Journal of the Institute of Circuit Technology

Vol.9 Apr-Sep 2016 Issue

2015 Events

22nd September ***ICT Evening Seminar***
Tuesday *at Newtown House Hotel, Hayling Island*
The REINDUSTRIALISATION of EUROPE
bill.wilkie@InstCT.org

24th November ***ICT Northern Evening Seminar***
Tuesday *at St. Georges Hotel, Darlington*
bill.wilkie@InstCT.org

2016 Events

1st March ***ICT Evening Seminar & AGM***
Tuesday *at the Hilton Puckrup Hall Hotel, Tewkesbury.*
bill.wilkie@InstCT.org

11th-14th April ***ICT Annual Foundation Course***
Monday - Thursday *at Loughborough University*
bill.wilkie@InstCT.org

13/14th April *EMPS-7th Electronic Materials and Processes for Space Workshop*
Wednesday-Thursday *at Portsmouth University*
http://emps.port.ac.uk/documents.html

1stJune ***ICT Annual Symposium in Birmingham***
Wednesday
bill.wilkie@InstCT.org

20 September ***ICT Hayling Island Seminar***

1 December ***ICT Harrogate Seminar at the Majestic Hotel, Harrogate***
bill.wilkie@InstCT.org

Editorial	2
Council Members	2
Membership News	2
ICT Tewkesbury Seminar 1st March 2016 *Peter Starkey*	3 - 6
ICT Birmingham Seminar 1st June 2016 *Peter Starkey*	7 -11
ICT Hayling Island Seminar 20th September 2016 *Peter Starkey*	12-15
News Item **Martin Goosey appointed Visiting Professor**	16
News Item **'Crabs'Project wins Environmental Award**	17
EIPC Workshop on PCB MEMS 1st December 2016	18
ICT Corporate Members	19
Notice **ICT Harrogate Seminar**	20

Editorial

Dear Members

Please accept my apologies for the very late publication of the *Journal*. This was due to my illness and disability.

My thanks to Richard Wood-roe for producing a very fine interim issue (Vol.9 No.3.pdf), some of which is duplicated in this publication.

It is now planned to produce the next normal issue in early January 2017.(Vol.10. No.1)

Bruce Routledge

Membership *New members notified by the Membership Secretary*

10400 Tracy Hodges M.Inst.C.T.
10401 Gavin Brown M.Inst.C.T.
10402 Philip King M.Inst.C.T.
10403 Paul Goodfellow M.Inst.C.T.

Corrections & Clarifications

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

The Journal of the Institute of Circuit Technology is edited by Bruce Routledge on behalf of the ***Institute of Circuit Technology.***
4 Burnhams Field, Weston Turville, HP22 5AF. Tel:01296 394 383 E-mail : brucer@john-lewis.com

Review of :-

ICT Tewkesbury Seminar

1st March 2016

by **Pete Starkey**

2016 AGM of the Institute of Circuit Technology

The **Annual General Meeting of the Institute of Circuit Technology** was held at Puckrup Hall, near Tewkesbury in Gloucestershire, England, on 1st March 2016, and was followed by a well-attended evening seminar with presentations on a novel laser-induced deposition process, an analysis of the market for PCBs, and a review of three development projects in which the Institute had participated. The programme was introduced and moderated by ICT Technical Director **Bill Wilkie**.

Laser-induced forward transfer (LIFT)

Dr James Shaw-Stewart

Could laser-induced forward transfer (LIFT) offer a novel deposition process for PCBs?

Dr James Shaw-Stewart, senior lecturer and researcher at Coventry University, gave an insight into the concept and applications of LIFT in transposing images from a donor substrate onto a receiver substrate. The transferred material could be a solid metallic or non-metallic film, or a liquid nano-ink, coated onto a sacrificial photosensitive layer on a transparent substrate. Ablation of the photosensitive layer by a laser caused transfer material to be propelled forward as "flyers", and deposited on the receiver, placed a short distance away. A video illustration of an early example showed an 80 nanometre aluminium layer on a 350 nanometre photosensitive layer being successfully transferred across a 1 millimetre gap at a laser intensity of 270 milliJoules per cm^2 and the efficiency of transfer increased as pressure was reduced from atmospheric. A further example demonstrated how a pulsed laser could be combined with a video image source to transfer a donor nano-ink to a substrate on an X-Y platform. The laser energy required to drive the transfer was significantly dependent on the viscosity of the ink.

LIFT techniques had been successfully used to build several different types of organic semiconductors, sensors and capacitors, and as a means of creating micro-bumps on flip-chip packages. The US Naval Research Laboratories had demonstrated the capability to laser-print metals to form microbridges and microcantilevers. More recently, extreme-aspect-ratio copper structures had been deposited from a solid copper donor. Dr Shaw-Stewart's description prompted a question from the floor about the possibility of applying LIFT techniques to the repair of open circuits on PCBs and it was acknowledged that this was a topic worthy of investigation.

Dr Shaw-Stewart concluded his presentation with "something a bit different" - a discussion of what could be accomplished by a technique known as scanned mask imaging (SMI), a development in which he was collaborating, which achieved excimer-style beam uniformity with cost-effective solid-state lasers. The system used a scanning 355 nanometre laser, with optics to shape the beam and project it onto a static substrate through a static photomask, to structure interconnects as fine as 3 micron lines and spaces with 10 micron vias. Scanned mask imaging had the potential to bridge the 1 micron to 10

micron “technology gap” between silicon wafer and PCB design rules in advanced packaging applications.

Business forecasting

Francesca Stern

From imaging technology the attention turned to business forecasting. Market analyst and ICT council member Francesca Stern presented an outlook on the global PCB and electronics industry, beginning with an overview of trends in world electronics equipment production.

Overall value in 2015 was about $1.5 trillion, almost unchanged from 2014, and distributed geographically: Asia 53%, North America 19%, Europe 15%, Japan 3%, Rest of World 10%. The forecast for 2016 was for a slight overall increase to $1.6 trillion.

Looking specifically at PCBs, world production in 2014 had been $60 billion, and this had declined about 3% in 2105 to an estimated $57.8 billion with slight growth in Europe and North America, no growth in Japan and a slight decline in South Korea and Taiwan. There had been a huge variation in the fortunes of the top twenty-five PCB fabricators in 2015, for example Fujikura showing as much as 46% growth whereas Daeduck’s figure was -22%, the overall average being 1.6% growth. Exchange rates could distort figures such that apparently positive growth measured in Asian domestic currencies could in fact be negative when converted to US dollars.

In terms of geographical distribution, of the $57.8 billion world PCB production total for 2015 China accounted for 46%, Europe 4%, and North America 5%. And the end market for PCBs was 45% in China, 10% in Europe and 8% in North America. The corresponding figures for 2016 were forecast to be $59 billion total, with production from China 46%, Europe 4% and North America 5%, supplying a market of which 46% in China, 10% in Europe and 8% in North America.

The outlook for the UK PCB industry was that the current downward trend would bottom-out mid-2016, and move into positive growth by the end of the year, peaking mid-2017 then cycle down again. European PCB production would follow a similar cycle, but with smaller peaks and troughs.

STOWURC and MACFEST.

Professor Martin Goosey

Back to technology developments, as Professor Martin Goosey took the floor with an update on ICT’s research and development projects, specifically the two current Innovate-UK funded programmes in which the Institute was the dissemination partner, STOWURC and MACFEST. (The acronyms stand for Sustainable Treatment Of Waste Using Recycled Chitosans, and Manufacturing Advanced Coatings for Future Electronic Systems)

The two-year STOWURC project, which had developed new effluent treatment processes using materials derived from crab shells had just reached a satisfactory conclusion, and demonstrated how a natural waste product from one industry could be utilised to treat waste from another industry by removing and recovering trace metals from PCB and metal finishing process effluents. Background to the project was that the seafood industry produced large quantities of shellfish waste, which was becoming increasingly expensive to dispose of. The potential value of crab shells was that they contained a compound called chitin, which was capable of absorbing metals, and one gram of shell could potentially absorb up to 250 milligrams of copper. A typical PCB factory effluent could still contain several parts per million of copper after normal effluent treatment, which required to be reduced to lower levels to satisfy discharge regulations, generally by the use of ion-exchange resins. Crab shells offered a readily-available natural alternative, and the project partners had comprehensively investigated and optimised the physical, chemical and economic parameters required to achieve a practicable and cost-effective effluent treatment

process, which was currently running successfully at 100 kg pilot-plant scale in a large PCB factory. An additional application of crab shell materials was as the active component in spill kits and static drag-out bags, to treat spills and localised effluent issues, and this had also been successfully demonstrated. Full details of the project and further information could be found on the website www.stowurc.co.uk .

The two-year MACFEST project had set out to utilise the properties of ionic liquids to produce solderable finishes with improved joint reliability, and had just passed its half-way point. New ionic-liquid-based nickel-palladium-gold systems were being investigated and a process for the deposition of good quality palladium and gold coatings onto 'aqueous' electroless nickel has been developed. PCB test coupons were currently being prepared for evaluation, and would also be tested as part of a major SMART Group programme taking place over the coming few months. Potential benefits of coatings resulting from the MACFEST project would be a reduction of environmental impacts through the elimination of cyanide-based aqueous chemistries and a reduction in the amount of palladium consumed. The principal technical benefit would be the elimination of known reliability issues with nickel-palladium-gold finishes deposited from aqueous chemistry, particularly black pad effects, brittle joints and void formation. And the new coatings would meet the requirements of the industry and current IPC standards. Further information could be found on the website www.macfest-project.co.uk .

Maskless electrochemical patterning of materials, (MESMOPROC)

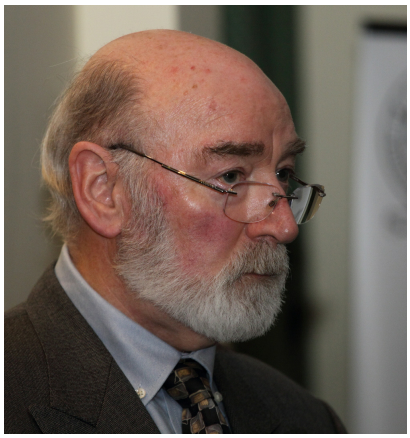
Project Manager and Research Fellow at Coventry University, Narinder Bains gave the final presentation, on the optimisation of process conditions for the maskless electrochemical patterning of materials, with particular reference the university's collaboration in the MESMOPROC project, co-funded by the EU Eco-Innovation initiative.

The concept of electrochemical 'maskless' selective metallisation of materials had been established and demonstrated in the Enface process, where instead of a plating resist image being applied photolithographically to each workpiece then stripped off after a single operation, the image was applied to the anode and effectively re-used many times. With the selectively masked anode placed close to the workpiece, and using a low-acid, low-metal electrolyte and good agitation, the pattern on the anode could be replicated in metal deposited on the workpiece, enabling selective metallisation of microscale devices, components and printed circuit boards. A limitation of the process had been the difficulty in maintaining the intensity and uniformity of solution agitation when scaling up the electrochemical reactor.

In the MESMOPROC project, low frequency ultrasound was introduced to the system to enable high efficiency, focused agitation. The team at Coventry, with many years' experience of ultrasonics applications, had modified the reactor to incorporate ultrasonic transducers and had studied the general effects of ultrasound on the electrochemical deposition process. The team had then studied the effects of ultrasound on deposit quality in low metal, low acid copper electrolytes with commercial electroplating additives. It had been demonstrated that low or no acid electrolyte formulations, together with very narrow anode-cathode spacing gave the best image reproduction and good deposit quality, although low frequency ultrasound tended to increase additive consumption. The overall conclusion was that ultrasound increased the limiting current density and opened up the process window.

The MESMOPROC process had been demonstrated and validated at pilot scale in a PCB shop and a specialist plating shop, and offered enhanced efficiency through a shorter and simpler process using fewer

materials and less energy, with reduced waste generation and CO2 emissions. Further information could be found on the website www.mesmoproc.eu.



Bill Wilkie

In his closing comments, Bill Wilkie acknowledged the generosity of Exception PCB Solutions in supporting the event, and reported that the membership of the Institute continued to increase, presently standing at over 350, with members drawn from over 100 companies. The seminar had once again brought together an enthusiastic group of industry professionals to further their technical knowledge and their awareness of business trends, and, equally importantly, to network with their peers.

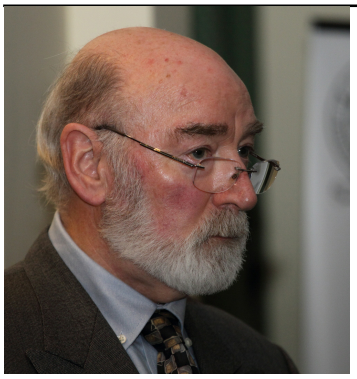
I am grateful to Alun Morgan for allowing me to use his photographs

Pete Starkey
I-Connect007
March 2016

Review of :-

42nd Annual Symposium of the Institute of Circuit Technology, Motorcycle Museum in Birmingham 1st June 2016

by **Pete Starkey**



Bill Willkie

Technical Director **Bill Willkie** introduced the 42nd Annual Symposium of the Institute of Circuit Technology, at the Motorcycle Museum in Birmingham, UK, commenting upon the success of the recent Foundation Course and acknowledging the sterling efforts of his course tutors, although recognising that some of his longest-standing experts were now retiring. With Institute membership currently standing at 422, there existed a wealth of talent from which he hoped to strengthen his team.

Automotive Electronics

Alun Morgan

Keynote presentation came from **EIPC chairman Alun Morgan**, with a highly informative and occasionally humorous insight into the evolution of automotive electronics, from 1986, when Karl Benz produced the first petrol-engined automobile, which at least had an electrical ignition system, to the present day where, in a world automotive market worth $600 billion, electronics represents 40% of the value. There had been rapid growth over the last decade, as a consequence of developments in lightweight materials, miniaturization, intelligence and electrification.

The first introduction of electronics into the automobile was in 1930, with Motorola's car radio, costing over $100 before installation, which was a major job occupying two men for several days and involved substantial modification to the bodywork and interior trim. The installation manual had 28 pages of instructions!

Once in-car entertainment had become established - radio, 8-track stereo, cassette tape and CD player along the way - the next generation of automotive electronics was engine management, with the Bendix Electrojector electronic fuel injection system in 1958, although the early electronic components were not reliable in under-the-hood service. The technology progressed through the 1960s, and the Bosch D-Jetronic became the industry standard in1975. ABS braking evolved through the 1970s and 1980s, became the norm in the 2000s, and was an early example of the synchronisation of a group of inputs to execute a function as a system.

Presently, vehicle electronics could be grouped into four functional domains:

(1) powertrain, including engine control, transmission control and start/stop systems;

(2)control/body, including air conditioning and climate control, dashboard, wipers, lights, doors, seats, windows, mirrors, cruise control, park distance control, alarm, keyless entry;

(3) multimedia/entertainment, including multimedia, infotainment, GPS and in-vehicle navigation systems, CD/DVD players, rear-seat entertainment;

(4) and safety, including rollover sensors, airbags, belt pre-tensioners, antilock braking, electronic stability programs, automatic stability controls, adaptive cruise controls, tyre pressure monitoring systems and auto lane keeping.

Morgan referred to an announcement by Toyota that they will integrate between 60 and 100 electronic control units into these four functional groups.

He discussed layers of increasing integration, from the low-level electronic system platform, up through intelligent actuators and integrated vehicle control, to direct vehicle-to-vehicle interaction and the control of vehicle groups and fleets.

The Internet of Things was driving the next generation of development, although there would inevitably be some issues related to the security of data and the protection of privacy that would have to be resolved.

Morgan switched his focus from electronic functionality to road safety trends. European statistics indicated a 26% reduction in annual road fatalities between 2009 and 2013, whereas the USA only achieved 3%, for reasons he could not explain. The fatality reduction forecast for intelligent vehicle safety systems indicated that electronic stability control and lane keeping support had by far the greatest potential for reducing fatalities. Electronic stability programme sensors and systems for anticipating problems could take corrective actions faster, and with more functionality to control the vehicle, than even the most skilful of human drivers. And he illustrated their capabilities with scary but very convincing video case studies. Elegant collision avoidance radar systems were becoming available, having evolved from early prototypes in the mid-1970s, and the achievement of accident-free driving as the objective, and systems were migrating to higher operating frequencies as a means of offering a homogeneous concept for deployment in the mass market at affordable cost. The car was becoming an intelligent vehicle that understood what was going on around it as well as within it. On a salutary note: the more complex the electronics, the more to potentially go wrong - recall figures had shown a steep rise through the 2000s, and were plateaued at an uncomfortably high level.

`Recently introduced all-electric vehicles - Morgan's example was the Tesla-S - were mechanically far simpler than conventional vehicles: in essence, an assembly of batteries constituting the floor pan and an electric motor driving each wheel, with digital control of motors, brakes and steering, and active, traffic-aware cruise control effectively offering "autopilot" capability.

REPRIME project,

Dr Steven Brewer

From automotive electronics, attention turned to metal finishing and printed circuit processing:

Dr Steven Brewer from C-Tech Innovation described the objectives and achievements of the **REPRIME project**, funded by the Home Office to investigate the application of advanced ultrasonics to enable the replacement of poisons and explosive precursors used in industrial metal finishing processes and the manufacture of printed circuit boards. The Home Office was conscious that quantities of chemicals which could support terrorist activities were held by SMEs in relatively unsecure locations, and wanted to work with industry associations to find alternative materials via technical solutions rather than by legislation.

Objectives were to overcome the barriers to the use of cyanide-free technology, to demonstrate cyanide-free zinc and zinc-nickel plating on an industrial scale, to extend the work to cyanide-free copper, gold and silver plating, to reduce hydrogen peroxide use in the printed circuit industry and to ensure that the technology could be easily and cheaply retrofitted to existing equipment.

It had been demonstrated in a pilot line that the use of ultrasound enhanced the deposition rate of cyanide-free zinc electroplating plating chemistries and improved coverage and distribution on complex

shapes. Ultrasound enabled the use of reduced concentrations of hydrogen peroxide in etchant solutions used in PCB manufacturing, and gave improved bath life with reduced frequency of replenishment and no adverse effect on downstream processing.

The project had been successfully completed, and was being rolled out to industry with continuing support from the Home Office, the Surface Engineering Association and the ICT. Update information was available on the project website www.reprime.co.uk.

tec-speed™ product

Tamara den Daas-Wijnen

Tamara den Daas-Wijnen, Ventec's Global Account Manager OEM Marketing, introduced the **tec-speed™ product portfolio**, which positioned Ventec's comprehensive range of high-speed low-loss PCB laminates under a clear single-brand identity, symbolised by a sharp-pointed pyramid with standard-loss material at the base and ultra-low-loss at the apex.

"Upwards is the direction we are going, as a technology leader - no longer a me-too!" was her comment. She described in detail the characteristics and properties of two examples from the range: tec-speed 3.0 (VT-464L) and tec-speed 6.0 (VT462S). tec-speed 3.0 was a high-Tg halogen-free low-loss material for telecom and networking applications, with Dk 3.7 and Df 0.009 at 50% resin content, which had better electrical properties and was more thermally robust than competitive products.

She quoted reliability results for a 32-layer 4 mm thick construction with 0.3mm holes at 0.8 and 1.0 mm pitch, withstanding 10 lead-free reflow cycles at 280°C without failure, and explained how Ventec's glass treatment and resin-impregnation procedure led to remarkable improvements in CAF resistance. Similar thermal reliability results were achieved with the ultra-low-loss tec-speed 6.0 material. The electrical performance characteristics of tec-speed 6.0 were interesting, particularly the fact that at 10GHz its Df decreased with increasing resin content - a consequence of the resin having lower dielectric constant than the glass.

Ms den Daas-Wijnen concluded her presentation by commenting that the whole of Ventec's supply chain was accredited to AS9100C - the only laminate manufacturer able to make that claim. And the Ventec App was now available, with instant access to data for the whole product portfolio.

2015 annual outlook on the global PCB and electronics industry

Francesca Stern

Industry analyst and ICT Council member **Francesca Stern** delivered her annual outlook on the global PCB and electronics industry, reviewing world trends in electronics and PCB production, and how they related to the industry in the UK.

Global electronics production, including components, for 2015 totalled $US 1861 billion, with China accounting for 38%, the rest of Asia-Pacific 22%, Japan 7%, the Americas 18% and Western Europe 11%. Principal end-use markets were cell-phone, standard PC, digital TV and automotive. Standard PCs and tablets were showing negative growth, but there was continuing growth in medical electronics and huge growth in Internet-of-Things applications.

` Electronic equipment production in Europe and North America remaining strong in 2015 in the industrial, instrumentation and automation sectors. There had been little growth in the military sector, but it was forecast to increase slightly in 2016. Growth in infrastructure equipment for 4G long-term-evolution had slowed in 2015, but industrial and instrumentation electronics production grew in China. UK electronics production, which had grown 3% in 2014, had fallen by1% in 2015.

PCB production in Europe had declined by 3% and some recovery, but no growth, was expected in 2016. Growth had been low in North America and there had been further decline in Japan. Exchange rate fluctuations could lead to distortions of the figures; for example, measured in domestic currencies, there had been positive growth in Asia, but negative if measured in US dollars. The outlook for 2016 was that it would be similar to 2015, with a recovery towards the end of the year, and the next surge expected in 2017-2018.

Ms Stern commented on recent updates to the Open General Export Licence (OGEL) by the UK government, which made it easier to export PCBs to most worldwide destinations for military contracts, and other more sensitive counties including China for aerospace and industrial-grade PCBs. The Export Control Organisation (ECO) was currently looking for feedback from PCB companies as to how these changes were affecting their business.

Applications of deep eutectic solvents in PCB surface finishing and electronics assembly, and an update of the MACFEST project.

Dr Andrew Ballantyne

Dr Andrew Ballantyne from University of Leicester presented a review of the **applications of deep eutectic solvents in PCB surface finishing and electronics assembly, and an update of the MACFEST project.**

He explained that deep eutectic solvents are types of ionic liquids in which organic cations are combined with halide anions and complexing agents to make an anionic complex. The specific example used in his research work was composed of ethylene glycol and choline chloride in 2:1 molar ratio and known as Ethaline 200, which was relatively inexpensive and environmentally benign. Ethaline 200 had low vapour pressure and good thermal stability, and exhibited unusual solvation properties with metal salts. Its benefits had been demonstrated in metal finishing applications such as electropolishing, electroplating and immersion plating, as well as metal recycling and energy storage. It had also shown remarkable properties as a flux, enabling soldering direct to electroless nickel and other difficult-to-solder metal surfaces.

The MACFEST Project, which was co-funded by Innovate UK, aimed at producing a "Universal Surface Finish" for electronics, capable of reflow soldering and wire bonding with gold, copper and aluminium. Required attributes were high reliability, good planarity and long shelf life. Deep eutectic solvent technology was being employed to improve functionality and to reduce safety and environment concerns. The first 15 months of the 24-month project had been completed.

Using a proprietary electroless nickel with an amorphous nodular structure and 8% phosphorus to form the base layer, immersion palladium had been deposited from Ethaline at 80°C to a thickness of 70-100 nanometres in 30 minutes. The palladium deposit had been over-plated with gold from a second Ethaline-based formulation at 50°C for 9-15 minutes. The source of gold could be either gold chloride or sodium gold thiosulphate, and bright uniform deposits had consistently been achieved from a chemistry free from acid and cyanide. This "ENIPIG" - electroless nickel, immersion palladium, immersion gold - finish had shown excellent solderability, with no evidence of "black pad" or "mud-cracking" effects on the nickel surface associated with acid attack when traditional aqueous chemistries were used.

Reviews of current research projects in which the ICT was a collaborator. REPRIME and MACFEST

Dr Andrew Cobley ICT Chairman

The final speaker was **ICT Chairman Dr Andrew Cobley**, from Coventry University, who **reviewed current research projects in which the ICT was a collaborator. REPRIME and MACFEST** had been discussed in earlier presentations, but two new projects were in their early stages.

The first was Selective Electroless Catalysis in a Magnetic Field (surprisingly, no acronym!), led by Coventry University. The concept was to use a magnetic field to selectively catalyse a material prior to electroless plating, using a template of magnetised iron rods placed against the reverse face of a thin substrate to attract catalyst selectively to the opposite surface. Proof of concept was being funded by Higher Education Innovation Funding (HEIF). A patent had been filed, and a PhD student would be working full-time on the project from September 2016. Other sources of funding, for example Horizon 2020, were being explored.

Acronyms again! The second project, SYMETA - SYnthesizing 3D METAmaterials for RF, microwave and THz applications - was being led by Loughborough University and funded by EPSRC. This project was looking at creating new materials for additive processes, to form substrates and conductive meta-atoms, and would take a radical new approach to high frequency circuit manufacture. Developing a more rational and sustainable use of materials would reduce waste, timescales and cost of manufacturing processes.

The main contribution of the ICT to these projects was as a dissemination partner, and the benefits of involvement were that the ICT could influence the direction of research and quickly inform its members of the latest R&D developments, as well as creating opportunities for ICT members to engage in and obtain funding for research.

Dr Cobley wrapped up the proceedings, thanking speakers for sharing their knowledge and experience, delegates for their attention, Ventec Europe for their generous support, and Bill Wilkie for once again organising a splendid event. Delegates made the most of the networking opportunity, and an impressive number of motorcycle enthusiasts emerged from the group to spend a while admiring the exhibits in the museum before departing.

I am grateful to Alun Morgan for allowing me to use his photographs.

Pete Starkey
I-Connect007
June 2016

Review of :-

ICT Hayling Island Seminar

20th September 2016

by **Pete Starkey**

In recent years, the Hayling Island Seminar has become established as the most popular date on the Institute of Circuit Technology calendar and, as expected, the 2016 event attracted a large gathering of industry professionals to the south coast of England to share knowledge and experience and to discuss current developments.

Made welcome by ICT Technical Director Bill Wilkie, delegates were treated to a series of presentations, not only on technology but also on utilisation of social media in business, PCB market analysis, and some of the obstacles to be surmounted in starting a new PCB manufacturing plant in central Europe.

Acid copper electroplating

Andrew Barlow

Andrew Barlow from MacDermid Enthone demonstrated how innovations in acid copper electroplating could help overcome some of the challenges of density and thermal management associated with modern HDI designs. Via filling and stacking had become established as a means of increasing interconnection density, but copper-filling of through-holes offered a more reliable process, with improved electrical and thermal conductivity.

How could this be achieved by electroplating?
Clearly, substrate thickness and hole diameter were significant considerations, but the two-step process he described had already been shown to be successful for mechanically drilled holes as small as 0.2mm in substrates up to 0.8mm thick, and work was in progress to extend the proven capability to include 0.15mm holes in 0.45mm substrates and 0.1mm holes in 0.35mm substrates. Laser-drilled "X-holes", popular in mobile phone PCBs, were easier to fill, and nominal 0.15mm holes in 0.2mm thick substrates had been successfully demonstrated.

The key first step was to form a copper bridge at the centre of the hole, effectively closing it to create two opposed blind vias, before filling these blind vias with electroplated copper.

A very specialised procedure was required to form the bridges - solution agitation and electrical waveform were critical factors. Banks of eductors gave extremely high solution movement across the surface of the work – a typical working installation had 60 eductors on each side, directly impinging upon the cathode surface with a solution flow of 3 litres per minute per nozzle, and 100 tank turnovers of electrolyte per hour. This solution agitation was combined with knife edge mechanical agitation, with a 10cm stroke at 6-12 cycles per minute

With insoluble anodes and asynchronous PPR rectification specifically tuned to suit the hole sizes being bridged, and anode-cathode spacing of approximately 4cm, best results were obtained if the range of hole diameters was kept to a minimum by the designer. Once the holes were bridged, the via-fill step employed an additive that was preferentially attracted to high-current-density areas so that electrodeposition was favoured at the bottom of the blind vias, so that they became progressively filled with copper without excessive deposition on the surface. Cycle times varied depending on via size, but 75 minutes was typical.

Barlow showed many examples of microsections and x-rays confirming void-free hole-filling, and no cracking or adhesion loss

between copper interfaces had been observed after 6 x 10 second solder shocks at 288°C. End markets for the bridge-and-fill technology included IC substrates, LED, military, aerospace and automotive.

"Lab-on-PCB" technology for medical diagnostic applications. "

Dr Despina Moschou

Dr Despina Moschou, until recently a research fellow at the University of Southampton and currently Prize Fellow in Bioelectronics at the University of Bath gave a fascinating presentation on "Lab-on-PCB" technology for medical diagnostic applications. "In the micro-scale, things change in the fluidics of fluids" she began her introduction to microfluidics: miniaturised systems to bring together microscopic volumes of liquids, transducers and microelectronic components to form biosensors.

She went on to describe the characteristics of microfluidic chips, which had micro-channels etched or moulded into a glass, silicon or polymer substrate. The micro-channels forming the microfluidic chip were interconnected to perform functions such as mixing, pumping and sorting, and connected to the outside by inlets and outlets pierced through the chip.

The trend towards smarter multi-functional microchips had resulted in the micro total analysis systems known as "Lab-on-a-Chip": integrated systems of reduced size and weight, performing sample handling steps and analytical measurements faster, at lower cost and with less chance of human error than traditional techniques.

"Lab-on-PCB", originally suggested in the 1990s as a cost-effective integration platform but side-lined by easier microfluidic fabrication processes, had recently become a main focus of attention because the long-standing industrial infrastructure of PCB technology enabled low-cost upscaling and currently offered adequate microfabrication capabilities: it was not necessary to work at the nanometre scale - 100 micron technology was sufficient.

Dr Moschou illustrated fluidic controls such as microvalves and micro pumps that had been integrated into PCBs, described various biosensor devices and discussed the results of the collaborative ELISA project, which had used exclusively PCB manufacturing techniques to successfully fabricate a 3-layer multilayer Lab-on-PCB measuring 4.6cm x 5.7cm with reference electrodes in layer 1, sensing electrodes in layer 2 and microfluidics in layer 3. There was significant interest both from academia and from industry in further developing the Lab-on-PCB concept.

Open general export licences (OGELs)

Ken Ball

Ken Ball from techUK, the association representing technical businesses in the UK, took a slot in the seminar programme at short notice with news from the Export Control Reform working group about updates to **open general export licences (OGELs)** for the export of "low risk" electronics components, which covered PCBs and components for military goods and for PCBs and components for dual-use items. Military OGEL applications covered all countries except Afghanistan, Argentina, Armenia, Azerbaijan, Belarus, Burma, Central African Republic, Democratic Republic of Congo, Eritrea, Iran, Iraq, Ivory Coast, Lebanon, Liberia, Libya, North Korea, Pakistan, People's Republic of China, Russian Federation, Somalia, South Sudan, Sudan, Syria, Yemen and Zimbabwe. He also commented on business issues regarding digital licencing and apprenticeship levies, and that techUK was seeking opinion from British industry on the possible consequences of "Brexit", in order to feed concerns back to government.

The seminar took on a different dimension when **Daniel Knowlton** literally leapt into action with an energetic and animated promotion of social media as tools for growing businesses. "**Get to grips with digital**

Get to grips with digital Marketing

Daniel Knowlton

marketing, it's hugely, hugely, hugely powerful! After today you will all be inspired to use social media!" he confidently predicted. "Marketing is all about attention. It used to be print and billboards – if you're not changing with the times, you're going to get eaten up. Become part of an on-line community – it's a great way to develop presence and brand awareness, build relationships and generate sales! Become a key centre of influence! The average user spends 2.3 hours a day on social media – people are forever checking their phones to be up to speed with what's happening and to make sure they're not missing out!" "Who is this bloke, and why should I listen to him?" was the rhetorical question he asked the audience, before cataloguing his credentials, which included being one of the world's top 100 influential people in digital marketing and having won an award as social media business of the year.

While moving around a lot, talking very fast and referring to strange-sounding websites, he commanded the attention of the audience as he listed five steps to social media success:

Step 1, find out who are the highly influential people in your industry, using sites like Followerwonk, and what information they are sharing, using sites like Buzzsumo, Socialmediaexaminer, Bufferblog and Blog.Bufferap.
Step 2: Use free resources to learn.
Step 3: Follow the influencers.
Step 4: Create an action plan.
Step 5: Measure success using social media analytics like KLOUT.

Son of business improvement specialist Mark Knowlton, a popular contributor to ICT events on the subject of Lean Manufacturing, Daniel Knowlton certainly left an impression on his audience. How applicable his techniques would be in the high-end electronics business, how inspired the specialist PCB manufacturer would be to use social media to supplement his direct technical sales effort will remain to be seen. The community printed circuit board platform Ragworm has already demonstrated the effectiveness of social media in driving its basic PCB prototyping service. Maybe the industry establishment should open its eyes, take notice of the ideas of an eager up-coming generation and recognise the influence they will have on the industry's future....

Latest outlook on the PCB and electronics industries

Francesca Stern

Back to normality: market analyst and ICT council member **Francesca Stern** gave her **latest outlook on the PCB and electronics industries**, based on UK and global trends in electronics production and the PCB production supporting it. Excluding components, global electronics production in 2015 was £980 billion, of which Europe's share was about £150 billion with the UK contributing about £12.5 billion. UK PCB production in 2015 had been estimated at £125 million, against a market demand in excess of £168 million.

Electronics equipment production in Europe and North America remained relatively strong in industrial, instrumentation and automation in 2015, whereas military expenditure had been low to flat but was forecast to creep up in 2016. UK electronics production had declined slightly in 2015 and continued to decline in the first half of 2016, more in the export market than the home market. PCB production had declined in Europe in 2015 and there had been some recovery in 2016 but no growth yet, although it was forecast to go positive in late 2016 or early 2017. PCB production in the UK was following a similar trend. There was low growth in North America and further decline in Japan. Measured in domestic currencies, there had been some growth in Asia but exchange rate changes meant that this was negative if converted to US dollars.

Repercussions of the "Brexit" referendum

Steve Driver

Exchange rates were a sensitive topic as the seminar programme concluded with the last-minute arrival of dare-to-be-different SCL PCB Solutions Group CEO **Steve Driver**, just back from Romania with an update on his PCB factory start-up there and comments on the **repercussions of the "Brexit" referendum**. In his opinion, the decision to leave the European Union was horrible news, and a lot of damage had already been done to the UK and to the PCB industry. For a company like Spirit Circuits, a significant proportion of whose business involved imported PCBs paid for in US dollars, the plunge in the value of the pound had major financial consequences. And imported materials and equipment would inevitably cost more - all hurting cash flow and profitability. "We're all in the same boat – we just have to keep calm, hunker down and take actions!"

What was the latest on the Romanian enterprise? "I've never worked so hard!" Romanian bureaucracy continued to frustrate his efforts to get the operation into production. He had only gained access to the industrial unit three weeks before, and his advance team of 16 people was working round the clock to get the basic factory infrastructure into place – cleaning, digging holes, laying concrete. And Driver was still awaiting formal authorisation to use the building for PCB manufacture. "The principle of it being better to seek forgiveness than to ask permission doesn't work in Romania!" he commented, taking as an example a document 142 pages long with stamps – "they're obsessed with them!" – on every page. The bureaucracy was also causing delays in obtaining waste water permissions and establishing electricity supplies. But Driver was determined to see the project through. The advance team had undergone 6 months training in the UK, the plan was to extend the workforce to 41 by January 2017 and to 100 later in the year. Three trucks-full of equipment were already in Romania, another five were loaded and ready to go, and pilot production was scheduled to start in December. Steve Driver thrives on challenges, and no-one in the room was in any doubt that the obstacles would be overcome one way or another.

Hayling Island lived up to expectations - once again an excellent technical seminar and learning opportunity, a tribute to Bill Wilkie's organisational skills and the generous support of Macdermid-Enthone and Spirit Circuits, and a premier be-there-or-miss-out networking event for the UK PCB industry.

Pete Starkey
I-Connect007
September 2016

Martin Goosey appointed Visiting Professor in Sustainable Electronics Manufacturing at Loughborough University

Martin Goosey appointed Visiting Professor in Sustainable Electronics Manufacturing

Loughborough University's engineering students will gain unique industry insights thanks to a new appointment supported by the Royal Academy of Engineering Visiting Professors scheme. Dr Martin Goosey joins the University for the next three years in the School of Mechanical, Electrical and Manufacturing Engineering, where his significant experience of industry practice and appreciation of the challenges the sector faces will help ensure Loughborough's engineering graduates have the skills and knowledge it demands.

He said:

"Having worked as a researcher in the electronics industry for over forty years, I am delighted to have this opportunity to pass on some of my experience to the future generations of scientists and technologists that are beginning their career journeys at Loughborough University.

I have been engaged with the University in various ways over the last 20 years, including working on collaborative R&D projects and co-directing the Innovative Electronics Manufacturing Research Centre. This exciting new appointment gives me the chance to continue my involvement with Loughborough and to engage with the undergraduate community."

News Item

'Crabs' Project wins Environmental Award

A multi-partner UK R&D project that developed a method for de-polluting printed circuit board (PCB) manufacturing waste has won an important environmental award. The Treatment Of Waste Using Recycled Chitosans (STOWURC) project had a focus on developing sustainable materials and processes that used waste products from the seafood industry to treat effluent, and recover metals, from the PCB and related industries.

The PCB industry is well known for using chemical processes that generate expensive-to-treat waste products. The shells of crabs, and other crustaceans, are a source of materials known as chitosans which can absorb metals such as copper, found in typical PCB manufacturing effluent. The UK's seafood industry generates large volumes of shellfish waste and the project used this waste to produce chitosan-based materials that could sustainably treat effluent, while also enabling the captured metals to be recycled.

On Friday, 30th September, members of the Env-Aqua Solutions team, who led the project, attended the Surface Engineering and Heat Treatment Associations' Gala Dinner & Awards Ceremony at the Midland Hotel in Manchester. Already knowing that they were one of three finalists, the team were delighted to learn that they had subsequently won the Environmental Award. The awards were presented by Lord Hoyle of Warrington in a ceremony led by the SEA's Honorary President, Mrs Linda Evans MBE. Dr Emma Goosey collected the award on behalf of Env-Aqua and the STOWURC project consortium, which comprised Env-Aqua Solutions, Kynance Cornish Crab, Institute of Circuit Technology, Surface Engineering Association, A-Gas Electronic Materials, Amphenol-Invotec and C-Tech innovation.

The project partners have subsequently identified additional international interest in using chitosan-based materials to treat waste and there are also much larger applications in other sectors that could benefit from the novel technology. Crab shells are typically expensive to dispose of and the project has enabled them to be converted from a waste product into valuable raw materials. The team are now exploring additional UK and European opportunities to take the technology forward. The project was co-funded by Innovate UK (Innovate UK is the UK's innovation agency). More information is available from the project website: www.stowurc.co.uk.

The Env-Aqua Team: L to R; Professor Martin Goosey, Dr Emma Goosey and Dr Rod Kellner

Dr Emma Goosey collecting the award from Lord Hoyle of Warrington with Mr Darren

The European Electronics Association

Workshop on PCB Bio-MEMs

Date: Thursday December 8, 2016
Location: Premier Inn Hotel London Heathrow Airport
Address: 15 Bath Road, Hounslow, Middlesex TW6 2AB, UK

Workshop Programme Language: English!

09:30 h. Registration
10:00 h. Welcome & Introduction
Dr. Despina Moschou, Unibersity of Bath, UK
10:15 h. Current LOC fabrication technologies, integration challenges and beyond
Dr Yuksel Temiz, IBM Research, Zurich Research Laboratory, CH
10:45 h. Lab-on-Chip standardization and commercialization challenges
Dr Peter Hewkin, MF7 microfluidics consortium CEO, CfBI, Innovation Centre, UK
11:15 h. Fluidic systems in PCB-Technology, challenges and applications
Prof. Lienhard Pagel, Professor for Microsystems, Faculty of Computer Science and Electrical Engineering, University of Rostock, DE
11:45 h. Co ee break
12:00 h. PCBbased microfluidics for DNA amplification
Dr Angeliki Tserepi, INN, NCSR Demokritos, GR
12:30 h. PCB-MEMS Devices and Systems for LOCs
Prof Jose Manuel Quero, SOLAR MEMS Technologies, Electronic Engineering, University of Seville, ES
13:00 h. Lunch
14:00 h. Special requirements for fluidic PCB MEMS devices
Prof Stefan Gassmann, Professor for Medical devices and Microtechnology, Jade University of Applied Sciences, Wilhelmshaven, DE
14:30 h. A biosensor on a PCB support
Dr Maria Goreti Sales, BioMarkCINTESIS/ISEP, School of Engineering, Polytechnic Institute of Porto, PT
15:00 h. Integration in bioanaylsis: the ivD-platform
Prof Frank Bier, Department of Biosystems Integration and Automation, Fraunhofer Branch Bioanalysis and Bioprocessing, IZIBB, DE
15:30 h. End User presentation (tbc)
16:00 h. Panel discussion
16:30 h. Moderator Closing Remarks

WECC
World Electronic Circuits Council
The EIPC is the European representative at the WECC

FED
Fachverband für Design, Leiterplatten- und Elektronikfertigung

ICT Institute of Circuit Technology Founded 1974

MESMOPROC
Maskless Electrochemical Surface Modification Process
www.mesmoproc.eu

Please visit
www.eipc.org
for the latest news

Sponsored by:

SPIRIT CIRCUITS Service beyond expectation
PLUS
PCB
DPS Plošné spoje od A do Z
emsnow
evertiq online european electronics

For more information contact EIPC:
Bourgognestraat 16
NL-6221 BX Maastricht
Phone +31-43-34408-72
E-mail kwestenberg@eipc.org

Corporate Members of The Institute of Circuit Technology October 2016

Organisation	*Address*	*Communication*
Adeon Technologies BV	Weidehek 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	0121 606 7777 www.atotech.com
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
Exception PCB Solutions	Alexandra Way, Ashchurch Business Centre, T ewkesbury, Gloucestershire. GL20 8NB	01684 292 448 wwwinfo@exceptionpcbsolutioncom
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

Institute of Circuit Technology

Harrogate Winter Seminar 2016 - Sponsored by GSPK

ICT Evening Seminar
at the
Majestic Hotel, Harrogate
1st December 2016

Presentations from :
Registration 17:00
Start - 17:30
MEETING INDUSTRY NEEDS

PAPERS TBA

A visit to the Railway Museum may be possible in the afternoon - let me know if you are interested

Enquiries to :-

bill.wilkie@instct.org

Supported by GSPK

Majestic Hotel,
Harrogate,
North Yorkshire,
HG1 2HU. Ripon Road

Tel.: 01423 229 017
https://www.thehotelcollection.co.uk/hotels/majestic-hotel-harrogate
A small number of rooms are available at £79 B/B