Journal of the Institute of Circuit Technology

2011 Events

1st Febuary — 17.00 Evening Seminar, Darlington

1st March — 17.00 Evening Seminar, Arundel, Comfort Inn

11th April - 14th April — **ICT Annual Foundation Course** , Loughborough University
bill.wilkie@InstCT.org

1st June — **ICT 37th Annual Symposium**, organised in collaboration with the Sonochemistry Centre, at the Coventry University Techno Centre supported by Ventec-Europe
bill.wilkie@InstCT.org

7th September — Facility Tour of Viking Test.
17.00 ICT Evening Seminar
bill.wilkie@InstCT.org
Newtown House Hotel, Hayling Island
http://www.newtownhouse.co.uk/
supported by Spirit Circuits.

21st September — 6th Annual IeMRC Conference
Holywell Park Conference Centre, Loughborough IeMRC@lboro.ac.uk

13th October - 14th October — EIPC Conference - www.eipc.org
Courtyard by Marriott Hotel Basel
Hardstrasse 55
Basel (Pratteln) 4133, **Switzerland**

17th October - 18th October — Next Generation Technologies in Electronic Packaging and Production
EIPC at Enthone Ltd. **Woking**
fvdpas@cooksonelectronics.com

1st November — **17.00 ICT Evening Seminar**.
bill.wilkie@InstCT.org
"Supporting Industry Needs"
Devonport Hotel, **Darlington**
http://www.devonporthotel.com
supported by LAMAR GROUP

9th November - 11th November — 12th Electronic Circuits World Convention
Taipei Nangang Exhibition Centre,**Taiwan**
http://www.service@ecwc12.org

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vol.4 no.4 October 2011

Editorial

When Bruce Routledge asked me to write this editorial, I had to really think about what I should say and why. Bruce then said you have ICT membership number 40..... this makes you well qualified to say something.

I moved from manufacturing Circuits to the supply side like so many others who saw the shiny new car and expense account the right move forward from working up to your neck in smelly dangerous chemicals and finding your nice new and expensive Levi's had rotted within days of coming into the plating shop... So I guess my 35 years or so on the supply side should have taught me something and allow me to make some observations.

So lets look at where we are now. Gone from 500 + circuit board companies in the UK and a possible total of 3500 Europe wide down to about 50 / 60 UK and 350 Europe wide, (roughly the same overall figure as the USA.)

Sure we have seen a steady decline over the last twenty years, including the big Captive shops GEC/Marconi, ICL, IBM, HP etc. Slowly we have lost private companies and small plc's. I have no intention of listing them but even if you took a list of board shops in the mid 1990's against today you would be surprised at the number of well know names that just aren't there anymore. Why have we lost so many? retirement, bad management, lack of investment. You make up your own mind. Oh! I nearly forgot of course CHINA. I knew the "C " word had to come in there eventually. Fortunately many took a look and could see China was to be a lifeline and not a noose. By embracing the China Market they were able to enhance their business and by working openly with their customers became a lot stronger.

However it is not just about taking the first e-mail contact from someone who sounds as if they have known you all your life and running with them. To make the Chinese connection work you need to work at it and with them. Those who heard Steve Driver's splendid paper at the recent ICT symposium at Hayling Island I am sure will agree. It will take years to build up a relationship and trust and this will mean a number of visits to the various suppliers and also not to forget some will be better suited to certain sectors of your market than others and this you will not find out without visiting and working with the companies concerned. (Steve's paper will be printed in the ICT *Journal* if not this issue then the next.)

By making use of the Chinese and other connections leaves us in a healthy state and lets hope we can see companies investing in equipment to get them up the technology chain whilst benefiting from their China experience.

In conclusion, we started it with Dr Paul Eisler [1] and we are still a leading technology country. Lets keep it that way, and retain a healthy industry here.

Maurice R. Hubert F.Inst.C.T.

Ex- Council Member and long time supporter of the ICT

[1] Check Dr Paul Eisler on Wikipedia.

Membership

New members notified by the Membership Secretary

Associate (A.Inst.C.T.)

10105 Valery Dichenko

10107 Stacey Driver

Member (M.Inst.C.T.)

10103 Roger Jamieson

10104 Ian Mayoh

Fellow (F.Inst.C.T.)

10106 Happy Holden

Corrections and Clarifications

It is the policy of the Journal to correct errors in its next issue.

Please send corrections to : -

E-mail : bruce.rout@btinternet.com

The Journal of the Institute of Circuit Technology, is edited by Bruce Routledge on behalf of the

Institute of Circuit Technology.

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Immersion Coating of Copper from a Deep Eutectic Solvent: A Novel Method for the Protection of PCBs

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http://gf41@le.ac.uk

With the advent of RoHS in 2006, restricting the use of lead in surface finishes of PCBs,[1] the deposition of noble metals onto a Cu substrate has become of great importance within the PCB industry. The noble metals are being used to protect the Cu from oxidation, which can lead to poor solder reflow.[2] ionic liquids are an area of great interest in both academia and industry, due to unique solvent properties and low environmental impact.[3] A deep eutectic solvent (DES), a type of ionic liquid, is a mixture of two strongly interacting molecules, which when combined exhibit a large drop in freezing point.[4] The DES, Ethaline 200, is easily produced by mixing a quaternary ammonium salt, choline chloride (ChCl), with a hydrogen bond donor, ethylene glycol (EG), in a 1:2 ratio respectively.[5] Both ChCl and EG are non-toxic, inexpensive and environmentally benign chemicals. Ethaline 200 is a solvent in which metal salts are readily dissolved[6] and has a relatively high conductivity of 7.6 mS cm.[7] The low cost, environmental impact and solvent properties make Ethaline 200 an ideal solvent for immersion processes in the PCB industry.

Figure 1 shows the cyclic voltammetry of selected metal salts, CuCl, AgCl, PdCl and AuCl, in Ethaline 200. This demonstrates that Ag and Pd can be readily deposited on to a Cu substrate by an immersion process. Figure 1 also demonstrates Au may be used as a secondary coating, deposited on top of the primary Ag and Pd coatings, also by an immersion process. The primary coatings are being used as a barrier layer between the Cu substrate and the Au coating. This is to prevent the Cu from migrating through the Au coating to the surface of the coatings where it can oxidize.[8]

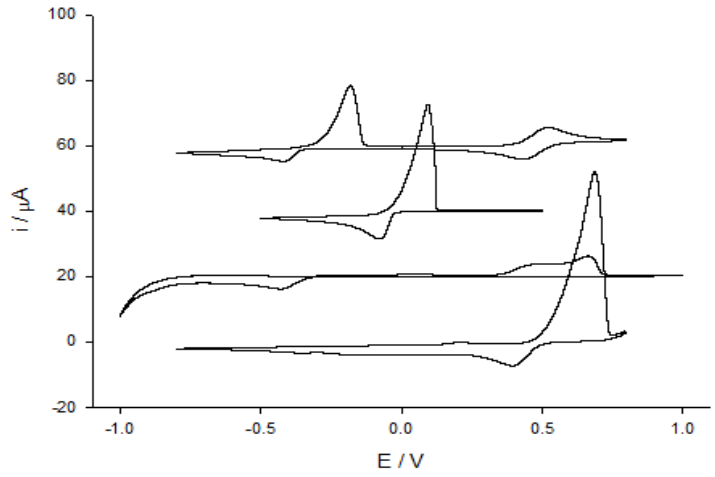

Fig. 1: Offset cyclic votammograms of metal salt / Ethaline 200: (a) 0.02 M CuCl, offset + 60 µA, (b) 0.02 M AgCl, offset + 40 µA,(c) 0.02 M PdCl, offset + 20 µA,(d) 0.02 M AuCl. Electrodes: working -2mm Pt disc, counter - Pt flag, reference - Ag wire. n = 10 mV s

The following work presents the results from Ag and Pd deposition on to a Cu substrate and the deposition of Au as a secondary coating. The analysis on the poster presents data in the form of spatial X-Ray photoelectron spectroscopy, a form of analysis that maps the position of elements at the surface of a sample.

[1] European Parliament and the Council of 27 January 2003, Directive 2002/95/EC

[2] J. Millal, Y. W. Lin, K. L. Lin, *Appl. Surf. Sci.*, 2010, **256**, 3531 – 3540

[3] J. P. Hallett, T. Melton, *Chem. Rev.*, 2011, **111**, 3508 – 3576

[4] A. P. Abbott, G. Capper, D. L. Davies, R. K. Rasheed, V. Tambyrajoh, *Chem. Comm.*, 2003, 70 – 71

[5] A. P. Abbott, G. Capper, B. G. Swain, D. A. Wheeler, *T. I. Met. Finish.*, 2005, **83**, 51 – 53

[6] A. P. Abbott, G. Frish, S. J. Gurman, A. R. Hilman, J. Hartley, F. Folyoak, K. S. Ryder, *Chem. Comm.*, 2011, **47**, 10031 – 10033

[7] A. P. Abbott, in *Electrochemistry from Ionic Liquids*, ed. F. Endres, A. P. Abbott and D. R. MacFarlane, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2008, ch. 2, pp. 31 – 40

[8] W. Wang, A. Choubey, M. H. Azarian, M. Pecht, *J. Elec. Mat.*, 2009, **38**, 815 – 827

A multi-partner research project to enhance the performance of nickel-gold solderable finishes.

At the 7th September 2011 Meeting of the ICT Council, the following report was submitted by Prof. Martin Goosey -

The ASPIS project continues to make good progress as it nears the end of the first year of activity (end of September).

The Lithuanian Institute of Chemistry has undertaken some excellent research work that has enabled a much better understanding of the fundamental influences on the formation of black pad in nickel gold systems.

The University of Leicester has also made some interesting developments regarding the deposition of metals from ionic liquid based chemistries.

In addition to the deposition of immersion gold, the deposition of nickel has also now been demonstrated.

A paper has been accepted for presentation at the EIPC Winter Conference in Basel in October and the one year review meeting will be held at TNO in Holland during November.

Peter Starkey

reviews
papers presented at the

ICT Symposium

7th September 2011
Newtown House Hotel,
Hayling Island

which was supported by ***Spirit Circuits***

Exercising creditable assertiveness against a babble of energetic conversation and a backdrop of loud rock music (of which more later), **ICT Technical Director Bill Wilkie** called the gathering of a hundred or so PCB industry professionals to order and introduced the Institute of Circuit Technology Southern Area Evening Seminar, in Hayling Island on the south coast of England on 7th September 2011.

The packed programme began with a joint presentation on lean manufacturing from **Martin Randall** and **Jason Barnett** of **Spirit Circuits.** Spirit were part-way into a **Structured Lean Manufacturing Programme**, and Randall and Barnett discussed how they had undertaken the value stream mapping process. Value stream mapping provided a clear focus to where lean tools needed to be applied, and ensured that the end process was optimised. The current state became the baseline for improvement and the creation of a future state map.

Randall referred to the eight "Tim Woods is stealing my time" wastes – transport, inventory, movement, waiting and delays, overproduction, over-processing, defects and skills – and how they absorbed time during the working day: time which could be better spent adding value.

Unrolling their actual project sheet, which was about twelve feet long and had been temporarily removed from the Sales Office wall, Randall and Barnett explained how they had approached the sales order logging process and, with the participation and input of the whole sales team, had mapped the current state, captured ideas, identified quick fixes, agreed the future-state vision, developed the action plan and implemented the future-state process. The procedure was currently being applied in Spirit's engineering department. They emphasised that the primary objective of value stream mapping was not the creation of the map, but the understanding of the flow of information and material, and using that understanding to improve the business.

Le Roux Cilliers of Laminin Solutions encouraged the audience to consider how lean principles could be applied in understanding the flow of information. Business could not exist without information although the importance was not in the information itself, but in the outcomes, and information only became valuable when it was in the hands of someone who knew what to do with it. He suggested asking the questions: "What information is really useful to me?" and "What do I need to do to that information to make it valuable?"

He defined five lean principles: specifying the value for the customer :–

1) the user of the information, identifying the value stream.
2) the best information for the action, making the information flow through a natural life cycle.
3) capture, process, use, store, dispose, pulling Information from the customer.
4) only producing what was needed.
5) continuously striving for perfection.

He estimated that lean information could add between 10% and 20% productivity for the average information worker.

Steve Driver, Spirit Circuits' charismatic MD, steered proceedings away from the heavily technical and towards the cultural considerations of doing business with the Chinese, based on his many years of personal experience.

There was no simple formula: being successful involved following a constant learning curve directed at a constantly moving target. Logic did not necessarily work; the most fundamental issue was the building of relationships – being patient and making friends first before expecting to do business. Driver discussed at length the concept of "Guanxi", one of the most powerful forces in Chinese culture, which expressed the relationships and obligations built up over time by the reciprocation of social exchanges and favours. If one person had guanxi with another, he would be quick to act on the other's behalf and do anything necessary to help him. Guanxi could almost be considered a type of currency that could be saved and spent between the two parties.

With humorous anecdotes and illustrations: "Eat the food, but don't visit the kitchen.." Driver gave a glimpse of some of the realities of the Chinese way of life. He answered the "China – threat or opportunity ? " question with some confidence: "You have to learn about China and work with the Chinese to make the threat into an opportunity".

Back to technical – **Glenn Swanton** of **JD Photo-Tools** gave a very practical and informative talk on **precision film work and tooling**, and discussed the effects of environmental control, film processor control and film and photo-tool storage on dimensional stability.

Whatever the investment in equipment, maintenance and calibration, dimensional problems were still a real possibility unless proper consideration was given to the environment in which film was stored, processed and used. Most plotter rooms had temperature control, but not all had humidity control, and humidity variations were not as obvious as temperature changes.

For illustration, Swanton showed a current atmospheric humidity map of the UK. Nowhere in the country was it less than 80%, and average maximum atmospheric temperature was about 20ºC. Manufacturers' recommended ideal conditions for film were 21ºC and 50% RH, and although the polyester and emulsion components of the film were meticulously formulated to maximise dimensional stability, relatively small environmental changes could have significant effects. For example the change in dimension when fully acclimatising film from 23ºC and 70% RH to 21ºC and 50% RH was 102 microns over 400mm, sufficient to cause serious image misregistration. Swanton advocated frequent measurement and recording of temperature and humidity in the production areas where photo tools were created and used in order to identify the controls necessary to establish the right balance of conditions to achieve and maintain precision in photo tooling.

"And now for something completely different!" **Bill Wilkie** introduced the climax of the evening's programme. **"Myths and Riffs of Creative Leadership"** was the title of **Peter Cook's** combination of presentation and performance.

Cook, Managing Director of the **Academy of Rock**, - an innovative management consultancy,- drew parallels between music and business and with the help of an impressive array of guitars, effects pedals and backing tracks generated a Rock'n'Roll business model where musical improvisation equated to business creativity, the audience equated to clients, customers and stakeholders, and the musical score equated to the business structure.

The leader's job in either scenario was to create enough structure to move people to action, encourage creativity within the acceptable range of the business culture, and to bring all the elements into harmony. Leadership could be considered as "jamming" – balancing the structure, the creativity and the customer, leveraging other talents along the way, learning from successes and mistakes and using emotional intelligence to tune into others and respond to signals.

"Are there any guitarists in the audience?" he asked. People were a bit reserved until Hubert Dias came forward, picked up a Gibson and played some inspirational blues, which encouraged half a dozen very competent musicians to emerge from the hidden depths of the Institute of Circuit Technology and join in a spontaneous session led by Peter Cook.

Before long they had a percussion session, Steve Driver in a pink wig on vocals, and the excellent Jim Francey on tenor saxophone. "Be prepared to improvise a little bit, but keep enough structure to hold your audience". Some of the audience were a little mystified at what Cook was trying to demonstrate but to the lateral thinkers, his message was clearly illustrated albeit in a somewhat unconventional manner.

Thanking all participants for making the evening a great success, and acknowledging the generous support of **Spirit Circuits**, Bill Wilkie retired to a safe distance whilst the band got bigger and louder and jammed on late into the evening.

Pete Starkey

September 2011

Jason Barnett

Martin Randall
Structured Lean Manufacturing Programme

Le Roux Cilliers

Glenn Swanton
Precision Film Work and Tooling

Steve Driver - Chinese Business

Section of audience

ICT Members "Jamming"

Peter Cook Academy of Rock

Bill Wilkie presenting Membership Certificate to Stacey Driver

ICT Symposium

7th September 2011
Newtown House Hotel,
Hayling Island

Peter Starkey

reviews
papers presented at the

IEMRC 6th Annual Conference

21st September 2011
Loughborough University

The IEMRC 6th Annual Conference Loughborough, UK 21st September 2011

On a bright September morning, over 130 delegates from industry and academia gathered at Holywell Park Conference Centre, at the University of Loughborough in the East Midlands of England, for the 6th Annual Conference of the Innovative Electronics Manufacturing Research Centre, the UK's internationally recognised provider of world-class electronics manufacturing research.

Academic Director **Professor Paul Conway** welcomed delegates, briefly reviewed the aims and objectives of the IEMRC, and was pleased to confirm that funding until 2015 had been secured. He introduced the keynote speaker **Professor Jim Morris**, who was directing research into **electrically conductive adhesives, nanoelectronics and nanopackaging** at **Portland State University** in Oregon USA.

Professor Morris gave a fascinating insight into some applications of nanotechnology in electronics packaging. "When is a metal not a metal?" he asked when describing the characteristics of metal nanoparticles. "You can't talk about the conductivity of two atoms!" Provided they were larger than about 12 atoms in size, approximately 1 nanometer, metal particles did indeed exhibit metallic properties but because of their very high surface to volume ratio and high surface energy very small particles had a tendency to merge together by mechanisms such as Ostwald ripening, sintering or liquid-like coalescence, and these phenomena could cause problems in nanoparticle technology. However, melting-point depression effects could be potentially turned to advantage in lead-free soldering: there was a possibility of a 5% reduction in melting point of a solder paste if the particle size could be reduced to the 5 nanometre level, although making particles this small was a real challenge.

There was considerable scope for using printed silver nanoparticle paste as a means of electronic interconnection. In principle the particles were capable of being sintered at very low temperatures once the carrier material was removed and Professor Morris described a process based on jetting paste on to the substrate, drying, removing the carrier by immersion in methanol then sintering at 60ºC. There were also opportunities for filling PCB microvias by nanoparticle sintering.

Turning to the subject of carbon nanotubes in packaging applications, Professor Morris explained that single-wall nanotubes had properties far superior to those of multi-wall nanotubes, but could only be formed at temperatures around 900ºC – too high to enable them to be grown directly on silicon devices. Carbon nanotubes were capable of carrying high current densities and had the advantage over copper of no skin effect at high frequencies. Moreover they had zero, or even slightly negative, coefficient of thermal expansion. This offered potential advantages over copper in through-silicon-via applications. A further favorable property was excellent thermal conductivity, and aligned single-wall carbon nanotubes offered the

possibility of a technology breakthrough in the heat-sinking of silicon devices.

However exciting might be the technological opportunities, Professor Morris advised caution in the manufacture of nano-materials, with regard to environmental and health and safety issues. For example, nano-silver had a very high level of toxicity in the aquatic food chain, and carbon nanotubes could present human a health hazard similar to that of asbestos. So products should be designed with safety in mind and researchers and manufacturers should endeavor to avoid litigation by ensuring that procedures were in place to protect the health of workers.

The second presentation came from **Dr Hazel Assender** of the **University of Oxford**, with a progress report on the **IEMRC RoVaCBE Flagship** project. The objective was to develop techniques for low cost, high-speed, roll-to-roll manufacture of organic field-effect transistors by adapting industrial vacuum evaporation processes already widely used in the packaging industry. Potential applications included flexible displays and tagging and tracking of consumer goods.

It had already been demonstrated that reliable working transistors could be produced, and novel organic semiconductor materials such as dinaphthothienothiophene (DNTT) were now being evaluated with promising results. Plasma curing of the insulator layer had proved to be more production-efficient than electron-beam curing and thermal annealing. Although organic semiconductors were reasonably stable in air, their shelf life could be greatly improved by encapsulation and work was in hand to determine whether established vacuum deposition methods for applying gas barriers to food-packaging film could be adapted for this purpose. Patterning processes for semiconductor and insulator layers were under development, and a fundamental aim of the project was to achieve web speeds of 50 metres per minute in an industrially realistic environment

Observations on Whisker Formation on Electrodeposited Metallic Coatings used in Electronics Manufacture was the title of the presentation by **Dr Geoff Wilcox** from **Loughborough University** who described some of the outcomes of the **IEMRC-funded WHISKERMIT** project, which sought to develop tin whisker mitigation strategies for high value electronics.

Not only tin – zinc and cadmium were also capable of forming whisker-like growths and Dr Wilcox quoted examples of catastrophic failure of electronic equipment caused by whiskers from mechanical and architectural components. The first documented evidence of failure attributed to whiskers was in the radios of World-War II Liberator aircraft after cadmium whiskers had formed on capacitors.

Whereas the tendency of electroplated tin coatings to produce tin whiskers had been significantly reduced by the alloying of tin with in excess of 3% lead, legislation banning the use of lead in electronics has removed this safeguard. Consequently, the threat posed by tin whiskers has risen to worrying levels, particularly where bright tin finishes were used. Shorting between conductors was not the only failure mode; whiskers could act as antennae and cause signal integrity problems in high-frequency devices.

The two main strategies in the WHISKERMIT programme were to determine how the chemical components and operating parameters of the tin-plating process could be modified to reduce the compressive stresses known to initiate whisker growth, and to formulate whisker-mitigating nano-structured polymeric conformal coatings. It was considered that the co-deposition of nano-particulates could reduce internal stresses in the plating, and it had been found that alkyd-based coatings were most effective at containing whiskers under accelerated testing conditions.
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IEMRC Research Coordinator Dr Darren Cadman moderated the second session and introduced **Professor Marc Desmulliez** of **Heriot-Watt University** who described new additive technologies for the patterning of fine metal tracks on flexible substrates, and discussed processes being investigated at Heriot-Watt for surface modification of Kapton polyimide film and reduction of embedded metal to form a seed layer for subsequent electroless deposition.

The first process sequence he described involved hydrolysis of the polyimide surface with potassium hydroxide followed by exchange of potassium ions for silver ions by immersion in silver nitrate solution. The next stage was to spray-coat with an alcohol solution of methoxy polyethylene glycol, which acted as an electron donor to reduce surface silver ions to silver nanoparticles upon subsequent laser exposure. Conventional photomasks or digital maskless imaging techniques could be used, with either helium-cadmium or diode lasers. After exposure, immersion in dilute sulphuric acid removed unexposed silver ions and re-imidised the Kapton surface. An annealing step was necessary to coalesce the silver particles into a condition suitable to seed the electroless deposition of silver conductors from a proprietary solution.

The alternative process involved a chemical, rather than a photochemical, reduction stage, a proprietary photoresist being applied in place of methoxy polyethylene glycol and imaged by

conventional exposure and development, then using dimethylamine borane as a chemical reducer for the silver exposed in the surface. The resolution of this method was limited to 50-micron lines and spaces, whereas the laser method could achieve 15 microns.

Courageously facing an audience of solemn techies and academics, fashion designer **Odette Valentine** from **Brunel University** captured and held their attention as she introduced the concept of "soft-wear" and talked about style and fashion trends from a user-centred perspective. Her research objectives were to elucidate the nature of the new relationships required between the designer and the consumer which would catalyse the development of meaningful wearable technology, and to design and produce novel modular garment platforms demonstrating various levels of integration of electronic textile components. Wearable electronics could offer mental stimulation, measure body performance or provide safety and protection.

"Fashion is the science of appearances and it inspires one to seem rather than to be" - Design and aesthetics could overcome any failure in function, and it was not enough to invent cutting-edge technology; it needed to have a "wow" factor, like the iPhone for example.

Initial findings had been that designing for context was as important as designing for function. The was an ongoing role for the enthusiast in the development of wearable tech, and the framework had underlined the need to understand acceptance factors for the user's context as well for the product.

In reality, however, despite early hype about the potential of wearable technologies, the integration of components into the kind of substrates found in current styles of clothing had lagged the development of the underlying technologies, so the practical benefits of wearable electronics had as yet been slow to emerge.

A specific functional application was described by **Professor Yiannis Vardaxoglou** of **Loughborough University** in his presentation on wearable flexible antennas.

In collaboration with industrial partners and specialists in textile fabrication at Nottingham Trent University, the project was exploring the most effective ways of manufacturing a fabric antenna and its associated electronics, and working to overcome the challenges of integrating the antenna into the fabrics of functional clothing and other products.

Electromagnetic design rules had been revised to enable experimental antennae to be adapted to suit the needs of potential end-users, and progress was being made in the identification of suitable fabrics and yarns and in adapting textile manufacturing techniques such as embroidery to integrate the antenna into the host fabric.

Challenges to be tackled included the minimisation of body interference, ensuring consistency of performance in harsh environments, and scalability to cost-effective mass manufacture.

After a very productive lunchtime networking opportunity, **IEMRC Industrial Director Professor Martin Goosey** introduced the third conference session. His first presenter was **Dr Robert Blue** from **Strathclyde University**, on the subject of polymer-based miniature sensors for explosives. A common feature of many explosives was the $-NO_2$ nitro group and the objective of the project was to fabricate and experimentally evaluate micro sensors based on monomers engineered have a high affinity for volatile nitro-compounds and capable of being deposited electrochemically as thin polymer films to sub-micron dimensions.

Prototype capacitance sensors formed on interdigitated gold electrodes had exhibited a large, reversible response to nitro-bearing compounds as well as a low cross-sensitivity to other volatile organic chemicals commonly found in the atmosphere. Intended areas of application included transport hubs, sports arenas and shopping malls. Future work would be directed at the production of conjugated microporous polymers whose increased surface area would enable higher sensitivity and faster response.

"Power Electronics is a £70 billion direct global market, growing at a rate of 11% per annum, and the UK plays a significant global role both in design and manufacture". **Professor Bill Drury** of **Emerson-Control Techniques** and the **University** of **Bristol** began his presentation entitled **Power Electronics in the Low Carbon UK Economy**.

Generally inconspicuous, power electronics was a critical enabling technology determining the performance of much larger systems, and was an essential component of renewable energy sources and the efficient use of electrical energy.

Taking industrial drives as an example, Professor Drury explained that 60% of all electrical energy was used in industrial electric motors. Power electronic control could reduce energy consumption typically by 30-40%, and could be applied effectively in about 50% of applications, leading to an overall reduction in total energy consumption of 9%. Power electronics was a significant factor in transport: automotive, rail, marine and aerospace, and all sectors continued to grow strongly.

For instance, global power consumption in automobiles was growing at 5000 GigaWatts annually,and rail transport in China by 22 GigaWatts.

But Professor Drury was concerned about the future of the UK power electronics industry. The market was worth £5Bn annually to the UK's GDP, and more than 95% was exported, but the biggest ongoing challenge was an increasing skills shortage, as witnessed by a decline in the numbers of students in electrical and electronic engineering – 41% fewer students accepting places to study EEE in 2010 than in 2002, and 33% of engineering graduates taking non-engineering careers

The final presentation of the conference came from **Professor Andrew Holmes** of **Imperial College London**, who reported the progress of an IEMRC project investigating the feasibility of introducing a thermosonic bonding step into flip chip assembly using anisotropic conductive adhesives. The use of anisotropic conductive adhesives has previously been limited to a relatively narrow range of applications, because the interconnections relied on purely mechanical contacts, which might suffer from high joint resistances and reliability failures.

The project sought to replace mechanical contacts by metal-to-metal thermosonic bonds in order to reduce contact resistance and improve reliability. A dedicated thermosonic-adhesive flip-chip bonder had been developed incorporating an ultrasonic bonding head that could be rapidly temperature cycled by infra-red laser heating and compressed-air cooling. Assembly trials with dummy flip chips on glass and flex substrates with copper-nickel-gold bumps had demonstrated the thermosonic-adhesive bonder to be a highly versatile bond tool. Joint resistance measurements had been used to monitor performance and some issues with coplanarity and alignment had been resolved.

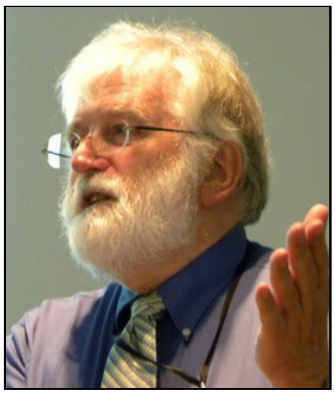
Before bringing the conference to a close and thanking all who had presented and attended, **Professor Martin Goosey** gave a brief update on the current status of **IEMRC**: two large multi-institute Flagship projects were in progress, a first round of standard projects had been awarded and started, and a second round was in review and due to be prioritised during October 2011. There would be a third call for proposals in 2012.

Another outstanding event ! The 6th Annual conference of the IEMRC - content of the highest quality, eminent speakers, a large and attentive audience and a first-rate networking opportunity. A great credit to the team at Loughborough who organised it so seamlessly.

Pete Starkey
I-Connect 007
September 2011

IEMRC 6th Annual Conference - Audience and Presenters

Professor Paul Conway



Prof. Jim Morris

Dr Hazel Assender

Dr Geoff Wilcox

Dr Darran Cadman

Prof. Marc Desmulliez

Odette Valentine

Prof.Yiannis Vardaxoglou

Prof. Martin Goosey

Dr. Robert Blue

Prof. Bill Drury

Prof. Andrew Holmes

21st September
2011
Loughborough
University

Precision Film Works and Tooling

Glenn Swanton
JD Photo-Tools

The effect Temperature and Humidity has on precision film work and tooling is a subject cropping up more and more as accuracy demands increase week by week.

- Environmental Control -
  Temperature and Humidity
- Film Processor Control
- Film and Photo - Tool Storage

Assuming that the plotter is regularly serviced and calibrated, the film processor is running to order, then these 3 topics are vitally important to maintaining accurate photo-Tools.

The temperature and humidity of the plotting room and all rooms where the Photo-Tool will be used, is vital to its accuracy. Without proper control, the Photo-Tool will become dimensionally unstable and will cause problems in manufacture.

Control of the film processor means control of track widths, and with simple checks the Photo-Tools will remain consistent.

Unexposed film storage and Photo-Tool archive storage is also crucial to the long term use of the Photo-Tool. Think about where the film is stored before it goes into the plotter room, is the room controlled, is the film you are putting into the plotter to cold, too hot or has it been subjected to high humidity.

Get these 3 things right and the photo-tool will be accurate.

Designs today are becoming more complex with increasing demands on PCB Manufacturers for narrower tracks and gaps and tighter registration.

Thousands of pounds are spent each year on the Maintenance and Calibration of Plotters, Drilling Machines, Optical Alignment Systems, Hole Punching Systems et al, to ensure the machines are achieving maximum accuracy and registration in the manufacture of PCB's.

Temperature and Humidity

Film manufacturers unanimously recommend that Silver Halide Film should be stored, exposed, processed and used in the ideal room conditions of :-

21º C with a relative humidity of **50%**

:

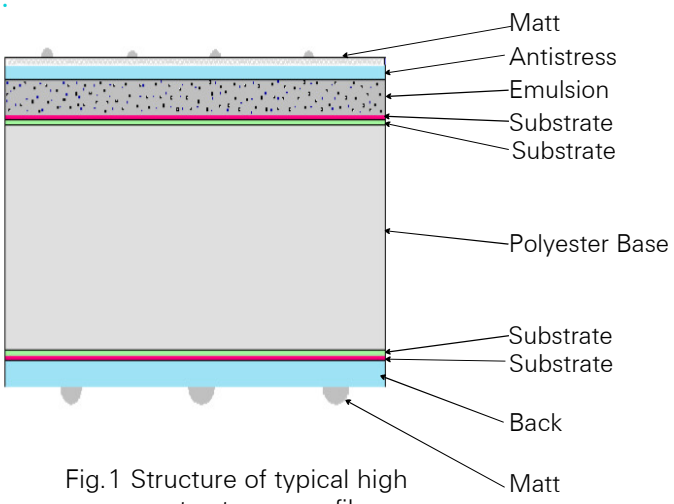


Fig.1 Structure of typical high contrast process film.

Photographic film is basically a polyester support base with a coating of light sensitive silver halide emulsion on one side, and various additional coatings on both sides to control stability and other factors. Film absorbs moisture and heat from the environment as well as heat from hot light boxes during inspection and even hotter contact frames during exposure.

So if the dark room has a high humidity and or temperature, the film and image will be slightly larger after exposure and processing

When the film is used in other rooms with equipment at other temperatures and environments, the film will expand or contract, depending on the relative values of temperature and humidity.

Natural temperature fluctuations are much smaller than humidity fluctuations, because it is rare that a room in a factory will be less than 10º below ambient temperature, or more than 10º above, thus making control of temperature fairly easy. Humans are sensitive to temperature changes.

Shifts of 30 or 40 points in either direction are much less noticeable, and controlling humidity is much more difficult.

On the 5th September 2011 the Relative Humidity in the UK varied from
100% in NW Scotland to
82% in S England
so that trying to maintain the ideal 50% internally was made very difficult.

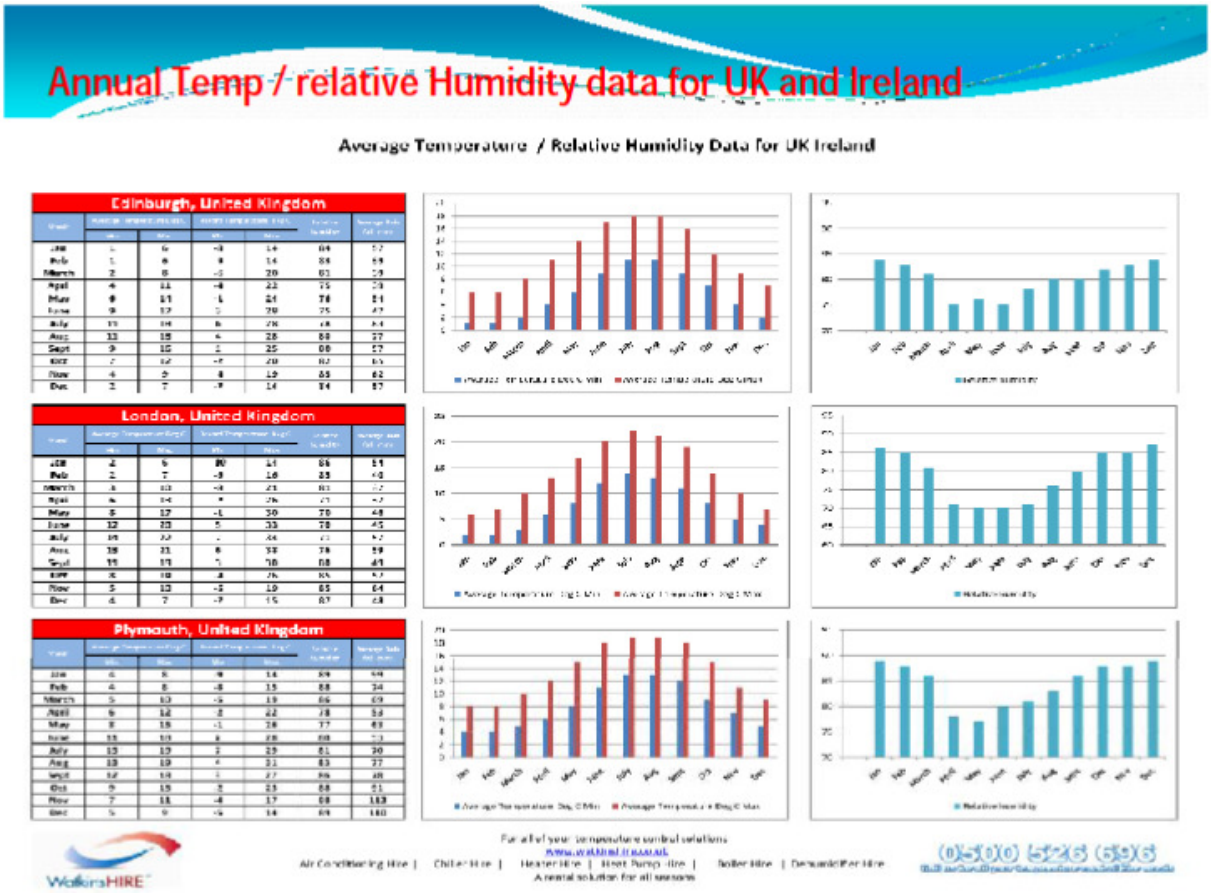


Fig 2. Humidity Data Tables

While the above tables are too small for the detail to be read, the patterns in the centre group of the average minimum temp. in blue, and average maximum temp. in red, compared to right group of relative humidity in light blue, show that maintaining a constant 21ºC 50% humidity cannot be left to chance.

Referring to Plymouth in the left hand group, in September the highest average temp. was 18ºC with a minimum average temp. of 12ºC and a relative humidity of 86%. In an uncontrolled plotting room or photomech room conditions could be well outside those recommended.

Many companies are now plotting through the night using automated plant and films are left for long periods before use by the day shift, while the temperature and humidity change dramatically and the film absorbs the environment and changes size with it.

Figures 3 & 4 are screen shots of a :-

Dimensional Stability Calculator

Showing an increase of :-

.004" in a length of 15.575"

When the temperature change +2ºC and the relative humidity increased by 20%

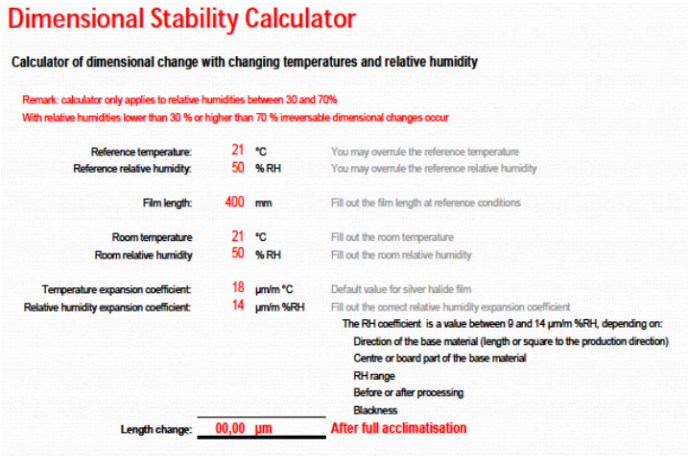


Fig.3 DMS Showing zero effect when working at ideal conditions.

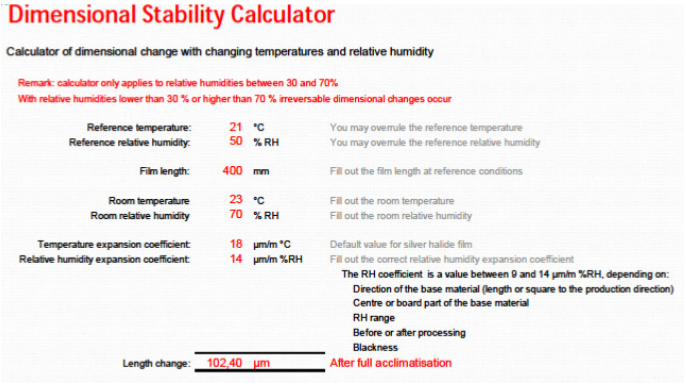


Fig.4 DMS Showing effect of rise in Temp. and Humidity

Not only is the film out of specification but as the calculator states, when film is subjected to R H of less than 30% or greater than 70%, irreversible changes occur and the film will never come back to its original state.

If the relative humidity stays between 30% and 70%, then the film will return to its original state after being acclimatised in the correct conditions.

Maintaining Accurate Photo-Tools

1). Control the room your film is stored in, prior to plotting!

2) Control the plotter room the Photo-Tool is plotted in!

3) Control the rooms the Photo-Tool is inspected and used in!

4) Log the temperature and Humidity where the Photo-Tools are created and used.

5) If it is recorded, it can be measured and used to improve.

Get the balance right !

Temperature and Humidity go hand in hand.

Precision Photo-Tooling means getting a perfect balance of the two, and maintaining it !

Glenn Swanton
JD Photo-Tools
glenn@photodata.com

Group Members of The Institute of Circuit Technology October 2011

Organisation	*Address*	*Communication*
Anglia Circuits Ltd.	Burrel Road, St.Ives, Huntingdon PE27 3LB	01480 467 770 www.angliacircuits.com
Atotech UK Ltd.	William Street, West Bromwich. B70 0BE	01210 067 777 www.atotech.de
CCE Europe	Wharton Ind. Est., Nat Lane, Winsford CW7 3B	01606 861 155 www.ccee.co.uk
Electra Polymers Ltd.	Roughway Mill, Dunks Green, Tonbridge TN11 9SG	01732 811 118 www.electrapolymers.com
Falcon Group	Riverside Ind. Est. ,Littlehampton BN17 5DF	01903 725 365 www.falconpcbgroup.com
Faraday Printed Circuits Ltd	15-19 Faraday Close, Pattinson North Ind. Est., Washington. NE38 8QJ	01914 153 350 www.faraday-circuits.co.uk
Graphic plc	Down End, Lords Meadow Ind. Est., Crediton EX17 1HN	01363 774 874 www.graphic.plc.uk
Invotec Group Ltd	Hedging Lane, Dosthill , Tamworth B77 5HH	01827 263 000 www.invotecgroup.com
Stevenage Circuits Ltd	Caxton Way, Stevenage. SG1 2DF	01438 751 800 www.stevenagecircuits.co.uk
Teknoflex Ltd	Quarry Lane, Chichester PO19 8PE	01243 832 80 www.teknoflex.com
Zot Engineering Ltd	Inveresk Industrial Park Musselburgh, EH21 7UQ	0131-653-6834 www.data@zot.co.uk

The Membership Secretary's notes - October 2011

The very first World Conference, inaugurated by the ICT, IMF and assisted by the IPC, was held in the Café Royal, London in 1978 and attracted over 800 delegates. Rex Rosario OBE, a Fellow of the Institute is intent on bringing the Conference back to London for 2014, also the fortieth anniversary of the founding of the ICT.

Rex has the initial support of all major electronics groups in the UK, but it will take considerable clarity and leadership to organise this event for the global Electronics Industry. We will have the major advantage in that the London Olympics will have been run in 2012 and London infrastructure will be at its peak, but we are still going to need the help and support of the entire UK electronics Industry if we are to succeed.

The first step is to ensure that everyone knows what Rex is trying to achieve and to get behind the idea and concept of holding a World Conference in the UK for the first time in 21 years. (The last world conference on these shores was in 1990 at Glasgow) This is a plea to members to make sure that they inform everyone they think might be interested to know about the project - their colleagues and also their boss if appropriate.

Bill Wilkie

The Institute of Circuit Technology

Northern Area Evening Seminar
about
Supporting Industries Needs
at
18.00 (registration 17.30)
Tuesday 1st November 2011
in the
Devonport Hotel, Darlington
http://www.devonporthotel.com/

Supported by LAMAR GROUP

Provisional Agenda

'Low Temperature Electroless' - Andy Cobley

'Soldermask for Insulated Metal Substrates' - Geoff Layhe

'Contact Cleaning' - Mike Partridge

' T.B.A.

The four papers will be followed by a Buffet.

By request, we will issue a 'certificate of attendance', to provide an official record of participation in the event. This certificate can be used to keep professional development records up to date and also as proof of career development.

Register with: **Bill Wilkie** **Technical Director, Institute of Circuit Technology**
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