European Institute of Printed Circuits

EIPC SPEeDNEWS

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NEWS FROM EIPC

EIPC AUTUMN CONFERENCE, BASLE, SWITZERLAND
13TH & 14TH October 2011

Held in the very modern Marriott Courtyard Hotel in Pratteln, just outside Basel, the EIPC Autumn Conference was launched by Chairman **Rex Rozario.** He is involved with the CALM project in Exeter, specifically research into 3D printing, a manufacturing technique for electronic structures which are built one layer at a time in specialist machines using high temperature materials. It is designed for SME's involved in the circuit board industry.

On an industry front, Rex reflected, from the manufacturing stand-point, that around the world military and defence companies are being scaled down, with the consequent impact upon the PCB industry in these countries. He was pleased to announce that the next ECWC (Electronic Circuits World Convention) will be held in 2014 in Nuremberg, Germany, and will be run by EIPC, and sponsored by Mesago.

He made a presentation to the EIPC Operations Manager, **Kirsten Smit-Westenberg,** who had served the EIPC with great competence and efficiency for the last 10 years; the appreciation of the members and the delegates was heard from some distance.

Walt Custer has always been close to the heart of EIPC Conferences, but on this occasion EIPC was very close to the heart of Walt Custer, who was about to have a stent fitted, in a hospital in California. Speaking via Skype to an EIPC Conference is about the best pre-med one can get if you are having a surgery. He will, however, be in Munich in November, that well-known centre of recovery.

Walt reported that the electronics supply chain has slowed, due to tighter fiscal policies, and whilst the US going no place at the moment, Europe is doing better than the rest of the world for a change, even if that world is in a no-growth situation. Industrial production in Europe is doing well, increasing in August and electronic equipment manufacturing in Europe is up 10%, in a world market valued at 1.46 trillion Euros. In the consumer goods manufacturing sector, it was China and Taiwan who slowed, whereas Europe is doing rather well, but not so Japan. Automotive electronics is back on track and rising fast, with some 40% of car costs being electronics. Forecasts for semiconductors show a flat scenario for the coming months.

In PCB fabrication, Europe has 5.2% of the world market, in Japan PCB shipments have dived for several good reasons, in Taiwan and China the manufacturing is growing, but it's been a slow year. German has 41% of the European market, with 1170 companies involved, and in 2010 PCB production was valued at 1.957 million Euros. The European PCB market has more orders in hand than in 2008, with UK taking over from France in the defence and industrial electronics sectors. However, PCB monthly shipments look to be on a downward

trend, and decline is also seen in North America. The entire global business cycle is in low growth mode, but component growth should see a rise in 2012 as a portent of improvement, with some modest growth next year. Walt commended us to focus on high growth markets and customers, but who they are was not clear. It will be good have Walt back in circulation with his heart in a similar condition.

Dietmar Leibrock of Huntsman Advanced Materials asked where they were going. It would seem everywhere. Formerly Ciba-Geigy, Huntsman is a $12 billion turnover company serving 11 market sectors. Of these electronics forms a good part, with products such as Probimer, which goes back to 1978. Not only are they active in the PCB industry, but also with encapsulation systems, LEDs, casting of ignition coils for the automotive industry, electronic control units, and transformers, modules and sensors. Their market share of 26% is down from 41% in electronics manufacturing, so for them the trends are to renewable energy, (solar and wind), and future mobility in aerospace and automotive. They are involved with developing higher efficiency of combustion engines and the employment of E-drive and H2 drives for cars, as well as Li-Ion batteries. Working on high-temperature electronics is a project in which Huntsman are involved along with Bosch, Daimler, Isola and Continental. It is in the field of OLEDs that there is excitement, this is projected to have a high growth rate but the encapsulation of them remains the biggest challenge to large scale commercialisation. Current price for OLED is $20,000 per sq. metre, which is of course quite unacceptable. He described the work being done at Huntsman in OLED encapsulation, with a thin film barrier, a water scavenging layer as well as a planarisation layer, this is cheap, flexible and has (thus far) a 10-year lifetime. Philips are now ramping up production of OLEDs in Aachen such that the per sq. metre cost will be commercially acceptable. At Huntsman they recognise that if you cannot change the direction of the wind, you can set your sails accordingly. They appear to be on the right tack.

Dyconex AG in Switzerland spared Michael Fink, their CEO, for a short time so that he could look at the strengths and weaknesses of the European PCB industry. His company produces flex-rigids boards for the medical markets, many for implants, mostly for diagnostics. In Europe we have a solid home market, with a more strategic than tactical approach, and we have a strong innovative capability with strong funding (such as I*e*MRC), a strong education base and strong execution focus in terms of reliability, culture and reputation. Local branding is also strong.

On the other hand, currency fluctuations do not help. The Swiss franc is now 20% higher, and this incurs a raw material cost factor as well as the prices for exporting finished goods overseas. The cost of labour in Europe is high, and the labour laws are not an aid to competiveness. We have a weakening supply chain, and we are dependant on OEMs for exporting; there is also an immobility of our workforce. Our culture, too, can be a handicap, and we do not always excel in communication. His experience is that we have no natural sense of urgency, but we do have a lack of sensitivity and flexibility.

Knowing which markets to pursue is, suggested Michael, as important as knowing what markets NOT to pursue. Is the medical market the one to pursue? If so, then you need to be aware of the degree of the level of market knowledge required; there are cost pressures, such as those associated with quality and reliability, and there are liability risks. It's the difference between 'price' and 'value'. It can take 5 years to win over just one customer.

On the supply side, there is no longer the depth, and local equipment companies are now focusing on solar and are neglecting PCB. Europe used to have a strong integration of material production and equipment, but we have lost the critical mass in which profitability was the incentive to commit resources and competition to commit to R&D.

Recently the Swiss Government allocated CHF 870 million to industry, but it might have been better spent if it had been invested in innovation. He suggested that we should maximise local OEMs sourcing share, develop international business, push innovation, focus on operational excellence and execution, and compare on value and not price.

Karl Stollenwerk from Isola thought that there was no industry in Europe that had changed as much as electronics. In 1980 5% of production was in Asia, in 2010 it is 82%. In Europe in 1990 we had 1500 PCB producers, now we have 250. In the 1980s we had 23 laminators, now we have one. High-speed and digital joins with opto-electronics and IMS to form some of the innovative products which Isola manufacture in their product range, and Karl explained how they had reduced delivery time from receipt of order down from 72 days to 30 hours by moving from manufacture for stock to manufacture to order. 94.2% delivery performance ex Duren is now standard. Lean manufacturing was mandatory, and related to improved competitveness, Isola has been making laminates for over 100 years, a core of experience that qualifies them to be innovative enough to survive.

The question time session proved free ranging, and covered everything from federations, political strengths, lobbying the EU, LED immersion, supply side innovation, selling value and providing a forum for PCB manufacturers to which they could commit, a body for innovation.

Chaired by Pete Starkey, the European Editor of the i-Connect 007 Group, the second session of the day saw with the welcome return of Paul Waldner of Multiline International who spoke about PCB silver film – Agfa, Fuji and Kodak, Fuji film is No 1 in Asia, but now 19 out of the top 20 use Fuji film. Silver Halide film is nothing new, but Paul gave us a good insight into how the film is manufactured, and the polyester film used has a unique property, which is its ability to be pulled in one corner to make the image fit, so that all the algorithms fit on a Hakuto exposure machine. The stability of the film is such that even after 2000 cycles the accuracy is ± 5 microns. So long term processing stability is good, and whilst the material itself is sound, the effective maintenance of the equipment is very much the responsibility of the manufacturers. Good house-keeping is essential. The effects of humidity over time were shown, as were the causes of black spots during processing. LDI is a growth area, with 900 LDI and DI machines in the world to-day., but LDI has not impacted upon film as had been predicted. Film, said Paul, does have a future; low cost, robustness and stability all count very much in its favour.

Dr. Peter Amann of KIV PCB ProFiChem is the man to talk to about copper pre-treatment in PCB production. Bad copper pre-treatment can lead to short circuits, loss of adhesion, blemished solder mask, and de-wetting of pads. The chemistry that he is offering as a process can be used in any machinery, it is easy to analyse, and the use of DI water is not necessary. The process is based on iron-containing sulphuric acid solution, which re-oxidises the Fe by dosing with small amounts of H_2O_2. Copper concentration is 45 g/l. Special additives promote adhesion, and non-plated holes remain clean even on double-sided boards. Adhesion meets IPC-TM-650, a thermal stress test. For solder resist coating, there is a 2-step treatment available, based on nitric acid, and the stabilising solution is hydrogen peroxide. Again, testing to IPC TM 650 tape test shows no problem. However, the arrival of a one-step process for the treatment of myriad surfaces appears imminent, Gripping stuff.

Johan Pellicaan of Cookson Enthone in The Netherlands introduced us, as if that were necessary, to his company which, amongst many other things, manufactures dry film. This can be for primary imaging, under the name of Photec, which is a dry film that has been

around since 1974, he informed us. It appears that it may be around for awhile more, as it has properties that are popular, in giving higher yields at lower cost with better sensitivity and accuracy. New polymers and monomers are being used to optimise process conditions. He listed some key products amongst the 150 different types of film available, with Raytec for solder mask, and a special film for LDI, the SL-1300 series. The very experienced and knowledgeable Johan made the subject interesting and cleared up at last any confusion between the two acronyms PCB and PWB.

Hans Fritz of Sense Advanced Technologies looked at the range of imaging technologies for PCBs. His company has a portfolio of products which cover film printing, or exposure, artwork scaling exposure for tooling, a digital linear scaling LDI printer, as well as non-liner, and a selective Ink Jet Printer. All have their applications, as Hans made clear, to achieve a clean panel. They have a system that guarantees complete accuracy by stretching the film to fit the image, with a clear glass screen used as a back up in the imaging process. Only 8 targets are needed, so the system is fast, and perfect for solder mask application. It can be used for both inner and outer-layers, with similar results. Tooling errors are the most harmful, but their new imaging process uses laser diodes and can image solder resists very rapidly at low temperatures. Resolution is 25 microns with a 10 second processing time.

The visit to Huntsman was impressive. Within the imposing buildings we were treated to a four-part tour of their superbly equipped laboratories, beginning with a look at the Probimer test facility. Here the two products, aqueous-developing Probimer 77 and solvent-developing Probimer 65, are evaluated in response to customer enquiry, and as part of progressive development. Their new white solder-mask is used for LED applications, and automotive lighting and instrumentation. The full range of equipment used in the industry is replicated here, including double-sided screen printing alongside the traditional curtain-coating lines. They can also replicate all the standard test procedures, and through micro-section can monitor resist performance and coverage. A trip down to the OLED lab. was of particular interest as there the major problem facing OLED commercial acceptance had been overcome, namely barrier protection. Huntsman have been working with the major OEMs in this field and we were shown the way in which OLEDs can now be encapsulated in a way that performance is not impaired, but protection over many years can be guaranteed. They have a special laboratory dedicated to encapsulation, and here the use of potting and encapsulation compounds were demonstrated as used for components for the automotive industry. Filling under vacuum was seen. The last area to be invaded was the Test & Measurement facility, where electrical testing as well as physical testing can be carried out, and such is the demand that they have a full Zwick robotic system that operates 24/7 on sample panels.

Diethard Kapp-Schwoerer of HiTech Photopolymer AG was the first speaker on Day 2. His company specialise in photopolymers for fine line technology, and he looked energetically towards the future. There was an article in PCB007 about liquid resists in which the history of dry film, the advent of liquid resists, the parallel development of LDI are covered, but then the state of the art became a little static. Liquid resist provide very good definition, better adhesion,
and the move towards 1 mil lines and spaces for medical and military means that liquid resists are well placed. So, LDI and LPR will be the primary system for the next generation of PCBs. Diethard indicated that copper thickness of 6 – 12 microns will be required, and the subtractive process will still dominate. Resist thickness will be 5 microns and a positive resist will play a significant role. With positive resists exposure to UV light leads to the development of very fine channels between the lines. Using an Ugra step wedge to measure exposure they have found that the channel gets wider and the line gets smaller; a diazo naphto quinine resist has many advantages, but it requires more energy than existing printing units, and there is a limitation to thickness. However, the wetting is excellent, existing pre-cleaning processes are sufficient, and formulations

are available for dip, spin, roller and spray coating. Conveyorised developing equipment can be used, and 15um lines and spaces are easily achievable.

MuTrac^{x} is the name for the future – their Lunaris ink-jet process is offering 100% yield for disruptive digital technology for imaging inner layers, explained Stuart Hayton, whilst taking out 11 of the present 15 process steps. From data to print in 5 minutes, there are no problems, there is no development process, none at all, and zero copper waste. The result is only good panels. Ink is applied as a flow process to create the image, at a rate of 50 million droplets per second from 20 print-heads, and there are 2 rows of 20 print-heads. The vehicle for this process started with a granite based ex-drilling machine base, with static heads, and Stuart described how they had developed from that, the various aspects considered, the improvements needed, and what they have finished up with is available from January 2012 and a short video showed a very fine system in full operation. 3 mil lines and spaces are standard, a maximum image size of 21" x 24", 50 cores per hour, and the first machines in the field will be located close to home to ensure good support, with two purchase choices - outright purchase, or per panel. This is an exciting technology breakthrough and progress will be keenly followed.

Agfa Gevaert has Eric Janssens, who spoke about ink jet ink for legend printing. Eric reminded us of the rules of engagement for legend inks, and explained that Agfa were only involved with the consumable aspect of ink jet ink, not the application equipment. Traditional legend ink application is/was slow, expensive and depended upon operator skill.

Now ink-jet and sound reasons; primarily has become popular for good application inkjet, and with two using the piezoelectric Eric listed the companies who inks, U.V curing and hot melt. inks and equipment, before have become established in who was responsible for handing over to Stefan Smet have much experience in inks for designing ink for inkjet. Agfa the graphic arts, and Stefan explained the complexity of formulating an ink to meet the specifications required for performance, shelf-life, etc. Based on acrylates, photo-initiators, a pigment and wetting agent, their imminently available non-toxic legend ink Wh03 has a 12 month shelf-life, a stable particle size throughout, good opacity, pencil hardness, and in which sedimentation can be easily recovered.

Hildo van Hettema from Huntsman spoke about new products for the more challenging markets. Within a PCB they have a good share, with the solder resists, liquid dielectrics, liquid etch resist, conformal coatings, and encapsulating systems for components. LD Flex is a liquid dielectric for flexible circuitry with thermal conductivity which is used for the production of PV cells. Hildo described how they are developing products to meet changing demands, and with their Probimer 77 white solder mask being of value to the automotive industry, he went on to show how they achieve a high level of whiteness in LPISM after HASL. Testing was very thorough, including thermal shock, thermal storage and abrasion resistance.

The face of Orbotech was manifest in Uwe Altmann who shared with us the work being done on scaling modes for LDI. These steer the manufacturer towards greater accuracy. Version 2.08.01 Paragon Imaging Modes were described, The traditional fixed imaging modes comprised 5 steps, with partial printing imaging modes this was down to three, but with the new system this is reduced to just two – auto scale and advanced scale. Paragon Imaging Modes 2.09 has new partial scaling for panel registration which is much faster, with automatic data correction. Group scaling leads to increased accuracy; it saves time and reduces costs. Why scaling? The machine becomes a little bit smarter, it looks for the scale factor in a certain area, an if it found to be outside it, the machine controls the best fit. Scaling modes are invaluable in the advancing HDI world, when lines and spaces are getting smaller.

Camtek in Israel had loaned us Tomer Segev for a couple of days, he reflected upon the work being done on direct digital solder mask printing using inkjet technology. A new machine from Camtek entitled Greenjet has been Beta-site tested at Eltek for some time now, and this is a novel way in which solder resist can be applied directly to the panel, and UV cured, without the need for drying, artwork, exposure and development. Ink with a drop size of 30 microns, spreads to 70-100 microns, and give 100um solder dams. There are three basic steps, which is pre-cleaning the panel, ink-jet application, and final cure. We were reminded of the traditional process limitations; 4 mil solder dams are available with this process; as is better track coverage though solder mask thickness controllability before tack free drying. No solder mask enters micro-via holes, so no post-cleaning is required. The ink is a gloss u/v-thermal hybrid formulation, RoHS and UL-compliant, solvent-free, with good chemical resistance and soldering resistance. The processing sequence is print, u.v bump, rotate, and print, u/v bump and then final thermal cure. OEM approvals is now required.

David Wayness of Dow Electronic Materials spoke about soaring gold costs and what Dow is doing to help. Final finish trends have included the shift to lead-free, higher feature densities, pad size reduction leading to fragile solder joints, large BGA devices; ENIG and ENEPIG finishes are good but expensive. Nickel finishes are still preferred, with electroless nickel at 306 microns DFT v gold at 0.03 – 0.10 microns. ENEPIG (electroless nickel, electroless palladium, ad Immersion Gold) has gold wire bond capability. But the use of gold in any form has a cost factor, with gold prices soaring to $1900 per ounce. Taking three different formulations, Dow experimented with different gold loadings, and they managed an increase of 80% in efficiency using the same amount of gold. Finishing is a very conservative market, slow to change, but the price of gold has changed that, and their Auroelectroless SMT 520 Gold has some fine features – with bath performance insensitive to nickel concentration, and tests showed very consistent results against nickel corrosion, ball shear performance was stable, as was ball pull. What they did achieve was a 30% reduction in gold usage. Does it meet ENEPIG requirements? Yes.

The ASPIS project was discussed by Professor Martin Goosey of Loughborough University. A 3-year project, it is aimed at solderable finishes; the partners are ITRI, the University of Leicester, LIOC (Lithuania) and TNO (The Netherlands). The other partners include Somacis, EIPC, Graphic, Atotech, amongst others. A multi-faceted approach begins with a complete understanding on ENIG and failures, and the idea is to have a method whereby boards are rigorously tested to find out how and why failures occur. The Work Plan for 2011 has included NiP coating behaviour, as well as Immersion Gold, thermal impact analysis on adhesion to determine weak boundary layers. Varying levels of pH result in a wide range of morphology on the board surface. Initial findings show that inadequate copper substrate preparation result in an EN coating deposit which can undergo black pad formation. A ENIG Screen tool has been developed by TNO, a non-destructive method to look for failure under pads. Optimising aqueous plating, the use of ionic liquid plating, both are under interested study, and ionic plating can obviate black pad formation, using a range of metals, and they can now deposit ENIG from an ionic liquid. The Institute of Circuit Technology is leading the project, and exploiting and disseminations on-going. www.aspis-pcb.org Great project work in the first year.

Alfred Kaisermann from Orbotech knows all about digital controlled laser technology for repairing circuit boards. Boards without shorts do not exist, and the finer the line the more difficult the repair. 60um is the limit where the manual repair can be employed, so now what?

Finding the defects or shorts is the first step, and seeing them is the second. UV light gives better visibility, and here the optics are working in conjunction with the CAM data, to guide the laser beam to the place for repair. Ablating the board is a balance between removing the short and damaging the laminate, so this was resolved by use of the CLR (closed-loop repair) Technology™ which is now able to repair boards that previously would have been scrapped. Orbotech also have a system called Perfix, with Universal Access. This repairs defects from electrical test, AOI or final inspection, and the ablation is effective and safe. He calculated that if we repaired 10 PCBs a day costing 5 Euros each, then you could save 175,000 Euros per annum. Repair one per day and you make a saving. Repair them all, and then set the cost off against your new machine from Orbotech. You can repair boards, correct stencils, inner layers, outer layers, down to 0.4mil line and space. You might have to get the OEM to approve this technique, but, that done, a good methodology awaits.

Glenn Oliver is the familiar face of Du Pont on the European PCB circuit who had come over to tell us about some new flex materials that they had magiced up to meet the demands of high speed and high frequency performance. High speed means more bandwidth for digital applications, and in general flex manufacturers do not make high speed circuits and high speed circuit board shops do not make flex. Comparing the characteristics of rigid and flex copper clad laminates, one could se that both had their own plus/minus points, and in processing the rigid and flex shops differed in what they could handle and be competent with. Putting the best of both worlds together would be a challenge, but Du Pont now has a new material involving a Kapton core with a Teflon adhesive. It has a lower dielectric constant, a lower loss tangent, and ultra low profile RA copper. It is referred to as Pyralux® TK Copper Clad Material.

Arlon in the USA have Alain Desire to look after their affairs in Europe and he too was interested in high speed reliability on some new materials. High performance resin systems have been used to manufacture laminates for high speed and high frequency applications for some time now, but over time these resins have demonstrated some drawbacks, notably in terms of copper peel strength and accelerated oxidation. These characteristics reduce the reliability of the PCB, as if the manufacturers do not have enough to worry about, so Arlon set to work to look closely at what was required to rectify affairs. Alain described the procedures followed, They now have an advanced polyimide resin that has some effective characteristics; it is halogen-free, will flow out in pre-preg to allow holes to be filled, and has the thermal properties required for high glass transition temperatures. Peel strength is excellent, and has a high resistance to oxidation.

Ventec Europe have a Technical Support Manager travelling around Europe, by the name of Ian Mayoh, Thermal management substrates are his line of business; thermally conductive PCBs keep embedded components cooler, reduce system costs, and are very good to mount LEDs. LEDS will capture 46% of the global lighting market by 2020, so the demand for such circuit boards will increase hugely. There are four substrates suitable for LEDS, but heat dissipation would be 74% through the carrier or substrate. So, the fillers of these substrates

plays a major part, with AL_2O_3 being the best. Such thermally conductive substrates have better heat transfer than standard by FR4 by factor of 12, and Ian explained how IMS (Insulated Metal Substrate) materials were made, their properties, and their applications.

Alun Morgan proved the point, and came last. He described how high-frequency current flows through laminate, known as the skin effect, in which current is forced nearer and nearer the surface by magnetic influences, with increase resistance across the surface area. Within his company, Isola, work is being done with foils, and glass fabric development, to meet typical 10 GHz demand. Dielectrics are insulators, but when subjected to an electric field, polarisation occurs, a 'Dipole Moment' and in dielectrics the loss factor values are altered. Alun explained in his own particular fashion how the effect may be seen with low loss laminate. At Isola they have recognised that the market vector is evenly divided between higher reliability and higher speed, 20GHz being achievable.

This conference was no exception to the norm for EIPC; a programme covering a wide range of entirely applicable topics to circuit board manufacture, along with some exciting new developments in technology which prove that within Europe innovation remains a strong point in a world class of its own. Congratulations to all concerned. As a precursor to Productronica next month, at which EIPC will be running three technical workshops, the timing was perfect.

John Ling

Editor