

# Journal of the Institute of Circuit Technology

## 2009 Events

3rd February	18.00 Evening Seminar - 3 Papers around Laminates. Pike and Eel at St Ives, Cambridgeshire. Supported by Anglia Circuits
12 - 13th February	<i>EIPC Winter Conference, Amsterdam</i>
3rd March	17.00 Evening Seminar, Devonport Hotel, Darlington.
18th March	12.00 Council Meeting London Canal Museum
24th March	<i>PCB Inspection &amp; Quality Assessment</i> <i>ITRI innovation, St Albans</i>
25th March	<i>Troubleshooting Your Assembly Yields</i> <i>ITRI innovation, St Albans</i>
30th March - 2nd April	Annual Foundation Course , Loughborough University
22nd April	<i>Step by Step Electronics Failure Analysis</i> <i>ITRI innovation, St Albans</i>
28th April	<i>SMART Group, PCB Materials+Finishes - What</i> <i>Assemblers Should Know, The White Swan -</i> <i>Arundel</i>
5 - 7th May	<i>CWIEME Berlin 2009 - Electrical Insulation</i> <i>Materials, Electromagnetic Coil, Electric Motor,</i> <i>Transformer Manufacture &amp; Repair.</i>
4th June	35th Anniversary Annual Symposium Bletchley Park, Milton Keynes
10 - 11th June	<i>IMFAIRO9 - Institute of Metal Finishing</i> <i>RAF Museum, Cosford, Shropshire</i>
16 - 18th June	<i>National Electronics Week, Earls Court</i>
23rd June	12.30 ICT Council Meeting- Canal Museum
4th August	<i>Joint ICT/MRC/EY Event at Rotherham</i>
24th September	<i>Southern Golf Day and PCB Dinner,</i> <i>Wiltshire Golf Club</i>
6th October	14.00 ICT Council Meeting - Comfort Inn, 17.00 Evening Seminar, - Arundel Supported by Lamar Group
3rd November	17.00 Evening Seminar, Devonport Hotel, Darlington

## 2010 Events

2nd February	17.00 AGM - followed by Evening Seminar, Norfolk Hotel, Arundel
2nd March	17.00 Evening Seminar, Devonport Hotel, Darlington
12th April - 15th April	Annual Foundation Course , Loughborough University

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vol.2 no.4 October 2009

## Editorial

We are approaching the end of 2009, a year that has seen our Membership increase by at least 15%, and during which we will have held, four highly successful Evening Seminars, an extremely pleasant 35th Anniversary Annual Symposium at Bletchley Park, and the Annual Foundation Course at Loughborough University. We have launched our vastly improved Web Site, and published four issues of our *Journal*.

Early next year on Tuesday 2nd February 2010, we will be holding our AGM at the Norfolk Hotel in Arundel followed by an Evening Seminar.

The 2009 Council are very keen to see the Institute and our Industry grow even more strongly in the coming years. Turning the AGM into a Major Event, rather than an occasion for reporting past progress, will we hope enable New and Old Members to contribute New Ideas and Enthusiasm for our advancement.

Please make a note in your personal diary of :-

ICT AGM on Tuesday 2nd February 2010 at 5.00 PM Norfolk Hotel, Arundel.

AND BE THERE !

*Bruce Routledge*  
*2009 Council Member*

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<b>Council</b>	Steve Payne ( <i>Chairman</i> ), Martin Goosey ( <i>Deputy Chairman</i> ), John Walker ( <i>Secretary</i> )
<b>Members</b>	Chris Wall ( <i>Treasurer</i> ), William Wilkie ( <i>Membership Secretary &amp; Events</i> ), Bruce Routledge (the <i>Journal</i> ),
<b>2009</b>	Andy Cobley, Peter Starkey, Francesca Stern, Bob Willis, Richard Wood - Roe

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## THE INSTITUTE OF CIRCUIT TECHNOLOGY COUNCIL VACANCIES

Members of the Institute are invited to apply to fill Vacancies on its Council. We meet four times a year with the purpose of organising Technical Educational Activities, Evening Seminars, Annual Symposium and General Administration.

Ideally Applicants should hold senior positions in the Industry and be well versed in the manufacturing processes of Printed Circuit Production. They should be appreciative of new technological Trends and be prepared to support the Aims of the Institute.

If you are interested in serving on the Council please contact the Honorary Secretary of the Institute, John Walker, whose E-Mail Address is :-

[bcsbasingstoke@btinternet.com](mailto:bcsbasingstoke@btinternet.com).

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### Membership

New members to be voted into membership by the Council  
6th October 2009

#### Associate Member (A.Inst.C.T.)

Mark Capers      10147  
Bao Xianzhu      10152

#### Member (M.Inst.C.T.)

Mark Harding    10149  
David Reece      10150  
David Maitland 10151

### Corrections and Clarifications

*It is the policy of the Journal to correct errors in its next issue.*

*Please send corrections to :-*

*E-mail : [bruce.rout@tiscali.co.uk](mailto:bruce.rout@tiscali.co.uk)*

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***Institute of Circuit Technology.***

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## REACH - Implications of Europe's New Chemicals Policy on PCB Fabricators & Assemblers

This article was drafted several months ago by an ICT member but a change of employer has resulted in the need for anonymity. As the resident 'REACH bore' I have been asked to update it for inclusion in the Newsletter.

**Len Pillinger F.Inst.C.T.**

(The Institute of Circuit Technology representative at REACH)

### Introduction

The Regulation for the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) entered into force on June 1. 2007. The regulation implements the EU's new chemicals policy, which has been designed "to replace a complex regulatory regime of forty-two existing EU laws controlling chemicals, with a single uniform system that aims to deliver greater protection to human health and the environment and to enhance the competitiveness of Europe's chemicals industry," ..... but in reality; nothing has happened since - WRONG!

There is little doubt that the regulation has driven major changes in the global chemicals industry most significantly, for manufacturers and importers into the EU of substances and preparations. It will also have considerable implications for any business in the EU that either uses or processes chemicals to make their products. This includes PCB fabricators and assemblers. The heaviest REACH responsibilities relating to registration obligations will undeniably fall on the supply houses and suppliers upstream from them. However, there will be product stewardship activities that will need to be addressed by fabricators in the coming years. This article sets out to provide a top level introduction to REACH, to highlight some of the key impacts of the regulation on PCB fabricators and to present some of the current and future activities that board fabricators can expect to undertake in order to comply with the regulation now and the in the years ahead.

### Is the Electronics Interconnect Industry REACH ready?

A 2008 published survey by the IPC on REACH Preparedness in the North American and European Electronic Interconnect Industry ([http://www.ipc.org/3.0\\_Industry/3.4\\_EHS/2008/REACH-readiness-survey-report-July-2008.pdf](http://www.ipc.org/3.0_Industry/3.4_EHS/2008/REACH-readiness-survey-report-July-2008.pdf)) highlighted a worrying lack of awareness and preparation in the industry. The survey revealed that over 30% of senior managers and 50% of manufacturing personnel in board fabrication facilities acknowledge they had absolutely no

awareness of the regulation. If this is still true of your business 12 months later; be afraid

There are activities that board fabricators should now be undertaking to ensure continuity of supply by taking advantage of provisions in the regulation to seek assurances that the chemicals supplied to them will continue to be supplied. This paper therefore addresses the latest information being distributed in the trade media, webinars and more formally from the European Chemicals Agency (ECHA).



A good start is to download a copy of the ECHA "Guidance in a nutshell. Requirements for substances in articles". It's rather a large nutshell at 16 pages but less wordy than the formal guidance on substances in articles which runs to 118 pages or the Regulation itself which is a hefty 278 pages of legal gobbledegook. It details the main obligations of 'downstream users' such as PCB fabricators and assemblers

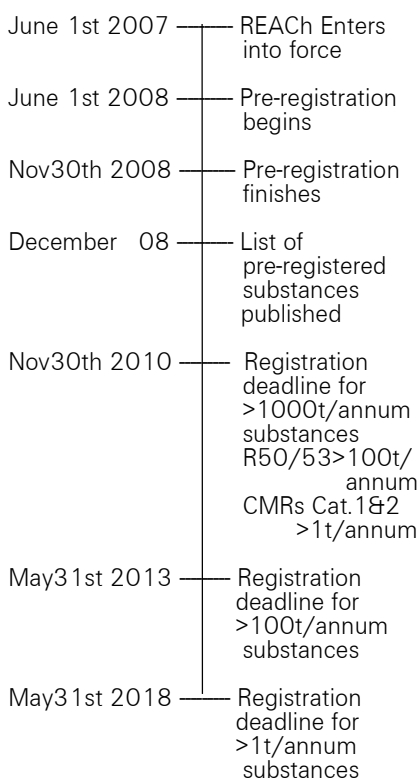
Principal REACH Obligations regarding Articles			
	Registration (with ECHA) of substances in articles	Notification of substances in articles	Communication (to customer) informing of substances in articles
<b>REACH Article</b>	Article 7(1)	Article 7(2)	Article 33
<b>Obligation</b>			
<i>Who is Responsible</i>	Producers and / or importers of articles		Suppliers of articles
<i>Which Substances</i>	Substances intended to be released from articles	Substances included in the ECHA candidate list of substances for authorisation	
<i>Threshold</i>	1 tonne per annum		No threshold
<i>Substance concentration</i>	No threshold	0.1%(w/w) in article (ie: not in homogeneous layer as per EU RoHS Directive )	
<b>Potential Exemptions</b>			
<i>Substance and use previously registered</i>	<b>Yes</b>	<b>Yes</b>	<b>No</b>
<i>Exposure can be excluded</i>	<b>No</b>	<b>Yes</b>	<b>No</b>

### Registration

Article 5 of REACH specifically prohibits the "manufacture" and "placing on the market" of non-registered substances. ECHA Guidance Documents inform us that a downstream user cannot use or place on the market substances that have not been (pre)registered. Enforcement authorities (the HSE in the case of the

UK) may seek to enforce this prohibition against any actor down the supply chain, including downstream users that use or place on the market a non-registered substance. As with all regulation; information is the best first line of defence. Assuming that your supplier has done the necessary is a risky strategy.

The registration of a substance includes the use of the material and method of processing. It is therefore necessary to ensure that your use of a substance is known to your supplier well before he registers it with ECHA (see timeline below).



Failure to do this in the case of a novel end use or method of use probably means having to register the substance / use yourself - something to avoid.

Current advice is for downstream users to submit their use to suppliers as soon as possible and in any event before 1st December 2009 if they want this use to be covered in the 'first tranche' registration dossiers to be submitted before 1st December 2010.

### Chemical Safety Reports:

During the Registration process, EU manufacturers and importers of chemicals will have to compile and submit a Registration Dossier that should prove they are managing their chemicals safely. This will involve generating and assessing hazard data on the physiochemical, toxicological and eco-toxicological properties of a substance. For substances manufactured or imported in volumes greater than

10 tonnes/year, a Chemical Safety Report (CSR) will also have to be submitted to the European Chemicals Agency. In addition to reporting the hazard data associated with a substance, the intended uses along with the associated risks and proposed risk management measures, in the form of 'exposure scenarios' for each intended application of the substance will also have to be detailed. These exposure scenarios will eventually be communicated to the 'down stream users' of the substance, as annexes in (Material) Safety Data Sheets.

Consequently, it is again important for fabricators to not only establish the registration plans of their suppliers but to seek assurances that their uses are going to be included in registration dossiers. It was originally anticipated that there would be approximately 150000 pre-registrations. The ECHA web-based pre-registration portal wilted under the weight of 2.7 million applications; eighteen times more than it was scaled to cope with.

In the years ahead, EU based fabricators should be aware that they will eventually be called upon by their suppliers to provide 'use' and 'exposure' information and to comment on risk management measures as well as passing any new hazard information to their supplier. Fabricators and assemblers will also have to implement the risk management measures set out in the exposure scenarios within a maximum of 12 months. This is in contrast to their non-EU competitors who will be able to continue using chemicals as they are now. Despite the obvious, potential benefits for human health and the environment, EU based fabricators will have to find the personnel and resources to meet these challenging demands in an already difficult operating climate.

### Authorisation

For some 'substances of very high concern' (SVHCs) Authorisation will be required before use. Substances of High Concern include the following: Category 1 and 2 carcinogens, mutagens and reproductive toxins (CMRs) substances classified as being persistent, bioaccumulative and toxic (PBTs); substances that

recorded for due diligence purposes.

To support industry the European Chemicals Agency has developed a number of guidance documents to supplement the legal text of REACH <http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2007:136:SOM:EN:HTML> these guidance documents are the REACH Implement Project (RIP) documents and they are free to download from the ECHA website [http://reach.jrc.it/guidance\\_en.htm](http://reach.jrc.it/guidance_en.htm). The next level of guidance down are the in a nutshell guides; another free download from <http://guidance.scha.europa.eu/>. In addition to the RIP documents each member state has established a REACH helpdesk to assist with enquiries relating to registration; a list of the contact details of each helpdesk is available from the following website [http://echa.europa.eu/reach/helpdesk/nationalhelp\\_en.asp](http://echa.europa.eu/reach/helpdesk/nationalhelp_en.asp).

### Stop Press

At the Beginning of September, 15 further SVHC have been proposed as detailed in the screen-dump below from the ECHA website. The electronics industry appears to have been only marginally affected. The Farnell 'Directives Decoder' web page quotes Dr Paul Goodman of ERA Technology:

"Di-isobutyl phthalate is a plasticiser used in the same applications as DBP. There are three chromate pigments - orange / yellow which we have found in yellow labels and they are also used in plastics and paints. The two aluminosilicates are used as thermal insulation - ovens, furnaces, etc. Tris(2-chloroethyl)phosphate is a flame retardant, its main use is in rigid and flexible polyurethane plus other plastics. The rest are chemicals used to make other substances and so will not be present in EEE".

Substance identification			Authority	Reason for proposing	Date of publication	Deadline for commenting	Link to the Annex XV report	Link to commenting form
Substance name	CAS number	EC number						
2,4-Dinitrotoluene	121-14-2	204-450-0	Spain	CMR	31/08/09	15/10/09		<a href="#">2,4-Dinitrotoluene</a>
Anthracene oil	90640-80-5	292-602-7	Germany	PBT	31/08/09	15/10/09		<a href="#">Anthracene oil</a>
Anthracene oil, anthracene paste, distn. Lights	91995-17-4	295-278-5	Germany	PBT	31/08/09	15/10/09		<a href="#">Anthracene oil, anthracene paste, distn. Lights</a>
Anthracene oil, anthracene paste, anthracene fraction	91995-15-2	295-275-9	Germany	PBT	31/08/09	15/10/09		<a href="#">Anthracene oil, anthracene paste, anthracene fraction</a>
Anthracene oil, anthracene-low	90640-82-7	292-604-8	Germany	PBT	31/08/09	15/10/09		<a href="#">Anthracene oil, anthracene-low</a>
Anthracene oil, anthracene paste	90640-81-6	292-603-2	Germany	PBT	31/08/09	15/10/09		<a href="#">Anthracene oil, anthracene paste</a>
Diisobutyl phthalate	84-69-5	201-553-2	Germany	CMR	31/08/09	15/10/09		<a href="#">Diisobutyl phthalate</a>
Aluminosilicate, Refractory Ceramic Fibres		(650-017-00-8*)	Germany	CMR	31/08/09	15/10/09		<a href="#">Aluminosilicate, Refractory Ceramic Fibres</a>
Zirconia Aluminosilicate, Refractory Ceramic Fibres		(650-017-00-8*)	Germany	CMR	31/08/09	15/10/09		<a href="#">Zirconia Aluminosilicate, Refractory Ceramic Fibres</a>
Lead chromate	7758-97-6	231-846-0	France	CMR	31/08/09	15/10/09		<a href="#">Lead chromate</a>
Lead chromate molybdate sulfate red (C.I. Pigment Red 104)	12656-85-8	235-759-9	France	CMR	31/08/09	15/10/09		<a href="#">Lead chromate molybdate sulfate red (C.I. Pigment Red 104)</a>
Lead sulfochromate yellow (C.I. Pigment Yellow 34)	1344-37-2	215-693-7	France	CMR	31/08/09	15/10/09		<a href="#">Lead sulfochromate yellow (C.I. Pigment Yellow 34)</a>
Acrylamide	79-06-1	201-173-7	Netherlands	CMR	31/08/09	15/10/09		<a href="#">Acrylamide</a>
Tris(2-chloroethyl)phosphate	115-96-8	204-118-5	Austria	CMR	31/08/09	15/10/09		<a href="#">Tris(2-chloroethyl)phosphate</a>
Coal tar pitch, high temperature	65996-93-2	266-028-2	European Commission	PBT/CMR	31/08/09	15/10/09		<a href="#">Coal tar pitch, high temperature</a>

Len Pillinger F Inst CT  
September 2009



# An Innovation in Horizontal Processing. (Part 1)



**Peter Lynn**  
**Ken Bishop**  
Cemco-FSL Ltd

PCB fabricators have used horizontal roller conveyers to transport copper clad laminate through chemical spray Treatment chambers for many years. These simple conveyerised spray processors have evolved over time to accommodate much thinner materials but the complication of guiding and supporting them through spray jets generally means two types of machine are required; one for thick rigid material and another longer, more complex system for very thin or flexible substrates. More recently this type of equipment has been further adapted to incorporate immersion chambers for plating and other surface treatment processes where spray jets are not suitable. The need to contain the static head above the roller transport system and the relatively long contact times required for immersion processes make these systems even longer and more complex.

This paper describes a non-contact laminar or streamline flow process chamber that results in a faster and more uniform chemical reaction than obtainable with conventional flood chambers. It also describes a transport and guiding method suitable for both thick and thin materials and expands on the mechanics and fluid dynamics that further reduce equipment length and operating cost.

## Chemical Process Chamber

In conventional immersion chambers, fluid is pumped from a sump to a dammed roller conveyor chamber. The solution is re-circulated at a rate of typically five times the chamber volume per minute through manifolds positioned between conveyor rollers. Transportation is achieved by using roller wheels to avoid excessive masking of the panel being processed. This combination of flooded jet and roller wheel transport results in chaotic turbulent zones within a relatively stagnant bath and variable chemical reaction across the panel.

The Fluid Engine immersion chambers by contrast, provide laminar flow up to 100X the chamber volume per minute or in excess of 11 meter per minute resulting in faster, more uniform reactions.

The engine comprises two plates closed at each side to form a narrow chamber. Fluid containment rollers, mounted at the entry and exit of the chamber, push and pull both flexible and rigid materials through it. Fluid is injected at the centre of each plate producing a laminar flow towards the entry and exit ends of the chamber.

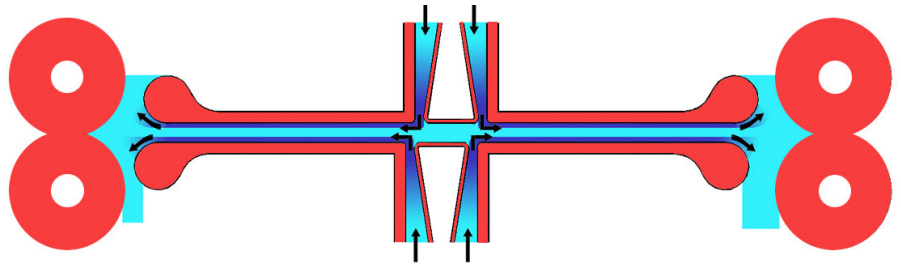


Figure 1: Diagrammatic view of the Fluid Engine showing the laminar flow and the Coanda effect.

This laminar flow results in steady boundary layers above and below the material being processed helping to guide it through the process chamber. The leading and trailing edges of the plates are shaped to produce a Coanda effect, diverting the boundary layer diffusion point away from the panel entry and exit zones. This maintains the streamline flow and diverts fluid above the plates, preventing flooding and material deflection.

## Dual Feed Engine

Some chemical processes associated with the printed circuit industry require a gas (normally oxygen in the form of air) to be introduced at the point of contact of the chemical with the panel being processed. A dual fluid version of the Streamline Fluid Engine that simultaneously feeds gas and liquid to the discharge slots provides this facility whilst maintaining the characteristics associated with the standard Fluid Engine.

The design of this engine is illustrated in figure 2.

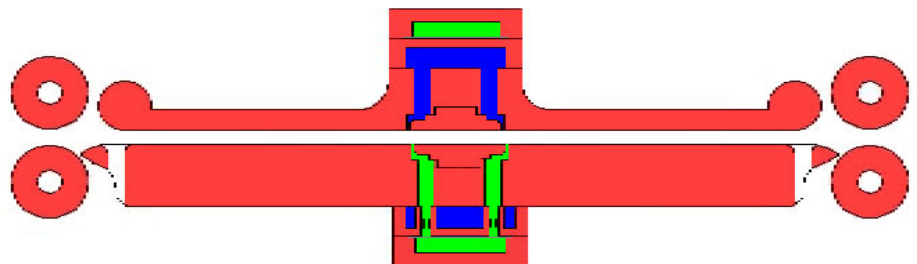


Figure 2 Dual Fluid Engine to introduce a gas into the chemical stream

The gas is fed under pressure to the outer gas plenum (shown in green) that is separated from the liquid plenum by a permeable membrane. The base plate has a series of closely spaced holes that normally connect the base plate directly to the liquid plenum across the width. In the dual feed head the liquid plenum has a series of tubes that connect the gas plenum to the baseplate. These tubes are pitched such that they line up with every other hole in the base plate and seal the holes from the liquid in the plenum. Therefore gas and liquid are delivered side by side across the width of the panel through alternate holes. Figure 2 illustrates how both gas and chemical reach the output jets. The lower head shows the path that the gas takes to reach the jets and the upper head shows how the chemical does. Gas is shown as green and chemical as blue.

## Fluid Knife

Where it is necessary to remove chemicals from the panel by dilution, or high fluid impingement is required to wet blind features, a shorter version of the Fluid Engine, known as a Fluid Knife, is used.

Typically this Fluid Knife is used for water rinsing after a chemical process or pre treating prior to a chemical process

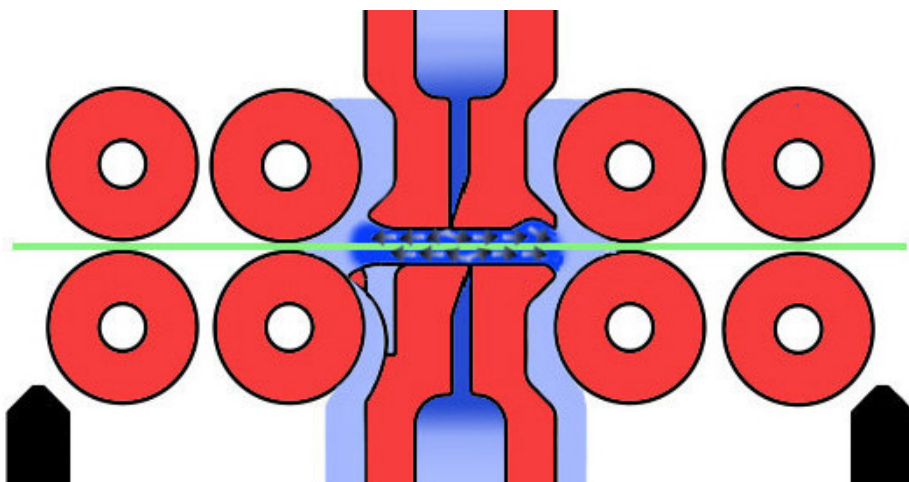


Figure 3 Fluid Knife showing passage of panel through knife and flow of fluid

The Fluid Knife considerably reduces both the conveyor length and the power required to pump solution onto the panel. For example a single Fluid Knife provides a solution rate of 40 litres per minute using a 110-watt pump compared to a more conventional spray rinse that delivers 28 litres per minute from a 750-watt pump. Similarly the Fluid Knife requires only 170mm of conveyor length compared to 240mm for the spray rinse.

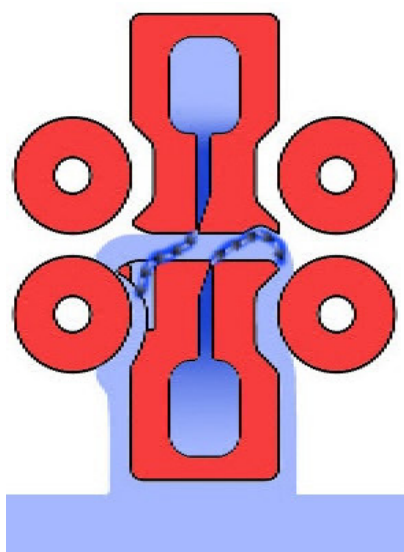


Figure 4: Fluid Knife showing fluid flowing to the side of a panel passing through the knife.

As with the Fluid Engine thin material transport is assisted by the fluid flow characteristics although the proportionally lower flow rate negates the need for the overhead fluid deflection, the upper outflow being deflected to the sides.

The liquid that escapes to each side of the panels is deflected downward using Coanda effect guides on the bottom knife and a jet deflector on the exit of the upper knife. This negates the need for segmented containment rollers or extended entry and exit zones. (see figure 4).

## Jet Knives.

The Jet Knife provides multiple upper and lower high impingement conventional spray jets to displace salts, fluxes and other 'contaminants' that are not readily dissolved.

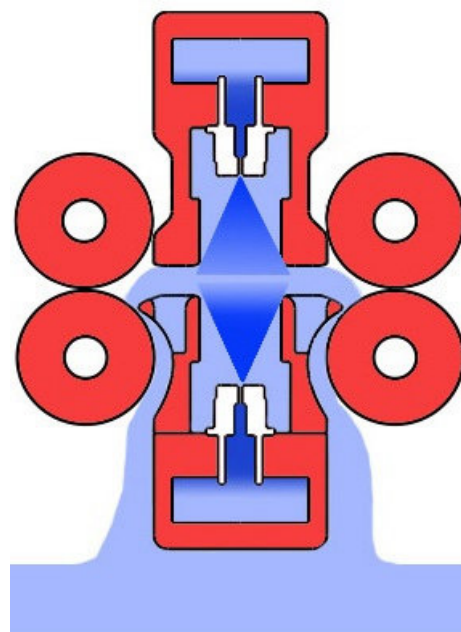


Figure 5: Jet Knife

The offset opposing jets balance material between the rollers and the ported entry and exit guides, ensure contactless entry and exit to the spray zone. Drainage holes in the lower chamber ensure that fluid is dispersed quickly and does not flood over the isolation rollers. The space required is the same as for a Fluid Knife but requires a higher power pump.

## Drying with a Fluid Knife.

Based on the knives originally developed and patented for Hot Air Levelling these single slot knives are shaped so that a pressure differential is produced between the upper and lower surfaces of the panel. Each knife has a series of slots cut in the leading edge separated by narrow

panel guides. The cutout in the lower knife is shaped so that air leaving the lower jet expands rapidly producing a low-pressure area below the panel.

This low-pressure draws water from the holes before the panel reaches the air jet and directs it to the bottom of the drying chamber. The force created by the pressure difference either side of the panel also stabilises the panel's position in relation to the lower knife and its integral guiding system.

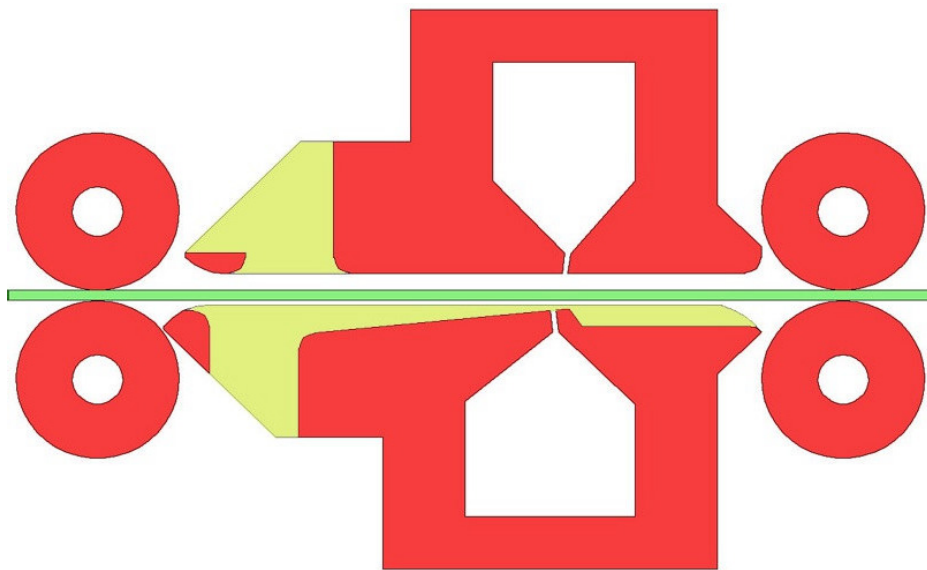


Figure 6 Drying Knife

When drying thicker material, problems can be encountered where water is left on the trailing edge of the panel. Although the water is removed from the surface by the jets a small amount remains along the trailing vertical face of the panel and returns to the horizontal face once the panel is clear of the jets. The thicker the panel the more water is likely to remain there.

A Fluid Knife incorporating the inclined knife technique, described in our earlier dryer patent, can successfully removed water from the trailing edge. In this design the air jet is inclined across the width of the conveyor. Water is removed from the surface and driven across the panel and effectively "wiped" off the trailing face by the jets.

Each parallel jet knife set occupies the space of just two roller pitches. Due to the angle of the slot used in the inclined jet knife producing a wider unit this design occupies 4 conveyor slots. Additional space is needed to prevent pressurisation of preceding chambers by the air from the jets, this space being filled with conveyor rollers.

Using the Fluid Knife technique, thicker panels can be dried and fitting both parallel and inclined knives in sequence provides higher speed capability.

## Combining the processes

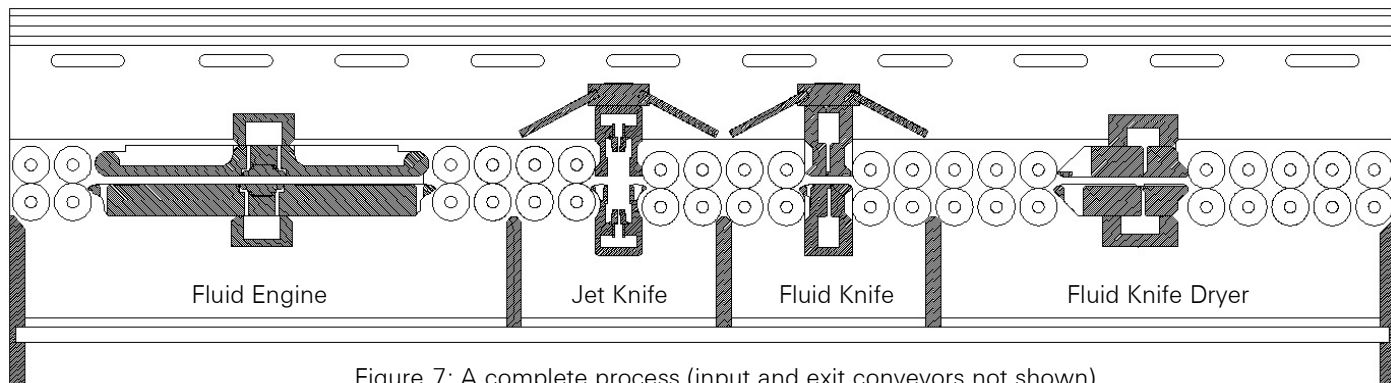


Figure 7: A complete process (input and exit conveyors not shown)

Figure 7 illustrates a simple horizontal treatment line using the Fluid Engine technology.

The first stage is a chemical process using the Fluid Engine.

Following this is a cleaning section consisting of a Jet Knife providing high fluid impingement forces and a Fluid Knife as the final rinse stage.

The last section dries the panel before exiting onto the output conveyor.

Each wet process section is separated from the next by fluid isolation bulkheads that allow the solution flowing from the head to flow back to the appropriate sump for recirculation.

Ken Bishop

Peter Lymn

**Cemco-FSL Ltd**

<http://www.cemco.com>

( the concluding Part 2 will appear in January 2010)

## Coanda effect.

Discovered by **Henri-Marie Coanda**, a Romanian born aeronautical engineer and named after him, the coanda or wall attachment effect is the tendency for a moving fluid to attach itself to a surface and flow along it.

When a fluid moves across a surface a frictional force occurs between the fluid and the surface and slows it down. This resistance to the flow pulls the fluid towards the surface, causing the fluid to stick to the surface. Therefore, a fluid flowing from a nozzle will follow a nearby curved surface if the curvature of the surface is not too sharp.

Coanda first noticed this effect when during a short flight of an experimental aircraft he observed that the burning exhaust gases from the engine seemed to hug the sides of the aircraft very closely and the plane caught fire and crashed.

Luckily he survived.

A simple illustration of the coanda effect can be demonstrated by placing the back of a spoon against a stream of water flowing from a tap. The stream will be deflected to follow the shape of the spoon as it hugs the surface.





## New Developments in PCB & Interconnect Manufacturing

Rotherham, UK, 4th August 2009

Over forty leading representatives of industry and academia gathered at the National Metals Technology Centre, in Rotherham, South Yorkshire, England, to attend the seminar. The event was hosted by EY, and supported by leMRC and the ICT.

After welcomes and introductions from Dave Williams, Business Development Manager of EY, Dr Darren Cadman, Research co-ordinator of leMRC, and Steve Payne, Chairman of ICT, Professor Martin Goosey introduced the keynote speaker,



Professor David Selviah of the Department of Electronic and Electrical Engineering at University College London, who explained the objectives of the leMRC Opto-PCB Manufacturing Project and gave an overview and update of the results and achievements of the project partners: three universities and eight industrial collaborators.

Driven by the need to reduce loss and eliminate crosstalk between copper conductors on high-data-rate backplanes by the use of optical waveguides, but accepting the reality that optics cannot transmit electrical power, the project sought to develop techniques of integrating optical and electronic interconnect into functional structures using processes compatible with those established in printed circuit fabrication. The focus of the OPCB project was to produce a 19 inch PCB with multimode waveguides working at up to 10 Gb/s with in-plane butt-connections to VCSEL transmitters and detectors. A variety of techniques and materials had been used in fabricating optical waveguides, including direct laser-writing with a 325nm Helium-Cadmium laser on photopolymerisable acrylic resin, laser ablation using Excimer, Nd-YAG and CO2 lasers on acrylic or polysiloxane resins, inkjetting with UV-curable polymer, and photolithography. In addition to the work on fabrication techniques, methods had been developed for characterisation of waveguide performance, by modelling and by measurement, to enable design rules to be formulated for incorporation into PCB CAD systems. Professor Selviah showed several examples of demonstrator assemblies together with their performance data: crosstalk, optical loss and misalignment tolerance.

Pete Starkey, on behalf of EIPC, gave an introduction to the EU-funded SurfEnergy, IONMET and ProSurf projects. Against a background of the European PCB industry having contracted over the last decade to leave around 400 manufacturers producing about 7% of world output, and most of these manufacturers being small-to-medium enterprises, the future of the industry lay in innovation, cost reduction and environmental safety.



The European Commission had made funding available through FP6 and FP7 Framework Programmes to promote scientific excellence, improved competitiveness and innovation in the field of research and technological development. EIPC were involved in three Framework projects: SurfEnergy, a new project to provide advanced tools for surface finishing processes to optimise energy efficiency, IONMET, a project nearing completion focused on radical new developments in metal finishing

using ionic liquid solvent technology, and ProSurf, a recently completed project promoting and supporting SME research and innovation in the surface finishing and printed circuit manufacturing sectors. One outcome of the Pro-Surf and IONMET projects was the PCB Technology Roadmap report, which was available from EIPC.



**Dr Andy Cobleby** of the Sonochemistry Centre at Coventry University gave a presentation entitled Sonochemical Surface Modification of Electronic Materials. Taking as his point of reference the traditional chemical process sequence for de-smearing and texturing epoxy-glass surfaces, with associated concerns of hazardous chemistry, VOCs, carcinogens, corrosives, rinse water consumption and waste treatment costs, he demonstrated what could be achieved using only water in conjunction with ultrasound. Explaining the phenomena of ultrasonic cavitation and micro-jetting, and demonstrating that ultrasound in water could cause aluminium foil to disintegrate, he described how significant sonochemical surface modification could be achieved on a variety of materials used in electronics manufacture: FR4, polyphenylene oxide/polystyrene, ABS and ceramic. The project had identified a number of influencing factors, including frequency, ultrasonic intensity, probe-to-sample spacing, liquid temperature and the effect of adding surfactant. Optimisation of conditions had reduced process times and increased weight loss by factors of 4, and the technique presented a technology platform from which potential commercial applications were emerging.



**Chris Rogalski** from Coretest Technologies described a novel anisotropic conductive fabric consisting of minute silver-plated nickel spheres embedded in a silicone rubber.

With a video, he illustrated how, under a magnetic field, the spheres were aligned into discrete "ball-wires" in the z-axis during the manufacture of the material, to give a membrane with 30 to 50 contacts per 1mm square at 0.38mm thickness, scalable down to 30 to 50 contacts per 0.1mm square at 0.06mm thickness for wafer-scale applications. The material was characterised by very low contact resistance and high bandwidth, with fast rise-time and low inductance and capacitance, and less than 0.3dB loss at 40GHz. Proven interconnection applications included test and burn-in, flip-chip packaging, sockets, flex circuit connectors, battery contacts and snap-together housing connectors. New applications continued to emerge. The material could be cut to any shape, and could be used as an RF gasket or for optical devices where a viewing window was required.

**Dr David Hutt** of Loughborough University had been investigating the practicability of using glass as an alternative to organic substrates in the fabrication of multilayer interconnects for high-density devices. A space-grade glass, designated CMZ and available in thicknesses of 50 – 150 microns, with expansion coefficient close to that of silicon, had been chosen as the base material. This had been machined with a pulsed 248nm Krypton Fluoride excimer laser, using mask projection to produce fine grooves for conductors and waveguides, and microvia holes. Challenges included re-melt, debris, hole taper and microcracking, and these had been minimised by careful process optimisation and the use of a protective film. Electroless copper and electroless nickel had both been successfully deposited onto smooth glass surfaces, and further work was in hand to improve adhesion, using self-assembled APTS monolayers as adhesion promoters.



**Dr David Hutt**

Metallisation of laser-machined areas gave comparatively good adhesion, and if a photoresist was used during laser machining of the conductor pattern, this could act as a mask to define the initial APTS image so that catalyst was attracted selectively to enable full-additive circuit formation. Glass layers had been successfully laminated together without the use of adhesive, by pressure-assisted low temperature bonding, and multilayer interconnects were in prospect.





**Nigel White**, European Product Marketing Manager with Atotech, explained the benefits of electroless nickel/electroless palladium/immersion gold as a selective finish for soldering and wire bonding, and how four different process variants had been engineered to suit specific applications: the IC substrate industry; PCB customers who wished to supplement their existing ENIG lines with a palladium-phosphorus stage; medical, military and aerospace requirements for pure palladium, and low-temperature co-fired ceramic manufacturers needing to plate on ceramic/silver paste materials. Nickel/palladium/gold had been demonstrated to give improved solder joint integrity when compared with ENIG, and significant cost savings over electroplated nickel/gold as a wire-bonding finish. White gave a detailed description of the process chemistry and deposition characteristics, and illustrated the fundamental differences between immersion and electroless palladium: electroless giving a more uniform deposit with no corrosive attack at the grain boundaries of the nickel-phosphorus layer. The nickel/palladium/gold finish was gaining wide acceptance with PCB, semiconductor and co-fired ceramic producers.



**Russ Crockett** from DuPont began his review of the latest developments in dry film photoresists for laser direct imaging by posing the question: "Is LDI an enabling technology to improve production capability, or a route to cost reduction through yield improvement?" The answer was Yes in both cases, depending whether the user was in small batch quick-turn or in volume production of HDI on large panels. He stressed that LDI was not the only factor in producing a perfect photoresist image – it was one of five process steps, each of which needed to be properly engineered and controlled if a satisfactory result was to be achieved. Discussing the different LDI systems available, principally those based on polygon mirrors working at a wavelength of 355nm and those based on digital micro-mirror devices working at 405nm, he explained the difficulties in producing a dry film photoresist which would suit both applications whilst maintaining acceptable photospeed, adhesion, resolution and processability, and why DuPont had chosen to formulate specialist products to suit specific applications. He illustrated the performance of state-of-the-art dry films with a series of photographs of cross-sections and sidewalls, together with a statistical analysis of the yield improvements in image defects and registration achieved by LDI.

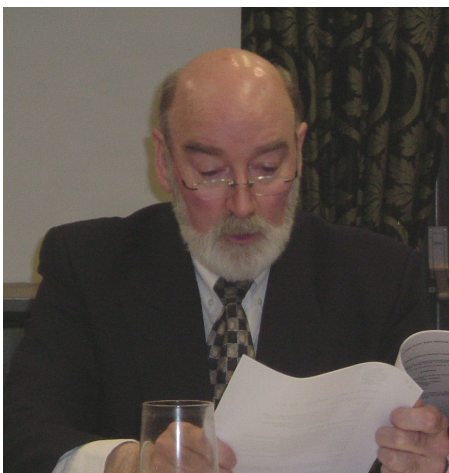
Final presentation was a detailed overview of solder mask processes and properties from **Chris Wall** of Electra Polymers. Starting from first principles he explained how to choose appropriate materials, application and imaging systems to suit particular PCB design technologies and performance requirements. He described how rheological characteristics needed to be optimised to match each of the three principal application methods for liquid photoimageable solder mask: flood-screen printing, curtain coating and high-pressure low-volume air spraying, which he compared in terms of coverage profiles, via plugging, hole cleaning and environmental considerations.



He discussed the practical aspects of resolution and registration, and presented the results of comparative tests to demonstrate the ability of a processed solder mask to maintain 10µm on track edges, wash clean 0.2mm via-holes and maintain 50µm solder dams. Solder masks were required to conform with specifications such as IPC-SM840, MIL-P55110 and Bellcore, to withstand the process chemistries associated with ENIG finishing, and the temperatures involved in lead-free soldering, as well as being compatible with fluxes, cleaners, underfills and adhesives.

Peter Starkey F.Inst.C.T.  
August 2009

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<b>Atotech UK Ltd.</b>	William Street, West Bromwich. B70 0BE	01210 067 777 <a href="http://www.atotech.de">www.atotech.de</a>
<b>CCE Europe</b>	Wharton Ind. Est., Nat Lane, Winsford	01606 861 155 <a href="http://www.ccee.co.uk">www.ccee.co.uk</a>
<b>Electra Polymers Ltd.</b>	Roughway Mill, Dunks Green, Tonbridge TN11 9SG	01732 811 118 <a href="http://www.electrapolymers.com">www.electrapolymers.com</a>
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<b>Graphic plc</b>	Down End, Lords Meadow Ind. Est., Crediton EX17 1HN	01363 774 874 <a href="http://www.graphic.plc.uk">www.graphic.plc.uk</a>
<b>Invotec Group Ltd</b>	Cunliffe Rod, Whitebirk Ind. Est. Blackburn BB1 5TD	01254 661 321 <a href="http://www.invotecgroup.com">www.invotecgroup.com</a>
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<b>Teknoflex Ltd</b>	Quarry Lane, Chichester PO19 8PE	<a href="http://www.teknoflex.com">www.teknoflex.com</a>
<b>Tru-Lon Printed Circuits (Royston) Ltd.</b>	Newark Close, York Way Ind. Est., Royston SG8 5HL	01763 248 922 <a href="http://www.trulon.co.uk">www.trulon.co.uk</a>



### The Membership Secretary's notes October 2009

This summer has seen both ups and downs for our Industry and our Members, but the recent PCB Golf Day at Wootton Bassett, highlighted our resilience in the face of economic difficulties. With 30 playing golf and 40 at the evening dinner, it was extremely well attended

Rex Rosario, of Graphic Electronics has announced that he intends to bring another World Conference to the UK in 2014 and that he expects the ICT to play its part.

Craig Soley of Anglia Circuits has been recognized as an IPC Trainer and has embarked on the 'arduous task' of identifying suitable candidates for training. He is to be congratulated and we wish him well. We also wish to congratulate both Jamie Pearson and Steve Spence of Faraday Circuits on their well deserved promotions.

We have also re-launched our website this summer, thanks to stalwart work from our webmaster, Richard Wood-Roe, and it was encouraging to note that the website re-launch was supported by eleven of the Industries premier technology companies and further highlights the standing of the ICT within the PCB Industry