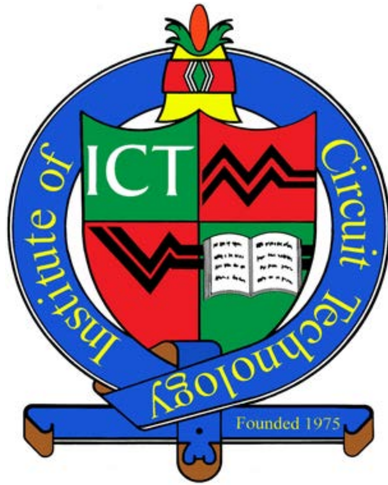

Journal of the Institute of Circuit Technology

Vol.7 no.1 Winter 2014 Issue

2013 Events

2nd /5th April *Tuesday - Friday* — **ICT Annual Foundation Course** at Loughborough University bill.wilkie@InstCT.org

5th June *Wednesday* — **ICT Annual Symposium** at the Heritage Motor Museum, Gaydon, Warwickshire bill.wilkie@InstCT.org

25th September *Wednesday* — I*e*MRC 2013 Conference at Holywell Park, Loughborough iemrc@lboro.ac.uk

26th September *Thursday* — **ICT Evening Seminar** at Newton House Hotel, Hayling Island bill.wilkie@InstCT.org

24th October *Thursday* — 9.30 Conformal Coating Reliability Seminar NPL & SMART Group event at NPL, Teddington Tony Gordon info@smartgroup.org

5th November *Tuesday* — **ICT Evening Seminar** at Darlington St George Hotel, Durham Tees Valley Airport, DL2 1RH 01325 332631 bill.wilkie@InstCT.org

2014 Events

6th March *Thursday* — **ICT AGM** and Winsford **Evening Seminar** Chimney House Hotel in Sandbach. bill.wilkie@InstCT.org

14th -17th April *Tuesday - Friday* — **ICT Annual Foundation Course** at Loughborough University bill.wilkie@InstCT.org

7th - 9th May *Wednesday - Friday* — **ECWC13 (13th Electronic Circuits World Convention)** at Nuremberg eipc@eipc.org

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Editorial

ICT Chairman
Prof. Martin Goosey

Welcome to the first issue of the *Journal* in 2014. At the time of writing, it was the middle of December and, as the year draws to a close, I thought it might be useful to reflect back on some of the ICT's activities throughout 2013.

As has been the case for a while now, the membership of the ICT has continued to grow during the year and council members are routinely being asked to review the applications of potential new members. This steady growth reflects the fact that the UK still has a significant PCB manufacturing base and in many areas a world class capability. It also confirms that individuals perceive real benefits in being part of the Institute and what it has to offer. I look forward to seeing what the membership numbers will be in a year's time.

Having been Chairman of the ICT for almost four years now, I have always been keen to support new activities and, in particular, to engage the Institute with scientific research and development projects that could lead to technological advances for the PCB industry. Regular attendees of our evening seminars will not need reminding that, for the last three years, the ICT has been leading ASPIS a multi-partner European R&D project that has investigated solutions to the problems encountered with ENIG solderable finishes.

The problems associated with these types of finishes have been well documented over a number of years, but when the project started, there was no real understanding of the basic failure mechanisms around such problems as 'black pad'. The project has recently finished and, like many other high risk R&D projects, it has produced some very interesting results, along with some disappointments. The project adopted a four pronged approach to addressing the 'black pad' problem and full details of the work undertaken can be found elsewhere (e.g. www.aspis-pcb.eu).

However, it would be remiss of me not to comment on two outstanding pieces of work successfully completed during the project. Firstly, Professor Rimantas Ramanauskas and his team at the former Lithuanian Institute of Chemistry in Vilnius, Lithuania, carried out a very detailed study of the fundamental mechanisms of black pad formation which really did move the understanding of this difficult reliability problem forward to a new level. The outcome was that, for the first time, the key factors that can lead to the occurrence of 'black pad' have been properly elucidated. Secondly, I must also mention the commendable work of Professor Karl Ryder and his team at the University of Leicester, who developed new gold deposition processes from novel ionic liquids. By using an ionic liquid-based approach, rather than a conventional aqueous one, it is possible to avoid some of the deposition conditions that can lead to 'black pad' formation. There was much good work in the ASPIS project and I would recommend a visit to the website if you would like more information.

While on the subject of supporting PCB related R&D, I should also briefly mention that, towards the end of 2013, the ICT joined a Technology Strategy Board funded project to develop new effluent treatment processes for the PCB industry that are based on the use of chitosan derived from crab shells. The ICT's role is to help with dissemination of the project progress and results to the UK PCB industry, so you can look forward to hearing me talking about the 'crabs project' at some of our future events! A brief description of the project and its objectives can be found later in this Journal on page 13, and a website should be established by the time you read this editorial: (www.stowurc.co.uk)

For me, one of the most memorable events of 2013 was the Evening Seminar held on Hayling Island in September, which was supported by Steve Driver and Spirit Circuits. This, had a focus on supporting youngsters and presentations by a range of young people really brought home to me that there is a lot of talent that we should be nurturing and encouraging to join our industry. With many of the established experts in the industry approaching, or having passed the retirement age, it really is time for us to be bringing in new expertise that will enable the industry to prosper and

ASPIS -
Advanced Surface Protection for Improved Reliability PCB Systems

ENIG
Electroless Nickel Immersion Gold
(solderable finishes)

grow in the future. I know that some UK PCB companies already have well established programmes for training new process engineers and chemists, but there is much more that can, and needs to, be done.

Our Editor has asked me to comment on new technologies for PCB and interconnect fabrication, but in an editorial of limited space, what should be included? There is the ongoing incremental evolution in materials and processes that will give improved performance over a wider range of operating conditions, e.g. the new laminates designed to meet high power and environmental legislation constraints, but what of the game changing innovations? There has been a massive amount of interest in metal in board approaches for high thermal conductivity requirements associated with LED lighting applications. LEDs have been available for decades, but it does at last seem that they have finally made it to large volume, mainstream lighting applications and thus there is significant demand for suitable substrates.

The big question of course is what will happen to production as volumes increase and prices fall?

One of the really new materials that has been of interest to just about every industrial sector is graphene. Heralded as a wonder material, graphene has many outstanding mechanical and electrical properties that have raised interest in its use in electronics applications, among others. While it is undoubtedly a fascinating material that will surely find a myriad of uses, I am a little more sceptical and feel that it may be some time before it sees any significant high volume application. Much of the promise is doubtless due to the fact that researchers are seeking new funding to explore and develop the material further. However, for those of us that have worked in R&D for most of our careers, we have been here before; remember high temperature superconductors or, dare I mention it, cold fusion.

For those who take an interest in new types of materials let me also mention stanene, which is already being proposed as a potential successor to graphene. Stanene is a single layer of tin atoms and could be the world's first electrical conductor with 100% efficiency. This would make it even more conductive than graphene and a potential replacement for the copper conductors used in modern computer chips, thereby offering higher operating speeds and reduced power consumption. However, like graphene, it seems that the main problem will be finding ways to make this new material and in sufficient quantities for use in practical applications.

Finally, may I wish you all a happy and prosperous 2014 and I look forward to seeing you at one of the numerous events that the Institute has arranged for the coming year.

Martin Goosey
ICT Chairman
18th December 2013

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

Membership

New members notified by the Membership Secretary

10298 Andrew Robinson M.Inst.C.T.
10299 Simon Thompson M.Inst.C.T.
10300 Dave Stapleton M.Inst.C.T.
10301 David Ward M.Inst.C.T.
10302 Mark Thurlow M.Inst.C.T.
10303 Jim Rosseter M.Inst.C.T.
10304 Garreth Brown M.Inst.C.T.

Corrections and Clarifications

It is the policy of the Journal to correct errors n next issue Please send corrections to : - brucer@john-lewis.com

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Review of the
"Fourth Electronic Materials and Processes for Space " Workshop (EMPS-4)
held on 29th May 2013 in Aalborg, Denmark.

The EMPS Workshops are a University of Portsmouth (School of Engineering) initiative which started in 2010 with EMPS-1. The Workshops are held at least once per year, typically at one of the six ESA-Approved Skills Training Schools. The Workshops are non-profit making and held to develop and promote the materials and manufacturing processes utilised for spacecraft applications.

Materials engineers and students are encouraged to attend. EMPS events are usually free of charge, but when participation is limited due to capacity constraints at any venue, priority is given to the workshop presenters, specialist engineers and scientists and students occupied in the fields of materials, manufacturing and the space industry.

The events are publicised on a University of Portsmouth website from which all past EMPS presentations can be freely downloaded:

https://sites.google.com/a/port.ac.uk/emps/

Past locations for EMPS events were at: the University of Portsmouth (2010); the Institut de Soudure, Paris (2011); and the Italian Welding Institute, Genoa (2012).

EMPS-4 was held last May at the Danish Institute of Technology and Research - Hytek, Aalborg. The modern lecture hall was filled by 64 enthusiastic engineers and academics (from 12 countries) together with several local university students.

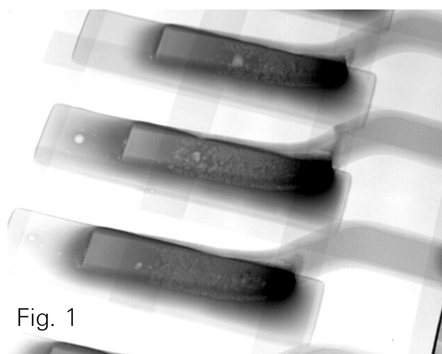

Fig. 1

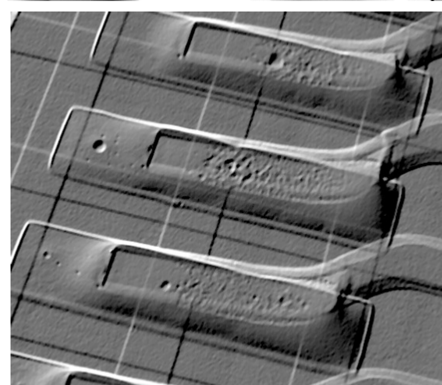

Fig. 2

Example of high definition x-radiograph (Fig.1) compared to X-ray tomograph image (Fig.2), to illustrate the extent and location of porosity within the joints of a flat package soldered to a multilayer pcb",

courtesy of Hytek,Denmark.

Poul Juul, the technical manager of Hytek, commenced the presentations with a review covering the effect of voids in soldered joints on the reliability of electronic assemblies.

Failure investigations and case studies undertaken by his Institute were illustrated by means of an impressive array of laboratory tools.

The fine focus X-ray tomography facility was able to assess the quality of hybrid package seals, as well as the shape of microwire bonds between package and chips, together with the extent of voiding in solder alloy between chip and package.

The effect of voids within the solder balls of area grid arrays was discussed and again X-ray tomography was used, after assembly to pcbs, to establish the number of balls having a well-defined void size. High-rel ball grid assemblies can be specified to contain voiding within 50% of their balls. However, in order to survive extensive thermal cycling in operation, the maximum void size in any ball must be less than 20% of the ball area.

Voids in solder were also shown to originate from the outgassing of component terminations during high temperature soldering as well as from the circuit board's laminated substrate. Large, well defined voids within solder joints were considered to be less of a risk than a continuous network of microvoids occurring along any solder-to-substrate interface.

Luca Moliterni, from the Istituto Italiano della Saldatura Group in Genoa, presented the very detailed failure analysis he had performed on CQFP352 component leads following both vibration and thermal cycling. It is usually the corner leads that crack and cause open circuits during qualification testing. Even when these

very large-sized packages are perfectly solder-assembled, care must be taken to avoid stressing the leads by over torqueing any nearby pcb mounting screws.

Staking compounds applied to the corners of such packages will also cause premature failure of the leads unless they have a low coefficient of expansion (made possible with the addition of carboxyle powder to the adhesive). Also, care must be taken during lead bending to avoid bends too close to the lead braze, to select the correct bend radius and to avoid stressing the leads during any soldering operation (assembly or rework).

Dr Per-Erik Tegehall from the Swerea-IVF Institute in Molndal, Sweden, summarised his extensive studies related to the intermetallic layers which form between various solder alloys and several surface finishes. Specific intermetallic compounds were related to solder joint reliability.

The effects of intermetallic compounds on the reliability of BGAs were illustrated by means of SEM fractographs showing ductile (in solder) and brittle (in/at intermetallic interface) fractures.

Dr Tegehall demonstrated the effect of increasing strain rate on the failure mode of *tin-lead solder* – the solder strength increases with increased strain rate. Simultaneously, the intermetallics' strength decreases with increased strain rate. These results highlight the fact that as strain rate is increased, the tin-lead solder will undergo a ductile-to-brittle transition. High strain rate stresses can be attributed to operations such as in-circuit testing, de-panelling by snapping end tabs, attachment of fasteners, aggressive key pad actuation and, by simply dropping a product to the ground.

Interestingly, the impact of *lead-free soldering* is shown to cause a reverse effect: as strain rate increases, the ductile to brittle transition is decreased because, in general with these solders, resultant intermetallic compounds have a lower strength than the bulk lead-free solder.

The paper continued, relating solder composition and termination finish to intermetallic growth.

Per-Erik ended his presentation by reviewing one cause of micro-void formation (due to contaminated plated layers) and the effect on reliability when soldering with SnAgCu (SAC) alloys to modern electrolytic and electroless finishes.

On a similar subject, **Mr Jussi Hokka**, previously from the Aalto University in Finland and now employed at ESA-Estec in the Netherlands, presented extensive data on the reliability of SAC solder interconnections.

Jussi described the various parameters selected by industry for thermal shock testing and temperature cycling testing of tin-lead solders. He discussed how they might be adapted when an electronic assembly has been constructed from a SAC solder alloy. Dr Tegehall, in his previous presentation, had also shown the properties of SnPb alloys to be vastly different to those possessed by SAC solder alloys.

Testing at Aalto University was performed using samples of BGA144 packages mounted to eight-layer (FR4) mlbs. A multitude of thermal profiles were evaluated, each having different lower and upper dwell temperatures, different dwell times and ramp-rates. Failures were monitored (on about 30 packages per test) by recording the resistance values of the daisy chained networks - a 20% increase from the initial resistance was selected as the

criterion for failure.

Failure sites were later established by metallography, cross-sections being made in a diagonal plane through the BGA packages.

Jussi indicated in his conclusions that standardised accelerated thermal cycling tests create failure mechanisms that are not seen in conditions representing real-use operation.

Activities related to material investigations and component failure analyses at the RUAG (previously Saab Space) laboratory in Gothenburg, Sweden, were described by **Dr Lars Ryen**.

RUAG is one of Europe's largest product suppliers to the space industry and is involved with launch vehicles, satellite structures and their mechanical equipment and electrical systems.

Lars demonstrated how Focused Ion Beam (FIB) cross-sectioning was used to determine the failure mode of MMICs after temperature step stress testing. An open circuit at a contact window was cross-sectioned to reveal extensive Kirkendall voiding within the device, together with voluminous aluminium palladium intermetallic phases. Several other examples demonstrated how this laboratory has enhanced the quality of RUAG products in orbit.

An interesting presentation was given by **Mr Dale Walkden** concerning the awareness of UK Ministry of Defence contractors to certain lead-free issues. Information was gathered by means of questionnaires and company visits.

It appeared to be clear that most companies had attempted to have mechanisms in place to manage lead-free issues. Most were aware of potential problems resulting from the growth of tin whiskers, mixing SnPb with lead-free alloys and the need for incoming inspection for pure tin.

Actual issues relating to lead-free had been experienced by the majority of responders, some related to tin whiskers and others to manufacturing, repair and solder joint reliability. This is a difficult and sensitive subject to monitor and Dale was keen to emphasise company and product anonymity.

Defence industries and similar organisations in other countries will probably have the same status regarding lead-free as determined by Mr Walkden's statistics.

An important minority of responders were considered to be of "high risk", as they either had insufficient understanding of lead-free issues and/or, they had limited mitigation strategies in place to manage the issues.

All topics related to the growth of tin whiskers on electronic materials are of great interest and **Martin Wickham** of the National Physical Laboratory in the UK was sure to highlight this during his presentation entitled "*The Attraction of Sn Whiskers*".

He began by outlining the many 'whisker works' presently being undertaken at NPL. One, the NPL tin whisker databank, involves partners forwarding components for storage and annual inspection – several of the submitted lead-free components have developed whiskers during the past 12 months, however for the DIL devices, no whiskers greater than 50% of the lead gap spacing has been observed.

The results of whisker resistance and, voltage versus current plots, were detailed by Martin. His results, not surprisingly, confirmed the measurements and findings published by the writer,

based on his tin whisker studies performed in the ESA-Estec laboratory 26 years ago!

A video was then shown and the audience were able to witness the electrostatic attraction of whiskers. The whiskers were seen to bend and become attracted to the pointed end of a microprobe situated at a distance of 50 microns and at a potential difference of 10V. Eventually the whiskers made physical and electrical contact with the probe, so creating a short circuit.

The effect of electric field was also demonstrated by means of whiskers growing on the surfaces of metal plates separated by a distance of 600 microns. The likelihood of electrical short circuits will increase due to this electrostatic attraction between whiskers and conducting surfaces when they are at different electrical potentials.

"*Industrial Failures due to Deviations from Design Rules*", was the following presentation by **Mr Karl Ring**, a veteran electronics failure analyst and Head of the ESA skills training school at the ZVE-Fraunhofer Institute in Oberfaffenhofen on the outskirts of Munich.

Examples of mechanical overloading and fracture of soldered joints were shown and the lessons learnt included :-

i) ensure proper mechanical support when manually attaching press fit connectors to pcb assemblies; and,

ii) small pcb assemblies should be detached from industrially assembled larger boards by milling because shear cutting bends the smaller board and cracks chip terminations.

Other examples:-

iii) cracked metallised chip capacitors were shown to be defective before assembly.

iv) gold embrittlement and fracture occurred when soldering to 3 microns thick gold on metallised ceramic.

v) thermal cycling fatigue failures of joints in plated through holes.

vi) absence of conformal coating caused dendritic growth and short circuits between adjacent tracks on a pcb exposed to some humidity and,

vii) high voltage melting of tracks due to poor requirements in international standards.

Karl's final case study involved examining the effect of fretting corrosion that had occurred between spring connectors and the mating surfaces of connector pads located on component-assembled pcbs. These circuits had been mechanically attached to a flexible metal sheet within the front door of a gambling machine. Here, the electronic units' design possessed no rigidity. Continuous movements and shocks, caused by the players of the machine, produced fretting and the build-up of oxides and corrosion products at the connection interface. The machines malfunctioned once the debris was thick enough to cause an open circuit.

Dr Pavel Shashkov introduced the EMPS audience to the novel "*Aluminium Nanoceramic Substrates for Thermal Management in Electronics*".

The process for producing this material has been patented by Cambridge Nanotherm, Haverhill, UK. Its high thermal conductivity and dielectric strength make it suitable for heat pipes and chip-on-heat sink applications.

The nanoceramic surface could be built up to a given thickness, possibly 40 microns, on thin aluminium sheet and used in spacecraft design as a printed circuit board substrate. Conducting

tracks based on gold, copper or platinum, can be easily coated onto the dielectric's surface.

The novel uses of Automatic Optical Inspection and X-ray inspection for high reliability pcb assemblies were described by **Kim Plauborg**, Director of the Danish company Terma A/S, based in Aarhus.

Numerous examples were shown where automated inspection proved to be more capable and more reproducible than human optical inspection.

Another presentation, given by **Thomas Mueller** of Zestron, Germany underlined the importance of "Cleaning before the Subsequent Processing" during electronic assembly.

Professor Jens Nielsen described the successful design, construction (by his students at the Aalborg University) and launch of a small Earth Observation satellite.

Students at this local university were again active with **Lars Alminde**, Director of GomSpace in Aalborg, during the completion and successful flight of a nano-satellite mission to demonstrate improved situational awareness for air traffic control. The resulting spacecraft images are extremely interesting and will be of great use to both ship and aircraft operators.

The Chairman's long term colleague and friend, **Mr Claes Berlin**, former Product Assurance and Quality Manager at Saab Space, and now owner of QUBE, Gothenburg, presented the post-lunch talk. Light-hearted and philosophical, "*From what to how – Process Management, a competitive tool*", was much appreciated by the Workshop participants as acknowledged by the duration of clapping.

Possibly too controversial, Claus' presentation is not available on the EMPS web-site! But all of the others are available, for both viewing and downloading.

Dr Barrie Dunn,

Chairman of the EMPS Workshop.

1 Luca Moliterni - *Italian Welding Institute, Genoa;* 2 Leo Schoberle - *IFE, Oberpfaffenhofen, Germany;*
3 Jussi Hokka - *ESA, Netherland;* 4 Karl Ring, *Fraunhofer Institute, Germany;* 5 Poul Juul - *Hytek;*
6 Bill Strachan - *Portsmouth University, UK;* 7 Barrie Dunn - *EMPS Chairman;* 8 Alex Christensen - *Hytek.*

An Observation

Use it or lose it ! Let the buyer beware

by ***Matthew Whyte***

Matthew Whyte

One was tempted to resort to Latin maxims to title this observation on the UK market for PCB laminates:

Uti aut amittamus! Caveat emptor,

but decided that plain English would convey a serious message more emphatically

We are not talking about a shortage of supply. Quite the contrary; there are probably too many suppliers, resulting in a potentially unstable situation. This can be perceived by an outside observer as a market which certain customers are in danger of spoiling, not just for themselves, but for the industry as a whole.

A study of the business models pursued by many a printed circuit board shop reveals a great similarity. Companies are understandably proud of their technical competence and maturity, their strong relationships with their customers, their understanding of their strategic place in the supply chain, their achievements, in meeting industry standards and gaining OEM approvals, and their willingness to go that extra mile in servicing their customers' demands.

And in the UK printed circuit industry, the emphasis is very much on service.

Those unfamiliar with the complexity of PCB manufacture can only marvel at the levels of competence and experience possessed by those technically-orientated souls who daily grapple with the intricacies and the culture of converting a sheet of copper-clad laminate to a complex PCB which meets all the customer's specifications and expectations, produced with a minimum of wastage, and in the minimal amount of time.

To achieve such a paragon of excellence, there is a critically important need to balance the processing competence's of the board shop with the availability of the right materials, meeting the required specifications and approvals, in the right quantities, and in the right place at the right time. And this need is met by the laminate manufacturer with a properly developed service infrastructure.

But this fundamental need is being challenged by an unwitting drift towards the more commercial aspects of the supply chain whilst losing sight of the reasons why such links need to be strong, and why they are. The human element creeps into the equation: materials buyers succumb to loss-leader offers from stockist and agents attempting to introduce their latest brand into the market, and the results are inevitably negative and potentially non-reversible.

The temptation for the materials buyer to play one supplier off against another is understandable. Professional commercial negotiation is reasonable and acceptable, but the provocation of a price war benefits no-one: inevitably the OEM laminate supplier has the strength and resources to drive the merchant out of the market and then take the opportunity in the longer term to recover his costs – at the customer's expense. Alternatively, in a limited market as exists in the UK, the OEM laminate supplier may decide to concentrate his efforts on supporting more substantial markets elsewhere. In either event, the local PCB manufacturing industry as a whole is the loser.

From the aspect of technical service and support, one could consider the difference between a specialist shop and a supermarket. Within the shop is, historically, an esoteric level of knowledge and service that rivals the deserted aisles with their soulless displays of merchandise; within a shop one can be advised on how best to employ a product, and on other complementary items that may enhance this employment. And the specialist will generally have a not only full range of his particular product lines in stock, but will even have some which are called for only occasionally (such as unbalanced copper, heavy copper, extra thick laminate for example) . Within a supermarket, assuming you can (a) find anyone and (b) anyone with any degree of technical knowledge, the chances are that you come away with something that, whilst seemingly lower in price, turns out to be more costly in application.

After 2003, and the rapid collapse of the PCB industry in the United Kingdom, there were many major suppliers who decided that it was no longer commercially viable to be regional, and tended to become more continental. Worries about the supply chain were considerable and the lack of choice as suppliers closed down or were bought up added to the concerns. Vacuums, however, tend to be filled, and usually by people who know the market, know the industry, and from previous experience know what it wants. They can bring stability to a supply chain, and support the major players, as well as the minor ones, by offering a level of technical service whilst supplying base materials at commercially realistic prices. Such companies tend to run 'lean', offering strong technical support and laboratory support, and combine knowledge of both product, and the production chain that it is to enter. Whilst the customer has his own expectations – yield, functionality, quality and price, he is not perhaps always aware of the limitations on the supplier that make it all possible.

Thus it is that pursuing the lowest price may, in the short term; prove to be the undoing of that vital element – the 90% plus availability on a same-day basis of the whole range of laminates and prepregs, standard or oddball, direct from the primary manufacturer, some of whom can also assist their laminate customers with the supply of ancillary materials such as copper foils, backing and entry boards and release films.

Once prices go through the floor-boards all that will be revealed is an empty basement, and the consequences for our domestic circuit board industry could be severe. Dealing directly with the laminator, and not with a coterie of would-be agents and distributors, who bring nothing to the table, avoids the terminator of instability.

Reverting to the Latin: *Uti aut amittamus! Caveat emptor*! Use it or lose it! Let the buyer beware.

Matthew Whyte
Matthewhyte48@gmail.com

Review of papers presented at the **Institute of Circuit Technology Darlington Seminar on 5th November 2013**

by Pete Starkey

"Remember, remember the fifth of November.... ", celebrated in the UK as Guy Fawkes Night or Bonfire Night; the anniversary of the failure of the Gunpowder Plot of 1605 when Guy Fawkes and fellow conspirators had planned to blow up Parliament and kill King James I, November 5th 2013 will be remembered by the stalwarts of the North-of-England PCB fraternity as the night when the attractions of the Institute of Circuit Technology Darlington Seminar outshone those of the fireworks party!

The programme was split between advances in PCB technology and some mechanisms available to help promote the transfer of technology and the development of export business.

High-resolution PCB imaging

Eric McLean

Technological innovation was central to the first presentation. **Eric McLean**, returning to his roots in PCB processing from a sabbatical in microelectronics, demonstrated what could be achieved in high-resolution PCB imaging with Rainbow's contact-print-on-wet-photoresist technique.

Of the many advantages of the process, perhaps the most significant was the extremely short optical path from photomaster feature through the thickness of the resist, typically 8 microns compared with a worst-case 69 microns for dry film. The outcome was that with a non-collimated light source of 6° divergence, a nominal 20 micron line would effectively expose as 21.7 microns compared with 35.4 microns for the dry film example.

The low coating thickness and high photospeed of Rainbow's 100%-polymerisable liquid resist enabled extremely short exposure times using low-energy LED UV sources.

A remarkable attribute of the coating system was its ability to tent relatively large holes, even though the coating was only 5-6 microns thick on the panel surface, and McLean showed examples of 0.9mm holes consistently tented.

In addition to the technical advantages of the process, there were environmental benefits including low material wastage, low energy consumption and the absence of solvents.

Knowledge Transfer Partnerships

Dr Andy Cobley

ICT Vice-Chairman Dr Andy Cobley, discussed how the Knowledge Transfer Partnerships programme was helping businesses to improve their competitiveness and productivity through the better use of knowledge, technology and skills that reside within the UK Knowledge Base, and speaking from his personal experiences as Director of the Functional Materials Applied Research Group at Coventry University described how the three principal players engaged in the KTP relationship: a company partner, a knowledge-base partner – generally a university or research association, and a KTP associate – generally a recently qualified person transferring the knowledge the company is seeking into the business via a strategic project.

Classic KTPs ran for 1-3 years, and Short KTPs for 6-12 months. There were currently over 700 partnerships running in the UK, with the government supporting 60% of the total eligible costs.

Dr Cobley's presentation prompted many questions from the audience – there was a lot of interest in the scheme and he outlined the qualifying conditions and application procedure.

Killing the myth: UK PCB manufacturers can only sell to the UK

Ian Kenyon,

Next came a case history from **Ian Kenyon**, Sales Director of GSPK Circuits, with a presentation entitled "Killing the myth: UK PCB manufacturers can only sell to the UK", describing how, with the commitment of the company, a determination to succeed in export markets and with the support of the government initiatives UK Trade & Investment (UKTI) and UK Export Finance, GSPK had become a truly international player, with a □6 million increase in sales over three years, and sales offices in Germany, France, Spain and Ireland. GSPK's achievements had been recognised with many business awards, including the prestigious Queen's Award for International Trade.

Kenyon explained how UKTI worked with UK-based businesses to ensure their success in international markets, and to encourage the best overseas companies to look to the UK as their global partner of choice, with an emphasis on innovative and R&D-active companies.

UK Export Finance was the UK's export credit agency, helping exporters and investors by providing access to working capital, credit insurance policies, risk insurance on overseas investments and guarantees on bank loans.

He reviewed the export challenges that his team had faced, and stressed the importance of communicating in the local mother tongue and understanding local logistics protocols and import regulations. "All UK manufacturers must acknowledge that UK PCB growth is dependent on export. There is a bigger market in Europe. If you want to achieve it be a structured approach, the opportunity is there!"

Susonence project, Progress

Dr Andy Cobley

The final presentation came from **Dr Andy Cobley**, making a second appearance because one of the scheduled speakers was unable to attend. He reported the progress of the Susonence project, developing ultrasonically enhanced surface modification processes for PCB and metal finishing applications, which had evolved out of an initial IeMRC-supported study and was now a multi-partner European eco-innovation project whose major objective was the first application of ultrasonically enhanced techniques for removing surface layers, etching, and texturing a variety of metallic, polymer and ceramic substrates with greatly decreased chemical consumption and significantly reduced environmental impact.

Current work was directed at the persulphate etching of copper, for applications including pre-treatment prior to electroplating, removal of conditioner prior to electroless plating, and pre-treatment of multilayer inner layers to improve bonding and resist adhesion.

Pilot-scale equipment had been designed and constructed to enable extended production trials at a European PCB fabricator.

Bill Wilkie

Bill Wilkie brought the formal proceedings to a close, thanking the presenters for their input , the delegates for their attention and acknowledging the generosity of GSPK Circuits for providing an excellent supper.

An interesting and informative evening, offering a positive alternative to rockets and firecrackers and, as ever, a tremendous networking event – the ICT has become the catalyst for bringing the UK industry together and membership numbers continue to increase.

Pete Starkey
I-Connect007
November 2013

A new project to develop novel PCB effluent treatment processes using materials from crab shells

Prof. Martin Goosey

The ICT has recently joined a new multi-partner research and development project to investigate the use of materials derived from crab shells for capturing and recovering metals from PCB manufacturing effluent.

With funding support from the UK's Technology Strategy Board (TSB), the seven partner, two year STOWURC (Sustainable Treatment of Waste Using Recycled Chitosans) project is aimed at developing sustainable materials and processes that use waste products from the seafood industry to treat effluent and recover metals such as copper.

The shells of crabs and other crustaceans, such as shrimps and lobsters, are a source of materials known as chitosans which have the ability to absorb metals including copper and nickel, as well as certain organic materials. They are thus able to recover the metals that are commonly found in PCB manufacturing effluent. The UK's seafood industry generates large volumes of shellfish waste which contains a material known as chitin. These materials are typically deemed to be of no value and are sent for disposal, often at a considerable cost. Therefore, the possibility of finding a use for these chitin-based materials could provide a sustainable use for what is currently an undesirable waste product. Although, the chitin found in crab shells absorbs metals, it can be easily converted, via a simple de-acetylation process, to chitosan, which is an even more efficient absorber.

A major objective of the project is to use these waste materials to produce chitosan-based granules that can sustainably treat the effluent produced by PCB makers and companies producing similar types of metal-bearing waste products.

A key initial aspect of the project will be to change the crab shells into useable materials and this will involve their mechanical and chemical conversion into a granular form with optimized absorption capabilities. The materials will then be evaluated over a range of operating conditions to determine how well they can absorb copper. Once saturated with copper, it will be desorbed into a solution from which it can be recovered as a metal by electroplating. The overall aim is to use the materials produced from the crab shells in a similar manner to ion exchange resins, so that once the metal has been desorbed, the chitosan materials can be reused. Again, the influence of absorption, desorption and plating conditions will be studied in order to optimize the overall process efficiency. Ultimately, the project partners are aiming to develop regenerable chitosan-based materials and to define accompanying processes for a range of metals.

The project consortium represents the whole requisite supply chain, from a supplier of crab shells to an end user PCB fabricator. Specifically, the partners are Kynance Cornish Crab, Chestech, Env-Aqua Solutions, C-Tech Innovation, Invotec, the Surface Engineering Association and the Institute of Circuit Technology. In addition to their own desire to develop and exploit the new technology, the project partners have also identified international interest in using chitosan-based materials from PCB manufacturers and there are also potentially much larger applications in other sectors, including surface engineering and metal finishing. The ICT is the dissemination partner for the UK PCB industry and it will deliver details of the project and progress to its members via presentations at its evening seminars and through articles in the Institute's journal.

Crab shells constitute a waste product that is typically expensive to dispose of; if successful, this project will enable them to become valuable raw materials that can used to treat waste from across a range of industries.

Martin Goosey

December 2013

Mike Rice BSc

Mike starting working at Mantracourt Electronics Ltd, a small local PCB assembly company based near Exeter, in 1982 at the age of 16. In 1983 he joined Circaprint plc (now The Eurotech Group plc) and he remained with the company for over 30 years. Initially

Mike worked in the drill department before moving to wet process, where he soon developed an interest in the technical side of the business and where he was fascinated by the role of chemistry in the manufacture of PCBs. Consequently he took upon himself to train as a chemist and obtained a degree in chemistry with the Open University.

He then moved to a technical role within the company and oversaw installation of both Black Hole and Silver technologies in the early 1990s, some of the first such installations in the UK. In 1994 he was made Technical manager and assumed responsibility for the whole of the Eurotech Group covering up to 4 sites in the UK and a joint venture in Azerbaijan.

More recently he also took on the Health and Safety Manager role, something he has also very passionate about. A key man in the company, Mike loved problem solving and was one of those rare people who actually understood pretty much everything about the details of PCB production from first principles. He was also keen to impart knowledge to others and always took time to help others whenever he could.

Outside of work he had a keen interest in Sailing, Fishing and Motorbikes. He will be sadly missed by all who knew him.

Our thoughts are with his wife Tracy and daughter Carleigh.

Mike Rice BSc
Technical and Health & Safety Manager
The Eurotech Group plc
Born 21 February 1966
Died 12 October 2013

Corporate Members of The Institute of Circuit Technology January 2014

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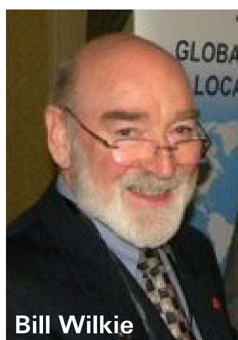

Bill Wilkie

The Membership Secretary's notes - January 2014

2013 was another successful year for the Institute, with membership continuing to grow above the 300 mark.

Our regional seminars were well attended and we had a record number attend our Annual Symposium at the Motor Heritage Museum in Warwickshire.

The ICT Annual Foundation Course in PCB Design and Manufacturing has now been running for over 30 years, and will be next held on the 14th– 17th April 2014.

In 2014 we look forward to celebrating the 40th Anniversary of the Institute of Circuit Technology and start the year with our AGM and Winsford Evening Seminar on the 6th March 2014, at the Chimney House Hotel in Sandbach.

We hope to make our Annual Symposium a very special event in 2014, and it is to be held at STEAM –the Museum of the Great Western Railway in Swindon on Thursday the 5th of June. We are also planning an anniversary dinner on the previous evening.

I would like to take this opportunity to thank all members and corporate members for their continuing help and support and wish them a Happy Christmas and a great New Year. *(Notes were written mid- December)*