NPL
National Physical Laboratory

METR OMNIA

Racing stiffness

Materials testing for Formula One

Faster better drugs
Biopharmaceutical testing

Catching nanoparticles

Don't go down with lead
Warning to small businesses

Inside the world of measurement science & technology

Issue 20 Autumn 2005

Warning to business over lead-free directives

- NPL has been investigating lead-free manufacturing for DTI since 1996.
- By August 2006 European directives will ban lead and other materials from electronic devices.

The manufacturing community has been warned by NPL and the Federation of Small Businesses that ignoring European lead-free directives could be a costly mistake. Free business seminars have been arranged to help small UK firms become compliant.

The Restrictions on Hazardous Substances (RoHS) directive will be enforced from August 2006, banning lead and five other materials from electronic devices. It may require companies to change their processes and equipment. As lead is the principal component of solder, anyone manufacturing for the electronics industry will be affected. Those who continue to supply 'leaded' products face imprisonment and fines up to £5000 per infringement.

Mistaken exemption?

Most manufacturing companies are not in the electronics sector and many think they are exempt.

But the new directive is product focused and applies to any device delivered to consumers, so all of its component parts need to be compliant.

Anyone supplying any part for that device must therefore ensure it is free of lead and other outlawed materials.

"Manufacturers have to consider not just their customers but also their suppliers," says NPL's lead-free expert Chris Hunt. "If a company cannot produce a lead-free version of its products it may lose business."

Importantly, a company's status with regard to the legislation today cannot protect against changes to the directives possible in the next four years, and effects from the market place.

www.npl.co.uk/training/lead_free

> "The lead-free effect reverberates up and down the supply chain."

Precision measurement and advanced materials testing are helping to create safer high-performance vehicles

Motion Blur Formula One Photography

Racing stiffness

Materials testing for Formula One

NPL is working with motorsport's world governing body, the Féderation Internationale de L'Automobile (FIA), to test the stiffness of metal alloys in Formula One racing cars.

F1 racing invests heavily in new technologies to balance racing speed, driver safety and the entertainment of millions of spectators worldwide. Races are run according to strict FIA regulations, which include the type of materials that can be used in the car, so no team has an unfair advantage.

NPL's expertise in materials testing and measurement led to its selection to provide confidential and independent advice to the FIA. The laboratory designed a new method to reduce the uncertainty that has plagued the testing of metal stiffness. NPL's role included development of a methodology for testing metals' specific modulus, which is stiffness relative to density.

> "Precision measurement and advanced materials testing are helping to create vehicles that are safer without reducing performance."

According to FIA regulations, metals with a specific modulus greater than 35 GPa/g/cm^3 (35 GigaPascals per gram per cubic centimetre) must be submitted to NPL for a specialised tensile test. The test gives F1 teams greater confidence in the quality of their test data and therefore their ability to comply with FIA specifications.

"Precision measurement and advanced materials testing are helping to create high-performance vehicles that are safer but without reduced performance," says NPL principal research scientist Jerry Lord.

Accurate measurement is also supporting the development of new materials for F1. NPL's guidance to the racing world is enabling the fine-tuning of metal compositions for maximum performance benefits. It is helping teams to characterise advanced aluminium and titanium alloys to reduce component weight while maintaining stiffness and performance. NPL is talking to the FIA about other test requirements, such as the chemical composition of metals used in racing cars.

Measurement to accelerate fuel cell economy

"Fuel cell technologies have been hindered by an absence of specific measurement capability."

Fuel cells are a pollution-free way to generate energy. They work like a battery to convert hydrogen and oxygen into electricity and heat, with water as a waste product. Fuel cells have the potential to replace batteries and engines as a power source for vehicles, phones, laptops and residential power grids.

NPL is helping to move fuel cells from specialist technology into the mainstream energy economy. It has opened a new testing division to focus on fuel cell research, solve some of industry's most pressing problems and make this energy source a commodity.

Fuel cells are expensive to run and they degrade too quickly to be a reliable source of energy. No mass-production technique has been established, which makes manufacturing time-consuming and expensive.

Scientists and engineers are trying to develop a viable fuel cell industry and supply chain. Industry expects it will be many years before fuel cells are a mass-produced commodity and reliable source of energy. But measurement scientists could help to pick up the pace.

NPL and industry are focused on the three fundamental problems facing fuel cells: cost, durability and the need for a refuelling infrastructure.

Working with leading fuel cell developers, NPL will address knowledge gaps about temperature distribution and degradation in solid oxide and polymer electrolyte membrane (PEM) fuel cells.

"There is an extent to which these technologies have been hindered by an absence of specific measurement capability," says NPL's Gareth Hinds. "We are addressing that."

NPL will give industry methods to extract accurate measurements about fuel cell performance in a number of environments.

Using these data, manufacturers can speed up development of an infrastructure and supply chain for this emerging market.

This is how quick and easy it may be in future to recharge a fuel cell in a mobile phone

Data from air quality monitoring networks are used to inform UK and European pollution mitigation strategies

NPL / Andrew Brookes

Catching nanoparticles

NPL has been challenged to improve the UK's measurement of nanoparticles, one of the components of airborne particles potentially most dangerous to human health.

Particulate matter contributes to 32,000 premature deaths in the UK each year. "Smaller particles reach further into the body than larger particles, have greater effects in proportion to their mass and therefore have the potential to do more damage," says NPL air quality scientist Rod Robinson.

A nanoparticle is defined by the British Standards Institute as any particle with one or more dimensions less than 100 nm. NPL recently won the contract to run the UK Particle Counting Network for the Department for Environment, Food and Rural Affairs (Defra). It assembled a powerful consortium, including Birmingham University and King's College London, to improve the quality and volume of data available to air quality and climate change researchers. Data from the network will be provided via the Air Quality Archive (www.airquality.co.uk) to academics, regulators, policy makers and health researchers. It is used to inform UK and European pollution monitoring and mitigation strategies.

NPL also manages networks which monitor heavy metals and hydrocarbons. And it is evaluating different manual and automatic techniques to analyse the chemical composition of particles, particularly for nitrate, sulphate and carbon components.

In a separate project building on expertise in surface analysis, NPL is developing a Nanoparticle Mass Analyser (NMA) that can detect particles with a diameter below 50 nm.

"Smaller particles have the potential to do more damage in the body. Our work will help to get to the bottom of why airborne particles are so detrimental to our health."

The need for robust and comparable measurement techniques for both natural and manufactured nanoparticles was highlighted in a 2004 report by the Royal Society and Royal Academy of Engineering. Noting NPL's reputation in metrology and responsibility for the UK's national standards, it points to technical challenges surrounding measurement of nanoparticles' physical and chemical properties, particularly in 'real-world' situations. The report calls for standard validated methods of nanoparticle measurement and recommends DTI support the standardisation of nanometre measurements through its funding of the National Measurement System.

How does it feel?

Psychophysics is the science of the connection between nerve action and consciousness; a branch of psychology that deals with relationships between physical stimuli and sensory response.

NPL is helping to predict how consumers will respond to soft-touch plastics

How do you feel about your tooth brush? What is it about your golf club handle? Can you put it into words?

The feel of consumer products is vital to their commercial success, and industry has long wanted to measure people's response to materials. Designers of new products know how they want people to feel. But it's not that easy to know which material will elicit the desired response.

NPL's Dr Paul Tomlins is helping manufacturers to predict how customers will feel about different types of soft-touch plastics. Working with City University's Centre for Human Computer Interaction Design, he hopes to discover the link between the psychological perception of plastics and their known physical characteristics.

Psychophysics

Consumers have a particular response when they handle soft plastics, like those in shampoo bottles or screwdriver handles. Dr Tomlins wants to quantify this response through more accurate measurement and characterisation. NPL believes manufacturers could influence buying decisions by better understanding the link between perception and scientific measures of properties – including hardness, friction and surface roughness.

The project combines qualitative and quantitative data from two experiments. To identify the link between perceived and true hardness, participants are asked to feel soft-touch plastics and assign a hardness value to them. NPL has also developed a system to measure the frictional behaviour of skin in contact with different materials, which plays a critical role in our sensory perception of objects.

Plastic vocabulary

Perceptual assessment of materials requires the identification of a common vocabulary for people from different age, gender and cultural groups. NPL worked with 105 people of different ages, including some who are deaf or blind, and people whose first language is Mandarin or Punjabi. Participants were asked to suggest adjectives to describe each material – such as 'sticking', 'gripping' or 'slippery'. Interestingly, age and cultural background appear to be a clear determinant of word choice. No Punjabi participant, for example, produced a word corresponding to the English term 'smooth'.

Words were clustered to represent the key psychological dimensions of perception, such as 'femininity', 'pleasantness' and 'uncomforting'. By understanding which words are associated with different materials, researchers can better understand which plastics elicit certain reactions and more accurately predict how customers may respond to a new product.

Seven words chosen to describe the feel of soft-touch plastics accounted for almost half the total:

> Smooth
> Soft
> Sticky
> Gripping
> Hard
> Slippery
> Rubbery

Some of the less-used words:

> Bendy
> Erotic
> Dull
> Waxy
> Pinchable
> Yucky

NPL / Andrew Brookes

Making better drugs faster

By reducing the time and cost of pharmaceutical testing, NPL's biotechnology experts are helping to get better drugs to market more quickly and cheaply.

It can take up to fifteen years to develop a biopharmaceutical from patent to mass market. Biopharmaceuticals are manufactured to specifications set by regulatory bodies such as the Medicines and Healthcare products Regulatory Agency (MHRA) and US Food and Drug Administration (FDA).

Approval requires extensive testing and clinical trials, and if drugs fail to comply with these regulations they cannot be sold. Regulators need to have confidence in measurements made by the drugs industry, which in turn would like to minimise measurements required to produce safe and cost-effective drugs. But only when there is less uncertainty in the data will regulators be satisfied with less testing.

NPL is working to bridge these two requirements as part of the new Measurements for Biotechnology (MfB) programme (2004-7), which it runs in collaboration with LGC Ltd and the BioIndustry Association. One of the programme's first projects was to quantify the accuracy of a common protein measurement technique - Circular Dichroism Spectroscopy. This is a rapid method of determining whether a batch of protein biopharmaceuticals has adopted its correct structure and still has biological activity traceable to material used in trials. Although valuable, the technique is not widely used due to perceived inaccuracies.

NPL's mission was to find where inaccuracies were coming from. Samples of a standardised protein biopharmaceutical were sent for analysis by 27 different laboratories – with widely varying results.

"There was a range of errors," says NPL's biotechnology expert Dr Marc Bailey. Some suggested the protein

was partially unfolded and therefore inactive. Even those laboratories which provided good data could not provide an absolutely accurate set of circular dichroism spectra for the biopharmaceuticals.

"This is the sort of test outcome that could delay approval or lead to the discarding of biopharmaceuticals which are suitable for release," Dr Bailey says. "Given the costs of manufacturing protein biopharmaceuticals, it is important to get these tests right."

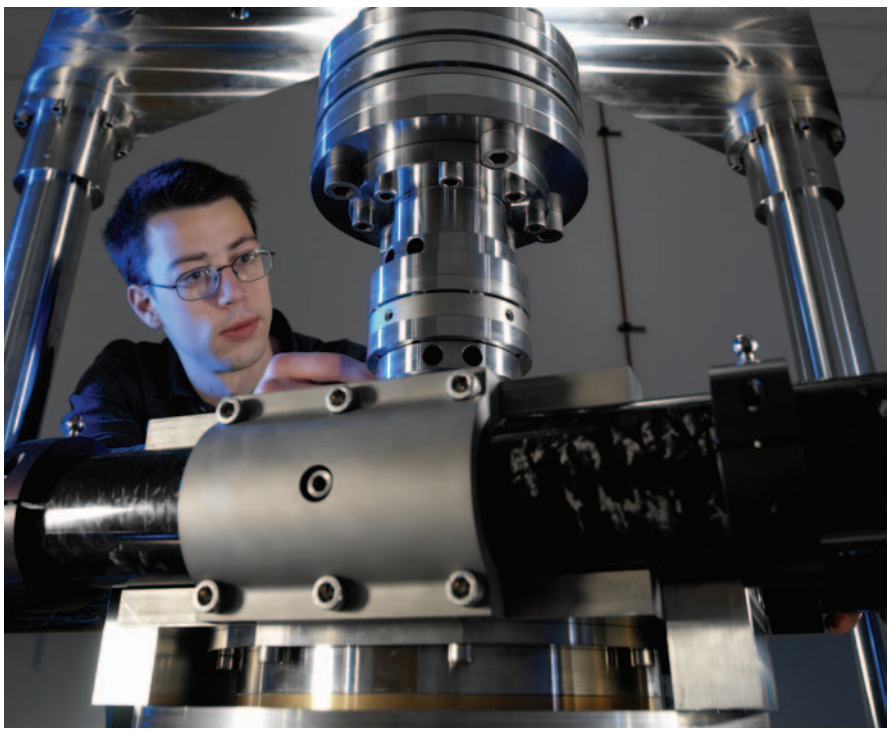
The variations were mostly down to poor calibration and operation of the equipment, prompting NPL to develop training and calibration services which will help laboratories to get reliable and consistent results.

www.mfbprog.org.uk

Spreading the word

This is the 20th edition of NPL's Metromnia newsletter. For seven years Metromnia has highlighted the work at NPL, the UK's national measurement institute. Previous editions have focused on specific areas of measurement, but NPL is now providing measurement solutions in so many diverse areas we decided to move to a magazine format. We look forward to sharing our passion for measurement and how it impacts UK competitiveness and our quality of life.

Fiona Williams Auty, Head of Communications



NPL / Andrew Brookes

NPL's torque calibration service in the 1 N.m to 2 kN.m range undergoes final adjustments

Force torque and hardness – back in business again

It was no small job moving NPL's force standard machines to our new laboratory and getting them ready for service again. We now have all of our force standard equipment up and running. These are complemented by new torque and hardness calibration services.

Diary of events

Lead-free manufacturing
25 October in London
27 October in Manchester
28 October in Birmingham
clare.melton@npl.co.uk

Audiometric calibration techniques
1-2 November
NPL, London
timothy.sherwood@npl.co.uk

Manufacturing and materials measurement
2 November
Rotherham, South Yorkshire
emma.mulligan@npl.co.uk

In process measurement - can machine tools ever replace CMMs?
7 November
Birmingham
odette.valentine@npl.co.uk

Low temperature thermometry
24 November
Oxford
richard.rusby@npl.co.uk

Developing advanced scientific engineering spreadsheet applications
23-24 November
NPL, London
gill.roe@npl.co.uk

EMC measurements
29 November
NPL, London
www.iee.org/events

Food and materials measurement
28 February 2006
Grimsby
emma.mulligan@npl.co.uk

Find all NPL events at:
www.npl.co.uk/news-and-events

Further information

For additional copies of Metromnia, and for more information about NPL's work and services to UK industry, please call the NPL helpline on 020 8943 6880.

National Physical Laboratory | Hampton Road | Teddington | Middlesex | United Kingdom | TW11 0LW

Switchboard 020 8977 3222 **NPL Helpline** 020 8943 6880 | **Fax** 020 8943 6458 | **www.npl.co.uk**