

# ASPIS

Advanced Surface Protection for Improved Reliability PCB Systems

*A project to enhance the performance of nickel-gold solderable finishes*

**Martin Goosey**

Chairman, Institute of Circuit Technology



9<sup>th</sup> November 2011



## THE ASPIS PROJECT

- ASPIS is a three year EC supported Framework 7 project under the FP7-SME AG-2008-2 call
- 'Research for SME Associations' project where much of the work is undertaken by 'RTD providers'
  - ITRI, Leicester University, LIOC and TNO
- The project has a focus on nickel-gold (ENIG) solderable finishes and is developing new more reliable materials and processes



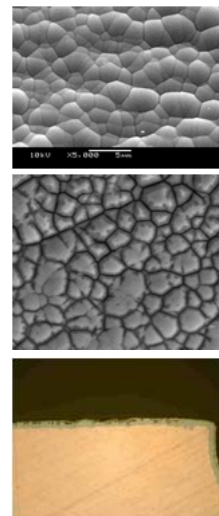
## ASPIS PARTNERS

Participant No	Participant Organisation Name	Participant type	Short Name	Country	Type
1	Institute of Circuit Technology	SME-AG	ICT	UK	SME AG
2	ITRI Ltd	RTD	ITRI	UK	RTD
3	European Institute of Printed Circuits	SME-AG	EIPC	NL	SME AG
4	TNO	RTD	TNO	NL	RTD
5	State Research Institute Center for Physical Sciences and Technology	RTD	LIOC	LT	RTD
6	University of Leicester	RTD	UoL	UK	RTD
7	ATOTECH	Other	ATOTECH	DE	LE
8	Merlin Circuits Technology	SME	MERLIN	UK	SME
9	Graphic plc	Other	GRAPHIC	UK	LE
10	Somacis spa	Other	SOMACIS	IT	LE
11	Global Interconnection Services	SME	GLOBAL	NL	SME

A new partner, Scionix, has also applied to join the project

## KEY ASPIS OBJECTIVES

- Investigate fundamental failure modes and mechanisms of ENIG coatings
- Develop an ENIG screening tool
- Develop improved coating methods & materials (aqueous & ionic liquid)
- Verify compatibility of technology with assembly methods and practices



## **RESEARCH ON ENIG MECHANISMS – LIOC**

### **Work Plan for 2011**

1. Deposition and characterization of NiP coatings including the following parameters: phosphorus content, thickness, porosity, internal strength
2. Corrosion behaviour studies of Ni-P coatings in citrate media
3. Structural characterization: analysis of initial samples and samples after corrosion attack

**The aim of these studies is to determine factors and conditions which are favourable for enhancement of corrosion resistance of Ni-P coatings**



## **RESEARCH ON ENIG MECHANISMS – LIOC**

### **Work Plan for 2011**

4. Investigation of IG process: characterization of Au layer including the following parameters: thickness, porosity and quality
5. Structural characterization of Ni-P samples after removal of the Au layer, including phosphorus distribution on the surface

**The aim is to determine factors and conditions which are favourable for the deposition of a uniform gold layer of required thickness**



## RESEARCH ON ENIG MECHANISMS – LIOC

### Work Plan for 2011

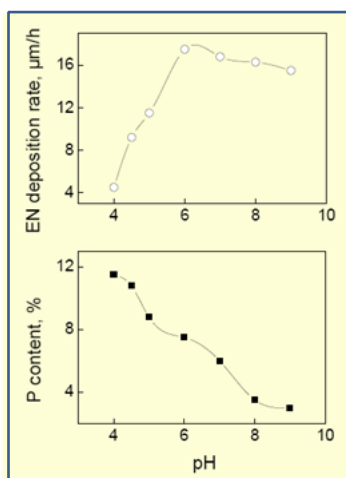
6. Thermal impact analysis on the phase composition of Ni-P coatings (XRD)
7. Thermal impact analysis on the adhesion and the phase composition of Ni-P-Sn system

**The aim is to determine weak boundary layers in the ENIG-Sn intermetallic system**



## RESEARCH ON ENIG MECHANISMS – LIOC

### Influence of pH on the deposition rate and P content of EN coatings



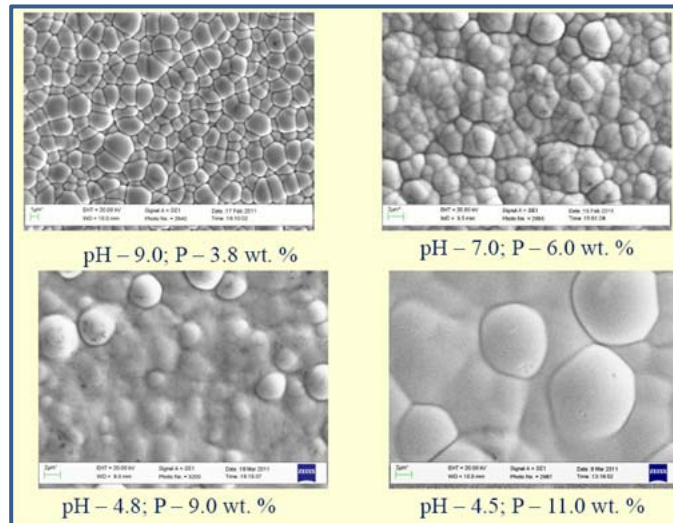
High quality EN coatings can be deposited in solutions with pH ranging from 4.5 to 9.0

EN coatings with a phosphorus content between 3.8 and 11.0 wt.% were obtained over a range of pHs

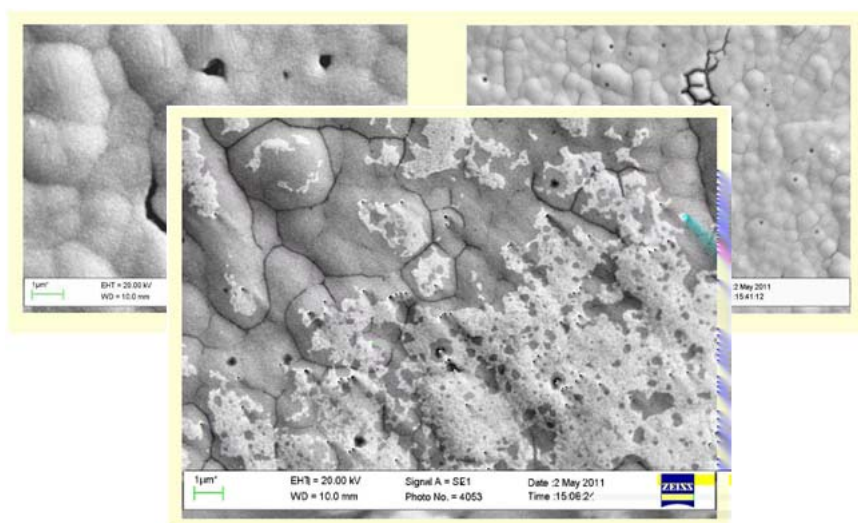


## RESEARCH ON ENIG MECHANISMS – LIOC

### Variation of EN coating surface morphology with pH



## RESEARCH ON ENIG MECHANISMS – LIOC



## RESEARCH ON ENIG MECHANISMS – LIOC

### Initial Findings

- Corrosion of the nickel surface is due to activity in the immersion gold process
- A high IG bath pH, together with a high concentration of citrate and a 'too thick' IG layer are parameters which encourage black pad formation
- Inadequate copper substrate preparation results in an EN coating deposit which can undergo black pad formation

## ENIG SCREENING TOOL - TNO

3	<p>Evaluation and selection of a non-destructive technique for detecting ENIG-specific problems</p> <p>Development of a patented prototype instrument for validation and demonstration purposes</p> <p>Identification of a manufacturer for the commercial model</p> <p>Preliminary development of a technology exploitation strategy for the equipment</p>
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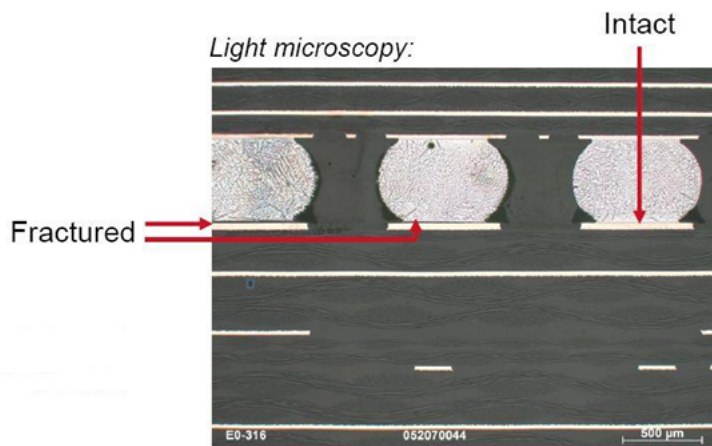
Led by TNO, with input from ITRI, LIOC with the SME/LEs affording PCB board fabrications and facilities

First deliverable due at Month 12 – 'Non Destructive Tests Report'



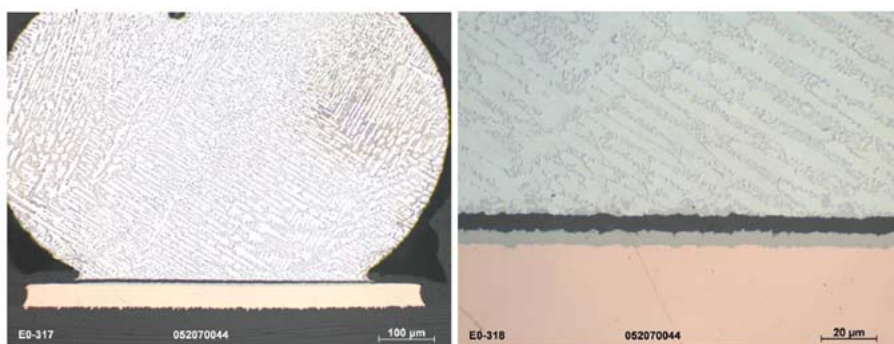
## ENIG SCREENING TOOL - TNO

Develop a non-destructive testing method



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## ENIG SCREENING TOOL - TNO



Fracture occurred between Ni-P and the intermetallic layer

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## Aqueous Processes - ITRI

4, 5	Development of improved nickel and/ or gold coatings via development and optimisation of current plating methods and materials  Investigation and development of alternative processes, materials and structures using novel aqueous and ionic plating methods
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Led by ITRI, with input from TNO and LIOC, with the SME/LEs providing input and facilities

WP4 started at the beginning of second quarter (Month 4, January 2011)



## IONIC LIQUID PLATING - University of Leicester

4, 5	Development of improved nickel and/ or gold coatings via development and optimisation of current plating methods and materials  Investigation and development of alternative processes, materials and structures using novel aqueous and ionic plating methods
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Led by UoL, with input from ITRI, TNO and LIOC with the SME/LEs providing input and facilities as required

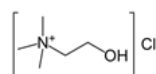
WP5 started at the beginning of second quarter (Month 4, January 2011)





## IONIC LIQUID PLATING - University of Leicester

- Black pad associated with phosphorus content, immersion coatings are possible from ionic liquids using no phosphorus-containing reducing agent
- A possible mechanism for black pad is associated with proton generation and corrosion of the nickel substrate during the immersion gold deposition (*Milad\**)
- Choline chloride eutectic ionic liquids can be formulated to function without acid for immersion coating applications



\* Milad G., "Is "black pad" still an issue for ENIG?", Circuit World, Vol. 36, Issue: 1, pp.10 – 13, (2010)



## IONIC LIQUID PLATING - University of Leicester

- A range of metals have been investigated for deposition from ionic liquids
- Initial approach involves conventional aqueous nickel deposition on copper and characterisation
- Deposition of gold from an ionic liquid formulation onto nickel has been demonstrated and gives reflective 'antique gold' coating
- Further optimisation of the solutions, eg formulation and deposition rates
- Characterisation of the coatings eg thickness, quality etc and wetting balance for solderability
- Nickel has also now been deposited from ionic liquids



## TRAINING, EXPLOITATION & DISSEMINATION - ICT

- Build and implement a project web-site
- Elaborate and implement the dissemination plan
- Present results at workshops, conferences, exhibitions and on ASPIS website
- Attract interest through publication of papers, articles and advertisements and through specific events (information days and training sessions)
- Organise and participate in conferences, workshops and exhibitions
- Produce an exploitation plan

## Progress to Date

- Website built and operational; <http://www.aspis-pcb.org/>
- Articles in Journal of the Institute of Circuit Technology, Circuit World, Soldering and Surface Mount Technology, Transactions of the Institute of Metal Finishing  
*eg Trans. IMF, Volume 89, Number 2, March 2011 pp 65-67*
- Presentations at ICT evening seminar and Intellect's PCB Fabricators and Suppliers' Group meeting, EIPC Conference 2011
- Partners have included ASPIS on their websites
- Further publicity via trade publications  
*eg PCB007, EIPC SpeedNews etc*





## Acknowledgement

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## ASPIS

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[www.aspis-pcb.org](http://www.aspis-pcb.org)

Goosey M., Circuit World, Volume 37, Issue 2, pp 33-35, 2011

Goosey M. et al., Circuit World, Volume 38, Issue 1, 2012

