European Institute of Printed Circuits

EIPC SPEeDNEWS

The Weekly On-Line Newsletter from the European Institute of Printed Circuits.

Issue 5 – February 2015

NEWS FROM THE UK

Manufacturing Advanced Coatings for Future Electronic Systems (MacFest)

Following on from its participation in two previous multi-partner collaborative R&D projects, the Institute of Circuit Technology (ICT) has recently joined another new project. With funding support from InnovateUK (formerly the Technology Strategy Board), the six-partner, two-year MacFest project is aimed at developing novel solderable finishes that offer all of the benefits of nickel-gold but without any of the associated problems.

The key aim of the project is the development and introduction of new types of solderable coatings for printed circuit boards (PCBs) that will meet the performance demands required by manufacturers of high value electronic systems, whose products must exhibit guaranteed long term reliability, while operating in harsh environment applications. This is an area of electronics manufacturing in which the UK has extensive expertise and one that is destined for considerable growth due to the demand in electronics for renewables, electric vehicles, smart grid, power management, medical, aerospace and related applications. The new coatings to be developed will improve PCB yields, quality and assembled electronic device reliability.

While the focus of the project is on the development of solderable coatings for use in PCB fabrication/electronics assembly, the manufacturing processes for which the technology is being developed may additionally also be applied across a range of metal finishing applications used in other industries of strategic importance to the UK, for example, marine, automotive, chemicals, and general engineering.

This will give significant additionality and user application leverage to the coatings developed and will open up new markets both in the UK and further afield. The major output from the work will be an ionic liquid derived nickel-palladium-gold solderable coating deposition process.

Earlier work carried out by the University of Leicester in the precursor Aspis project highlighted the potential benefits of depositing metals from non-aqueous solutions. In particular, the use of specially developed ionic liquids enables coatings to be produced that have markedly different properties to those deposited by traditional routes. Ionic liquids have been described as 'designer solvents for green chemistry' and are acknowledged to offer great potential as novel materials capable of driving new innovation. MacFest will further develop and scale up high performance ionic liquid-derived nickel-palladium-gold (ENEPIG) coatings that provide the enhanced solder joint performance required for high value/performance electronics systems.

The conventionally used nickel-gold (ENIG) coatings are typically based on aqueous solutions and the replacement of water with ionic liquids represents a paradigm shift in the approach to depositing these coatings and their subsequent properties. The traditional aqueous based approaches use only nickel and gold and often introduce latent reliability issues (such as 'black pad', poor solderability and premature solder joint failure), which are not easily detectable and which lead to failures when products are in service. Such failures can be of critical importance in high performance electronics used in mission critical applications and there is a strong pull from electronics manufacturers for new coatings that can avoid the occurrence of such costly and potentially dangerous reliability issues.

The MacFest project will build on the earlier work and additionally extend its activity to the increasingly popular nickel, palladium, gold coatings that offer good reliability and the added bonus of being gold wire bondable. The protection of the nickel layer with a thin coating of palladium, prior to gold deposition, has been found to eliminate the potential for the subsequently used gold plating solution to attack the nickel surface; a major cause of problems with conventional coatings. The key advantages of the proposed approach, apart from its ability to offer both excellent solder joint and wire bond reliability, can be

summarized as follows. It prevents 'black pad' formation because there is no possibility of grain boundary corrosion of the nickel surface by the gold plating solution. The palladium also acts as an additional barrier layer to further reduce copper diffusion to the surface, thus ensuring good solderability, especially with ever smaller components and solder pads. The palladium completely dissolves into the solder, without leaving an excessively high phosphorus-rich interface, which is known to lead to problems in conventional approaches. It will also be compatible with the multiple soldering operations often required in modern electronic systems assembly and the final finish will be wire bondable. The project objectives will be achieved by using a combination of experimental investigation, process modelling and industrial validation.

The project consortium represents the whole requisite supply chain, from suppliers of the ionic liquid-based chemistry and equipment to an end user PCB fabricator. Specifically, the partners are the University of Leicester, A-Gas Electronic Materials (formerly Chestech Ltd), MTG Research, C-Tech Innovation, Merlin Circuit Technology, and the Institute of Circuit Technology.
The project is being managed by MTG Research Ltd, which has considerable expertise in this area, as well as multi-partner R&D project management experience at both a UK and European level. The University of Leicester will produce and evaluate the basic formulations, which will be initially optimised on the laboratory scale. Preferred chemistries will then be scaled up and used in larger scale evaluations where factors such as process control, the operational window and replenishment schedules will be evaluated in combination with assessments of the impact of these on coating properties.

A-Gas Electronic Materials (formerly Chestech Ltd) will work on the scale up and production of larger quantities of the chemical processes and the process control parameters, which will enable the preferred solutions to be operated on a production scale in the existing processing equipment at Merlin's Broughton, North Wales facility.

Merlin is leading the industrial production scale technical performance evaluation of both the process and the resulting products. Merlin will also make an assessment of PCB design criteria, since it is known that board design/solderable pad layout has an important influence on assembled device reliability.

C-Tech will be engaged in the scale up activities, with particular focus on the equipment and control aspects of the process. The ICT is the dissemination partner for the project and will bring its attention to its members across the UK and to an international audience via its extensive network of contacts.

This new project started on the 1st January 2015 and runs until the end of December 2016. Further details can be found at the project website; www.macfest-project.co.uk.

Martin Goosey,
February 2015

The 9th IeMRC Conference
Holywell Conference Centre,
Loughborough University
Tuesday 17th February 2015

Welcoming the delegates to a packed conference hall, **Professor Paul Conway** reflected on the journey which began eleven years ago to promote research in the electronics industry. Since then a great deal of work has been done by a networked community involving people from universities and industry. It all began in 2004, and now with the future funding coming from EPSRC, the I*e*MRC closed officially this month, although many of the major themes that began under IeMRC are continuing.

During the past decade, 26 universities have been funded, 162 researchers have been engaged, 33 PhD students have graduated, 54 projects have been funded, 4 of which were flagships ones, and of these 13 were feasibility studies. £48 million was the amount of funding achieved. No less than 183 different companies were involved, and the additional funding was mainly in the value of support from industry which was valued at £7.3 million.

There are now 16 EPSRC Centres of Innovative Manufacturing (CiMs) running at present, with one in photonics and large area electronics. There will also be 8 manufacturing research hubs. Electronics in the UK adds £2 billion to the economy, employs 850,000 people, and has revenue of £29 billion.

The keynote address was given by **Dr. Luigi Occhipinti of the University of Cambridge**, who is working with Large Area Electronics. They are working with UCL,

the University of Manchester, Imperial College and the CIKC (Cambridge Innovative Knowledge Centre). Funding for LAE is £5.6 over 5 years, plus direct funding from many industrial partners,

LAE as a topic covers sensors, printed intelligence, lighting, integrated photo-voltaic, amongst many others, and the high growth sectors in LAE include ultra-thin, curved and flexible displays, for which AMOLEDS are required, and roll-to-roll production of PVs has been achieved most successfully. Organic Photo Detectors(OPDs) and organic thick film transistors (OTFTs) are some of the manufacturing devices which include printed electronic sensors, such as iPESS, standing for integrated printed electronics with silicon for smart sensors. iPESS is foil to foil integration like a 3D stack, initially used for gas sensors, with the work being led by Cavendish Laboratories in Cambridge.

Dr Tina Lekakou of the University of Surrey spoke about conductive nano-composites. Between 2007 and 2015 they have been working on the fabrication of electrically conductive transparent polymer coatings from Inkjet printing of PEDOT:PSS from either spin coating or ink-jet printing. Dr. Lekakou explained how through process modelling and optimisation, they had had with better results with spin coating in conductivity, due to hopping length increase. But with a transverse charge, then inkjet was 600 xs higher in conductivity than spin coated models. They took this further into a project for PV cells, using both processes, with inkjet printed modules being better in conductivity. Multiple wall covering nanotubes (MWCNTs) was another project, where the use of surfactants gave better conductivity, Polyurethane nanocomposites were used in actuators which gave a very high dielectric constant, and MWCNTs electrophoretic ally deposited to make super capacitors, gave very high power. They have three projects running at the moment and have Bae Systems and Thomas Swann as partners looking at nanocomposites for super-capacitors.

Dr Darren Southee of Loughborough University was joined by colleague Professor Upul Wijayantha of Brunel University to present a paper on the impact of printed electronics on product design. Their work was focused on finding an alternative to the costly use of offset lithography to produce voltaic cells, and to determine the feasibility of making rechargeable energy storage devices using printed electrodes. Using a super capacitor formed from lithographically printed electrodes, they compared litho v flexo printing, and with an activated carbon layer a super-capacitor gave light for over one minutes before gradually fading, having been charged to 6V and a capacity of 0.5F. The conclusion that rechargeable power sources can be made from printed electrodes was deftly illustrated.

Professor Mark Johnson from the University of Nottingham is working in conjunction with both Dyconex and Alstom to produce a high performance low cost alternative way of producing power semiconductor modules. Power electronics sit behind a whole load of applications but are never seen in their own right. Power electronics underpins the whole low carbon energy supply chain. The research they are carrying out starts with the design of a planar power module which can block high voltages, and he described how the module was employed. The sintering of Ag nanoparticles was illustrated.

Loughborough University also have Dr. Robert Kay who knows all about intelligent sensor systems for condition monitoring. This is a project that has been running with Loughborough and Heriot-Watt Universities, and a large number of industrial partners. The industrial sectors need remote sensors that can be reliable when operating in harsh environments. To produce the LTCC packages that make this possible, additive manufacturing was assessed to see if it could overcome the current limitations of ceramic substrate manufacture. Dr. Kay discussed their experi3nce with printing through a nozzle with alumina paste, and getting excellent definition (700 microns line width) with low resistivity of 0.3 ohms/sq. They produced the first 3D printed LTCCC. They are going further into multilayer circuit capability, and will test this all in harsh environments, and they are also developing a co-fireable ceramic paste formulation.

3D components for microwave and millimetre-wave SiP technology was the topic covered by **Professor Ian Robertson from Leeds University.** He described the various ways of enhancing standard LTCC and MCM technology so that it capable of being used to manufacture large-scale systems such as active antenna arrays and adaptive metamaterials for a range of applications at microwave and millimetre wave frequencies, including applications for 5G.

Professor Karl Ryder at the University of Leicester brought the conference up-to-date with the work being done with ionic liquid solvents, known as DESs, which are deep eutectic solvents, and are excellent as a solder flux. They can be used as a wetting agent on a wide range of OCB surface finishes including bare copper and ENIG. It is much faster than standard rosin based fluxes, and the bond to copper shows intermetallic formation in the range of 2-3µm, whereas ENIG has limitations in this regard. Dr Ryder is entitled to claim that this is a disruptive technology, eliminating the need for the more expensive gold or palladium-gold finishes used in PCB manufacturing to-day.

Chemically amplified NGL photo-resists were discussed by **Dr Alex Robinson of the University of Birmingham** who maintained that these could be the path for a spin-

out company producing fullerene based resist for extreme UV lithography and electron beam lithography for semiconductor fabrication at sub 100nm levels. Having an IeMRC project reaching commercialisation would be perfect timing.

The final paper was from someone who has been arguably more active than many in IeMRC projects since inception, and that is **Professor Marc Desmulliez from Heriot-Watt University** who reflected on his journey across the various manufacturing capability readiness levels of microwave curing. The particular emphasis being on the use of microwave curing of TFPs used in microelectronics packaging, and the use of a microwave sensor used to detect water ingress in food products, contributing to massive savings in waste reduction.

That the Holywell Conference Centre was packed from beginning to end of the final IeMRC Conference says all there is to say about an organisation that has done a great deal of constructive good for the electronics industry over a decade of dedicated duty by the Directors. Many have benefitted from having their research funded properly, many a doctorate has been earned, and the microelectronics sector has not only played an important support role, but has been able to meet the demands of OEMS competing on the world stage. It has been no mean achievement, and it is to be hoped that the end of IeMRC is not a decision to be regretted in the coming years.

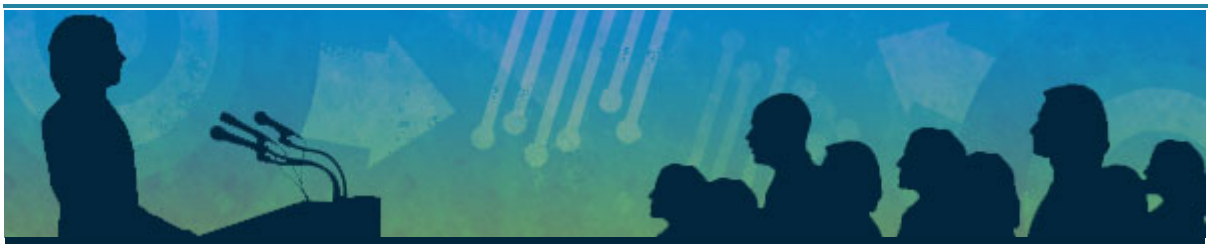
John Ling
Editor
EIPC Speednews

The judging of the 50+ poster displays was not an easy task, faced as they were by boards of excellence wherever one looked, but the judges finally agreed upon the following result:-

1st prize (£100 amazon vouchers) – Professor Martin Taylor, Bangor University "Vacuum-thermal-evaporation: The Route for Roll-to-Roll Production of Large-Area Organic Electronic Circuits"

2nd prize (£75 amazon vouchers) – Tom Wasley, Loughborough University "Hybrid Additive Manufacturing of 3D Electronic Circuits"

3rd prize (£50 amazon vouchers) – Greg O'Callaghan, University of Birmingham "Developing Conductive Organic Molecular Resists for Nanofabrication of Insulating Materials"



ICT AGM

Quick Links

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www.lamargroup.co.uk

ICT Sandbach Seminar and AGM

The 2015 Sandbach Evening Seminar and AGM will be held at the Chimney house hotel, Congleton Road, Sandbach, Cheshire on March 3rd.

ICT Evening Seminar and AGM

An AGM information pack will be sent to Members

FULL AGENDA BELOW

Event Info
March 3rd 2015

AGM - 16:30

SEMINAR :Registration 17:00 with the Seminar at 17:30

Address Chimney House Hotel, Sandbach.
CW11 4ST **(Tel: 01270 764141)**

SPONSOR

This event is supported by Lamar Group UK

AGENDA

with presentations by Professor Martin Goosey,

During 2014, the ICT has participated as a dissemination partner in a UK multi-partner project to develop new effluent treatment processes for the PCB industry that are based on the use of chitosan derived from crab shells. Many of you will have heard me talking about the 'crabs project' and I am pleased to be able to report on its progress (see www.stowurc.co.uk) for more information).

Towards the end of 2014, we were notified that another research project had been approved for grant funding support from InnovateUK. The project will build on some of the earlier research work undertaken in the Aspis programme and will seek to deliver high performance solderable finishes that are deposited from ionic liquids. This project is known as MacFest and I will be reporting on its progress (seewww.macfest.co.uk).

Geoff Layhe of Lamar Group will present - 'Thermal Management - the Role of the Substrate'.

Stuart Flack, of Electronics Yorkshire will deliver a presentation on - 'The Role of the IPC in the Electronics Industry'

Steve Payne, Manager of European Operations at iNEMI will discuss their Roadmap and Research Projects

Register with
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NEWS FROM THE USA

Isola Expands Its Portfolio of PCB Materials Engineered to Mitigate Skew in High-Speed Electronic Designs

Chronon™ ultra-low loss laminates and prepreg are now available for alpha testing.

Isola Group, a market leader in copper-clad laminates and dielectric prepreg materials used to fabricate advanced multilayer Printed Circuit Boards (PCBs), today announced the introduction of Chronon™, the company's latest ultra-low loss, high-speed laminate and prepreg materials engineered to mitigate skew issues in high-speed designs that have differential pairs. The introduction of Chronon, which follows the 2014 launch of Gigasync®, expands the company's portfolio of PCB materials to mitigate skew in high-speed designs.

Independent testing has confirmed the ability of Chronon materials to reduce weave-induced skew. Skew caused by the glass-weave effect can be as high as 130 picoseconds when trace lengths exceed 20 inches. Using test vehicles from Speeding Edge, an independent consultant to the PCB industry, the maximum skew on a horizontal 14-inch trace using Chronon materials was five picoseconds. The maximum skew on a proprietary test vehicle from a large original equipment manufacturer was 1.79 picoseconds.

Chronon laminates and prepreg are in the same UL family as Isola's Tachyon®-100G, I-Tera® MT and Astra® MT materials. PCBs manufactured from Chronon materials use the same parameters as Tachyon and Tachyon 100G products. Chronon materials are available with Reverse Treat Foil (RTF) and very low profile copper with 2-

micrometer surface roughness (Rz) copper foil, otherwise known as VLP-2 foil.

Tarun Amla, Executive Vice President and Chief Technology Officer at Isola stated, “Numerous OEMs have expressed concerns about skew issues on high-speed designs. The introduction of GigaSync, and now Chronon, reduces these issues. Although there are pre-emphasis and equalization techniques to recover the eye diagram from a near-closed state, skew poses a unique challenge. The current practice to reduce skew, signal rotation, is only partially successful and comes at a high cost. Chronon specifically eliminates the need to route signals at 5.0- to 7.5-degree angles to the glass weave, which saves board space and reduces overall cost."

Fred Hickman, Sr. Director of High-Speed Digital Products at Isola stated, "After we introduced GigaSync, designers praised its skew mitigation capabilities but noted its high dielectric constant (Dk) of 4.13. Chronon delivers a lower Dk of 3.64, a lower insertion loss, and mitigates skew better than competitive products in the market. Since the Dk matches the leading competitive high-speed digital product, Chronon materials provide an easy path for OEMs to attain more bandwidth on existing designs without having to generate new Gerber data. Chronon and Tachyon can also be used in hybrid designs since they share the same UL file.”

Samples are now available from Isola’s Chandler, Arizona manufacturing facility. To inquire about this product, order samples and participate in alpha testing, please contact Chronon@isola-group.com. The datasheet is available at http://www.isola-group.com/wp-content/uploads/2015/01/Chronon-Low-Loss-Low-Skew-Laminate-and-Prepreg-Data-Sheet-Isola.pdf.

To learn more about Chronon, please visit http://www.isola-group.com/products/chronon/.

John Deere Electronic Solutions Becomes First OEM to Earn Certification as a Qualified Manufacturer to IPC J-STD-001 and IPC-A-610

IPC's Validation Services Program has awarded an IPC J-STD-001 and IPC-A-610 Qualified Manufacturers Listing (QML) to John Deere Electronic Solutions, a manufacturer of custom, integrated electronics components based in Fargo, N.D. The company became the first OEM to successfully complete an intensive audit based on two of IPC's foremost standards: IPC J-STD-001, *Requirements for Soldered Electrical and Electronic Assemblies* and IPC-A-610, *Acceptability of Electronic Assemblies*.

John Deere Electronic Solutions met or exceeded the requirements for the electronics industry's most rigorous classification, Class 3, which is intended for high-performance electronics assemblies. As a result, the company is now listed as an IPC-trusted source capable of manufacturing in accordance with industry best practices. John Deere Electronic Solutions and other trusted sources of supply can be found on IPC's QML/QPL (Qualified Product Listing) database at www.ipcvalidation.org.

“John Deere Electronic Solutions has been a leader in advanced electronics manufacturing for more than 25 years,” said Bryan Bossert, JDES operations manager. “Our commitment to quality and the success of our customers drives us to maintain and exceed the standards set forth by the IPC QML certification. We are honored to be recognized by IPC with this affirmation of excellence and consistence in electronic assembly.”

IPC's Validations Services QPL/QML Program was developed to promote supply chain verification. It also provides auditing and certification of electronics companies' products, and identifies processes which conform to IPC standards.

"Different from other audit programs, IPC's Validation Services Programs uniquely provides technical and in-depth assessments of products and processes in accordance with IPC standards," said Randy Cherry, IPC director of Validation Services. "We are pleased to recognize John Deere Electronic Solutions as the first OEM member of IPC's network of trusted QML suppliers."

For more information about IPC's Validation Services QPL/QML Program, visit www.ipcvalidation.org or contact Randy Cherry at RandyCherry@ipc.org or +1 847-597-2806.

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PRINTED ELECTRONICS NEWS

Semiconductor works better when hitched to graphene

Graphene - a one-atom-thick sheet of carbon with highly desirable electrical properties, flexibility and strength - shows great promise for future electronics, advanced solar cells, protective coatings and other uses, and combining it with other materials could extend its range even further.

Experiments at the Department of Energy's SLAC National Accelerator Laboratory looked at the properties of materials that combine graphene with a common type of semiconducting polymer. They found that a thin film of the polymer transported electric charge even better when grown on a single layer of graphene than it does when placed on a thin layer of silicon.

"Our results are among the first to measure the charge transport in these materials in the vertical direction - the direction that charge travels in organic photovoltaic devices like solar cells or in light-emitting diodes," said David Barbero of Umeå University in Sweden, leader of the international research team that performed the experiments at SLAC's Stanford Synchrotron Radiation Lightsource (SSRL), a DOE Office of Science User Facility. "The result was somewhat expected, because graphene and silicon have different crystalline structures and electrical properties."

But the team also discovered something very unexpected, he said. Although it was widely believed that a thinner polymer film should enable electrons to travel faster and more efficiently than a thicker film, Barbero and his team discovered that a polymer film about 50 nanometers thick conducted charge about 50 times better when deposited on graphene than the same film about 10 nanometers thick.

The team concluded that the thicker film's structure, which consists of a mosaic of crystallites oriented at different angles, likely forms a continuous pathway of interconnected crystals. This, they theorize, allows for easier charge transport than in a regular thin film, whose thin, plate-like crystal structures are oriented parallel to the graphene layer. By better controlling the thickness and crystalline structure of

the semiconducting film, it may be possible to design even more efficient graphene-based organic electronic devices.

"The fields most likely to benefit from this work are probably next-generation photovoltaic devices and flexible electronic devices," said Barbero. "Because graphene is thin, lightweight and flexible, there are a number of potential applications."

Read more
at: http://www.printedelectronicsworld.com/articles/7468/semiconductor-works-better-when-hitched-to-graphene

TactoTek structural electronics out of stealth mode

Exciting start-up TactoTek spun out of VTT in Finland has just come out of stealth mode.

IDTechEx has been following the company for some time using the limited information previously released. TactoTek is at the centre of the move from 100 years of "components in a box" to merged structure, electronics and electrics. It manufactures products that integrate printed circuitry and discrete electronic components into 3D injection molded plastics.

VP Marketing David Rice says this is "a form of advanced in-mold labelling" consisting of high-pressure, high-temperature molding of PCBs and components.

Basically, a complete electrical and electronic system becomes an attractive piece of solid, shaped plastic that is load-bearing and conformal in a structure or vehicle. Typically a dumb structure is replaced, saving money to net off against the cost of the innovation.

Why do this?

Well, the benefits are many. Marketing VP David Rice claims that his products promise to be thinner and have less volume. They are lighter and can be more reliable with longer life. They are more rugged, often tolerating freezing and total immersion. The TactoTek part effectively takes no volume and it adds little extra weight - something very precious in an electric vehicle, for instance, because range is improved.

Further, the functionality is actually improved in many cases. For example, their integral controls are more sensitive than conventional parts.

IDTechEx believes TactoTek's costs and performance are getting further validation and, if the claims are correct, the potential is huge. So far, TactoTek's, customers mainly want to replace parts in an existing structure but, as Rice points out, maximum benefits accrue where products and vehicles are designed from the start

with these smart structures incorporated: "born integral". Meanwhile, the company is not standing still. It even sees potential to reduce existing costs by two thirds.

Read more at: http://www.printedelectronicsworld.com/articles/7463/tactotek-structural-electronics-out-of-stealth-mode

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INTERNATIONAL DIARY 2015

Smart Systems Integration
Copenhagen, Denmark
11th & 12th March 2015
smart@mesago.com
www.smartsystemsintegration.com

CPCA SHOW
Shanghai, China
17th - 19th March 2015
www.cpca.org.cn

Institute of Circuit Technology
Foundation Course in PCB Design and Manufacturing
Loughborough University
13th - 16th April 2015
www.instct.org

KPCA SHOW
Kintex Exhibition Centre, Kyunggi-do, Korea
22nd - 24th April 2015
www.kpcashow.org

IPC APEX India
Bangalore, India
TBA
www.ipc.org

SMT Hybrid Packaging
Nurnberg, Germany
5th - 7th May 2015
www.mesago.de/en/SMT

JPCA SHOW
Tokyo International Exhibition Centre
3rd – 5th June 2015
www.jpcashow.org

ICT Annual Symposium
The Black Country Museum.
Dudley, West Midlands.
3rd June 2015
www.instct.org

PRODUCTRONICA
Messe Munchen
10th – 13th November 2015
www.productronica.com