MACFEST

www.macfest-project.co.uk

MANUFACTURING ADVANCED COATINGS FOR FUTURE ELECTRONIC SYSTEMS

Welcome: to the final newsletter. I hope you have enjoyed reading about topics related to our project, plus learning a little more about the capabilities of the consortium partners.

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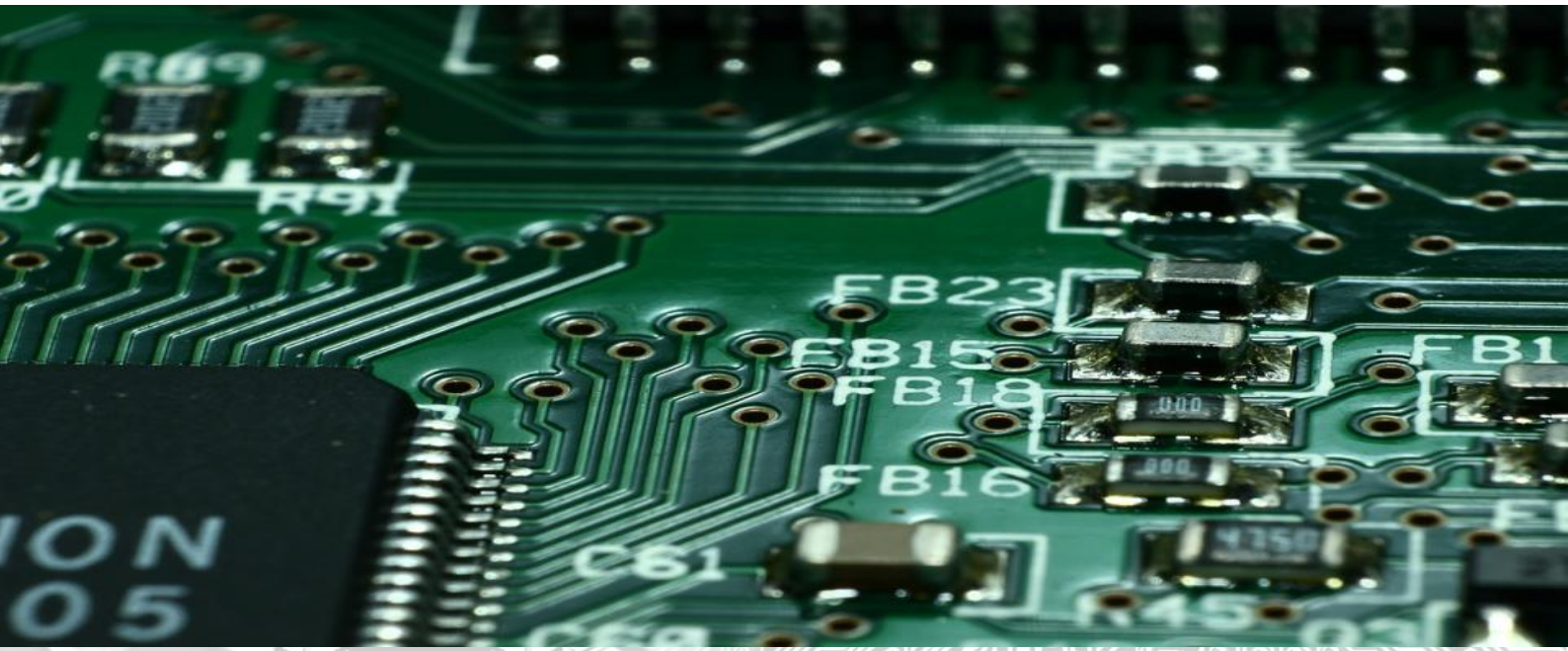
MACFEST Project Update:

The MACFEST project delivered a webinar last month on the development of the project, including the results from a successful comparative trial with other PCB surface finishes. Professor Karl Ryder presented the fundamentals of the electrochemistry which have allowed us to develop this novel solderable coating. Karl and his team developed the new chemistry, and, throughout the lifetime of the project, they have been able to tailor the metal deposition properties, to provide the optimal immersion palladium and immersion gold coatings that meet IPC standard operational requirements. Professor Ryder was followed by Tom Jones from Merlin Circuit Technology, who presented and explained the results from an international comparative assessment. The results were very favourable, demonstrating that the solderable finish provided by this project is, in many aspects, superior to current ENIG and related surface coatings. If you missed the webinar you can listen again here.



Future Interconnect Possibilities - Integrating Optoelectronics

With the Internet of Things (IoT) transforming into the Internet of Everything (IoE), whereby everything is connected – machines, processes and people, electronics and their fabrication remains at the fundamental base of these innovations. Current state of the art technology is leading to the incorporation of computing and communication functionality into our clothing, household goods, and many day-to-day products and materials. The demand for consumer goods to be connected to each other has increasingly been pushing the capabilities of printed circuit board (PCB) designs, applications and virtual sites, but it has been our thirst for ever greater computing power and its need for connectivity that is driving the need for faster processing speeds, larger memory capacity, higher operational frequencies and more bandwidth. These demands, along with the long standing need to pack more utility into smaller spaces are continuing to drive the evolution of the PCB in terms of designs, materials, components and overall board densities.

This insatiable demand for smaller and more densely populated electronics is not predicted to stop any time soon. Future technology predictions suggest that computing power may be reduced to 'zero sized intelligence' where the size of the computing part of a device approaches zero. This is based on the assumption that atomic scale transistors will replace the already small and nanometre sized devices found on current microprocessors and related chips. Development in this area in the past has been characterised by 'Moore's law', whereby the number of transistors per unit area have doubled every two years since their invention. This law (which was familiarly named after the observation by Gordon Moore in 1965) has held true for many years, but it is predicted to cease in the coming quinquennium, at which point transistor density will plateau. This is because the smallest current production transistor sizes are currently being produced with dimensions in the region of just 10 nm and because any further decrease in size will soon be limited by the size of the silicon atoms used in chip fabrication, which are around 0.2 nm each. Despite this, there is still the desire to store and use more data, have more computing power and deliver greater services, which will continue to drive the need for ever smaller devices and greater levels of integration. These demands will continue to advance the development of new types of devices and with the need for ever great board densities, operating frequencies and bandwidths.

Current PCB designs often already have their limitations including in terms of;

- Maximum operating speed i.e. data rates
- Achievable board density and size which are restricted by the need for heat dissipation
- Power consumption and efficiency
- Maximum signal pathway due to crosstalk and degradation.

To mitigate these constraints, researchers and manufacturers are adopting a number of new approaches including the use of new PCB designs, materials and manufacturing approaches. There is clearly still much that can be done to enhance the performance of conventional circuit boards but it is also true that alternative approaches are also being further developed. One such area is related to the use of photonics. This discipline offers the opportunity to transmit energy by photons rather than electrons. The telecommunications industry has been leading the way for many years (e.g. fibre optic broadband), but other developments have seen optical devices being increasingly included in a broad range of what were once purely electronics applications.

Optical PCBs and optoelectronic devices have been used for some time in high value and specialist applications, but they are increasingly expected to replace purely electronic components and conventional PCBs. The technology offers the ability to build optical circuits, optical components, and optical chip to chip pathways that are capable of handling the speeds and bandwidths required in a range of future products.

Using optical systems challenges the issues that have begun to plague electrical PCB designs and that are thought to limit the rate of growth in the area. Issues for current PCB designs include further reducing the PCB size whilst still offering bandwidth increases and without using more power. There are also challenges around electromagnetic interference and its impact on device performance. Developments in the last decade have seen the optoelectronics industry grow continuously and it now accounts for ~6 % of the electronics market. There are a number of companies who are developing optoelectronics for use with board applications. At the end of 2015, a US team fabricated a microchip with the capability for both optoelectronic and electrical connections. More significantly, the microprocessor was fabricated using existing microchip facilities. This R&D demonstrates the possible next stage of electronics – the hybrid optical/electronic PCB. This could, for example, be a development of an existing board that also incorporates waveguides, optical components and optical interconnections. Industry is keen to develop this sector because the potential benefits offered by optoelectronic designs include:

- faster data rates (10 – 100 x) to support terabit speeds
- greater energy efficiency (less heat loss)
- enhanced signal to noise ratios
- immunity to electromagnetic interference
- extended transmission distances
- potential for board layer count reductions of up to 50 %
- potential for surface area reductions of up to 20 %.

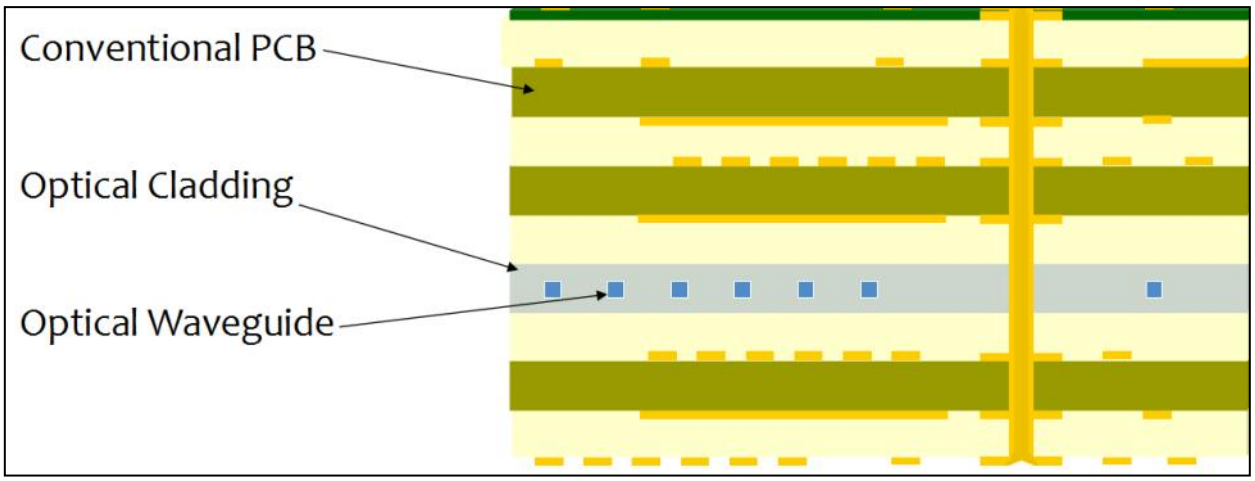


Figure 1 Proposed integration of optical waveguides in multilayer boards (source: TTM Technologies)

A key sector investing in optics research and development is that encompassing data centres. These large centres have been growing to meet demand and, in 2013, 2 % of the power used in the USA was consumed by their own onshore servers. Internet traffic is the main driving force, with demand for data transmissions capabilities growing by 50 % per annum. Huge costs are involved in operating these centres and the majority of the costs are related to the sheer amount of energy required (up to 40 % of operational costs). The energy consumption not only comes from powering of the servers, but 50 % of the energy is consumed by the cooling systems built to reduce operating temperatures. Development of designs which offer smaller units capable of handling more data, more efficiently (with less heat production) could make huge differences in both the operating costs, and their environmental footprints.

The transition between copper PCB fabrication and optical circuitry is currently developing through the incorporation of optical structures within the fabrication of electronic PCBs. These hybrid systems will marry together the two different technologies. Hybrid systems will bridge the gap between optical paths and copper tracks on the same board. The hybrid boards are designed to allow high speed signalling through optical paths for chip to chip interaction, whilst low-speed data is sent through copper tracks (power distribution and low speed signals). For their physical incorporation, optical waveguides can be embedded inside the PCBs, providing an independent optical layer (figure 1), figure 2 demonstrates the cladding and laser ablation used for the optical guides, or instead of being built in, waveguides can connect components with flyover cable designs. Flyover's are thought to be the simplest design, using headers and plugs terminated with ribbon cables, for point to point connection or to an I/O port. Initial use of optical solutions already includes such flyover designs and it is currently the cheapest method, and allows for novel board designs.

As optical components and interconnects continue to penetrate the market, it is expected that these hybrid systems will initially be used to bridge the gap between pure electronic designs and the optoelectronics of the future. An industry roadmap by the National Institute of Standards and Technology (PSMC consortium's interconnect roadmap for photonicsmanufacturing.org 2015) for optoelectronics identifies nine key applications to keep an eye on, including on-card, on-chip and I/O which could all have an impact on future PCB designs and fabrication technologies.

It is clear that while the traditional methods of providing interconnections may not be suitable for some future electronics products, there are still various ways forward and one such route embraces the combination of optical and electrical interconnects in a single interconnection substrate.

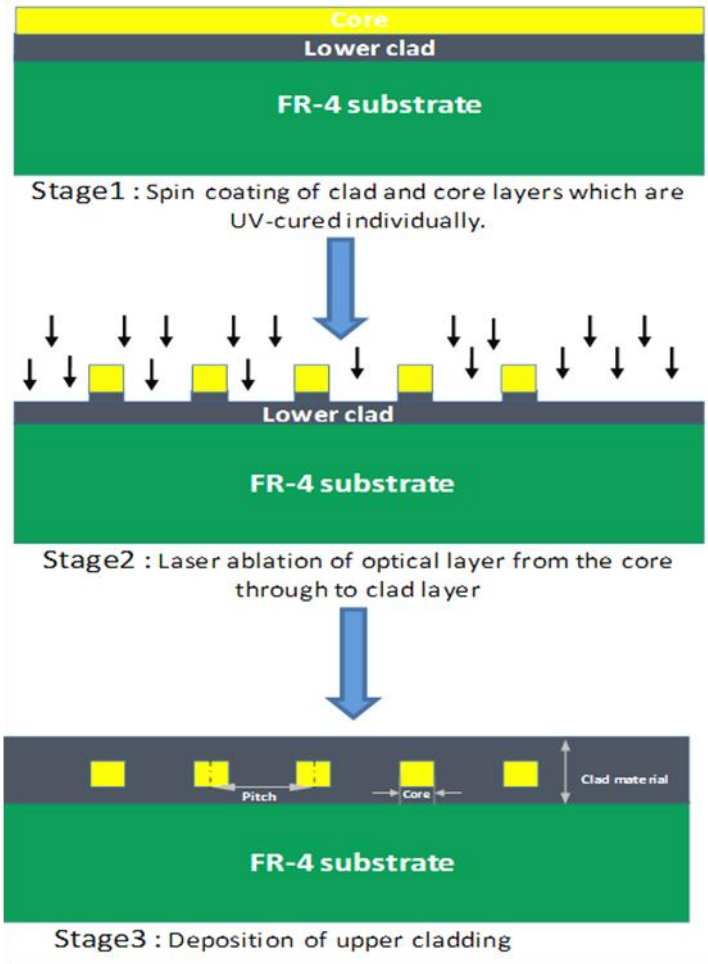
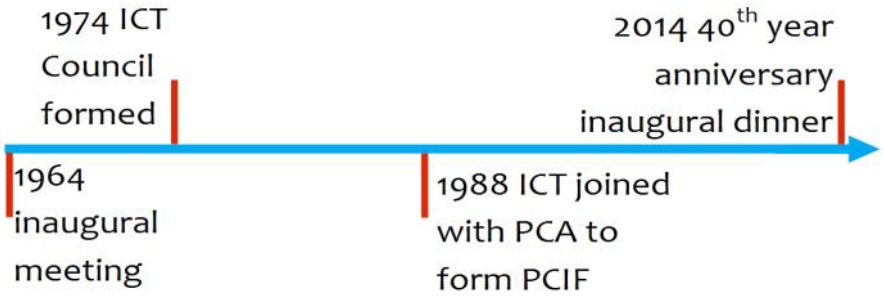


Figure 2 Integration of waveguides on single sided or top layer of boards (source: IeMRC OptoPCB, 2014)

CONSORTIUM FOCUS:
Institute of Circuit Technology (ICT)

The Institute of Circuit Technology was established in 1974. Since then, it has successfully provided technology based training and seminars to the UK's PCB technologists and engineers, keeping them up to speed with developments in the industry.

- The ICT is dedicated to technical aspects of Printed Circuit Board Manufacture and Assembly.
- The ICT was originally established as a forum for discussion on technology matters relating to printed circuit interconnection. This has now been expanded to include their assembly and related technology.
- The ICT facilitates this improvement in standards by providing opportunities for its membership to improve their knowledge of manufacturing process technologies, materials, and practices through research, discussion and seminars around the country.
- The ICT operates a grading procedure for membership that will enable industry to measure the levels of specialist education, skills and experience. The membership is graded into Fellow, Member and Associate, designating the level of expertise and experience.



The key objectives of the Institute of Circuit Technology are:

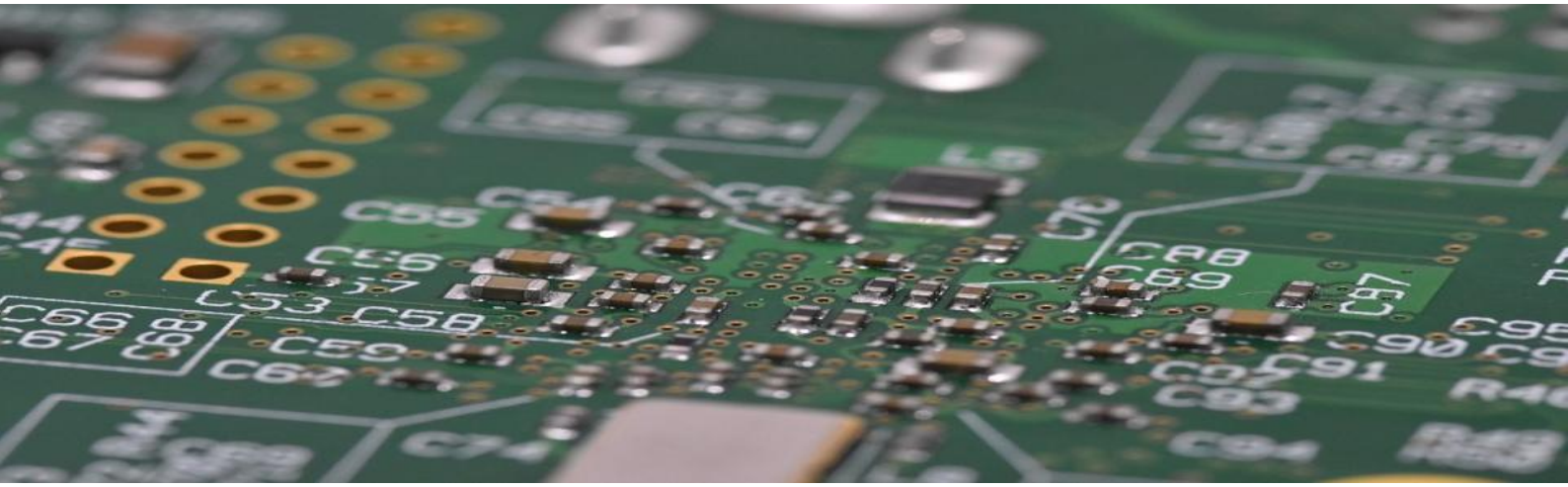
- To provide a forum for members.
- To unite through membership in printed circuit technology.
- To seek to improve the standard of knowledge.
- To develop a better understanding of circuit technology in all types of economic endeavour.
- To hold meetings, seminars and training courses for the exchange and dissemination of knowledge.
- To co-operate with organisations formed to improve knowledge and promote interest in circuit technology.
- To sponsor educational facilities for the training of persons in circuit technology.
- To provide such educational facilities where this is expedient by setting up a training college.
- To provide a professional status to those members who are engaged in electronic & electrical circuit design and manufacture.
- To make grants to or for the benefit of and education of all such Members or otherwise.
- To create and administrate scholarships, exhibitions, bursaries and prizes for the encouragement of study.
- To organise exhibitions, lectures, public meetings, classes and conferences.

RECENT DEVELOPMENTS IN THE IONIC LIQUIDS SECTOR

The development of ILs for polycyclic aromatic hydrocarbons (PAHs) removal from soil and sediment has been demonstrated by a research team in Argentina. The process offers a way to remove PAH contamination without damaging the sediment.

In a similar manner, researchers are using ILs to desulfurize fuels. This comes at a time when 2016 has seen severe smog events globally, including effects of sulfur dioxide (in December Paris experienced such poor air quality that it made public transport free, and strictly regulated car use, in order to alleviate the situation). Desulfurization could be a major asset in terms of urban air quality.

Momentum is gaining for the use of Protic ILs (PILs). Compared to Aprotic ILs, which are considered to be classic ILs, PILs are often cheaper to produce, are simple to fabricate and have biodegradable properties.



UPCOMING EVENTS:

02 February 2017	EIPC Winter Conference (MACFEST dissemination)	Salzburg, Austria
14 March 2017	Embedded World 2017	Nuremberg, Germany
24th - 27th April.2017	ICT Foundation Course	Chester, England
05 April 2017	UK Intelligent Engineering Forum	Coventry, England
18 June 2017	EuCHeMS Int. Conference on Chemistry and the Environment	Oslo, Norway
03 September 2017	Congress on Green and Sustainable Chemistry	York, England
18 October 2017	Engineering Design Show	Coventry, England