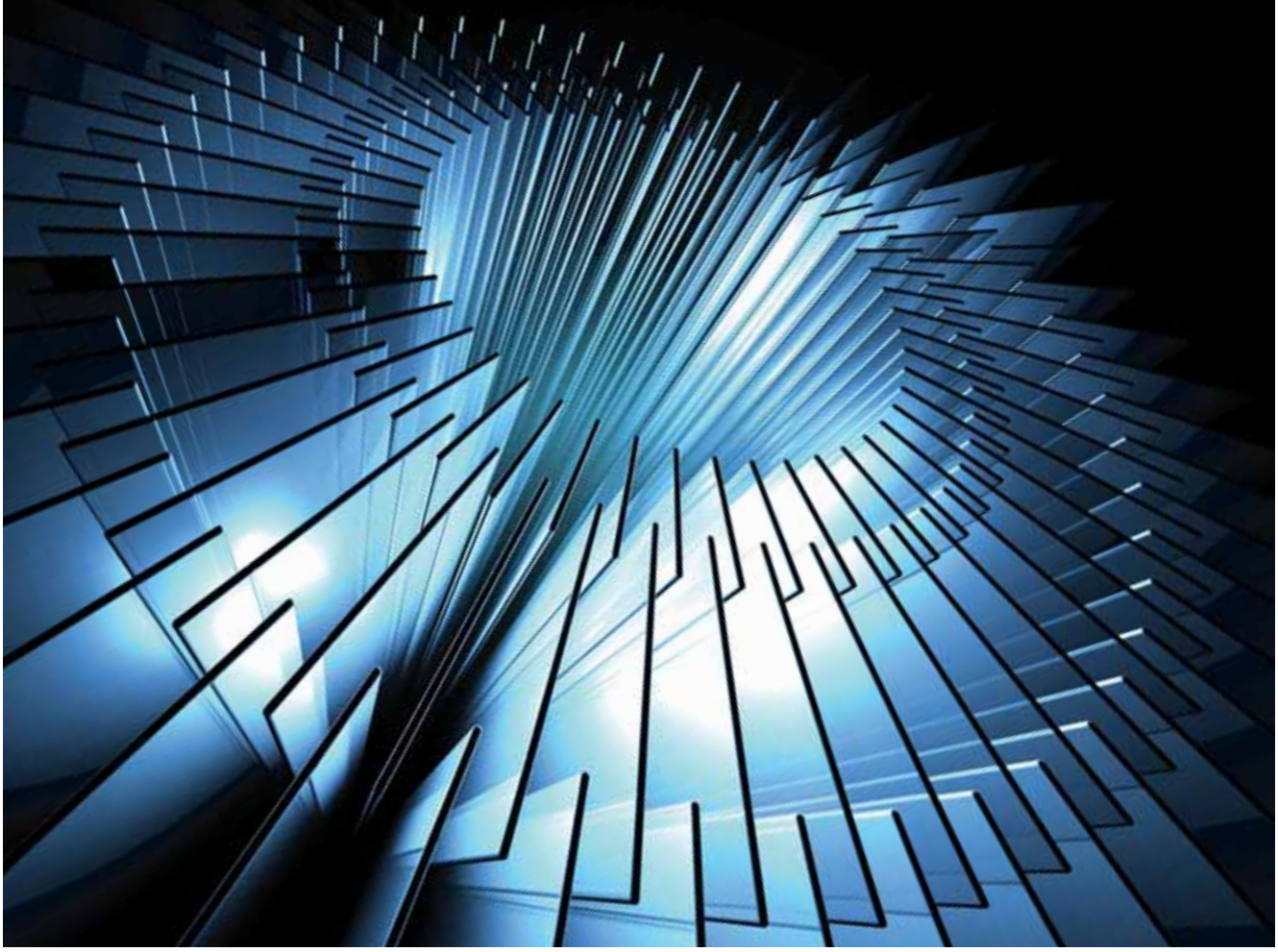
The price and availability of cobalt is volatile, causing uncertainty for manufacturers of power plant where Co-based overlays are used to reduce supersonic water droplet erosion (SWDE) of turbine blades and sliding wear in valves. Cd is a heavy metal toxin posing serious health issues and is therefore banned from most applications except those for which there is no alternative. This project will address this requirement through new nanostructured and self-lubricating hard coatings, to provide tailored properties of barrier corrosion resistance and sacrificial protection with lubricity.

The same coating concept will be tailored to provide SWDE resistance by incorporating additional functionality through nanocomposite structuring.

Processes will also be developed to strip these new coatings from components after use to promote recycling and reuse.

NPL's role in the project is to develop the UK's first test rig to evaluate SWDE, where good practice in carrying out these tests will be developed.

For further information, please contact:
Mark Gee
T: 020 8943 6374
mark.gee@npl.co.uk



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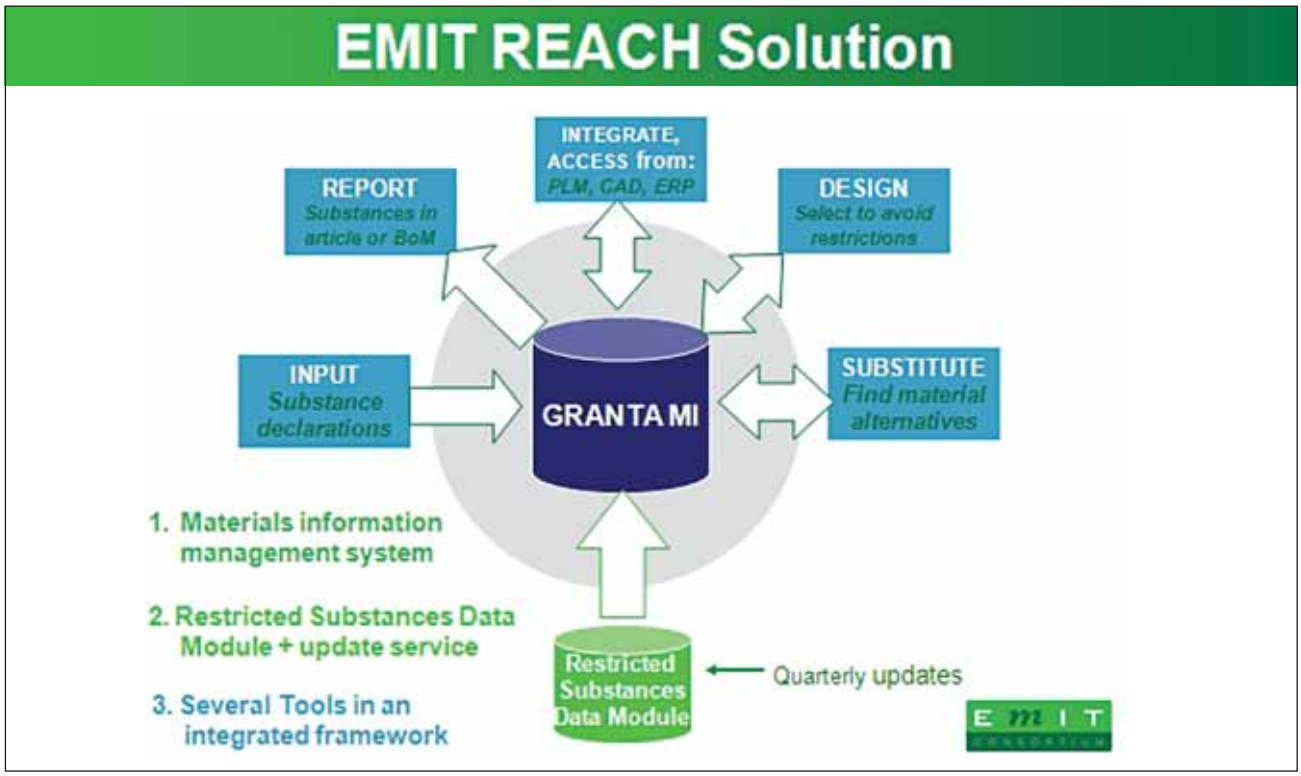
Eco design & environmental regulations



NPL is coordinating the EMIT (Environmental Materials Information Technology) project, which focuses on eco design and environmental regulations. The founding industrial members, Rolls-Royce, Eurocopter, Emerson, NASA, have recently been joined by Astrium, US Army Research Laboratory and Honeywell.

The EMIT consortium is targeting materials and process decisions that control the environmental impact of engineered products. It is developing information resources and software to aid consortium members' response to environmental regulations and to enable design for minimum environmental impact, including low carbon footprint, energy efficiency, reduced wastes and emissions, and avoidance of restricted substances.

Choices of material and of manufacturing process are of central importance, since these determine the use of restricted substances and can have a major influence on energy usage and emissions over a product's lifetime. Requirements for such choices include:

- Accurate information on restricted substances and on 'eco properties' such as the carbon dioxide generated in producing a raw material
- Specialist analysis capabilities - for example, to estimate the carbon dioxide that a potential product will generate at each stage in its lifecycle based on the materials and processes it uses
- Well-managed corporate materials information integrated with the organisation's wider business and engineering systems - for example, to enable all materials in a company's products to be identified and the impact of materials substitutions to be assessed; or to be aware of processes and process fluids used by a sub-contractor

Today, most manufacturing enterprises have none of these elements in place. Excellence in eco design demands integrated and easy access to all of them. Consortium members will implement and apply this technology in their designs, and guide further development and integration of eco-design processes. For many members, the eco-design tools are fully integrated in the established and world leading MI (Materials Information system) database system developed by Granta Design, a spin-off company from the University of Cambridge Engineering Department.

The EMIT consortium is keen to recruit further companies, who should contact the Coordinator, Graham Sims at NPL.

T: 020 8943 6564

graham.sims@npl.co.uk

Centre for carbon measurement

NPL has been working with the National Measurement Office (NMO) to progress a proposal to support climate change mitigation and the low carbon economy through the establishment of a 'Centre for Carbon Measurement' with a hub at NPL, but working in partnership with other organisations.

The aim of the proposed Centre is to contribute to making the UK the best place in the world to locate or build a low carbon business and the obvious centre for the global carbon market by developing and deploying the scientific and technical tools to:

- Accelerate development and assess performance of low-carbon technology
- Support existing and prepare for emerging carbon tax, trade and regulatory instruments
- Ensure confidence in environmental data

The proposed Centre will be based around three technical themes, building on existing capability at NPL (and partners) to provide measurement infrastructure to support:

- Low carbon technologies
- Carbon pricing and trading
- Climate data

The proposal to establish the Centre for Carbon Measurement was most recently included in 'The Low Carbon Capital: London as a Global Leader of the Low Carbon Economy' - a broader proposal by the Mayor of London, Boris Johnson which presents a number of recommendations to establish London as a global leader of the Low Carbon Economy.

In particular the document recognises that the Centre for Carbon Measurement would create knowledge and skills in these areas and plug into the international measurement community thereby providing a strong platform from which to influence the standardisation of carbon accounting internationally.

Find out more by visiting:
www.nmo.bis.gov.uk

For further information, please contact:
Hilary Elliott
T: 020 8943 6256
hilary.elliott@npl.co.uk

C-Save

The C-Save project involves several industrial partners and the Environment Agency focussing on Carbon Capture and Storage.

The project, C-Save, will develop tools to monitor, and in some cases control, the efficiency of the individual processes associated with the capture, transport, injection and storage of carbon dioxide from power stations, chemicals facilities and other large sources of carbon emissions. This way of abating carbon is known as Carbon Capture and Storage (CCS), and CO_2 is injected in underground storage sites. Energy companies and governments around the world are striving to be the first to demonstrate the entire CCS process at full scale.

In addition to the safety aspects associated with the leakage of CO_2 from storage sites, the C-Save project will provide further support to the UK Emissions Trading Scheme. CCS will be integrated into the EU ETS so that any carbon, which is not captured or lost from transport, injection or storage will be classed as emitted and allowances will need to be surrendered for every such tonne. Monitoring will be an important part of this process and experience gained by UK companies from early implementation, will add to the pool of expertise which underpins London's financial dominance of the carbon trading market.

NPL will provide input to the project by adapting leak detection equipment to detect CO_2, providing solid-state laser instrumentation vital for scanning above on-shore storage areas with high sensitivity, along with the uncertainty analysis associated with the measurements.

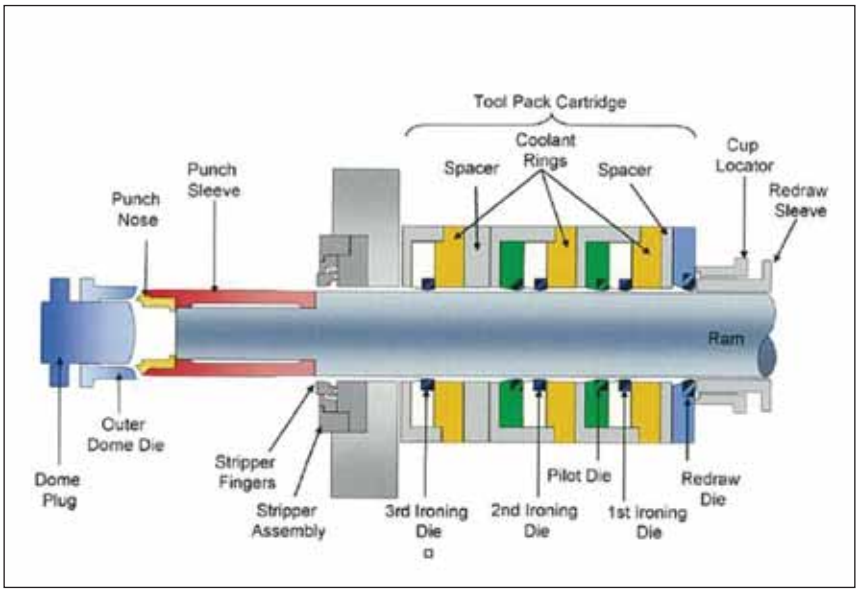
Find out more by visiting:
www.npl.co.uk/environmental

For further information, please contact:
Melanie Williams
T: 020 8943 6121
melanie.williams@npl.co.uk

Bel Canto – Lightweight beverage can punch

The Bel Canto project targets the development of a new, lighter weight beverage can punch with improved wear resistance. It involves the measurement excellence of the National Physical Laboratory, the expertise of Sandvik Hard Materials, a world leader in the manufacture of cemented carbides, and the manufacturing skills of a leading UK beverage can manufacturer, producing about 25% of the world market for beverage cans.

Around 260 billion beverage cans are produced every year worldwide with over 8 billion manufactured in the UK; the market for these cans continues to grow at approximately 10% per year. A single production line can make up to 500 million cans every year in a continuous process from aluminium or steel strip. A cup, pressed from the metal sheet, is formed into the can body in one continuous punch stroke in about one fifth of a second, forming the inside diameter of about 66 mm, and increasing the height from 33 mm to 57 mm, then, through three ironing rings, to stretch the wall to 130 mm high, before forming the concave dome at the base of the can.



Bodymaker assembly for can manufacture featuring redraw die to produce final diameter, ironing dies to form the height, and nose punch to form the domed base of the can.

Due to the very tight tolerances required for the tooling (± 0.002 mm) to keep the correct can dimensions, the alignment of the punch with respect to the ironing rings and dome die is critical. By reducing the weight of the punch the bending of the ram can be reduced and this will improve the alignment of the tools resulting in less vibration related damage on the tooling, improved can wall thickness consistency, reduced bodymaker maintenance and reduced energy consumption or faster production speeds as a smaller mass is being transported. Improved wear resistance will also improve can wall thickness consistency as well as reducing tool downtime for regrinding.

The main failure mechanisms for punch tooling are not straightforward, which challenges development of new materials. In the real application the tool is subject to a combination of many different factors such as corrosion, wear and high temperatures simultaneously whereas lab tests tend to evaluate one property at a time. In order to understand the process, and develop new products, NPL are developing a novel test system to examine the ability of the new materials to resist degradation from the combination of high stress sliding contact and impact that is found in the can pressing application. The test can be adjusted to provide conditions that vary from full sliding to impact only, and is instrumented so that a real-time measure of degradation can be obtained by measuring normal and friction forces. Finite Element Modelling and in-situ measurements utilising load sensors on the tooling will be used at the can manufacturer to validate the test protocols. NPL is also carrying out full examination of the damage that results from these tests so that an understanding of the relationship between degradation mechanisms and microstructure can be achieved. State of the art techniques used include orientation imaging (EBSD - Electron Backscatter Diffraction) in a high resolution FEGSEM (Field Emission Gun Scanning Electron Microscope) and a unique scanning depth sensing microhardness instrument to assess material variability from the surface to the interior of graded structures.

Find out more by visiting:

www.npl.co.uk/advanced-materials/materials-areas/powder-route-materials

For further information, please contact:

Ken Mingard

T: 020 8943 6558

ken.mingard@npl.co.uk

New caesium fountain

The new UK caesium fountain is ready to calibrate the international timescale.

The accuracy of the one-second step interval (that is, the possible deviations from the SI definition) of the international timescale TAI/UTC is independently monitored by a small number of primary frequency standards operated only by the leading NMIs. NPL's new primary standard NPL-CsF2 was made operational and fully evaluated in 2009. The new fountain uses a novel approach to reduce a frequency shift due and can achieve an overall accuracy that is five times better than for its predecessor. The accuracy of the new standard matches or even surpasses these of similar devices worldwide. In addition, it has shown excellent reliability with weeks of non-stop operation. Availability of such a system will also underpin efforts at NPL to develop optical clocks and influence in future the expected redefinition of the SI second.

For further information, please contact:
Krzysztof Szymaniec
T: 020 8943 6460
krzysztof.szymaniec@npl.co.uk

Defects database

IPC, the world's most well known electronics standards association is actively supporting the NPL Defects Database (http://defectsdatabase.npl.co.uk). The NPL Defects Database was set up to be a practical resource, available 24/7 for practical information and to help solve electronic production process problems. The resource was specifically created based on feedback from our industry collaboration projects.

IPC are now featuring an 'NPL Defect of the Month' video available at www.youtube.com/user/IPCAssociation and will continue to publicise the NPL project to their members world wide which should increase the number of users and hopefully expand the scope of the process issues featured.

Find out more by visiting:
www.npl.co.uk/ei

For further information, please contact:
Chris Hunt
T: 020 8943 7027
chris.hunt@npl.co.uk

Vince Cable – the importance of science

In his first major speech as Secretary of State, Vince Cable has outlined how the Government will support business, mentioning NPL and LGC and the importance of supporting science. "My younger son, who works in a particularly recondite area of quantum physics, is a one man lobbying industry for scientific research. I also have the National Physical Laboratory in my constituency and LGC. So I don't have any doubt about the importance of support for science."

What is the National Physical Laboratory?

The National Physical Laboratory (NPL) is one of the UK's leading science facilities and research centres. It is a world-leading centre of excellence in developing and applying the most accurate standards, science and technology available.

NPL occupies a unique position as the UK's National Measurement Institute and sits at the intersection between scientific discovery and real world application. Its expertise and original research have underpinned quality of life, innovation and competitiveness for UK citizens and business for more than a century.

www.npl.co.uk

If you would like further information on any aspect of Metromnia, please contact:

Metromnia Editor
National Physical Laboratory
Teddington
Middlesex
UK
TW11 0LW

Tel: 020 8943 6983
Web: www.npl.co.uk/contact

The National Physical Laboratory is operated on behalf of the National Measurement Office by NPL Management Limited, a wholly owned subsidiary of Serco Group plc

National Measurement System

The National Measurement System delivers world-class measurement for science and technology through these organisations

National Measurement Office

NPL National Physical Laboratory

LGC Setting standards in analytical science

nel technology for life

www.npl.co.uk

Autumn 2010

NPL
National Physical Laboratory

Metromnia

Metromnia Extra + *Events, Training & News*

Image source: FAAM

Frost point calibration supports atmospheric research

NPL has provided a humidity calibration for the UK Facility for Airborne Atmospheric Measurements (FAAM), at instrument body temperatures down to -40 °C. This is an unusual requirement, for application in aircraft-borne measurements.

FAAM operates a large BAE-146-301 aircraft deployed for atmospheric science research projects for a number of users.

Atmospheric water vapour is key to studies of climate and weather. Aircraft-borne measurements of frost point under harsh conditions are required with small uncertainty of 0.1 °C to 0.2 °C and correspondingly smaller calibration uncertainty.

Using an NMS-funded standard, NPL was able to provide both the required uncertainty and the low ambient temperature for calibration of FAAM's hygrometer, appropriate to the conditions of use.

For further information, please contact:
Stephanie Bell
T: 020 8943 6402
stephanie.bell@npl.co.uk

National Measurement System

How many measurements are

Other measurements

- Measurement of Laser power and energy for engine and airframe manufacture laser welding, cutting, hardening
- Calibration of x-ray instrumentation used by personnel to check welds for defects.
- Source and power calibration of UV meters for crack testing
- Coordinate measurement of components
- Stochastic modelling to determine measurement and operational uncertainties
- Environmental conditioning and testing services for characterisation and certification of adhesives and bonded joints/structures
- Full field strain measurement capability
- MTDATA for development of airframe alloys and glass for cockpit windows

Miniaturised testing - rapid evaluation of novel materials

Fuselage, wings and en

- High temperature testing of cond diffusivity of metallic materials

Wings and engine

- Supply and calibration of NPL AC

Wings and Instruments

- Modelling of heat transfer throug
- FE structural modelling of compo

Wings, airframe and en

- Mechanical property measureme fracture toughness

Cockpit

- Measurements of cosmic ray doses and dose calculations
- Photometric and Spectroradiometric measurements for instrument illumination and display screens
- Transmittance measurements for window and glass
- Consultancy on sunlight readability on display screens
- Consultancy on head up displays for the pilot
- Measurement of specific absorption rate (SAR)
- Power Flux Density measurement for non-ionising radiation hazard assessment

Radar

- Antenna gain, pattern and polarisation measurement
- Internet-enabled network analyser facility for microwave measurements
- Measurements on Laser rangefinders: Power; Energy; Beam propagation parameters
- Detector responsivity for remote sensing
- Measurement of complex permitivity of radome

Undercarriage

- Cleanness assessment of steels
- Hydraulic pressure measurement

Electronics, EMC & radio communications

- Antenna and field probe calibrations for EMC measurements
- Measurement of RF attenuation and pulsed power
- Measurement of RF impedance and amplifier noise
- Measurements for fibre optic 'fly by wire' control systems
- Solder Joint Integrity (degraded by thermally induced creep)
- Circuit Board Laminate Integrity (degraded by poor processing, residues and design)
- Component Reliability
- Thermal cycling and harsh environment trials to assess the robustness of electronics
- Validation of safety critical software
- Data processing of coordinate measurements

Instruments

- Calibration of acoustic emission sensors
- Calibration of capacitance standards used for bridg level sensors and accelerometers
- Calibration of wattmeter's; very low frequency ac vo barometers
- Traceability and calibration of dew-point; frost-point measurements
- LED; perception and output measurement of critical
- Calibration of air test data for altimeters and air spe
- Consultancy on timing aspects of GNSS and time &

NPL
National Physical Laboratory

National Measurement System

e involved in building a plane?

gine
uctivity; expansion; heat capacity; emissivity and

conductivity reference blocks used for NDT

s
gh multilayered components
nents

gine
ents, incl elevated temp modulus, strength, fatigue,

Engine
- Thermo mechanical fatigue
- Cleanness assessment of alloys for disc materials
- Standards for thermocouples and radiation thermometry

Turbine blades
- Modelling and assessment perfomance of coatings and lifetime prediction
- Calibration of radiation thermometers and blackbody sources for monitoring temperature to avoid overheating.

Thrust
- Calibration of load cells for thrust measurement
- Measurement of hot gases and rocket exhaust

Components
- Measurement of the DC permeability and full hysteresis of magnetic materials
- Measurement of the specific total loss of soft magnetic materials for electrical machines and actuators
- Measurement of the magnetic moment of valves and components
- Lifetime prediction of composite structures
- High temperature mechanical properties of metallic alloys

Emissions
- Nationally traceable Gas Calibration Standards that enable aircraft emissions to be accurately monitored.

Eurofighter image courtesy of BAE SYSTEMS

Wings
- Multilateration using conventional or specialised laser trackers to measure size and shape
- Structural health monitoring of in-flight damage or mechanical fatigue

Flaps
- Measurement of hydraulic components and pressure

Paint
- Reflectance measurements where Infra-red detection is important

Weight
- Calibration of load cells
- Traceability measurements associated with take-off weight

t

Fuel tank
- Density measurements for fuel parameters.

e instruments: capacitive fuel

ltages; ac/dc transfer systems;

t and pressure critical sensors

lighting
ed meters
frequency traceability

EJ200 jet engine ©2004 Rolls-Royce plc

www.npl.co.uk

NPL Events

Dimensional Measurement Training: Level 1 - Measurement User
1 - 3 Sep 2010 - Mitutoyo, Coventry, UK
A three-day training course introducing measurement knowledge focusing upon dimensional techniques.
www.npl.co.uk/1-3-sep-training

1st TYC-Workshop on Energy Materials
7 - 9 Sep 2010
Department of Chemistry,
University College London, London
This two-day workshop brings together experimentalists, theorists and computer scientists investigating the electro- and photo-chemical properties of materials for energy applications.
tyc-administrator@ucl.ac.uk
www.npl.co.uk/1st-tyc-workshop

Portable Co-ordinate Measurement Systems Training: Level 1
20 - 21 Sep 2010 - WMMMC, Coventry, UK
A two-day training course for users of large volume metrology systems.
training@npl.co.uk
www.npl.co.uk/20-21-sep-training

8th Millimetre-wave Users Group Meeting
1 Oct 2010 - NPL, Teddington
The Millimetre-wave Users Group was set up for people and organisations interested in science, engineering and technology in the millimetre-wave and submillimetre-wave bands.
nancy.moore@npl.co.uk
www.npl.co.uk/8th-millimetre-wave

Temperature Measurement and Calibration
4 - 6 Oct 2010 - NPL, Teddington
A two/three day training course on temperature measurement and calibration, covering measurement techniques; thermodynamic background and temperature scales; calibration techniques; traceability and accreditation; and hands-on laboratory sessions.
gill.roe@npl.co.uk
www.npl.co.uk/4-6-oct-temperature-course

Neutron Users Club
6 October 2010 - NPL, Teddington
The Neutron Users Club (NUC) acts as a focal point for discussion of the production, use and metrology of neutron fields. It aims to facilitate the exchange of information between members on research and development activities in this area and on the neutron facilities in the UK.
stuart.humphreys@npl.co.uk
www.npl.co.uk/events/6-oct-2010-neutron-users-club

Humidity Measurement and Calibration
7 - 8 Oct 2010 - NPL, Teddington
A two day training course on humidity measurement and calibration, covering measurement techniques; terms and definitions; calculations; traceability and calibration; and hands-on laboratory sessions.
gill.roe@npl.co.uk
www.npl.co.uk/7-8-oct-humidity-course

Future Thermal Analysis Conference
12 Oct 2010
Coventry TechnoCentre, Coventry
If your organisation will have requirements for thermophysical property data in the future, this is your chance to help ensure that the facilities are available to make these measurements.
hannah.carter@npl.co.uk
www.npl.co.uk/events/12-oct-2010-future-thermal-analysis-conference

34th ANAMET Meeting
21 Oct 2010 - NPL, Teddington
The main theme of this meeting will be Current Accreditation Issues for RF and Microwave Measurements.
nancy.moore@npl.co.uk
www.npl.co.uk/events/21-oct-2010-34th-anamet-meeting

Understanding & Evaluating Measurement Uncertainty
3 - 4 Nov 2010 - NPL, Teddington
A two day training course on understanding and evaluating measurement uncertainty, directed at practitioners concerned with more difficult measurement problems.
gill.coggins@npl.co.uk
www.npl.co.uk/training/3-4-nov-2010-understanding-evaluating-measurement-uncertainty

Nano-Molecular Analysis for Emerging Technologies IV
9-10 November 2010 - NPL, Teddington
Surfaces and interfaces are critically important to products and devices in healthcare and personal care. These complex systems present their own challenges for analysis and characterisation. This meeting will focus on both the frontier science in these novel systems as well as recent advances in analytical techniques to characterise them including XPS, SIMS, AFM, SPM, SPR, near field optical methods, optical trapping, ambient mass spectrometries and MALDI.
stuart.humphreys@npl.co.uk
http://conferences.npl.co.uk/nmaet/

Airborne Radioactivity Monitoring Users Group (ARMUG)
16 November 2010 - NPL, Teddington
The NMS Airborne Radioactivity Monitoring Users' Group (ARMUG) provides a forum for discussion of all aspects of air monitoring for radioactivity, including monitoring for particulate or gaseous radioactivity at environmental, workplace and process control levels.
stuart.humphreys@npl.co.uk
www.npl.co.uk/16-nov-armug

Ionising Radiation Metrology Forum (IRMF)
17 November 2010 - NPL, Teddington
The IRMF facilitates the exchange of information about UK calibration and testing facilities, for those who must comply with the requirements of the current Ionising Radiations Regulations.
stuart.humphreys@npl.co.uk
www.npl.co.uk/events/17-nov-2010-ionising-radiation-metrology-forum

NPL's Measurement Network

The network enables measurement knowledge to be shared between NPL scientists and network members as well as providing a forum for the exchange of information and advice between members and other measurement experts. It does this through a programme of seminars and conferences and by involving members in working groups or other activities tailored to their own particular interests.

Membership benefits include: a full programme of seminars and conferences; quarterly newsletter and regular e-alerts; access to presentations from previous seminars; networking with other members and NPL scientists; free access to Good Practice Guides and other publications and opportunities to influence the formulation of future research programmes.

www.npl.co.uk/measurement-network/

TUV NEL Events

Oilfield Water Management Workshop
15-16 September 2010
Westin Hotel, Calgary, Canada
Extraction of oil requires the use of a significant amount of water. This Workshop will bring together industry experts to discuss various issues relating to good oilfield water management.

Oil-in-Water Management Monitoring Workshop
23 September 2010
Thistle Aberdeen Airport Hotel, Aberdeen, UK
Measurement and analysis of oil-in-produced water offshore continues to be a hot topic. This Workshop will bring together industry experts to discuss various issues.

For further information on these please visit: www.tuvnel.com/tuvnel/courses_workshops_seminars/

LGC Events

Science for REACH and CLP compliance
4 November 2010 - LGC, Teddington
A half day, free event to help towards the progression of REACH
dossiers and effective regulatory enforcement

For further information on all of these please visit the Events section at: www.nmschembio.org.uk

If you would like further information on any aspect of Metromnia, please contact:

Metromnia Editor
National Physical Laboratory
Teddington
Middlesex
UK TW11 0LW

Tel: 020 8943 6983