

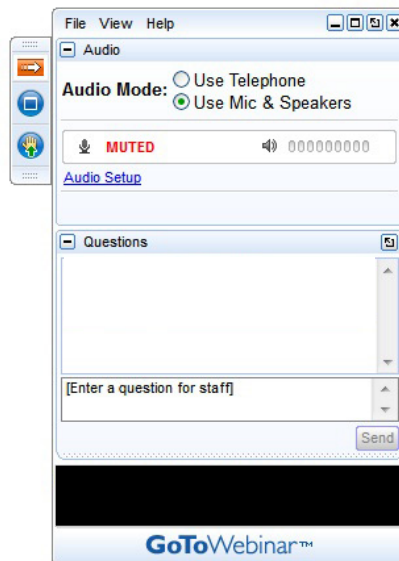
UV Inspection and Thickness Measurement of Conformal Coatings

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Electronic & Magnetic
Materials Group



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Electrical Performance of Organic Substrate Materials and Coatings Aged at High Temperature
Tuesday 11th July Dr Adam Lewis, Christine Thorogood & Martin Wickham

Electrical Metrology for Flexible & Printed Electronics
Tuesday 12 September Dr Adam P. Lewis

Condensation Failure & Improved Testing for Electronic Assemblies
Tuesday 14 November Ling Zou

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UV Inspection and Thickness Measurement of Conformal Coatings

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About NPL ...

The UK's national standards laboratory

- Founded in **1900**
- World leading **National Measurement Institute**
- 600+ specialists in **Measurement Science**
- State-of-the-art standards facilities
- The heart of the UK's **National Measurement System** to support business and society
- Experts in **Knowledge Transfer**

36,000 m²
national
laboratory



World leading
measurement
science building

EMM Current Research Areas

Wearables



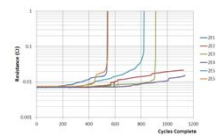
Tin
Whiskers
Mitigation



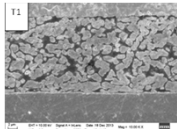
Printed
Electronics



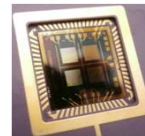
Prognostics/
Testing/
Prediction



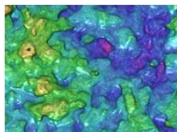
High Temp.
Interconnect



Coatings/SIR/
Condensation
Testing



Printed
Sensors



Electronics
Recycling

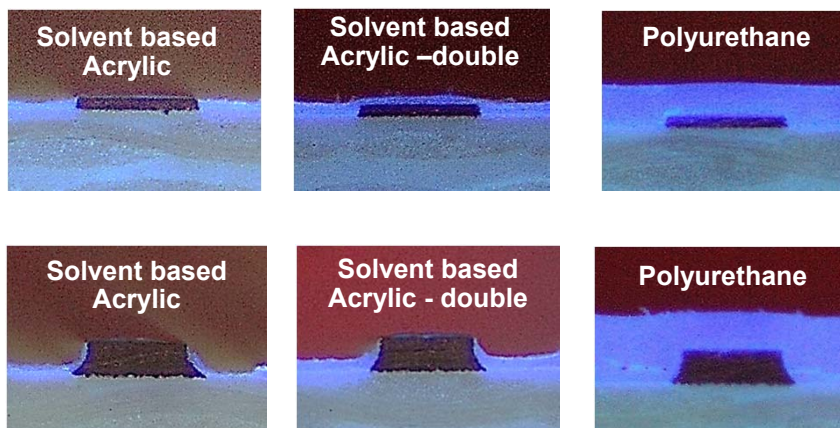


High humidity and condensation

- Conformal coatings are applied to protect electronic assemblies
- CC are not a moisture barrier, SIR drops as coatings are applied. But they are a liquid barrier.
- The issue with CC is that perfect coverage over all terminations can be problematic.
- Any exposed termination can act as an electrode
- Condensing conditions will seek out these exposed areas and cause problems

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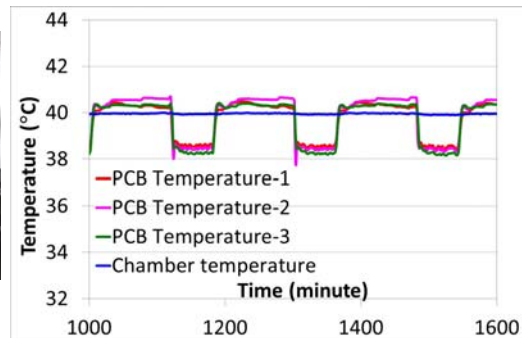
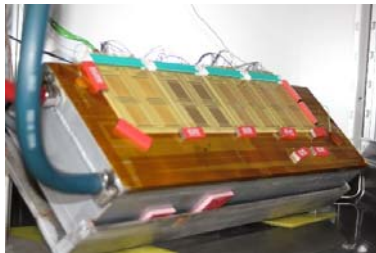
Coating coverage – 1oz. & 3oz. Cu track



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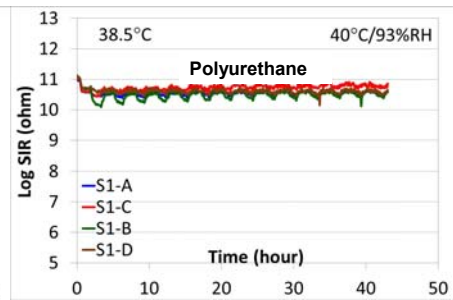
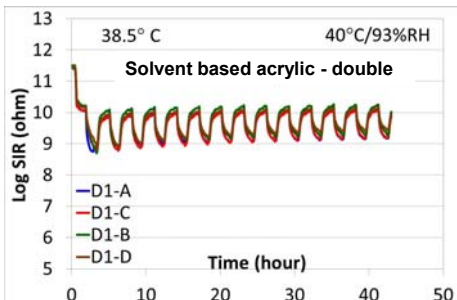
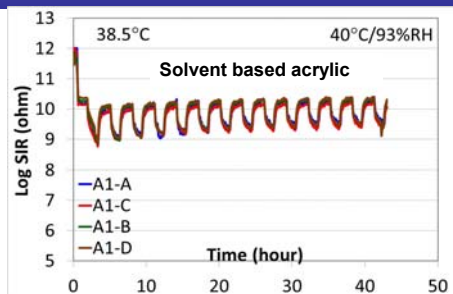
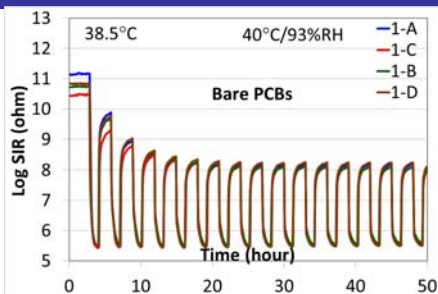
How it works: The Condensation System

- The test boards are mounted on a platen.
- The platen temperature is independently controlled, and can be lowered to required temperature to control condensation level.



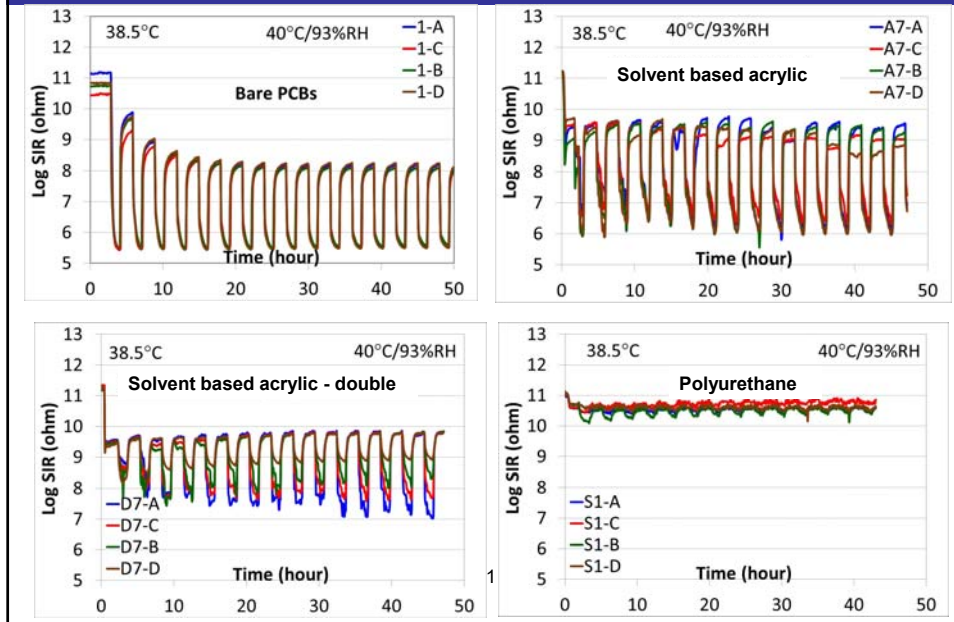
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Coated PCB SIR results – 1oz Cu tracks

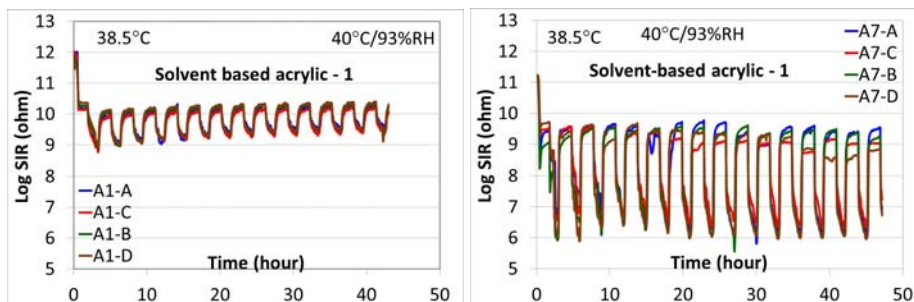


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Coated PCB results – 3oz Cu tracks



Coverage



Whisker Mitigation

- Annealing/reflow
Can reduce internal stress of plated deposit
- Ni undercoat
Significantly slower intermetallic growth
- Other coatings
Electroless nickel
ALD (atomic layer deposition)
Physical barrier/stress dissipation
- Reterminate
Add Pb >5%
- Conformal coating
Physical barrier/stress dissipation



Source: reference.findtarget.com



Source: eriehardchrome.com



Source: nordson.com



Source: clivebanks.co.uk



Source: Labsafety.com

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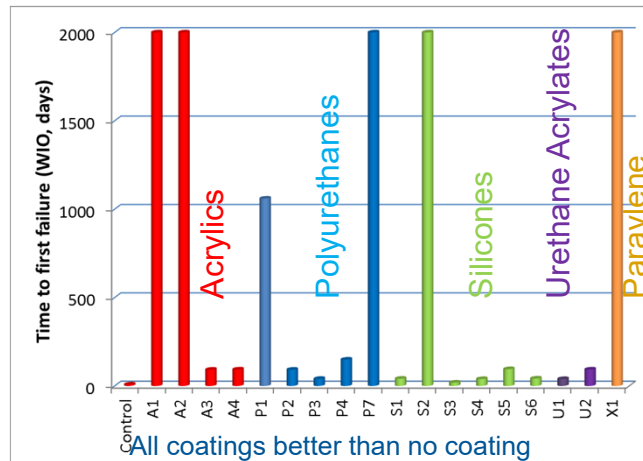
NPL CCWM Project

- In the project (CCWM), NPL has shown that using a suitable tin plating chemistry with a high propensity to whisker, a coatings ability to mitigate against whiskering could be successfully tested
- It was found that frequency of whisker occurrence was dominated by whiskers erupting at the edge of the plates.
- This result reflects the well known problem that coatings have in achieving good coverage around right angle bends, such as found on all components.



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NPL CCWM Test Vehicle Time to first short – both surfaces coated



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CCWM Lessons Learned

- Edges are important
- Plates are easy to coat
- Plates always handled by mounting screws by potential for damaging edges of structures
- Limited data set
- Whisker grow at any time
 - Many intermittents
 - Did we catch all the failures?
 - Whisker grows, makes contact, grows, breaks contact



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Real Assemblies

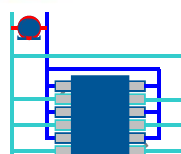
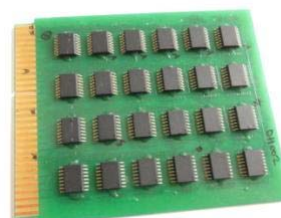
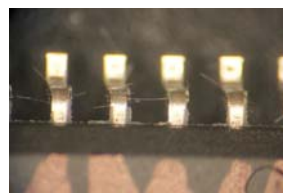
- Parallel plate test vehicle
Ratio edge length to surface area
176mm : 1250mm²
0.14mm/mm²
- SOIC14
Ratio edge length to surface area
6.4mm : 1.64mm²
3.9mm/mm²
- ~30x increase in edge length to surface plating



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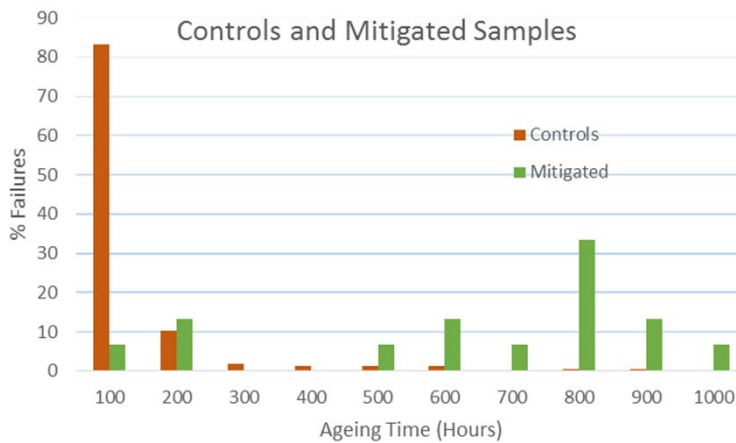
SOIC Whisker Test Vehicle

- SOIC, Olin194 leadframe
- Address individually each component
- 192 components per batch + controls + dummy boards for coating trials
- Assemblies delivered to partners for coating
- Return to NPL for testing and analysis
- Continuous monitoring

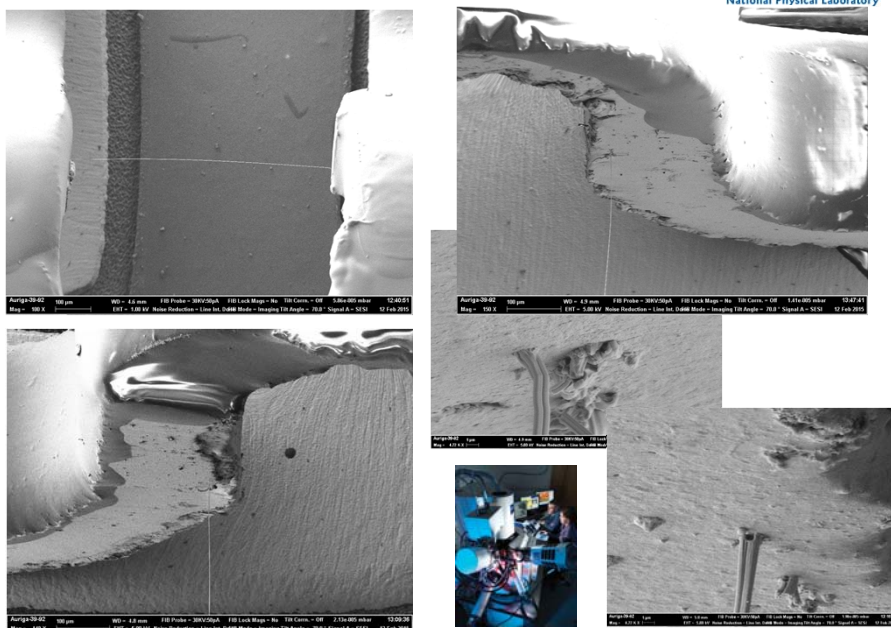


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Comparison of Age Distribution



Conformal Coating Whisker Failures



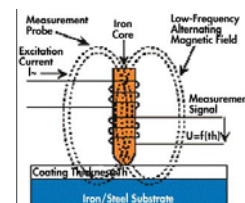
UV Non-Destructive Thickness Measurements - Aims

- To develop a method for the non-destructive characterisation of coating thicknesses
- To develop an instrument able to perform accurate measurements in a manufacturing environment

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UV Non-Destructive Thickness Measurements

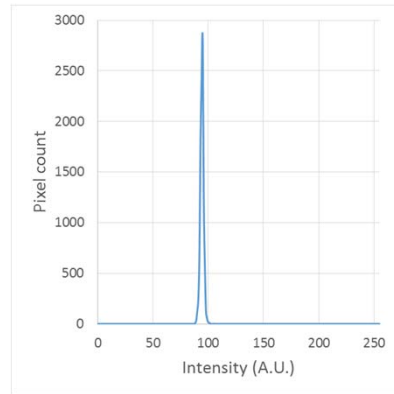
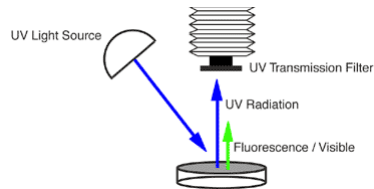
- State of the art for coating thickness measurements:
 - Destructive thickness measurements
 - Sectioning
 - Non-destructive thickness measurements
 - Eddy current measurements
 - Magnetic induction methods
- To date, no effective method is available for reliable non-destructive thickness measurements



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UV Non-Destructive Thickness Measurements – Technique Outline

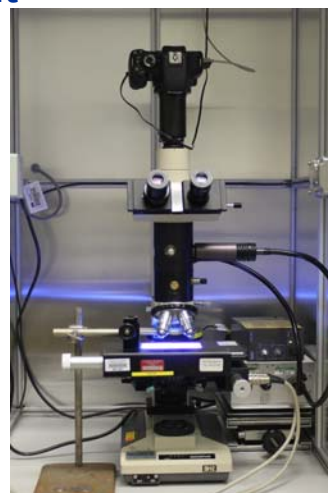
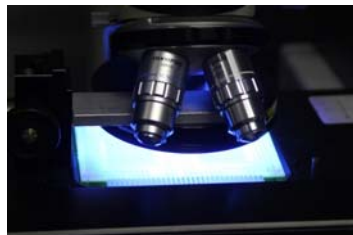
- UV narrow band light source shone onto samples
- Coating fluoresces due to UV brightener
- Visible light emitted from the sample
- Light emitted measured by CCD



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UV Non-Destructive Thickness Measurements - equipment

- UV ring-light mounted on a microscope in an interlocked enclosure
- Motorised XY stage allows the precise positioning of samples under the objectives
- Up to 100× magnification available under current system



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UV Non-Destructive Thickness Measurements – Proof of Concept



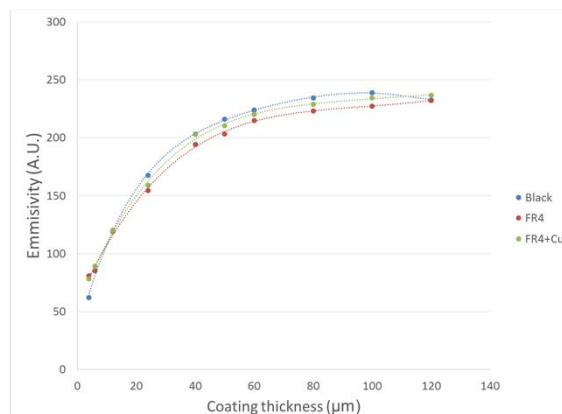
- Coating applied onto PET films using calibrated draw-bars
- Wet thickness of films can hence be determined
- UV brightener present in coating



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UV Non-Destructive Thickness Measurements - Characterisation

- Range of different thicknesses of films were made and characterised
- PET films are transparent and therefore a range of backgrounds can be used

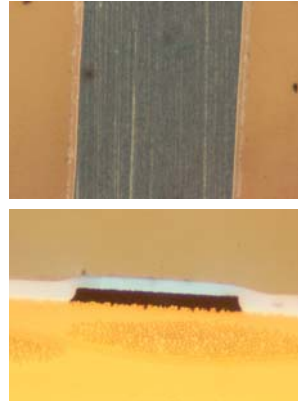
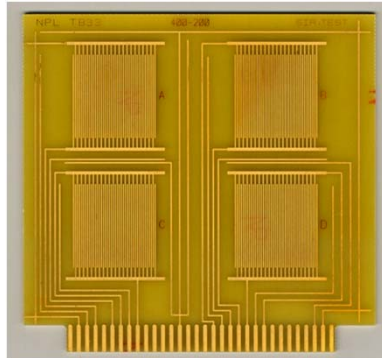


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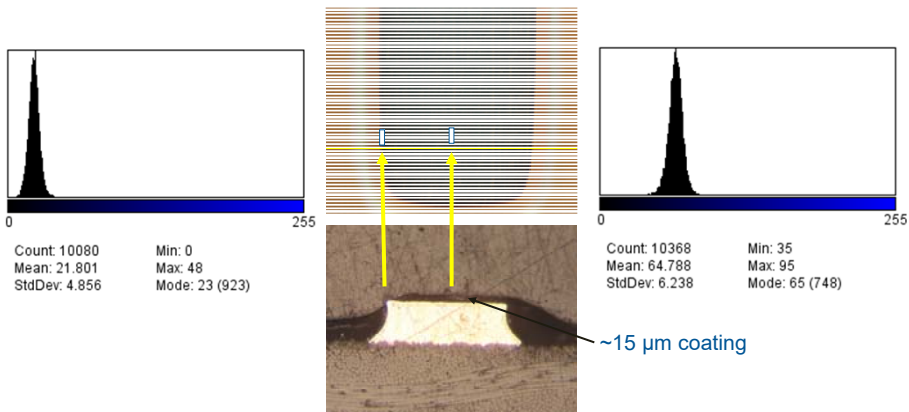
UV Non-Destructive Thickness Measurements - experimental



- Humiseal have provided test boards with varying coating thicknesses for characterisation
- Standard test patterns with 1oz. and 3oz. copper tracks were coated, imaged and sectioned

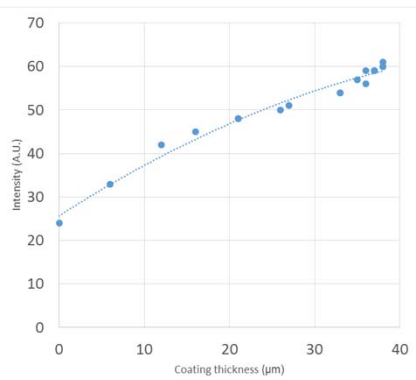
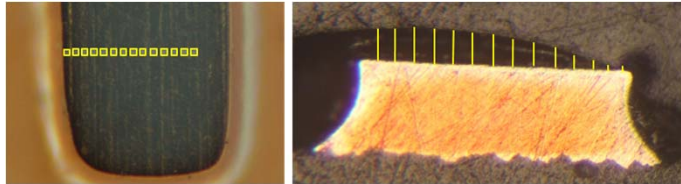


UV Non-Destructive Thickness Measurements - experimental



- Standard test pattern with 3oz. copper tracks coated, imaged and sectioned
- Edge coverage issues for thin coatings
- UV inspection system can differentiate between no coating and thin coating

UV Non-Destructive Thickness Measurements - experimental



- 3oz. copper track imaged and sectioned
- Thickness correlated with intensity
- Increase in light intensity noted with increasing coating thickness

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Planned future work

- Different surface finishes to be coated and light intensity measurements taken
- Coating of component leads and characterisation of coating thicknesses by sectioning
- Acquisition of tilt stage and z-axis stage to enable imaging of samples normal to sample surface (e.g. edge of leads etc.) and hard to reach areas
- Investigation into higher magnification imaging for increased resolution

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Project Participation



- Following the meeting, partners to indicate their desire to participate by email to Vimal Gopee (details below)
- NPL will prepare project plan that will form the basis on which partners can join and circulate by Aug 1st
- Project to commence 1st Sept
- Please respond to:
Vimal Gopee
Tel: +44208 943 6403
Vimal.gopee@npl.co.uk
www.npl.co.uk/ei

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NPL Kick off meeting for UV inspection of coating thicknesses



- Work plan generation
- Test vehicle design
- Test vehicle build
- Coating characterisation
- Equipment manufacturers – interest in building a partnership with equipment suppliers for this project
- Prototype equipment – Interest in supplying partners with prototype equipment
- Round robin – partners to feed back data from experiments

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Thank you for listening

Questions?

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