

Journal of the Institute of Circuit Technology

Vol.7 No.4 Autumn 2014 Issue

2014 Events

- 6th March **ICT AGM** and Winsford **Evening Seminar**
Thursday Chimney House Hotel in Sandbach.
bill.wilkie@InstCT.org
- 14th -17th April **ICT Annual Foundation Course**
Tuesday - Friday at Loughborough University
bill.wilkie@InstCT.org
- 7th - 9th May **ECWC13 (13th Electronic Circuits World Convention)**
Wednesday - Friday at Nuremberg
eipc@eipc.org
- 4th June **ICT 40th Anniversary Dinner**
Wednesday at Wiltshire Golf Club
bill.wilkie@InstCT.org
- 5th June **ICT Annual Symposium**
Thursday at **Great Western Railway**
STEAM Museum, Swindon
bill.wilkie@InstCT.org

Editorial	<i>Bruce Routledge</i>	2
Council Members		2
Membership News		2
Collaborative research projects	<i>Martin Goosey</i>	3-4
Low Frequency Ultrasound	<i>Andy Cobley et al</i>	5-8
ICT Hayling Island Seminar, "Manufactured in the UK" September 23rd 2014	<i>Pete Starkey</i>	9-12
Dieter Bergman – a personal remembrance	<i>Len Pillinger</i>	13-14
KTP News piece		15
The Membership Secretary's notes - October 2014	<i>Bill Wilkie</i>	16
ICT Corporate Members		16

- 23th September **ICT Evening Seminar**
Tuesday at Newton House Hotel, Hayling Island
bill.wilkie@InstCT.org
- 18th November **ICT Darlington Evening Seminar**
Tuesday at St George Hotel, Durham Tees Valley Airport, DL2 1RH 01325 332631
bill.wilkie@InstCT.org

2015 Events

- 3rd March **ICT Northern Seminar and AGM**
at Chimney House Hotel, Sandbach
bill.wilkie@InstCT.org
- 13th -16th April **ICT Annual Foundation Course**
Tuesday - Friday at Loughborough University
bill.wilkie@InstCT.org

It has been a long hot summer, which inhibited contributors from writing.

However they showed willingness at the end of September, which coincided with the Hayling Island Seminar, and caused your Editor several late afternoons.

So please get reading.

Bruce Routledge

Council Martin Goosey (*Chairman*), Andy Cobley (*Deputy Chairman*), John Walker (*Secretary*), Chris Wall (*Treasurer*),
Members William Wilkie (*Membership Secretary & Events*), Bruce Routledge (*the Journal*), Richard Wood-Roe (*Web Site*),
2013/4 Maurice Hubert, Lawson Lightfoot, Tom Parker, Steve Payne, Peter Starkey, Francesca Stern, Bob Willis.

Membership

Returning member notified by the Membership Secretary
10082 Mark Loader M.Inst.C.T.

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Institute of Circuit Technology.

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The ICT and its role in collaborative research projects

Professor Martin Goosey
Chairman ICT



Professor Martin Goosey

Since becoming Chairman of the ICT, and being an industrial researcher at heart, I have made it one of my objectives to not only help keep the Institute abreast of new developments but also to engage it in research and development activities that might ultimately translate into new technology from which the UK PCB industry can benefit.

Our first foray into the world of collaborative R&D was via the European Commission funded Aspis project on nickel-gold solderable finishes. This project's aim was to investigate the fundamental causes of the well known problems, such as black pad, that are encountered with nickel gold solderable finishes and to develop improved alternative processes and coatings.

The ICT was the project's coordinator and it proved to be a baptism of fire. We very quickly came to understand that managing such a project required a substantial level of commitment that was, with hindsight, better suited to a larger organisation with more resources. However, the project was successfully completed and, despite the disappointing outputs from a couple of key partners, it made some valuable contributions to the basic knowledge base, especially in terms of the fundamental causes of black pad and in demonstrating new solderable finish formulations based on novel ionic liquids. The recent review by the European Commission's technical expert was very positive and participation in the project did give us exposure to the vagaries of European collaborative research.

More details about the Aspis project can be found at the Aspis website; www.aspis-pcb.eu

Having realised that leading such a large and complex project was probably not something the ICT would wish to repeat, we decided that a better approach might be to play a smaller role in any future projects and to undertake activities utilising the Institute's key strengths. In particular, the ICT is ideally suited to a dissemination role in which it can help to promulgate the progress and outcomes of a project.

To that end, last year, we joined with several UK companies in a Technology Strategy Board (now InnovateUK) supported collaborative project to develop novel effluent treatment and copper recovery technology based on the use of chitin and chitosan recovered from crab shells; a waste product of the sea food industry.

This project has now been running for approximately 12 months and there have already been a number of interesting developments demonstrated (see, for example, my 2014 ICT Annual Symposium presentation from June this year). The ICT's role is to promote the project and to disseminate the outputs to the UK PCB industry. Further updates on the progress of this two year project will be presented at our evening seminars and via this journal over the coming year.

Additional information is also available at the STOWURC project website; www.stowurc.co.uk

We have recently heard that another project in which the ICT is the dissemination partner has been approved for funding support by the Technology Strategy Board (now InnovateUK).

This project, known as MACFEST, is actually not concerned with eating hamburgers, but builds on some of the work carried out at the University of Leicester in the Aspis project. In particular, the project is focussing on the use of ionic liquids to formulate high performance ENEPIG solderable finishes for the PCB industry. The project partners include all parts of the requisite supply chain from an ionic liquid company to a process chemistry supplier and a PCB end user. We are particularly pleased to have Merlin Circuit Technology as a key partner in the project.

At the time of writing, we are in the process of completing the preliminary paper work to enable the project to commence. The official start date for this two year project is likely to be 1st January 2015. As the dissemination partner, we will be promoting the project aims and outputs to as wide an audience as possible, just as we are doing with the STOWURC project. There will be a dedicated website and I will provide more details in due course.

In summary then, the ICT now has an established track record of participating in collaborative research and development projects that will hopefully bring new knowledge and benefits to the UK PCB industry.

Although my term as ICT Chairman is drawing to a close, I do hope that the ICT will be able to build on the experience gained to date in these projects and to continue with this type of activity, as I am convinced they offer benefits both to individual members and the UK industry as a whole.

Martin Goosey -
ICT Chairman
September 2014

The effect of Low Frequency Ultrasound on Catalysed Electroless Copper Plating

Cobley A J; Abbas B; Hussain A; Mkhlef B

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One of the most advantageous features of the electroless copper process is that it enables the metallisation of non-conductive substrates. For this reason it has been employed in the electronics industry for decades since it has enabled the plating of 'through holes' and 'vias' in printed circuit boards (PCBs). The non-conductive substrate must first be catalysed (or 'activated') and this is normally achieved using a palladium (Pd)/tin colloidal solution. The tin is subsequently removed in either an 'accelerator' solution or in the electroless copper electrolyte itself leaving Pd on the surface. The chemistry of electroless copper plating on a catalysed surface is a complex mix of electrochemical and chemical reactions but a simplified model is shown in Figure 1.

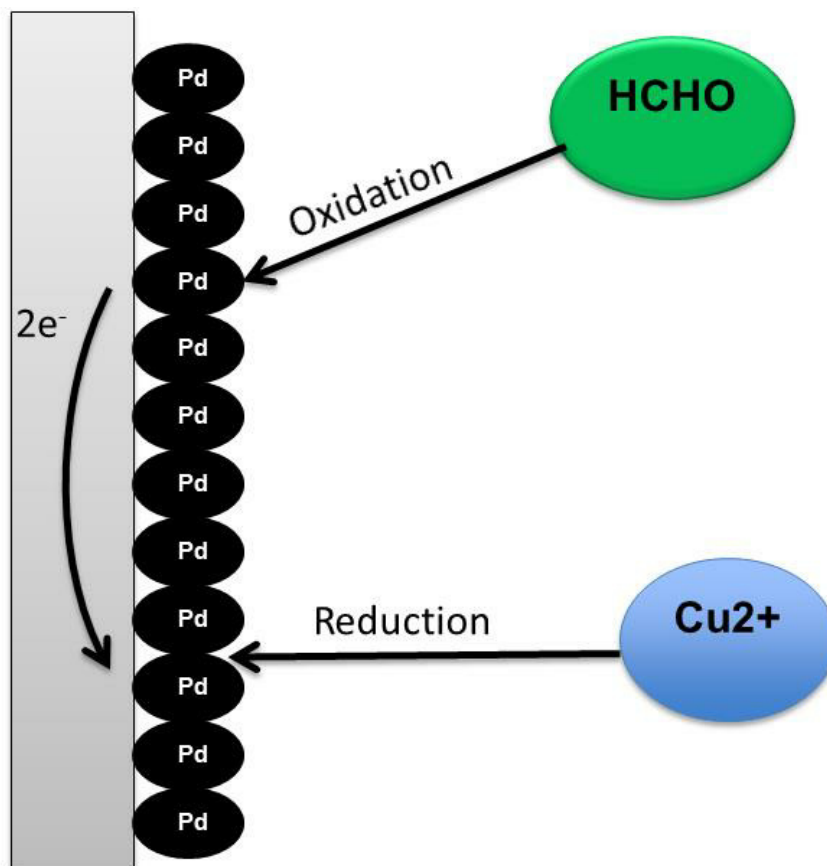


Figure 1. Oxidation/Reduction reactions occurring on a Pd Catalysed Surface

Formaldehyde (HCHO) oxidises on the Pd catalyst generating electrons (e^-) which are then consumed in the reduction of copper ions (Cu^{2+}) to copper metal (Cu^0).

There are many potential benefits in applying ultrasound to an electroless process and this was the subject of a recent review by the author[1]. The majority of the previous studies on the effect of ultrasound investigated electroless nickel plating where sonication generally produced a significant increase in plating rate[2-5]. Studies on the use of ultrasound during electroless copper plating are less numerous and few take into account the catalysation stage despite the

fact that this is a critical part in the process. One notable exception to this are the papers published by Touyeras et al [6, 7]. They showed that if relatively high frequency ultrasound (530 kHz) was introduced to the catalyst bath then an increase in the subsequent electroless copper plating rate could be obtained. Indeed, by applying ultrasound in both the catalyst and the electroless copper solution the plating rate could be almost doubled. These papers clearly demonstrated the importance of the catalysation step in the electroless copper process.

Studies at Coventry University

The Functional Materials Applied Research Group at Coventry University has carried out a 3 year project funded by the Innovative electronics Manufacturing Research Centre (IeMRC) investigating the effects of ultrasound on electroless and immersion plating processes. This work mainly utilized sonication at low frequency (40 kHz) which, for industrial applications, is preferred due to cost, availability and its more uniform effects in a bulk solution.

These studies quickly indicated that the effect of ultrasound on the catalysed surface must be considered if the beneficial effects of sonication are to be realised. X-Ray Photoelectron Spectroscopy (XPS) Analysis of the surface of the catalysed substrate after immersion in a 'simulated' electroless copper solution (Table 1) showed that the application of ultrasound had a dramatic effect on the concentration of Pd on the surface. It can be seen that the catalysed substrate that had been immersed in the sonicated electroless copper solution had almost no Pd remaining on the surface after 10 minutes.

	After Catalyst	Simulated Electroless Copper			
		4 mins. In	10 mins. In		
		Silent	Ultrasound	Silent	Ultrasound
Pd (Atomic %)	4.3	4.5	4.8	2.9	0.1
Sn (Atomic %)	17.0	0.6	0.7	0.4	
Pd/Sn	0.2	7.5	7	7.2	

Table 1. The effect of Ultrasonic Agitation in a Simulated Electroless Copper solution on Pd and Sn concentrations on the surface of epoxy test coupons, after Catalyst

When ultrasound is applied to a liquid medium a phenomenon known as acoustic cavitation occurs which leads to the creation of cavitation bubbles. The collapse of these cavitation bubbles near a solid surface produces microjetting which is the driving force behind ultrasonic cleaning as these microjets have a scrubbing action on the surface of material resulting in soil/dirt removal. Microjetting is also beneficial in electrochemical systems, enhancing mass transport and thinning diffusion layers.

However, Table 1 clearly shows that in this catalysed electroless copper process it can have a negative effect by removing catalyst from the surface of the substrate to be plated (Figure 2 - on next page)

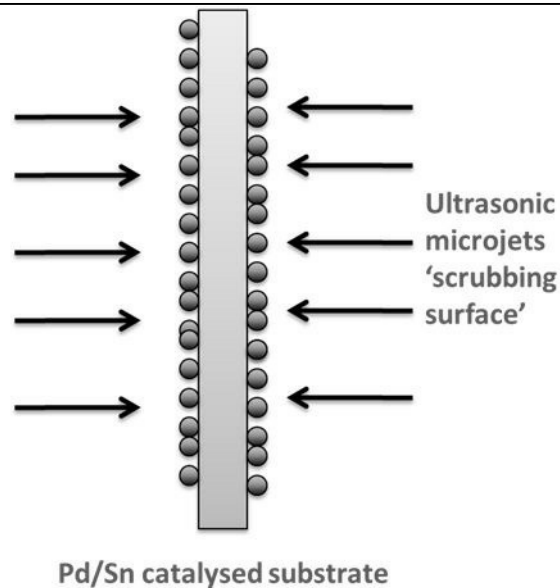


Figure 2. Ultrasonically induced microjetting 'scrubbing' catalysed substrate

These effects were reflected in the practical plating tests that were performed. Using an electroless copper solution operating at 40 °C the application of continuous sonication resulted in only a modest 8% increase in plating rate compared to the plating rates obtained using conventional agitation. However when a 7 minute 'delay' time was introduced before the electroless copper solution was sonicated a significant 38% increase in plating rates were observed. Indeed the plating rate obtained at 40 °C using 'delay time' sonication (3.2 $\mu\text{m}/25$ minutes) was equivalent to those obtained using conventional agitation at 46 °C.

A change in the grain structure of the electroless copper deposit was also recorded on test coupons that had been sonicated. Figure 3 indicates that a much finer grain structure occurs on samples that have been subjected to ultrasonic irradiation.

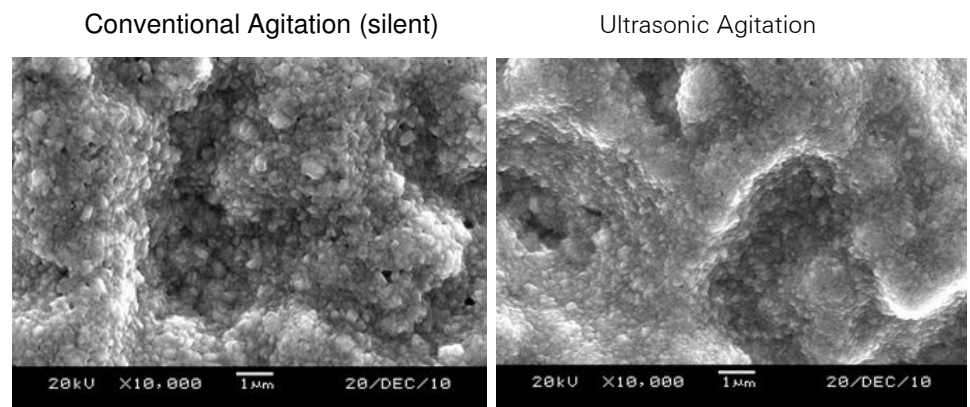


Fig. 3. Electroless Copper grain structure obtained using a plating temperature of 40 °C

For electronic applications this modified grain structure has the potential to bring benefits in terms of lower porosity, better coverage, increase conductivity and a reduction in signal attenuation.

Conclusions

Experimental studies performed by the Functional Materials Applied Research Group at Coventry University have shown that the introduction of low frequency ultrasound to an electroless copper process has the

potential to bring about many benefits in terms of increased plating rates, low temperature processing and grain structure refinement. However it must be understood that ultrasound can remove Pd from a catalysed substrate and therefore the sonication procedure must be optimised if these benefits are to be realised.

Acknowledgements

The authors wish to thank the leMRC and EPSRC for funding this project and our consortium partners Graphic Circuits PLC, Solar Capture Technologies Ltd, Chestech Ltd, LSA Ltd, The ICT, The IMF, The SP Technical Research Institute of Sweden and The Université de Franche-Comté.

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Review of papers presented at the
Institute of Circuit Technology
Hayling Island Seminar, "Manufactured in the UK"
September 23rd 2014 by Pete Starkey

Goodwood, in West Sussex on the south coast of England, is legendary in its association with horse racing, motor racing and the factory of Rolls Royce Motor Cars. Steve Driver, MD of Spirit Circuits has become legendary for providing memorable extracurricular experiences for the benefit of delegates to the Institute of Circuit Technology's annual Hayling Island Seminar.



To remove trace metals from PCB manufacturing effluent



Professor Martin Goosey

UK's Huge manufacturing heritage



Steve Driver

This year, his colleague Peter Dobromylski had organised a conducted tour of Rolls Royce's assembly plant, to observe at first hand the engineering and quality assurance procedures involved in creating motor vehicles to the ultimate standards of luxury, performance and reliability. The factory was characterised by calm and purposeful activity, combining the latest in mechanical and electronic engineering technology with traditional craftsmanship in custom woodwork and leatherwork.

Well-impressed with what they had seen in the assembly area and learned from the knowledgeable engineers who had conducted the tour, delegates took a short bus ride to Hayling Island to attend the technical seminar, on a theme of "Manufactured in the UK"

The proceedings were introduced by ICT Chairman **Professor Martin Goosey**, who reported progress on the TSB-funded STOWURC project, using crab-shell bioabsorbent to remove trace metals from PCB manufacturing effluent and now approaching the end of its first year. (*see also pages 3 & 4*) Goosey also announced the awards for the "Best Young Person's Paper" won by **Tom Jones** from Merlin Circuit Technology, with a report on applications of ultrasonics.

The opening presentation came from **Steve Driver**, flying the flag for UK manufacturing, reminding the audience that the UK is the eleventh largest manufacturer in the world, and the second largest in the global aerospace industry. The UK had a huge manufacturing heritage, with numerous UK manufacturing industries continuing to thrive. He listed many internationally recognised brand names, in sectors ranging from aerospace and defence, automotive and electronics to plastics, furniture, pharmaceuticals, food and drink. But heritage and tradition aside, British engineers continued to be globally recognised for their inventions and the quality of their innovation, and those attributes were inherent in a whole new generation of systems and products.

The UK electronics industry was worth $\pounds 78$ billion and employed 850,000 people. The origins of the printed circuit and modern electronics could be traced back to one UK company, Technograph, who developed the ideas of Dr Paul Eisler "perhaps the world's most unsung inventor of the 20th Century"

Reviewing recent developments in his own group of companies, strategic acquisitions, shrewd investment and positive, often lateral, thinking had built one of the UK's most innovative PCB manufacturers with a unique suite of services.

Always conscious of the need to encourage young people into the industry by engaging them as early as possible in STEM skills, the latest initiative was an educational programme aimed at teaching PCB technology in schools to 7-10 year-olds, under the name Ragworm Education. Specially developed and researched workbooks were focused on the fundamental science behind the PCB, with cartoon-style

illustrations and friendly characters based on ground-breaking scientists of the modern era.

Driver's summing-up message was to be proud of heritage and brand, to innovate and educate, to be different and be first, to think global and partner for the greater good, to listen to the customer and to create new standards.

Ink-jet printing



Mark Loader

Second presentation came from **Mark Loader** of Viking, UK equipment distributor and manufacturer of ink-jet printers, with an overview of the history and development of ink-jet printing and its applications. The concept of ink-jet printing was established in 1867, when a patent was registered by Lord Kelvin for a recorder for telegraph signals. Commercial devices were introduced in the early 1950s, as medical strip-chart recorders, but it was not until the late 1970s that printers were developed that could reproduce digital images generated by computers.

Loader explained the principles of continuous and drop-on-demand technologies. The continuous technique was the most widely used in industry, particularly for batch-coding, bar-coding and date-coding of products and packages, whereas the drop-on-demand technique, as used in document printing, presented opportunities in electronics manufacturing.

He listed a range of jettable materials and gave examples of applications developed for PCB and printed electronics fabrication. In PCB manufacture, ink-jet offered a digital alternative to screen print for etch resist and legend printing. In printed electronics, ink-jet offered a precise means of depositing polymer thick film conductor, semiconductor and dielectric materials, with the possibility to perform multiple operations on the same machine.

Optoelectronics and displays was a rapidly growing market sector where ink-jetted thin-film silver nanoparticle inks were increasingly used, and significant progress was being made in roll-to-roll processing of flexible substrates.

"Innovative Thermal Management – Made in UK" was the title of the presentation by **Ralph Weir**, CEO of Nanotherm, who claim to produce the world's highest performance thermal management substrates for electronics.

Innovative Thermal Management



Ralph Weir

Their nano-ceramic dielectric coatings, applied on to the surface of aluminium by an undisclosed electrolytic process, were 4-10 times thinner than conventional resin-based materials, and conducted heat 2-3 times better. This enabled extremely efficient heat dissipation and allowed LED manufacturers to reduce costs, improve the lifetime of their LED products by up to four times, and to generate greater luminosity within the same physical footprint.

Most engineers do not understand thermal management – 'I want a 2 Watt material' – and that naivety pushed their costs up, and their jobs out of Europe" was the bold statement against which background Weir quoted examples: "UK lighthouses use Nanotherm – 2.5X increase in light, 16X increase in reliability", "UV cured digital inks use Nanotherm – double throughput from printer", "Consumer light bulbs use Nanotherm – halve the cost to manufacture" and "Thermo electric generators – 36% more power output". The smartphone market was a current target for development, and thermoelectric generators presented a substantial future opportunity.

Enough excitement! Calm was restored as **Chris Wall**, - ICT Treasurer and Technical Director of **Electra Polymers** gave a cool and informative insight into how a privately-owned UK company, celebrating



Chris Wall

its 30th anniversary, had established an outstanding reputation for delivering reliable and innovative products with world-class technical support to all customers irrespective of size or location.

With 25% of its UK workforce focused on R&D, Electra was recognised as specialist in the development of solder masks, and Wall described the evolution of solder resist materials from screen-printed heat-cured two-component epoxy-polyamine adducts, through single-component UV-cured products to present-day liquid photoimageable formulations rheologically optimised for screen or spray application, with photoinitiator systems optimised for traditional UV exposure or specifically formulated for fixed transmission laser or LED wavelengths.

There was an increasing demand for solder masks for high-brightness LED lighting circuits with particular attributes such as rapid tack-drying on high heat-conductivity substrates, high opacity, tailored reflectivity and resistance to thermal and UV ageing.

Summarising the current market expectation of solder mask performance, over and above its original purpose of enabling mass soldering techniques, Wall indicated that it was required to prevent corrosion of underlying circuitry, to act as a plating resist for surface finishes, to prevent growth of metal whiskers, to insulate substrates from debris and environment, to assist with component placement and to reflect light from LED backplanes, whilst being able to be applied by every known method, impossible to over-dry, cheap, fast-exposing using any imaging process, easy to develop out of small holes, able to coat or tent large holes, cheap, rapid curing, resist all known chemical processes yet easy to remove if required, cheap, and available in every colour and surface finish under the sun....!

The day had started with Rolls Royce Motor Cars; it was appropriate the seminar concluded with **Rolls Royce Motor Cars** – what better example of high quality, low volume, bespoke manufacturing in the UK? **David Monks**, Manager of Drive Train, Chassis and Electronics, described the quality assurance procedures employed at the Goodwood plant that delegates had visited earlier.

He began by quoting Sir Henry Royce: *“Strive for perfection in everything you do. Take the best that exists and make it better. When it does not exist, design it”*, Albert Einstein: *“Intellectuals solve problems, geniuses prevent them”* and Lord Kelvin: *“I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advance to the stage of science, whatever the matter may be”*. These were guiding principles in the Rolls Royce operation.

Monks briefly introduced the model range, from the driver-focused Ghost (base price around £220,000) to the passenger-focused Phantom (base price around £450,000) and explained that, with few exceptions, each car was commissioned specific to an individual customer’s personal needs and preferences, with certain customers prepared to spend enormous sums on customised woodwork, leatherwork, paintwork and electronics. Whatever the specification, customers demanded the best and Rolls Royce’s quality assurance systems had been developed to ensure that the best was consistently delivered. In particular, there had been heavy investment in employee training. There were automated measurement and testing systems in place at several stages along the assembly line, and every completed car was subjected comprehensive testing including full dynamometer analysis, calibration and alignment of on-board cameras and radars, and



David Monks

analysis, calibration and alignment of on-board cameras and radars, and measurement of the effects of severe vibration and monsoon rain.

Finally each car was meticulously hand-polished before delivery.

ICT Technical Director **Bill Wilkie** brought proceedings to a close, thanking delegates for their attention and presenters for sharing their knowledge and experience, with particular acknowledgments to Rolls Royce for their hospitality, to Peter Dobromylski for arranging the factory visit, and to Steve Driver for his continuing support of the Hayling Island seminar. Who knows what surprise he may have in store for next year's event....?

Pete Starkey

September 2014

ICT Hayling Island 2014 Seminar Registrations

John Walker	ICT Hon Sec	Delegate	Derek Lloyd	Guest	Delegate
Martin Goosey	ICT Chairman; eIMRC	Speaker	Pete Dobromylski	Lyncolec	Delegate
Bill Wilkie	ICT Technical Director	Delegate	Les Blakeman	Spirit Circuits	Delegate
Pete Starkey	ICT Recorder	Delegate	Steve Snell	Lyncolec	Delegate
Maurice Hubert	Ventec-Europe	Delegate	Rupert Harzenetter	Spirit Circuits	Delegate
Lawson Lightfoot	ICT Council Member	Delegate	Pat Mannion	Spirit Circuits	Delegate
Tom Parker	CCE Europe	Delegate	Les Round	Spirit Circuits	Delegate
Steve Payne	Cirflex Delegate	Delegate	TBA	Linwave Technology	Delegate
Chris Wall	Electra Polymers	Speaker	TBA	Linwave Technology	Delegate
Richard Wood-Roe	ICT Webmaster	Delegate	TBA	Linwave Technology	Delegate
Andy Prince	Technic	Delegate	Barrie Williams	Airbus Defence and Space,	Delegate
Andre Bodegom	Adeon Technologies	Delegate	John Cunningham	Rainbow Technology	Delegate
Mark Goodwin	MD, Ventec-Europe	Delegate	John Cornforth	Enthone	Delegate
David Driver	Farthing Corner Coaches	Delegate	Frank Hartshorn	TMT Trading GmbH	Delegate
Mike Partridge	Sends Apologies	Delegate	Jamie Pettit	Labcraft	Delegate
Geoff Layhe	Lamar Group	Delegate	Martin Randall	Spirit Circuits	Delegate
Jim Francey	Optiprint	Delegate	Sammie Roden	Spirit Circuits	Delegate
Bruce Routledge	ICT Journal Editor - AFA	Delegate	Tom Hill	Spirit Circuits	Delegate
David Fitzgerald	FTL Ltd	Delegate	Darren Borg	Spirit Circuits	Delegate
Stephen Bailey	Faraday Circuits	Delegate	Peter Coakley	Mutrax	Delegate
Gaz Brown	Ventec-Europe	Delegate	Ian Kingshott	GSPK	Delegate
Steve Thornley	Lyncolec	Delegate	Rex Rosario	Graphic Electronics	Delegate
Alun Morgan	Isola Group	Delegate	Ruth Harbottle	Graphic Electronics	Delegate
Emma Hudson	UL International	Delegate	Paul Watson	CEMCO-FSL	Delegate
Tino Facchini	Holders Technology	Delegate	Martin Gaudion	Polar Instruments	Delegate
Gillian Herriot	Holders Technology	Delegate	Guest	Technic	Delegate
Colin Martin	Sends Apologies	Delegate	Martyn Green	Spirit Circuits	Delegate
Neil Allen	ParaChem	Delegate	Rud Lewis	Guest	Delegate
Wendy Heyes	Hayton Heyes	Delegate	Graham Temple	Lyncolec	Delegate
Ralph Weir	Cambridge Nanotherm	Speaker	Grant Greenham	Lyncolec	Delegate
Steve Driver	Spirit Circuits	Speaker	Peter Lymn	CEMCO-FSL	Delegate
Rozanna Griffin	Eurotech Group	Delegate	Edward Lymn	CEMCO-FSL	Delegate
Bradley Taylor	Eurotech Group	Delegate	Zaphod Lymn	CEMCO-FSL	Delegate
Mark Loader	Viking Test	Speaker	Jason Barnett	Spirit Circuits	Delegate
David Monks	Rolls-Royce Motor Cars	Speaker	Andrew Weddell	Spirit Circuits	Delegate
Dave Hunton	Spirit Circuits	Delegate	Stacey Driver	Stickleback Manufacturing	Delegate
Angus Brunton	Isola Group	Delegate	Stephanie Driver	Stickleback Manufacturing	Delegate
Gavin Barclay	Sends Apologies	Delegate	Ian Hood	Spirit Circuits	Delegate
Dave Cornell	Sends Apologies	Delegate	Calvin Gatland	Lyncolec	Delegate
Kirsten Smit-Westenberg	EIPC	Delegate	John Smith	Northern HiTec	Delegate
Brian Morgan	Consultant	Delegate	Henry Coakley	Mutrax	Delegate
Phil Leader	BLT Services	Delegate	Chris Mundy	Spirit Circuits	Delegate
Lee Lloyd	Spirit Circuits	Delegate			Delegate



Dieter Bergman

Dieter Bergman – a personal remembrance

by **Len Pillinger**

The passing of Dieter Bergman has rightly been marked with glowing tributes from those recalling his tireless work at IPC over many decades. It is pointless repeating the bare facts of his at Philco and IPC again; these may be found in the trade journals and at the IPC website. I would like to offer an affectionate look back on his contribution to IEC's PCB Standards and the legacy he leaves (which includes two wedding ceremonies!).

In the late 1980s I was responsible for BT's PCB industry approvals. Wherever I went, Dieter would be mentioned and when my boss began attending IEC Standards meetings he would come back with Dieter stories.

My first IEC meeting was in Munich in May 1989. Dieter missed the meeting but with the retirement of Hans Schultz, was elected Chairman. I finally met him six months later at the following meeting in Dubrovnik.



Dieter would often take an hour to answer a one minute question!

From L-R: Ad Koenig, Hans Brosalme, Lutz Treutler, Dieter, Pierre Amiguet and Peter van Reekum



Relaxing in Tel Aviv in May 1994 wearing my Warwickshire cricket sun hat.

Over the next couple of years I 'crossed swords' with Dieter inasmuch as the UK or European position did not always align with the US interests. My inexperience was no match for his force of personality and so this meant that Dieter invariably won the day. I learnt not to take this personally (he was simply doing his job) and realised that to compete I needed to match his immense work ethic and lobby furiously. I managed the occasional narrow victory or score draw! Irrespective of whether or not you

agreed with the direction of travel, Dieter was undoubtedly a born leader.

Whilst I recall battles in committee, he was always generous and genial when it came time to relax in a bar or restaurant. Dieter liked to be in control in the restaurant too; wanting to order everyone's meal and then helping to mop up any leftovers! My wife has also reminded me of his habit of marching everyone off to "a great restaurant only ten minutes walk away". Then 45 minutes later we would be completely lost and asking for directions; with wives and girlfriend who had dressed-up for the evening complaining that their high heels were cutting their feet to shreds!

I only saw Dieter speechless once: Whilst at a meeting in Tel Aviv we took an excursion to Jerusalem to visit the holy sites. At the Western 'Wailing' Wall, he was approached by an enthusiastic rabbi who decided Dieter was a lost sheep. He eventually escaped once Kaddish had been recited.

So why two weddings? The first took place in a Kabuki Theatre in downtown Tokyo arranged by the JPCA. A volunteer was needed to go through a mock wedding ceremony with a geisha. Dieter's name was called-out by absolutely everyone and he took this election as a good sport even though it must have been excruciatingly embarrassing. Shamefully, I have

lost my photos from that trip but I dare say that Michael Weinhold or Bob Neves still have the incriminating evidence.

The second wedding was a real one; mine! The IEC meeting in October 1995 was the week before the IPC Fall Meeting, both held at the Westin Hotel in Providence Rhode Island. My fiancée, Roz, and I had decided to marry but with my parents divorced and a similar schism in Roz's family any arrangements would have been fraught with difficulty. We decided that we would both go over to New England and marry whilst there. It was easy enough to find a local Judge willing to perform the ceremony at his office.

At the opening meeting I invited any willing delegates to attend. Dieter would not hear of such a thing. He announced that IPC had booked the conference suite for two weeks and the wedding was to be an additional item of 'Any Other Business'! So we got married in probably the best hotel in the State with Dieter / IPC having paid for the splendid surroundings.



Too many names to list; delegates from Asia, Europe and the USA

I was pleased to repay this kindness on two or three occasions by having him as a house guest or by taking a 100 mile detour to deliver him to Heathrow airport. Dieter invoked that kind of loyalty.



Len Pillinger

To avoid excess word count I must cut this short, so if you knew Dieter and want to hear how he got trapped for a couple of hours in no man's land between Spain and Gibraltar or about when he arrived in India without a visa to be detained overnight; just let me know.

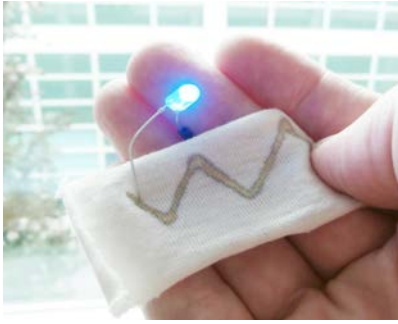
One final thought, I recall an IEC meeting in Guangzhou in 1997 where I thought Dieter looked rather tired and overworked. I commented to one of the senior US delegates that I hoped Dieter would perhaps limit his travelling and workload and 'enjoy some days in the sun'. It was suggested to me that he considered his endless round of meetings, exhibitions and conferences to be his days in the sun. I am sure he did.

Dieter Bergman born 10th April 1931 - died 23rd July 2014

Len Pillinger
July 2014

KTP News piece -

Coventry University and NPL win KTP Award for Smart Textiles research project



Smart textile

Coventry University is pleased to announce that they have won a Knowledge Transfer Partnership (KTP) award from the TSB and will be partnering with NPL to work in the area of smart textiles. A KTP is a collaborative initiative between a company and a university, which shares knowledge and expertise for an innovative research project with a clear commercial objective. The project benefits from combining academic input with the business know-how to develop successful IP and contribute to company growth.

The award brings together the Functional Materials teams from both institutions to look at additive techniques for applying conductive tracks to a range of textiles. There are numerous applications for the work across the wearable technology sector, for example within health, sport and the military. There are already methods to produce conductive textiles, such as weaving a conductive yarn into the material or by printing conductive inks onto the fabric surface. However it is more advantageous to treat the fabric in such a way as to introduce conductivity onto the individual fibres within the textile. A key goal will be selective metallisation of the textile, i.e. the incorporation of conductive tracks into the textile rather than coating the whole surface, which could lead to circuit designs being incorporated into clothing.

The process of depositing nanoparticulate silver onto fibres has already been developed by NPL, with the resulting fabrics demonstrating excellent coverage of silver and conductivity, whilst retaining the necessary flexibility for textile applications. The next step in the additive process will use the metallisation expertise at Coventry University to thicken the conductive layer and develop a robust prototype. There are many factors to consider when working with smart textiles, for example, the texture of the treated material and also its lifetime; how well will it survive repeated washing cycles? The chemistry of each fabric is also a factor since the differences between natural and synthetic fabrics results in different responses to the conductivity treatments.

Kathryn Wills has joined the project for two years as the KTP Associate and will be working with Chris Hunt and Roya Ashayer-Soltani at NPL and Andrew Cobley and John Graves at Coventry University. She will spend her time developing the technology as well as identifying opportunities for commercial links and business development.



L to R Dr John Graves (Coventry University), Dr Andrew Cobley (Coventry University),
Dr Kathryn Wills (KTP Associate), Dr Roya Ashayer-Soltani (NPL), Dr Chris Hunt (NPL)

<i>Organisation</i>	<i>Address</i>	<i>Communication</i>
Adeon Technologies BV	Weideheek 26, 4824 AS Breda, The Netherlands	+31 (0) 76-5425059 www.adeon.nl
ALR Services Ltd.	Unit 9 Thame Business Park , Thame, Oxon OX9 3XA	01844 217 487 www.alrpcbs.co.uk
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 3BS	01606 861 155 www.ccee.co.uk
ECS Circuits Ltd.	Unit B7, Centrepoint Business Park, Oak Road, Dublin 12, Ireland	+353-(0)1-456 4855 www.ecscircuits.com
Electra Polymers Ltd.	Roughway Mill, Dunks Green, Tonbridge TN11 9SG	01732 811 118 www.electrapolymers.com
The Eurotech Group	Salterton Industrial Estate, Salterton Road Exmouth EX8 4RZ	01395 280 100 www.eurotech-group.co.uk
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
GSPK (TCL Group)	Knaresborough Technology Park, Manse Lane Knaresborough HG5 8LF	01423 798 740 www.gspkcircuits.ltd.uk
Invotec Group Ltd	Hedging Lane, Dosthill , Tamworth B77 5HH	01827 263 000 www.invotecgroup.com
PMD (UK) Ltd.	Broad Lane, Coventry CV5 7AY	02476 466 691 sales@pmdgroup.co.uk
Rainbow Technology Systems	40 Kelvin Avenue, Hillington Park Glasgow G52 4LT	01418 923 320 www.rainbow-technology.com
Spirit Circuits	22-24 Aston Road, Waterlooville, Hampshire PO7 7XJ	02392 243 000 info@spiritcircuits.com
Stevenage Circuits Ltd	Caxton Way, Stevenage. SG1 2DF	01438 751 800 www.stevenagecircuits.co.uk
Ventec Europe	1 Trojan Business Centre, Tachbrook Park Estate Leamington Spa CV34 6RH	01926 889 822 www.ventec-europe.com
Zot Engineering Ltd	Inveresk Industrial Park Musselburgh, B19 EH21 7UQ	0131-653-6834 www.data@zot.co.uk



The Membership Secretary's notes - October 2014

Apart from the *Journal*, the main benefit of ICT Membership to arrive in your Inbox is the Market Outlook Column from Walt and Jon Custer.

We can all suffer from information overload, so it is great to have someone funnel it all down into a bite sized package and explain the cyclical nature of the global market place for the PCB's in our Industry sector.

Walt has been collating information from various sources for many years and is a recognised authority on the subject, even if sometimes we don't want to hear the dreaded phrase – Inventory Correction!

The Institute are committed to making it easier for members to access information and are planning to record the next evening seminar at Darlington. Both the presentations and the audio recording will be placed on the website as a Members only benefit, ensuring that even overseas Members will be able to enjoy the 'live' experience of an ICT event.