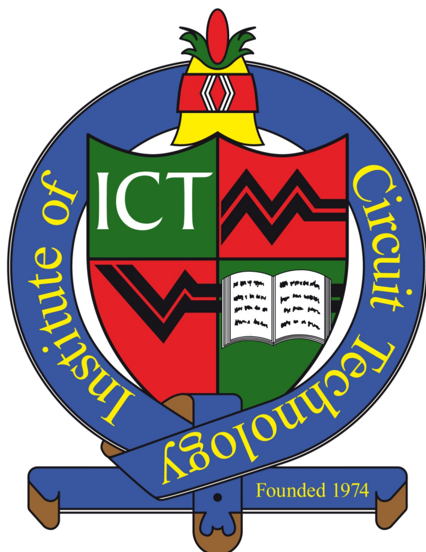

Journal of the
Institute of Circuit Technology

2012 Events

4th September *Tuesday* — 17.00 Registration
17.30 ICT Evening Seminar.
'UK PCB Manufacturing in association with the rest of the world'
bill.wilkie@InstCT.org
Newtown House Hotel, Hayling Island
supported by Spirit Circuits.

6th September *Thursday* — 20th Southern PCB Golf Day at the "The Wiltshire Golf and Country Club".
rwoodroe@aol.com

15/16th October *Monday & Tuesday* — Graphene Conference - National Physical Laboratory,Teddington,TW11 0LW
events@npl.co.uk

6th November *Tuesday* — **17.30 ICT Evening Seminar**
There will be four papers , followed by a buffet bill.wilkie@InstCT.org
Historic Quay, Hartlepool
www.hartlepoolsmaritimeexperience.com
supported by Falcon Group

27/28th November *Tuesday & Wednesday* — 6th International Symposium on Tin Whiskers
Loughborough University
bill.wilkie@InstCT.org

2013 Events

6th February *Wednesday* — 17.00 Registration
17.30 ICT Evening Seminar & AGM.
bill.wilkie@InstCT.org
Norfolk Arms Hotel, Arundel.
http://www.norfolkarmshotel.com

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

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Vol5no4 October 2012

IMPORTANT

This issue of the *Journal* is accompanied by two additional .pdf files, which contain lists of the 'topics' and the 'authors' which have appeared in the first 3 issues and the last 4 issues, both in the form of reviews and papers.

Topics have been worded so that its' main subject is contained in the first word of the 'topic'.

Each record gives, 'topic', authors name, vol no, and page. (and in future links to more information)

Members can then refer to the appropriate *Journal* , either their own copy or the .pdf's that appear on our Web site.

The 'authors' list is intended for further research on the same author.

Members are requested to make a trial search, and to send their findings and comments to the editor :-

Bruce Routledge bruce.rout@btinternet.com

before the arduous task of compiling the data from Vols 2,3 and 4 is begun.

Council Members 2012/3 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*), Lawson Lightfoot, Tom Parker, Steve Payne, Peter Starkey, Francesca Stern, Bob Willis.

Membership

New members notified by the Membership Secretary

10265 Stuart McDonald M.Inst.C.T.
10266 Ocean Ho M.Inst.C.T.

Corrections and Clarifications

t is the policy of the Journal to correct errors in its next issue.
Please send corrections to : -
bruce.rout@btinternet.com

The Journal of the Institute of Circuit Technology is edited by Bruce Routledge on behalf of the
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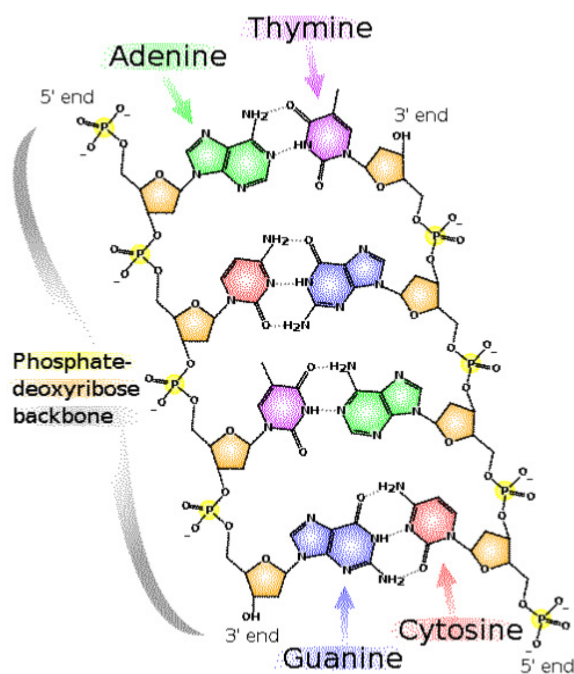
DNA
as a
Digital Storage Medium

Prof. Martin Goosey

We are all familiar with the term DNA and know that it in some way it contains the vital genetic instructions that are used in the development and functioning of all known living organisms. DNA is a long polymer made from repeat units called nucleotides and its structure was discovered by Watson and Crick in 1953. The DNA of all species comprises two helical chains each coiled round the same axis. The unique structure of DNA has made it the subject of much research in recent years, and the fact that it is such a complex molecule has encouraged research into its potential for data storage.

In the last few weeks it has been announced that American researchers based at the Wyss Institute for Biologically Inspired Engineering in Boston, Massachusetts and the Johns Hopkins University in Baltimore, Maryland have managed to encode a 53,000 word e-book, including 11 images and a computer program onto chemically synthesised deoxyribonucleic acid.



DNA's chemical structure

The book, program and images first had to be made into an HTML file and this in turn was converted to a sequence of over 5 million zeros and ones, which then ended up as 54,898 strands of nucleotides in the DNA itself. The double helix of DNA is linked by four different bridging molecules all the way along its structure and it was these that were used to represent the data to be stored in the molecule. These four structures are adenine, thymine, cytosine and guanine or A, C, T and G for short.

DNA's chemical structure

The researchers used an A and C structure to represent a 'zero' and a T and G for the 'one' of the data and processed to assemble strands of DNA representing the binary code of the book.
Once the data was encoded, drops of DNA were attached to the surface of a micro array chip. These devices were then kept at 4°C for three months before being dissolved and sequenced to re-read the data. Each copy of each strand was sequenced up to 3000 times to check the reliability of the information and only 10 read errors were found. The book was decoded using standard DNA sequencing techniques that are commonly available in university laboratories and hospitals.

It has been calculated that one gramme of DNA should, at least in theory, be able to store around 455 billion gigabytes (455 exabytes) of data or, in more prosaic terms, more than 100 billion DVDs. However, while these numbers are very impressive and while DNA is undoubtedly among the densest and most stable information storage media known, it is unlikely to be a viable replacement for the types of storage devices that are currently in wide use such as the hard drive in a PC or the ubiquitous memory stick. One reason for this, is that writing data to, and reading data from, DNA is an extremely time consuming and costly process. However, it could be an effective long-term storage option for securely archiving large amounts of information, especially as the cost of DNA sequencing has dropped by a factor of ten over the last few years and may continue to fall. The work also illustrates what can be achieved when scientists delve into the biological world to solve an electronics problem.

Are we likely to see DNA based memory devices becoming commercially available in the next few years? It seems that the short answer is no, but it would be wrong to dismiss this approach completely and, over the longer term, it might well be adopted as a viable high density data storage material. However, the need for storing ever greater amounts of data in decreasing volumes is likely to continue unabated and, while conventional approaches may eventually run out of steam, new developments such as quantum holography and IBM's 12 atom memory approach may provide a way forward, but these are a story for another issue!

Martin Goosey

ICT Chairman

Review of papers presented at the

38th Annual Symposium of the Institute of Circuit Technology

by Pete Starkey

Renowned for his ability to locate impressive venues for Institute of Circuit Technology events, ICT Technical Director Bill Wilkie made yet another excellent choice and brought the UK printed circuit industry together at the Imperial War Museum in Duxford near Cambridge for the Institute's 38th Annual Symposium, on the theme of Manufacture and Materials.

Sell the Advantage, Not the Commodity

Phot::Alun Morgan

ICT Vice-Chairman **Dr Andy Cobley** opened the symposium, welcomed the many delegates and introduced keynote speaker **Bill Burr**, who captured the attention of the audience with his views on inspirational intuition, with particular reference to the development of PCB technology from Paul Eisler to the present day and beyond: "Knowledge plus perseverance plus intuition equals the anatomy of a brainstorm, and intuition is one of the most brilliant aspects of the higher unconscious"

"People who lived the problem developed and invented solutions", he continued: "Inspiration is the fruit of perception and perspiration."

Taking microvia technology as an example of an innovation that enabled a whole new generation of electronics, Burr made it clear that it was PCB manufacturers who developed the technology – "you couldn't buy it in a bucket!" and invariably the PCB manufacturer occupied the position of translator – standing between the material supplier and the subsystem manufacturer, understanding the languages of both sides and turning materials into electronic function - effectively translating smart molecules into smart products.

Moving back to the future, Burr discussed added value and how western-world PCB manufacturers could retain value by providing enabling technology in order to regain the high ground, break away from the commodity trap and make a difference by studying industry trends, new and emerging applications, product characteristics, global issues, component packaging trends and customer roadmaps. Against this backdrop, he described a project in which he was cooperating with Nick Pearne of BPA called Metal-in-the-Board, MiB. Increasing power density in electronic devices in general, and the rapidly increasing utilisation of electronic control of electrical power opened up a new generation of opportunity for innovation in thermal management, particularly in automotive and electro-mobility applications.

In a *Quo Vadis* sum-up, Burr urged delegates to stay alert for opportunity, to watch and guard the added value, and to sell the advantage, not the commodity.

Via-hole plugging techniques

.Phot::Alun Morgan

Next to present was **Bob MacRae** from **Taiyo America**, who explored all the options, advantages and disadvantages of via-hole plugging techniques. Typical reasons for plugging vias were to prevent corrosion of the via connection, to improve vacuum performance at in-circuit test, to prevent solder wicking into via holes connected to SMT pads, to prevent contamination under components, to gain back outer layer real eatate and, in sequential builds, to fill buried vias without voids and reduce prepreg loss. Three decades ago, it had become common practice to tent via holes with dry-film solder mask and since the introduction of liquid photoimageable solder masks

there had been many permutations of procedure for achieving the equivalent with liquid materials. In most cases, removal of solvent was a major issue hindering the success of these techniques and, unless a 2-stage final cure or a vacuum chamber were used, popping or outgassing could occur during soldering. Incomplete hole plugging could lead to chemical entrapment and result in field failure as well as skip plating of ENIG.

High-performance hole-filling pastes were now available which offered the best combination of performance and reliability. These are based on zero-solvent formulations which showed little or no shrinkage on curing, giving flat, planar plugs which could be plated-over. Moreover, these materials are compatible with high-performance laminates in terms of glass transition temperature and thermal expansion characteristics.

ASPIS-update on EU P7 and Susonence-12/6/12

Standing-in on behalf of Professor Martin Goosey, **Pete Starkey** gave an update on the EU FP7 projects ASPIS and Susonence. ASPIS, a 3-year project to enhance the performance of nickel-gold solderable finishes, had the key objectives of investigating the fundamental failure modes and mechanisms of ENIG coatings, developing an ENIG screening tool, developing improved coating methods and materials based on aqueous and ionic liquid systems, and verifying the compatibility of technology developments with established assembly methods and practices.

The project had reached a half-way stage and already a clearer understanding of the underlying chemistry, physics and metallurgy of the ENIG process was emerging. Some encouraging progress had been made in the study of alternative chemistries, and an initial examination had been made of non-destructive predictive test methods. The ICT continued to disseminate up-to-date information through presentations, technical papers and press releases, and the ASPIS website www.aspis-pcb.org was proving to be an effective resource.

Susonence - Sustainable Ultrasonically Enhanced Chemical Processes, was a multi-partner project developing advanced sonochemical processes to reduce chemical usage and decrease waste in the PCB and metal finishing industries, with the key aims of implementing ultrasonically enhanced surface modification processes for removing surface layers, etching, and texturing a variety of widely used substrates with greatly decreased chemical consumption, enabling a step-change in competitiveness within the surface finishing and printed circuit board manufacturing sectors and significantly decreasing environmental impact. Expected benefits were reduced use of toxic and hazardous chemicals, waste minimisation and diversion from landfill, reduced energy consumption and reduced water consumption. Up-to-date project information could be found on the Susonence website www.susonence.eu.

Material innovations for power electronics

Manfred Walchshofer from Panasonic gave an overview of material innovations with a focus on power electronics. Objectives were to achieve high soldering reliability for PCBs with thick copper, long-term insulation reliability both within the structure of the board and upon its surface, and heat dissipation solutions.

Regarding insulation reliability within the boardWalchshofer discussed the factors influencing the formation of conductive anodic filaments, [CAF.] These were apportioned approximately 50/50 between PCB manufacturing process conditions, particularly those related to pressing, drilling and plating, and laminate properties such as the completeness of impregnation of glass fibres by resin, adhesion of resin to glass, ionic impurities and the heat resistance of the resin. He showed some actual examples of CAF failures, both in the laboratory and in the field. In Germany, ZVEI were working on a method for CAF evaluation appropriate to automotive applications, with test conditions 85% RH, 85ºC, 100v and an insulation resistance requirement greater than 10 M□. Insulation resistance on the surface of the laminate was measured by its comparative tracking index CTI and classified according to EN 50124 or UL. Halogen-free materials had been shown to give higher CTI values than standard FR4.

Power electronics demanded effective thermal management, and thermally conductive laminates could free-up real-estate on PCBs by reducing the requirement for thermal via holes. Whereas standard FR4 had a thermal conductivity around 0.4 W/mK, certain filled laminates could now achieve values as high as 4W/mK.

Fine-line imaging automated process line

Phot::Alun Morgan

Bill Wilkie moderated the afternoon session and introduced as his first speaker **Lawson Lightfoot**, who described the details of the recently-launched **Rainbow** fine-line imaging process.

Key to the technology

was a liquid etch resist with very high photospeed, developed with the cooperation of **Electra Polymers**. A unique feature of the resist was that it could be exposed immediately after coating and without drying. A proprietary coating on the photomasters prevented them sticking to the resist, and the very short optical path enabled the imaging of lines and spaces as fine as 20 microns without the need for collimated light: LED arrays were used as the UV source.

The compete Rainbow automated process line was compact, occupying only 12 square metres of floor area including its own clean-air enclosure, and had very low power consumption, about 3 kW. It was designed to deliver a double-sided panel, ready for etching, every 15 to 20 seconds and a full system would be made available for customer evaluation during Q3 2012.

"Printing, coating and nano-imprinting equipment, and processes for large area printed electronics", was the topic of the presentation of **Thomas Kolbusch,** Vice-President of **Coatema Coating Machinery** and member of the board of the Organic Electronics Association. Coatema had over 30 years' experience in the production of coating and printing equipment with a background in the textile industry, and had established a major R&D centre in Germany. Kolbusch gave a comprehensive overview of the available printing and coating systems that could be applied to the manufacture of printed electronics from small batch-type coaters to large roll-to-roll systems.

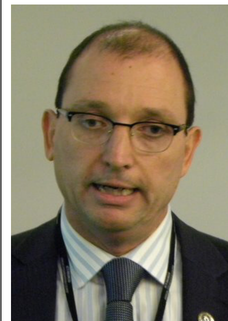
Phot:Alun Morgan

He reviewed market projections for organic and printed electronics with reference to the OE-A roadmap, listing organic photovoltaics, flexible displays, OLED lighting, electronics & components and integrated smart systems as principal areas of development, then discussed the range of different existing and not-yet-existing roll-to-roll production technologies and processes requiring to be integrated to enable successful printed electronics manufacture, taking the in-line fabrication of organic photovoltaics as an example.

Key technology hurdles were resolution, registration accuracy, layer thickness, pattern on pattern precision, environmental control and inline quality management. A wide choice of printing and coating techniques could be used to suit various applications, and Kolbusch made specific reference to slot-die coating as a technique with great potential in printed electronics.

Many organisations were engaged in research, and an FP7 project, FACESS – Flexible Autonomous Cost Efficient Energy Source and Storage – had recently been completed, demonstrating the manufacture of efficient organic solar cells and thin film batteries on flexible substrates using commercially available materials and cost efficient roll-to-roll mass production techniques.

Looking to the future, Kolbusch was under no illusion that many challenges lay ahead, funding for industrial up-scaling was required and the industry needed to define processes and standards. The European industry was largely composed of SMEs and he believed that this was where its strength lay, provided the SMEs took a joined-cluster approach to driving the technology forward with the support of global networks like the Organic Electronics Association and the Large-area Organic Printed Electronics Convention.


Phot::Alun Morgan

Lean and Benchmarking – a driver for growth".
The final presentation came from **Mark Knowlton** of **KPS**, business improvement specialist and advocate of lean manufacturing, and was entitled "Lean and Benchmarking – a driver for growth". He described how a lean methodology could be applied to drive cost out of the business and achieve increased capacity, improved price competitiveness and reduced lead times, with streamlined and efficient business processes that were fit for purpose. The process began by establishing what it was that customers really valued, then mapping the value stream and eliminating non-value-adding activity to create more capacity for value adding activity and growth. The five golden rules were: to speed-up the order fulfillment cycle, to make only what could be sold, to buy only what was needed, to reduce work-in-progress and to collect what was owed. And the two main pillars of lean were continuous improvement and respect for people. Knowlton listed lean principles, tools and techniques, the eight wastes and the eight key competences, and illustrated the differences between supplier and customer perspectives and perceptions with regard to the supply chain. He emphasised the importance of benchmarking as a systematic process for identifying and implementing best practice and learning from the experiences of others, quoting the Cheshire Cat from Lewis Carroll's Alice in Wonderland: "If you don't know where you are going, any road will lead you there"

Bill Wilkie wrapped up the **38th Symposium**, thanking speakers and delegates, acknowledging the generous support of **Lamar Group.**

He then reported that ICT educational courses were remarkably well subscribed and that the Institute continued to gain membership.

As the audience dispersed, very few went straight home – the opportunity to see some of the attractions of the Imperial War Museum was too good to miss! The only disappointment was that we were not allowed to take photographs...

Pete Starkey

June 2012

Dissemination Seminar:

Results from Applied Research Projects in the Surface Engineering and Printed Circuit Sectors

Surface Engineering Association,
Federation House,
Vyse Street, Birmingham

by **Martin Goosey**

Hosted by the **Surface Engineering Association** at its excellent conference facility in Birmingham's Jewellery Quarter, this seminar had been organised to provide a dissemination platform for nine UK and European multi-partner projects that were each addressing different, but related topics of interest and relevance to both the printed circuit board and surface engineering sectors.

David Elliot, Chief Executive of the Surface Engineering Association (SEA), opened the seminar by welcoming the delegates to Federation House and then immediately invited the first speaker to the rostrum.

Ionic liquid electrolytes in surface finishing processes

The opening technical presentation of the event was given by **Karl Ryder** from Leicester University, who gave an update on surface finishing processes in ionic liquid electrolytes. Karl began by discussing some of the motivations for using ionic liquids and key advantages included environmental benefits and the ability to comply with increasingly stringent legislation.

Example, ionic liquids were then described and their novel properties outlined; they typically had very low vapour pressures, good thermal stabilities, unusual solvent properties and wide potential windows for processes. They had been known for almost 100 years, but it was only in the last ten years or so that there had been growing interest in their use in PCB and surface finishing applications. Eutectic-based ionic liquids formed using choline chloride, a very low cost component that was used as an animal feed, were then described.

One such example was made by mixing choline chloride and ethylene glycol or, as Karl stated, by mixing 'chicken feed' with 'antifreeze'. Chromium plating had been performed using choline chloride-based ionic liquids and a pilot plant built by C-Tech Innovation was shown. The process had been developed for hard, decorative and black chromium deposits and good current efficiencies had been achieved. The process used a less toxic source of chromium with no acid and the deposits had excellent corrosion resistance and hardnesses up to 1500 HV after thermal treatment.

Karl also described an aluminium plating process. A 40 litre demonstration unit had been built that included a nitrogen gas blanket. Both bright and matt aluminium finishes were possible and these also exhibited excellent corrosion resistance.

Work on electropolishing of stainless steel using ionic liquids was also reported. The choline chloride-ethylene glycol-based process offered low toxicity and high current efficiencies. A pilot plant had also been built for this process and it had operated for three years using the same electrolyte.

As part of the IONMET project (see http://www.ionmet.eu), an immersion silver process for PCBs was developed and scaled up to an 800 litre ionic liquid production demonstration scale.

In addition, immersion gold coatings for PCB applications had also been demonstrated as part of the **ASPIS FP7** project.

Another ionic liquid technology that had emerged from the IONMET project was related to zinc rechargeable batteries that used a choline chloride ionic liquid-based electrolyte. The advantages included low toxicity, light weight, low cost and high power density. This work was undertaken in the PolyZion project (see http://www.polyzion.eu).

Karl then discussed zinc-tin alloy corrosion resistant coatings from ionic liquids and examples made by Promet were shown.

He concluded by summarising the potential benefits of eutectic- based ionic liquids.

Susonence

Andy Cobley from Coventry University followed by presenting the results of his work on ultrasonically (U/S) enhanced surface modification processes in a project that had originally been funded by the IeMRC and that had been taken forward to a European Eco-Innovation project called Susonence (see www.susonence.eu). Andy began

by outlining the hazardous nature of traditional wet chemical surface modification methods used in the PCB and Surface Engineering sectors.

Sonochemistry was described as the effect of sound on the chemistry of a solution and it could be used to offer alternative processes to the more traditional ones. Advantage was taken of acoustic cavitation, along with so-called micro jetting/micro streaming.

Micro jetting could be used to clean and mechanically attack a surface and, at the extreme local temperatures generated, chemical reactions via free radicals could also be utilised. By using this approach, it was possible to reduce operating temperatures, reduce the use of aggressive chemicals and generate less waste.

The approach had been used on ceramic, thermoplastic and thermosetting polymer surfaces.

In some cases the use of U/S enabled surface modification in water alone and examples of circuit board laminates treated in this way were shown.

The optimum ultrasonic frequency was found to be 20 kHz and the ultrasonic power density had also been optimised, along with a number of other factors such as sample to probe distance.

The success of the initial IeMRC project lead to the nine month TSB funded 'HEPPROC' feasibility study which focused on the PCB desmear process. In this work it had been possible to reduce the operating temperature of the process by 20 C and to use half strength permanganate chemistry.

Printed circuit boards had been produced using the process which had comparable reliability to those processed through the standard desmear process. This work was now being taken further towards industrial implementation in the Susonence project which was building five units for installation at factories in France and the Czech Republic.

'Energy efficiency-path to'

After a networking coffee break **Stuart Dalrymple** from C-Tech Innovation discussed energy efficiency support for the surface engineering and PCB sectors that had been developed in the recently completed Surf Energy multi-partner collaborative 'Intelligent Energy Europe' project (see www.surfenergy.eu). The project had developed a free toolkit for use in the PCB and surface engineering sectors which provided a 'path to energy efficiency'. Stuart then proceeded to demonstrate the toolkit by working through each of the individual stages which began with the set-up of an environmental management system. The next stage involved energy auditing and he described the five phases of the audit process. Key performance indicators needed to be identified before moving on to the interactive benchmarking tool part of the process. The benchmarking was performed on line and enabled a comparison to be made in terms of performance relative to others and industry standards. If costs were above the benchmark, a potential 'savings' figure was indicated. A more detailed part of the toolkit was a downloadable spreadsheet that could be used by companies for monitoring their performance. The spreadsheet had three parts for recording past, current and future desired performance. By inputting this data, it was possible to obtain information on the potential savings that could be made. The toolkit also provided a pathway to energy efficiency via technology intelligence and road-mapping. This was based on intelligence that had been gathered on technologies, know how and other measures with the potential to reduce energy consumption. The toolkit also contained detailed best practice guides for both PCB and surface finishing activities and was available in nine European languages.

The final part of the morning was focussed on the results of two projects concerned with new technologies for nickel recovery.

Nickel recovery - 'new technologies' (1st Project)

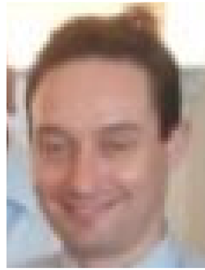
The first presentation was given by **Rod Kellner** of Env-Aqua Solutions who detailed work on the European Commission supported Ecometre project (see www.ecometre.eu) which had developed new electrocoagulation and electrowinning technology.

The process had integrated three existing technologies which combined electrocoagulation, acid extraction and electrowinning for metal recovery. This enabled nickel from different sources, such as filter cake, waste streams and spent chemistry, to be recovered.

Rod then discussed the electrocoagulation process and how it was utilised in the Ecometre approach. Sacrificial metal electrodes were used to donate coagulant ions leading to in-situ floc formation. The process was current driven and controlled and the floc could be settled, skimmed or filtered depending on the application. No liquid chemicals were used.

The process had been developed to have high coagulant dosing efficiency, reduced downstream chemical requirements, quick and easy electrode replacement, reduced energy consumption and a plant availability of around 98%. The pilot plant that had been developed and installed at Promet in Paris was shown and its operation explained.

Nickel recovery - 'new technologies' (2nd Project)



Paul Fitzpatrick of C-Tech Innovation then presented the work that had been carried out on the UK Technology Strategy Board supported Reconif project. The Reconif approach had used ionic liquids for the selective extraction and recovery of nickel.

Paul gave some background information on ionic liquids and explained how a 'task specific' ionic liquid had been selected for the targeted approach that matched the ionic liquid against the target metal profile and the waste source to be treated i.e. the presence of other metals. The best match was then optimised for solubility and separation capability.

Paul gave an overview of the complete Reconif process which was designed to treat nickel containing filter cake or battery waste. Ligands were used to bind the target metal selectively. The complex was then broken down to free the nickel ions, which were taken into an aqueous phase that enabled subsequent electrowinning using a Chemelec cell. The ionic liquids operated in a closed loop part of the process and sourcing them from China had enabled their cost to be significantly reduced.

The operation of the pilot plant was described and examples of the nickel recovered were shown. There was around 100 tonnes of nickel available in the UK per annum that was suitable for recovery using the Reconif approach and significantly greater quantities throughout Europe. The project was due to end later this year and an LCA was currently being undertaken to assess the true benefits of the process.

FP7 Aspis project

The afternoon session began with a talk by **Martin Goosey** on the FP7 Aspis project (see www.aspis-pcb.eu).

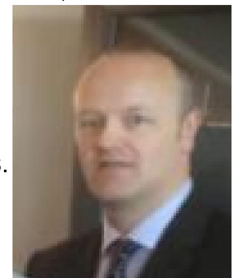
Aspis was short for 'Advanced Surface Protection for Improved Reliability PCB Systems' and the project's objective was to enhance the performance of the nickel-gold solderable finishes used in PCB assembly. The key objectives of the project were to; investigate fundamental failure modes and mechanisms of ENIG coatings, develop an ENIG screening tool, develop improved coating methods and materials (both aqueous and ionic liquid-based) and to verify the compatibility of any new technology developed with assembly methods and practices. In the first part of the project a large amount of fundamental research had been undertaken to gain a better understanding of the key factors influencing the reliability of assembled circuit boards employing nickel-gold solderable finishes. A large number of variables were known to have an influence on the occurrence of problems such as 'black pad' and these included the pre-treatment of the copper before nickel deposition, the formulation of the electroless nickel chemistry used, the deposition conditions, and the presence of copper ions in the immersion gold solution.

Martin then described some of the longer range research that had been undertaken in the project by Karl Ryder's team Leicester University. Gold had been successfully deposited onto nickel using an ionic-liquid-based immersion process. A variety of gold salts had been used and some of the deposits gave much smoother coatings than those obtained from conventional aqueous processes.

Another part of the project required the development of a non-destructive test method for circuit boards and Martin highlighted the challenges in developing a suitable process that could successfully detect potential issues at one specific region (the solder circuit board interface) inside an assembly comprising a multilayer circuit board populated with a range of surface mount components including flip chip devices.

There had been numerous dissemination activities for the project and Martin concluded by giving examples of the publications and presentations that had been made on the project and he gave references to the Aspis website and to two papers that gave more detailed information.

Nanocoat Aluminium anodisation techniques



David Hall from C-Tech Innovation, then presented details of a 'Research for SMEs' project called Nanocoat (see www.nanocoat-project.eu), which had a focus on new aluminium anodisation techniques. The aim was to produce uniform nanostructured anodised aluminium oxide coatings and to develop improved functionality and new coating applications for products in surface engineering.

David then gave an overview of the Nanocoat process, which actually had two anodising steps, and he described the scale-up activities that C-Tech had undertaken.

Eductors were employed to provide energy efficient agitation and heat removal from the process tank and computational fluid dynamics (CFD) was used to help with the equipment design and educator location.

Testing had been performed on samples prepared using the Nanocoat process and improvements achieved in a number of key mechanical properties. Structural analysis had

shown that the Nanocoat process gave uniform nanostructural coatings. Industrial applications were being tested and a life cycle assessment was being undertaken.

Electropolishing of aerospace alloys

Karl Ryder then returned to give a presentation on the electropolishing of aerospace alloys in new sustainable ionic liquid electrolytes. The work had been supported by the Royal Society and had the intention of developing electropolishing processes for super alloys using ionic liquids. The alloys being studied had very complex metallurgies and were typically grown as single crystals. The aim was to remove scale on the surface of these single crystal castings by electropolishing and work had been conducted on turbine blades using the pilot plant at Leicester University. Karl highlighted the mechanisms for the formation of scale on the surface of these metals during casting. The scale had successfully been removed using ionic liquids and the changes occurring during the process had been characterised.

Results indicated that the alloy composition had not been affected by the electropolishing process and that the surface roughness had been greatly reduced. Examples of electropolished turbine blades were shown and the scale had clearly been removed.

Etch rate characterisation work had also been undertaken and AFM data used to assess etch rates. Karl concluded by confirming that electropolishing was effective in removing nickel-based surface scales on turbine blades.

ULTIEmet' project - electroless metallisation

Andy Cobley also returned to give a second presentation, which was entitled ultrasonically enabled immersion and electroless metallisation and he detailed work carried out on the three year IeMRC funded 'ULTIEmet' project. The aim had been to enhance the performance of electroless nickel, electroless copper and immersion silver and immersion gold processes.

The first part of the project had focussed on electroless copper processes. Andy described the process stages involved and explained the palladium catalysed deposition of copper.

Initial studies had been carried out to assess the effect of ultrasound on the stability of the plating bath. The stability varied with U/S frequency and at several frequencies the baths became unstable with the copper being precipitated from solution. This was thought to be due to destruction of the EDTA that was used to complex the copper.

Plating rates were then evaluated using a commercial EDTA-based copper bath with an agitation frequency of 40 kHz. Not surprisingly, plating rates increased with increasing temperatures and the use of U/S gave only a further slight improvement, which was disappointing. One suggestion was that the U/S was scrubbing some of the catalyst from the surface and this had subsequently been confirmed by XPS analysis.

However, if a delay time was introduced before the U/S was applied, the plating rate was found to increase. A seven minute delay before introducing the U/S led to a significant increase in plating rates at 40C, giving a rate that was higher than that using standard agitation at 45C. Deposit morphology had also been studied and this had shown that fine grained deposits had been achieved.

At the end of an intense programme of nine presentations David Elliot made the concluding remarks and thanked all the speakers before closing what had been a very useful, interesting and well attended seminar.

Martin Goosey

28th June 2012

Review of papers presented at the Hayling Island Seminar

Institute of Circuit Technology

on 4th September 2012

by Pete Starkey

Thankful for some respite from three months of miserable English-summer weather, over 100 printed circuit enthusiasts made the journey south across Langstone Bridge in bright September sunshine to attend the Institute of Circuit Technology Seminar in Hayling Island, now firmly established as the venue for a not-to-be-missed annual event in the PCB industry's technical calendar.

ICT Chairman **Martin Goosey** welcomed the delegates, commenting that the membership of the Institute, now in its 38th year, continued to grow in numbers. He was delighted to announce that **Ocean Ho**, Spirit Circuits' sourcing manager who had travelled from China to attend the seminar, had been elected as a Member of the Institute and presented his membership certificate.

Be British, Think Global

Prof. Goosey introduced the first speaker, Spirit Circuits' Managing Director **Steve Driver** – recognised for his talent in presenting serious messages with a touch of mischief and good humour – whose theme was "Be British, Think Global"

Once Driver had completed his inevitable mockery of associates and contemporaries, he focused on recent events in the UK – Queen Elizabeth's Diamond Jubilee and the Olympic Games in particular – and how the excitement and elation that these had generated should form a foundation for some positive thinking against a background of economic gloom.

Although the PCB industry had not been in good shape, Driver believed it still held some great opportunities. Citing Graphic PLC as a success story, and probably the best PCB company in the UK, he remarked upon their strategic thinking – UK manufacturing, trading globally: Chinese joint venture with Somacis, acquisition of Printca in Denmark – and the attributes of Graphic Chairman **Rex Rozario OBE:** grit and commitment, tenacity, enthusiasm, vigour, passion, charisma, vision.

Driver also acknowledged Rozario's successor as Chairman of EIPC, **Alun Morgan**, and was confident that the industry would benefit enormously from Morgan's energy and zest for life, especially his technical and industry knowledge and, not least, his talents as a musician.

Returning to his Olympics theme, Driver reiterated Team GB's successes, which had inspired the nation but could not have been achieved had funds not been provided to support training and facilities, and then focused on some examples of British design and engineering skills which had helped create the infrastructure and some iconic accessories like the Torch and the Cauldron. "We have just witnessed one of the biggest successes in the last decade, we are a country locked in depression yet we have just pulled an almighty rabbit from the hat. Sharing with the world our best musicians, performers, engineers, athletes and our culture, it proves what can be achieved when there is a vision, a plan, a good leader and a committed team! Be proud of our country and its cultures, and take it with us wherever we go!"

Controlling registration in PCB manufacture

Dominic Millett, Application Support Manager with Xact PCB, then gave an extremely informative presentation on the challenge of controlling registration in PCB manufacture, where multiple sources of distortion, related to materials, processes, environment and design, all added to the complexity of the problem.

Starting with copper-clad laminate, he explained how stresses originated from the weaving of glass fabric, roll-to-roll prepreg manufacturing and the pressing operation, and how these stresses were released and new ones introduced during the fabrication of a multilayer bosrd.

He listed 12 stages at which dimensional distortion could occur, whether they originated from artwork, stress relief during etching, material movement during lamination and sequential build-up, stretching during mechanical brushing, moisture uptake during chemical processing, or stress relief during solder mask curing.

When quantified with physical dimensions, many of these individual distortions combined to make layer-to-layer and hole-to-pattern registration within acceptable tolerances exceedingly difficult to achieve, especially when the distortion was non-linear, and the situation became particularly critical as build-up complexity increased.

The capability of laser drilling and direct imaging systems to automatically align and compensate was not necessarily the answer, since they were aligning to an already distorted pattern and the result was to pass the actual registration problem further down the line – often to the assembler.

Xact's approach was to gather real information from the interaction of all of the sources of distortion and feed this knowledge into a user-configurable material database library. Using this "predictive intelligence", a stackup model could be generated which would predict and simulate material movement and allow artworks to be plotted with scaling factors precisely calculated to compensate in advance for in-process material movement.

Thermally conductive dielectric coating directly on aluminium

Dr Pavel Shaskov from Cambridge Nanotherm described a novel method of producing a thermally conductive dielectric coating directly on aluminium, claimed to represent a breakthrough in the thermal management of solid-state lighting.

The Cambridge Nanotherm process formed a nanocrystalline aluminium oxide layer in-situ on an aluminium component of any geometry – a heat sink, or a board, or a luminary frame – minimising the number of thermal interfaces by enabling the LED chip to be placed directly on to the surface of the dielectric. This concept of chip-on-heat-sink packaging gave the shortest possible thermal path and hence the highest thermal conductivity. There was no need for a printed circuit board as such: conductors could be printed on the dielectric surface using silver or copper inks.

With a thermal conductivity of 6-7.2 W/mK, the coating could be as thin as 5 microns or controlled to thicknesses up to 50 microns, depending on the required breakdown voltage based on a dielectric strength of 60-110KV per mm. The crystalline grain size was in the range 20-40 nm. Dr Shaskov stressed that the process was not anodising, although it was electrochemical in nature. He did not disclose the chemistry, other than to say it was extremely environmentally friendly and could be discharged directly to drain, consisting of more than 99% water – the remainder being "our know-how".

In a case study based on an LED down-light module, changing from a standard metal-core PCB with a 100 micron dielectric of 2W/mK to a nanoceramic aluminium substrate with a 20 micron dielectric of 6W/mK had resulted in a 24ºC reduction in LED operating temperature, a 9% increase in light output and a x4 increase in lifespan.

Human development

Final presentation of the evening came from human development specialist **Nigel Risner**.

Perhaps appearing loud, larger than life and a little intimidating to begin with, he soon developed a rapport with the audience as he encouraged people to increase their confidence and self-esteem. Expounding his theories on effective communication, he classified people into four personality groups, based on their style of communication - monkeys, lions, dolphins and elephants - and invited the audience to categorise themselves and also their colleagues, employees and customers.

Monkeys were lively, energetic and extrovert, creative and full of good ideas, but not so good at seeing projects through to a conclusion. Lions were visionary leaders, focused and purposeful – good at making tough decisions and achieving

results. Dolphins were emotional, caring and sharing, and liked to be part of a team, although they found change unsettling. Elephants were loyal and reliable; meticulous problem-solvers but cautious and in need of detailed data and evidence – they would rather be right than happy (certain members of the ICT Council admitted to fitting the "elephant" category).

In order to work better with other people, a person needed to know what type of animal he was himself and to find out what type of animals he was dealing with. And it was absolutely essential for a leader to communicate effectively with his staff, to motivate them and provide them with information to enable them to make decisions and meet changing objectives - in effect to be a good zoo-keeper - and to make sure he was communicating in their language, not his own. Similarly, in business, Risner maintained that there were no "difficult" customers – just "different" - and the key to dealing successfully with them was to recognize what personality-group or animal-type they belonged to and communicate with them accordingly.

On the subject of "change", Risner acknowledged that it could be perceived as a threat or a barrier, whereas with the right way of thinking it could in fact be a natural and exciting experience. He challenged members of the audience to turn to a colleague and share what they might do different in the next twenty-one days, on the basis that it took twenty-one days to break a habit, commenting that it was easy to say that they wanted to do things differently then go back and do what was comfortable.

Risner succeeded in getting people thinking, and talking to each other. He maintained that most peoples' dreams could be met if they were prepared to share their ideas with other people and not to be scared of looking stupid. Certainly there was a lot of enthusiastic conversation in the networking session that followed his presentation.

Martin Goosey brought proceedings to a close and acknowledged the support of Spirit Circuits in sponsoring an extremely successful and well-attended event.

Pete Starkey

September 2012

Review of papers presented at the IeMRC 7th Annual Conference on 5th September 2012

by Pete Starkey

Henry Ford College at Loughborough University was a popular and appropriate venue for the 7th Annual Conference of the Innovative Electronics Manufacturing Research Centre, the UK's internationally recognised provider of world-class electronics manufacturing research.

Pyroelectric materials and their applications.

IeMRC Coordinator **Dr Darren Cadman** made the opening remarks, gave a brief update of the status of past, current and future projects and introduced keynote speaker **Professor Roger Whatmore** from the Tyndall National Institute in Cork, Ireland, whose topic was "Recent advances in pyroelectric materials and their applications: People Counting, Cooling and Energy Harvesting".

Phot: Vin Scothern

The pyroelectric effect was the change in polarisation of a polar material with temperature, which had been recognised over a century ago and had led to the discovery of the piezoelectric effect. From the basic physics of pyroelectric and related electrocaloric effects, derived from interactions between electric displacement, electric field, temperature and entropy, Professor Whatmore explained the construction and operation of pyroelectric infra-red detectors and how they were sensitive to very small changes in infra-red flux, which made them particularly suitable to sensing and monitoring the movement of people.

Performance and cost were a function of the materials used and, from a wide range of candidate materials, pyroelectric ceramics offered advantages in array fabrication and could be chemically doped to modify their properties. Professor Whatmore discussed tape-casting methods for producing functionally gradient Lead Zirconate Titanate (PZT) ceramics, then described low-temperature sol-gel processes for depositing ferroelectric thin films direct on silicon ASICs to make integrated arrays and fabricate MEMS-based structures. Arrays of thin-film pyroelectric detector elements could be combined with three-dimensional radiation collectors to improve their efficiency.

In an alternative application, pyroelectric energy harvesting had been shown to be significantly higher in efficiency than thermoelectric methods.

Converse of the pyroelectric effect was the electrocaloric effect: the change in temperature which occurred when an electric field was applied to a pyroelectric material, and the electrocaloric effect in thin films offered potential for solid state refrigeration

Supply Procedures for Military Contracts

It seemed the business of supplying aircraft to the military had undergone a radical transformation. No longer did manufacturers simply supply a product; they were now required to provide an availability of the product. In a two-part presentation, **Paul Green** from BAE Systems and **Dr. Linda Newnes** from University of Bath described how a collaborative of universities and industrial partners, representing the supply chain from concept design through to manufacture and disposal, was working to provide a set of modelling tools to enable the manufacturer to estimate the cost of providing a long-term availability contract.

Part 1

Phot: Vin Scothern

Paul Green began by outlining the differences between traditional and modern support solutions. Effectively, all the military now wanted to do was fly the aircraft and it was the responsibility of the industry to keep the aircraft available. "What are the cost relationships we need to understand?" he asked, and added: "Can you give me a crystal ball?"

Part 2

Dr Newnes listed and examined cost estimating relationships and described the challenges of acquiring quality data for through-life costing: a paradigm shift was necessary and one of the first questions to ask was what should be done differently now if designing for service. She emphasised the need to provide evidence-based decisions in terms of identifying a methodological approach that could be utilised to model a true representation of cost of availability that encompassed the factors influencing the cost of providing a service.

Phot: Vin Scothern

Taking as an illustrative example a very simple scenario of a hand dryer on an availability contract to dry one hundred pairs of hands per day, she demonstrated the enormous number of factors involved, questions to be asked and decisions to be made, in particular how would success and performance be measured, and how would the provider would be paid for providing the service – would it be on the basis of performance or availability? She advocated "system thinking" in an operations-based approach and gave an indication of how the CATA (Costing for Avionic Through-life Availability) team of academic and industrial partners was addressing its extraordinarily complex task.

High-performance low-cost power modules

Theme of the second conference session was assembly and test, and the first speaker was **Professor Mark Johnson** from University of Nottingham with a presentation on high-performance low-cost power modules for energy smart network applications. Predicting that by 2050 the UK would be supported by an integrated smart energy infrastructure, he discussed the role of power electronics in the conversion of electricity from one form to another, and the control of energy flow to provide for grid quality and security, whilst underpinning the low-carbon energy supply chain. Against this background, he focused on the characteristics and limitations of power modules, specifically voltage source converters for high-voltage DC transmission. These converters were typically based on insulated-gate bipolar transistor switches, connected in series or in chain-link modules to withstand voltages in excess of 11kV. It was necessary to build-in a degree of redundancy, but preferable that in the event of a switch failing it should fail to a short-circuit condition.

Phot: Vin Scothern

Historically, this requirement had been addressed by complex "Press-Pack" or "StakPak" devices which were expensive and had limited flexibility. The challenge was to develop a low-cost alternative which would still fail-to-short-circuit, using existing die technology, existing PCB processes and appropriate high-reliability bonding processes.

Planar modules offered many potential advantages, particularly the elimination of weaknesses associated with bond wires and the opportunity for more efficient cooling, and work was under way to simplify the assembly process.

Sintered silver nano-particle pastes were the preferred bonding medium, with polyimide flexible PCB interconnects using nano-paste filled vias providing alignment and circuit functions.

Interconnects - ultra-fine pitch

The requirement for ultra-fine pitch interconnects for micro-BGAs and flip-chip devices presented major challenges, particularly in achieving acceptable yields on large-format devices such as high-resolution sensors. **Changqing Liu** from Loughborough University reported the progress of a project investigating the feasibility of using to metal-coated polymer microspheres to replace traditional solder joints and achieve interconnection at pitches as fine as 10 microns.

Phot: Vin Scothern

The capability already existed to manufacture mono-sized microspheres and to coat them with nickel-gold, and these materials had been used in anisotropic conductive adhesives.

The objective of the project was to find a way of selectively depositing controlled quantities of these particles directly onto the bond pads of integrated circuits. Various routes had been considered: physical, chemical, mechanical, electrical, electromagnetic and electrochemical.

Chemical methods using self-assembled octanethiol monolayers had been evaluated but yields were low.

Electrophoretic deposition appeared to be a viable method, but required the microspheres to carry an ionic charge and a process had been developed to acid-etch the surface of the nickel-gold coating. This resulted in a positive surface

charge through the formation of Ni^{2+} ions and hence enabled the microspheres to be deposited electrophoretically. Once conditions were optimised it had been demonstrated that 100% deposition yield could be achieved on full 6” wafers with pads as small as 40 microns on 75-micron pitch, and low-temperature thermocompression bonds had been successfully formed between bumped devices and gold substrates.

Flip-chip solder joints - non-destructive monitoring

Through-life non-destructive monitoring of flip-chip solder joints in automotive electronic systems was the subject of the presentation of **Ryan Swee How Yang** from Liverpool John Moores University. He began by stating that 20% of the value of a typical automobile was in its electronics, and 80% of automotive innovation involved electronic systems.

Phot: Vin Scothern

Flip-chip-on-board assemblies were widely used in automotive electronics, which were expected to operate reliably in harsh environments, and flip-chip solder interconnections tended to be the weak link because of thermal expansion mismatch between silicon die and organic substrate potentially resulting in fatigue failure.

The project objective was to track the condition of solder joints from manufacture to failure using non-destructive techniques, and to assess how reliability was influenced by joint position. Acoustic micro-imaging was most effective in detecting gap-type defects, but was not sensitive to volumetric defects, where X-ray was the preferred method. Using the two techniques in combination offered the basis of a complementary method for automatic inspection and non-destructive monitoring of solder joints.

An FR4 test board with double-sided flip chips had been used as a test vehicle in a 96-cycle accelerated thermal cycle test, with samples checked at 8-cycle intervals by ultrasound, X-ray and microsectioning. Analysis and feature extraction from individual and combined ultrasound and X-ray images had yielded information about the characteristics of good joints and fractured joints and enabled discrimination between fracture and voids. It was possible to plot 3-dimensional failure distribution to determine how reliability was related to the position of the flip chip on the board .

Wire-bond reliability under extreme environments

Another aspect of interconnection reliability was addressed in the presentation of **Maria Mergkizoudi** from Loughborough University on wire-bond reliability under extreme environments.

Phot: Vin Scothern

She explained that qualification tests for wire-bonded devices were typically carried out in separate environments, for example: temperature storage, temperature cycling and vibration, and this approach could fail to detect the effects of combined parameters.

Her work was aimed at testing gold-wire-bonded components under a combination of thermal loading up to 180ºC and mechanical loading in the form of high frequency vibration.

The investigation covered bond strength and mechanical integrity, electrical resistance changes, microstructural defects induced, the role of wire orientation on wire degradation and the effect of applied conditions on loop geometry, using wire-pull and ball-shear testing, electrical resistance measurement, and metallographic examination.

The results had revealed significant differences between thermal testing without vibration and testing in thermal-vibration combination. Observations on gold-wire ball-bonded devices indicated an appreciable decrease in electrical resistance after testing, which could be attributed to annealing of the wire, a reduction in the shear force to failure of the ball bonds, particularly at higher temperature and low frequency vibration, and a more severe distortion of wire loops when testing at low frequencies.

Future work would focus on extending the vibration-temperature regime and examining the effect on wire bond pull strengths.

High-speed PCB materials - characteristics

Printed circuit boards was the theme of the afternoon conference session and the keynote presentation was given by **Alun Morgan**, Chairman of EIPC and Director of OEM Marketing with Isola Europe. Noted for his ability to present complex technical issues in plain language, he gave a detailed insight into the characteristics, applications and limitations of low-loss, high-speed PCB materials, starting with an explanation of the causes of signal losses and where they occurred, and what could be done by the laminate manufacturer to reduce them.

Phot: Vin Scothern

Losses fell into two major categories: conduction and dielectric. Conduction losses occurred in the copper and, as signal frequency increased, were increasingly associated with the

surface of the copper because of a phenomenon known as the "skin effect". This was the tendency of an alternating current to distribute itself within a conductor such that its current density was highest near the surface. As a result, current flowed mainly at the "skin" of the conductor, and the depth of the skin varied enormously with frequency.

For example for copper it was 9.3mm at 50Hz, 6.6 microns at 100MHz and 0.66 microns at 10GHz. The skin effect effectively reduced the current carrying capacity of the conductor and increased its resistance at higher frequencies.

Copper foils for PCB laminates were "treated" during manufacture to give a rough surface to promote good bonding to resin : standard foil had a treatment depth of about 10 microns. At low frequencies, the treatment had little effect on signal loss but because of the skin effect it could have a dramatic effect at high frequencies, which was why low-profile foils were available for high-frequency applications.

Dielectric losses resulted from alternating signals causing polarisation and molecular vibration within the glass and resin components of the laminate, generating heat, a familiar example being the microwave oven. The dielectric constants of glass and resin were different, which meant that in a glass-fabric reinforced laminate the microimpedance effects of filament distribution could cause problems with signal integrity ay high frequencies. Laminate manufacturers had begun to use square-weave fabrics with spread fibres to minimise this effect.

Morgan listed loss factors for a range of PCB substrate materials. Standard FR4 had a loss factor of 0.015 at 1GHz, compared with 0.002 for PTFE and 0.003 for certain ceramic-filled materials.

New-generation, non-PTFE, non-filled PCB substrate materials were becoming available with loss factor around 0.003 at 1 GHz as a lower-cost, easier-processing alternative to traditional solutions.

Traceability - use of RFID tags

Phot: Vin Scothern

Axel Bindel from Loughborough University stressed the importance of clear and easy-to-access information about the manufacturing history of a product in supporting traceability requirements and decision making at end-of-life, as well as providing scope for re-use and re-manufacturing.

He explained that information could be stored in an electronic product by embedding an RFID tag within the structure of the PCB, with the facility to read or write data wirelessly, and described how this had been successfully achieved. During the manufacture of a multilayer PCB, the RFID chip was assembled on to an inner layer by a flip-chip process, and became fully encapsulated within the epoxy resin during the laminating process. The only significant modification to the PCB layout was the incorporation of an antenna in the periphery of the design.

The embedded RFID had been shown to withstand harsh environments and multiple thermal shocks. Product information could be stored from the very beginning of the manufacturing supply chain and during subsequent production processes for each individual product, and accessed with a hand-held reader even when the PCB assembly was enclosed within a piece of equipment.

Electroless copper plating & effect of ultrasound

Phot: Vin Scothern

The effect of ultrasound on electroless copper plating was the subject of the presentation by **Amirah Kassim** from Coventry University, who reported the progress of the IeMRC-funded ULTIEmet project.

Using a commercially available EDTA-based self-accelerating electroless copper process, initial studies had examined the effect of ultrasound of different frequencies on the stability of the bath, and 40KHz had been chosen as the working frequency for plating-rate experiments as it caused no spontaneous precipitation of copper.

Plating rates were measured over a range of operating temperatures, with and without ultrasonic agitation, and only slight increases were observed when ultrasound was applied from the start of the process. It had been shown that, in the early stages of deposition, ultrasonic agitation was tending to scrub the palladium activator off the surface and reduce the plating efficiency. When a delay was introduced to enable complete initiation before the application of ultrasound, a significant increase in plating rate was observed.

Ultrasonic agitation also appeared to yield a finer-grain deposit with improved mechanical properties.

Immersion gold processes - deep-eutectic solvents

Phot: Vin Scothern

The final presentation was given by **Dr Karl Ryder** from University of Leicester, a partner in the EU Framework 7 funded ASPIS project. His department specialised in developing applications for ionic liquids and as part of the ASPIS project was investigating immersion gold processes based on deep-eutectic solvents as an alternative to

known to have been contributed to “black pad” effects on traditional electroless nickel – immersion gold solderable finishes.

Immersion gold had been deposited on a standard aqueous electroless nickel surface from solutions in a deep eutectic solvent based on readily available choline chloride and ethylene glycol. Three different gold salts had been used: gold chloride, gold cyanide and potassium cyanoaurate, and their electrochemical behaviour had been studied

A standard aqueous solution based on citric acid had been used as a control, and plating rates had been measured with a quartz crystal microbalance.

Immersion gold deposited from the gold cyanide – ionic liquid formulation was bright and uniform in appearance, and gave faster and more reliable solder wetting than the deposit produced from the aqueous control formulation. Addition of cyanide to the ionic liquid formulation had been observed to improve plating rate and deposit appearance.

Future work would include further investigation of the effect of additives other than cyanide, and the effect of ageing on solderability.

The 7th Annual Conference was yet another outstanding IeMRC event and a great credit to the team at Loughborough. If I might steal a few words from the IeMRC mission statement to capture the spirit: “....focus on sustaining and growing high value manufacturing in the UK by delivering innovative and exploitable new technologies...”, and reflect upon a statement attributed to Henry Ford, displayed on a wall in the conference venue: “If I had asked people what they wanted, they would have said faster horses”

Pete Starkey

I-Connect007

Corporate Members of The Institute of Circuit Technology October 2012

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The Membership Secretary's notes - October 2012

ICT and 4G

The connection may seem tenuous for our members, but one of our aims is to be able to offer an audio version of our events to our members on our website. To do this we first need a PA system and although we have tracked down a suitable speaker system, we are at an impasse over the most suitable microphone. Microphones normally come equipped with either channel 70, which is free and used by small operations and channel 38, which is licensed and used by large organisations. This is all about to change, when the government in its drive for digital and always in need of cash, is to sell off the channels adjacent to channel 70 for 4G. Depending on the rate of take-up of 4g, there MAY be a an influx of users into channel 70 which will affect performance of these microphones and we are awaiting clarification.

When we finally have our PA set-up, we will be able to add the necessary recording and editing software and provide on-demand audio of our events on our website - a members only benefit.