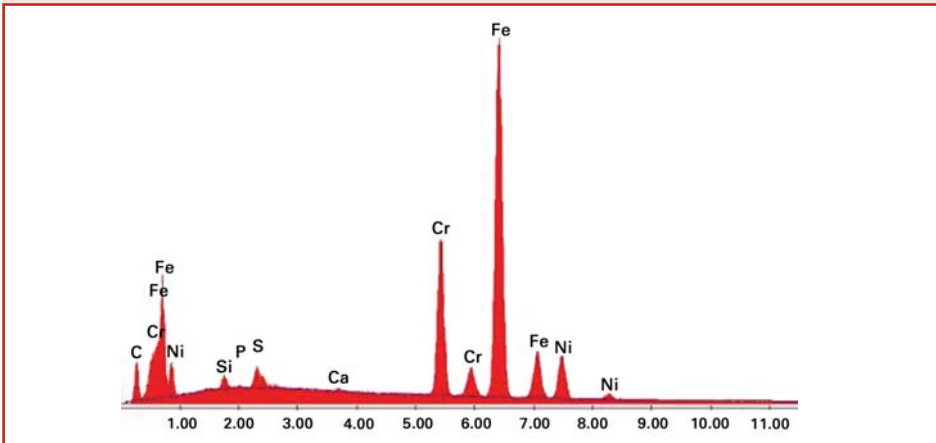


XRF tools help ROHS compliance

Companies failing to comply with recent EU legislation banning the use of certain materials can now be fined. Consequently, industry is urgently seeking an inspection tool to ensure only ROHS-compliant materials are used, and one strong candidate is XRF (X-ray fluorescence) spectroscopy. There are many instruments available (both handheld and benchtop), but their technical capabilities are not well understood by the industry. Consequently, NPL, with its proven background of support for industry in such areas, is leading a short, collaborative study to benchmark commercial instruments. The round-robin intercomparison of both instruments and test sites, will provide the industry with increased confidence in the technique. The twelve partners represent a mix of instrument manufacturers and users.



Typical XRF spectrum from a steel

The important objectives are

- to improve industry confidence in XRF testing for the presence of ROHS-prohibited materials
- to determine if there are detection issues with any ROHS-prohibited materials
- to evaluate and compare different commercial XRF instruments
- to prepare standard samples of known composition

The project is well underway and the findings should be available in early 2007, incorporating a Good Practice Guide for use of XRF measurements in identifying ROHS-restricted substances.

Chris Hunt

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Lightening the lead-free load

Over the past nine years, NPL has undertaken a long series of projects addressing various aspects of lead-free soldering. The output from these projects has now been used as the basis for a new Guide for industry, 'The lead-free minefield: A guide to mitigating risk during the transition to ROHS compliance'. The driving force for these projects, the two EU Directives, *Restriction on Hazardous Substances (ROHS)* and *Waste in Electronic and Electrical Equipment (WEEE)*, ban materials and set recycling targets for electronic and electrical equipment. Industry is already facing major changes e.g. alternative lead-free alloy systems are being introduced. The result is a difficult transition period for industry, with no simple "drop-in" material replacement, a lack of processing knowledge, and a relative paucity of reliability data for these new materials,

in an industry worth £23 billion a year in the UK.

This period of change means industry needs new measurement tools to control and improve processing, and new characterisation tools to avoid field failures. NPL's projects have helped address these demands by providing a range of tools for predicting the reliability of new ROHS-compliant materials and processes. Using these tools, manufacturers can be sure their products are safe, reliable and resilient.

Under secondment to the Component Obsolescence Group NPL's Alan Brewin developed the Guide, which draws heavily on NPL work. It addresses in a practical way the main issues for successful implementation of the ROHS Directive.

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International awards for NPL

At APEX 2006, one of the world's most important networking events for the electronics industry, NPL scientists Chris Hunt and Martin Wickham were awarded the Best Conference Paper for their presentation on 'The impact of lead contamination on reliability of lead-free alloys'.

The paper reported confirmation that there are no issues regarding solder joint reliability when mixing the lead-free soldering process with tin-lead terminated components. This welcome finding came after an extensive investigation carried out by NPL in collaboration with fifteen partners.

Chris Hunt received two personal IPC Distinguished Committee Service Awards in appreciation and recognition of his contribution to the development of International Standards. The first award related to his work on "Solderability", whilst the second was associated with work on "Tin whisker Guidelines".

Serco has also recognised Dr Hunt's work by presenting him with one of the 2005 Serco Chairman's Awards.



Chris Hunt receiving the award for the Best International Paper at IPC APEX 2006 from Chairman Peter Murphy.

Chris received the award, one of thirty around the world, at a meeting in the Greenwich Maritime Museum. Kevin Beeston, Serco Chairman, said that as the industry struggles to find reliable technical solutions that comply with new lead-free regulations, Chris had taken forward his research leadership into leadership of the world community of electronics manufacturing engineers.

Interested in project formulation?

At the invitation of DTI, NPL is formulating three new projects:

- "Sensor for wireless measurement of coating performance" - the specification and generation of an integrated sensor and control system to monitor coating performance, particularly in hostile and remote conditions such as automotive and aerospace environments, and power applications. The system, based on previous NPL work, will indicate the remaining lifetime of the coating.
- "Meeting the interconnect challenge of Moore's Law" - increasing device complexity means that interconnect current densities are increasing rapidly ($>10^4$ Acm²), which in turn can cause void formation, high resistance and poor fatigue performance. The project will obtain a better understanding of void generation, and develop barrier systems that allow the interconnect to carry higher current densities.
- "Sustainable electronic substrates for 2015" - as industry aims to recycle 10% of pcb base materials by 2015, assembly must incorporate more environmentally friendly materials and new end-of-life strategies. The performance of alternative pcb base materials (including biodegradable) will be investigated, and disassembly methods using dissolvable materials evaluated. The study will help industry devise a coherent strategy for equipment end-of-life disposal, re-use and recycling.

Participation in the formulation process, or in the projects themselves, is welcomed, as are any comments on their contents.

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Lead-free soldering again the focus of SSTC meeting

As companies struggle to meet both WEEE and ROHS requirements, it was inevitable that lead-free soldering should again provide the focus for the **Soldering Science & Technology Club** meeting, "Managing & reliability of lead-free assemblies".

Following his Master Class on the previous day, David Hillman (Rockwell Collins) was involved in two papers. In the first he discussed possible joint degradation when both bismuth (e.g. from 98Sn₂Bi-terminated components) and lead are present in a SM joint. In the second, "JCAA/JG-PP lead-free solder testing for high reliability", he joined forces with Clive Simmons (BAe Systems) to present the work largely emanating from a DOD programme, and driven by the need for comprehensive test data.

They examined performance data for high reliability (IPC Class III) applications from three lead-free solder alloys on newly manufactured and reworked circuit cards. Clive Simmons then explained the BAe strategy for dealing with SnPb soldering allowed in the aerospace and defence industries, and the resolution of the issues it faces.

Just how the new regulations are to be enforced in this country was carefully explained by Chris Smith (of NWML, the UK enforcement body), in his talk "ROHS Enforcement in the UK". He emphasised that it will not be "a soft touch". Looking to the future, an alloy developed to meet future automotive requirements (e.g. 150 °C operating temperature) was described by Hector Steen (Henkel). Nathan

Barry (Goodrich) outlined a new method for high-cycle fatigue testing of lead-free solder joints, and indicated that the performance of SnAgCu and SnCu solder joints over the stress range 20 MPa to 35 MPa was compared favourably with that of the baseline SnPb solder.

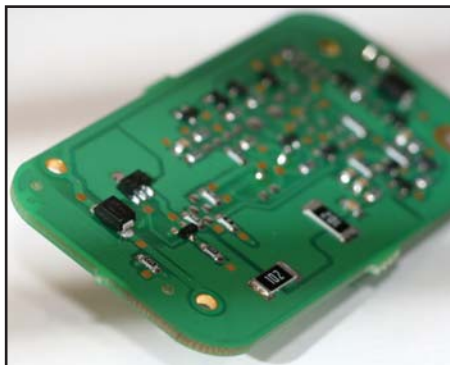
The one deviation from the subject of lead-free soldering was provided by Chris Hunt (NPL) who reported on the protective performance of a range of conformal coatings. He warned that there is a tendency for some organics to permeate the coatings and cause corrosion.

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Promising ICA demonstrator performance

Many sections of the industry will be encouraged by the results of the latest NPL-industry collaborative programme to evaluate isotropic conductive adhesives (ICAs) as an alternative to solder for assembly of certain products.

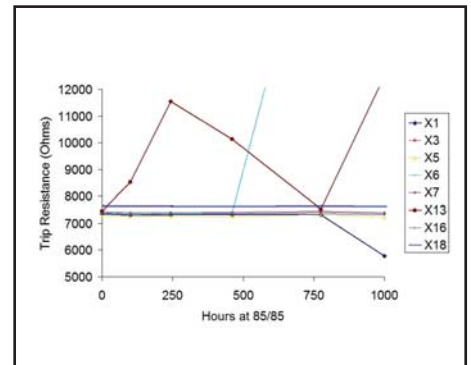
The results go some way to allay fears of low reliability and low mechanical strength. Following the European ban on lead in solders, many assemblers are turning to lead-free solders, which are now available. But there is concern that the higher melting points associated with these alloys may cause some end-user problems in the assembly of temperature sensitive components (e.g. LCDs, electrolytic capacitors, optoelectronics) or in hierarchical soldering. In these cases ICAs might prove attractive. Following previously reported encouraging results, a commercial fire detector has been assembled as a demonstrator using ICA materials. The functional



Fire detector demonstrator substrate.

behaviour of the detector was then monitored after damp heat stressing to ascertain the likely field performance, and the results benchmarked against those of a conventionally soldered system. The salient findings were:

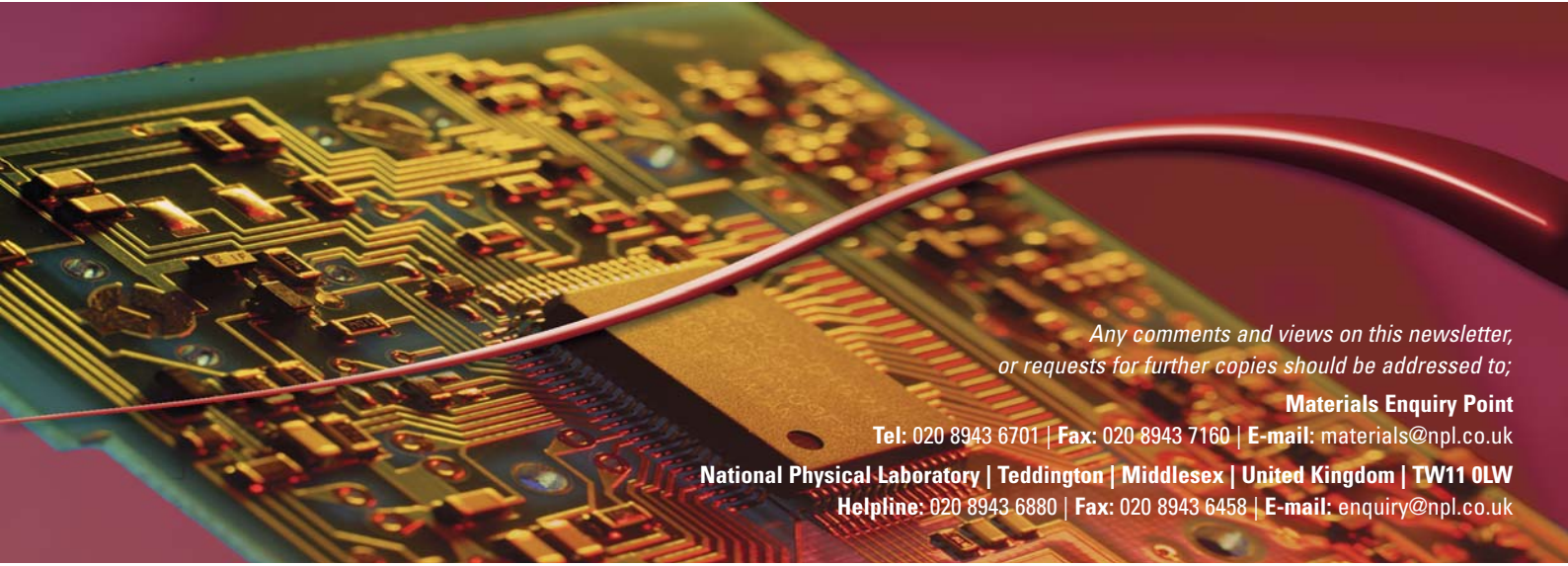
- the reliability of the detectors assembled using ICA materials was encouraging, whilst not quite mirroring that of the soldered circuits. With minor processing adjustments the ICAs could find application as a solder replacement.
- the reliability of joints produced with one particular ICA material was close to that of soldered joints. The assemblies survived 1000 hours at 85%RH/85°C



Resistance required to trigger the alarm circuit for demonstrators assembled using an ICA material after ageing at 85%RH/85°C.

- components with few leads and small bond areas (e.g. SOT23) benefit from additional mechanical support to improve tolerance to mechanical handling
- processing yield issues associated with R0603 components could be eliminated by normal process optimisation techniques
- damp heat testing is a suitable tool for assessing the reliability of ICA joints.

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Masterclass highlights lead-free solder process requirements

The precise requirements essential for developing a reliable lead-free soldering process were highlighted and explained in the latest NPL Masterclass by world renowned speakers. In their day long workshop, two experts from Rockwell Collins, USA, **David Hillman** and **Doug Pauls**, carefully and comprehensively discussed what must be understood in developing a robust lead-free product. The credibility of the workshop was underlined by the knowledge that it had been generated by process engineers actually responsible for

defining, developing, maintaining and supporting a proven lead-free process within their own organisation. Aspects covered by the speakers included materials, components, finishes, processing, assembly, testing, qualification and cost. The pragmatic responses to questions on practical implementation issues, were both informative and impressive.

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Electronics interconnection group strengthened



Davide Di Maio

NPL's Electronics Interconnection Group has been strengthened with the recruitment of Dr Davide Di Maio. He obtained his doctorate at Oxford University, and brings invaluable materials science expertise to complement the wide range of skills already existing within the Group. Davide is already leading two projects:

- Tin pest – studying whether the phenomenon occurs in lead-free assemblies, and if so the extent of any joint degradation
- Vibration stressing – studying whether the application of vibration (up to 5 kHz) has any detrimental effect on the integrity of lead-free solder joints

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New NPL Reports

- Development of preheat on solderability testing. NPL Report DEPC-MPR 036
- Measuring the impact of component solderability on lead-free solder joint reliability. NPL Report DEPC-MN 038
- The analytical model II for predicting solder shape and volume impact on lifetime. NPL Report DEPC-MPR 039
- Measuring the impact of land size and solder joint volume on lead-free solder joint reliability. NPL Report DEPC-MPR 044
- Measuring the effect on isotropic electrically conductive adhesive reliability of joint design characteristics. NPL Report DEPC-MPR 045
- Measuring the reliability of technology demonstrator manufactured with isotropic electrically conductive adhesives. NPL Report DEPC-MPR 046
- Statistical analysis of the effect of pcb finish and processing of solder joint on integrity. NPL Report DEPC-MPR 047
- Test approach to isothermal fatigue measurements for lead-free solders. NPL Report DEPC-MPR 048