Journal of the

Institute of Circuit Technology

Vol.10 No.4 Autumn 2017

2017 Events

14th March Tuesday — **ICT Evening Seminar and AGM**
at the Best Western Plus Manor Hotel,Meriden
bill.wilkie@InstCT.org

24th-27th April — **ICT Annual Foundation Course**
at Chester University
bill.wilkie@InstCT.org

9th - May Tuesday — **ICT Annual Symposium**
at the Black Country Museum
bill.wilkie@InstCT.org

19th September — **ICT Evening Seminar**
at Newtown House Hotel, Hayling Island
bill.wilkie@InstCT.org

5th December — **ICT Evening Seminar**
at Majestic Hotel, Harrogate
bill.wilkie@InstCT.org

Editorial

Donald Trump's Presidency has sensitised us to "Fake News", which has sadly now afflicted our industry with the headline "PTFE is About to be Banned by IEC TC111". To appreciate the fallacy of this headline one has to understand the role of IEC TC111, this committee has the scope of Standardization of environmental aspects concerns but has no power over matters of safety and no competence to propose a ban of a substance that is not hazardous.

You may wonder what led to the hullaballoo? The offending specification is the draft of IEC 63031, entitled "Definition of Low Halogen Materials used in Electrical and Electronic Products". The IEC (International Electrotechnical Commission) is the world's leading organization for the preparation and publication of International Standards for all electrical, electronic and related technologies. The first question is "Why is this standard needed"? Individual parts of the electronics supply chain already have definitions of "halogen free", it would appear foolhardy to try and roll these all up into one specification that will satisfy nobody. The real issue, however, is the inclusion of fluorine as a halogen in the specification. Until now the targets for arbitrary restriction have been bromine and chlorine. These are both members of group 17 of the periodic table, known as halogens. Halogens are highly reactive, and as such in elemental form can be harmful to biological organisms in sufficient quantities. Traditionally standards that attempt to restrict halogens specifically exclude fluorine, which is undeniably a halogen, on the grounds that it forms strong bonds with carbon and thus has limited bioavailability. This is indeed the paradox of halogens, they are *all* highly reactive and *all* form strong bonds with carbon and therefore *all* have limited bioavailability which is especially important when used as reactive flame retardants in PCB laminates. PTFE producers were conspicuously silent whilst fluorine was "excluded" from low and halogen free specifications but may now realise that any restriction for any substance should be based on a knowledge that the substance is environmentally hazardous and not simply because it contains a halogen. Let's not forget that halogens are safely used in everyday products such as table salt, non-stick coatings, cable insulation, water purifiers, photographic paper, antiseptics, disinfectants, dietary supplements and medicines.

The author's particular area of interest lies in the use of the halogen bromine in compounds known as brominated flame retardants (BFRs). The particular BFR most widely used in PCB laminates, TBBPA (Tetrabromobisphenol A), was the subject of an 8-year EU Risk Assessment for the environment and human health. The environmental risk assessment reported no risk to the environment when TBBPA is used as a reactive component in printed circuit boards and the human health part of the risk assessment concluded that TBBPA poses no risk to human health. We do know, however, that fires present a real and present danger to human life – Grenfell Tower is a poignant reminder. Arbitrary restrictions on the use of life saving compounds would seem to the author to be irresponsible.

One still hopes for a world where materials science matters are debated by materials scientists and where those with political aspirations and headline seekers learn to better tend their gardens. In the interests of the environment the author believes the best way forward would be to deposit all copies of the draft IEC 63031 in the waste recycling bin!

Alun Morgan

Membership *New members notified by the Membership Secretary*

10427 Tony Upton-Huang M.Inst.C.T.
10428 Gareth Markey M.Inst.C.T.

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

The *Journal* apologises to :-

10407 Mike Fairclough Inst.C.T of Stevenage Circuits

for previously reporting him to be an Associate Member

Please send corrections to : - brucer @ john lewis.com

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Additive manufacture of microwave substrates

Dr Darren Cadman,
Symeta Project, Loughborough University

Introduction

In the autumn of 2015 the UK's Engineering and Physical Science Research Council awarded Loughborough University £4 million to lead the Grand Challenge project "Synthesising 3D metamaterials for RF, microwave and THz Applications: SYMETA". In collaboration with Exeter, Oxford, Sheffield and Queen Mary Universities, the project aims to deliver a palette of metamaterials that designers can deploy when creating high frequency circuits and components. In doing so it will provide microwave circuit and component engineers greater design freedom. The manufacturing processes to fabricate these circuits and components will be based on additive manufacturing principles. This article gives an overview of additive manufacturing and metamaterials, and how we aim to combine them.

Additive Manufacturing

Additive manufacturing (AM) describes a set of processes driven by technological advancements that are underpinned by the ethos of waste reduction to create products. It's a market that is predicted to see £600 million investment in the UK over the next 5 years, with the UK AM community recently launching a National Strategy. The AM processes available enable the creation of functional structures that it would not have been possible to produce using standard manufacturing processes such as injection moulding or CNC milling. Typically, AM processes create products layer by layer. There are various methods available to do this, often dictated by the material that is being used to create the product, and of course, the product performance requirements. Examples include powder bed melting and sintering for creating products in metals or nylon. Recently, Airbus Space and Defence have produced a metal microwave waveguide that is space qualified for the European Space Agency.

There is also Stereolithographic Apparatus (SLA) that produces structures made from a vat of UV curable polymer. These processes are compatible for single material products, but can be modified or functionalised with post processing. Swissto12 are a company producing SLA manufactured waveguides that are then copper plated for deployment at microwave and terahertz frequencies.

For electronics products, the real interest in AM is those processes that can handle multiple materials, in particular insulators and conductors. Ink jet processes have been the foundation for printed and plastic electronics and can deliver multi-material deposition capability.

Key challenges for deploying AM processes for microwave and high frequency applications reside in the material choice available; UV curable polymers are relatively lossy at GHz frequencies and are therefore not suitable. Additionally, inkjet printing doesn't lend itself to building large structures such as lenses whereby the structure's dielectric constant is varied through the designed placement of air cavities.

Extrusion based processes, now popularised by consumer units such as those made by Ultimaker and referred to as 3D printers, offer the advantages of multi-material capability, can create relatively large structures in the X, Y and Z dimensions on a build plate, have modest resolution, and from suppliers such as PREMIX there are now materials emerging that are tailored for microwave applications.

Fused Filament Fabrication (FFF) is a process that involves the deposition of thermoplastic polymer layers through a heated nozzle. Such polymers include those based on polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS) and have been typically used for rapid prototyping and model creation. More recently there has been an interest in the development of conductive filaments that are polymer based and loaded with copper particles, such as that produced by Electrifi®. FFF lends itself to multi-material processing whereby a second nozzle and filament, or a second extrusion head, can be deployed as demonstrated by products from nScrypt® and Voxel8®.

Each of these have one head for FFF or material extrusion and a second for highly conductive silver ink extrusion.

Artificial Dielectrics

Metamaterials have distinct properties not found in naturally occurring materials, in domains such as acoustics, optics, mechanics and, as presented here, in the microwave band of the electromagnetic (EM) spectrum. In the EM domain, these new materials can control wave propagation and be tailored to create localized and designed dielectric properties. As such they can be used to fabricate new microwave substrates that have manufacturing, physical and EM advantages over conventional dielectric materials. The metamaterials are designed to have certain EM properties by having dielectric or metallic inclusions within a host material. The spacing, size, material, shape and design of these inclusions determine the EM properties of the bulk material.

The 3D printing of a solid piece of PLA generally produces a material that has $r \sim 2.75$, $\mu r = 1$ and a loss tangent *tan* ~ 0.008 (properties can vary between filaments and 3D print quality). The insertion of inclusions of a different dielectric, air for example with a lower relative permittivity as illustrated in Fig. 1, enables a designer to create substrates with a bulk effective permittivity $eff < 2.75$. As the volume of those air inclusions increases then the permittivity of the composite substrate tends closer to that of air.

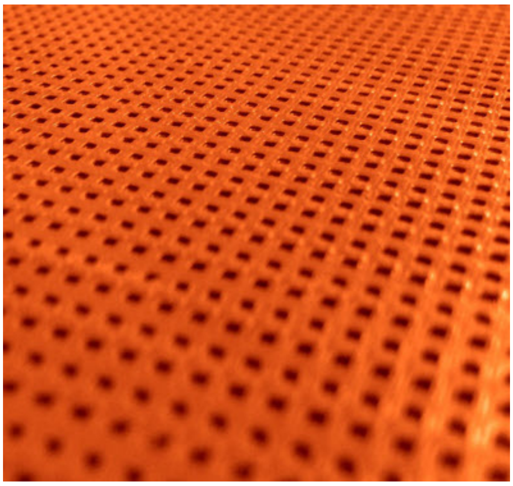

Fig. 1: Air inclusions within a PLA 3D printed substrate, prior to encapsulation with additional layers of PLA.

Instead of dielectric inclusions, if conductive elements are introduced, then rather than decreasing the host PLA dielectric constant, it can be enhanced as a result of introducing additional capacitance. Fig. 2 shows the Voxel8 printer creating silver inclusions within a PLA ‘ice cube tray’ which are then encapsulated with further layers of PLA on top. The structure shown in Fig. 2 displayed a dielectric constant of 4.5 at 10 GHz, in contrast to a solid piece of PLA with a dielectric constant of 2.75.

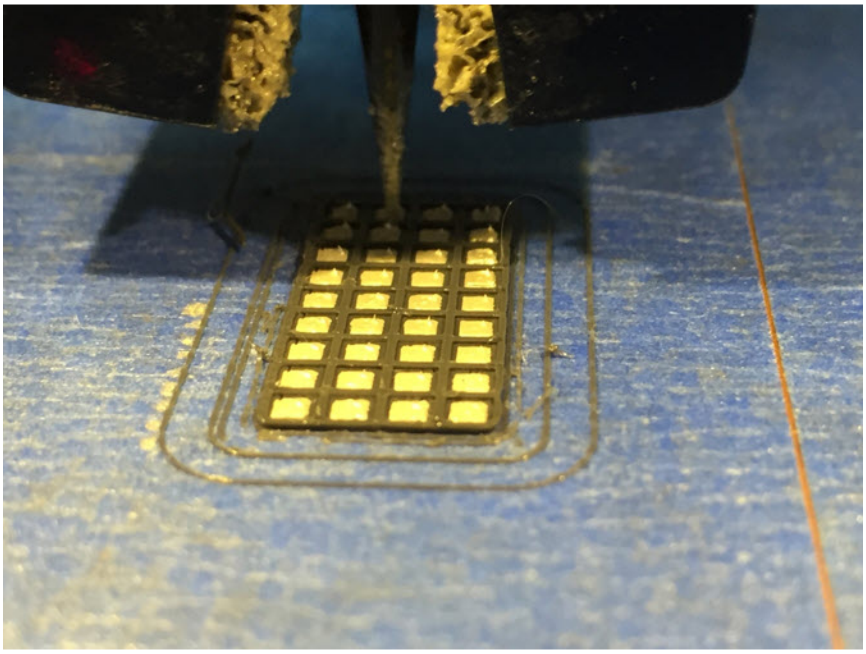

Fig. 2: Silver inclusions printed within a 3D printed PLA substrate for assessing at 10 GHz**.**

Increasing the volume fraction of metal within the PLA does however have a drawback. The relative permeability decreases as shown in Fig. 3.

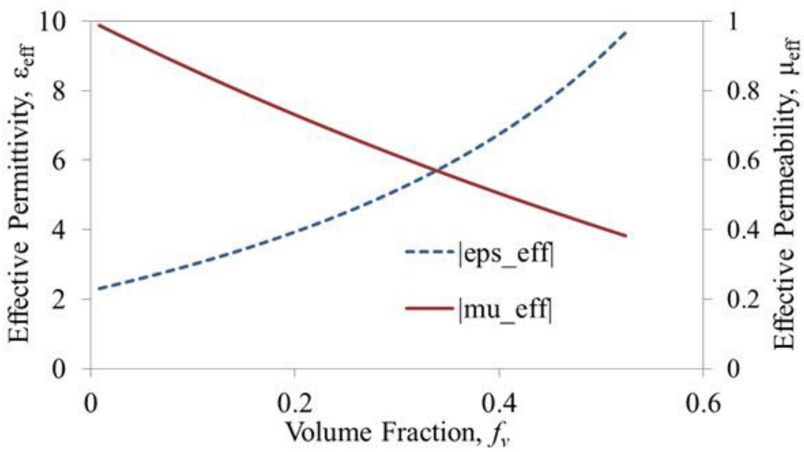

Fig.3: Trade off of increasing conductor content within a PLA substrate against relative permittivity and permeability.

This effect can be mitigated to some degree through the design of the metallic inclusions. Such design consideration can inhibit or disrupt the surface currents induced upon the metallic inclusions.

Potential for substrates and microwave circuit design:

By being able to regionally create distinct substrate EM properties using AM processes, miniaturised filters, antennas and lenses could all be built in a single manufacturing step. To further push these concepts, ceramic-based materials are being developed within the consortium that have high dielectric constants and low loss, and that can be 3D printed to create novel microwave substrates. The challenges that lie ahead reside not so much in the AM processes, but in the materials that can be used with an end application in mind.

More information about the Symeta project can be found at https://www.symeta.co.uk

Dr Darren Cadman,
Symeta Project, Loughborough University

Mr. Laminate tells all PTFE is:-

About to be Banned by IEC TC111

Doug Sober, Essex Technologies Group, with
Stephen Tisdale, Tisdale Environmental Consulting LLC

There, I said it,. Technical Committee 111 of the International Electrotechnical Commission (IEC) is preparing to effectively ban PTFE (polytetrafluoroethylene) materials from electronics. As history goes, the electronics industry has focused on only two of the five halogens (bromine and chlorine) to be limited in order to be called “halogen-free” or more accurately “low-halogen.” But now, fluorine is being dragged down too, just because of its location in the periodic table.

Currently, an important standard development activity is taking place in IECTC 111 in the “Environmental Standardization for Electrical and Electronic Products and Systems” committee [1]. The newly proposed standard, IEC 63031, is titled “*Definition of Low Halogen Materials used in Electronic and Electrical Products*.” The latest committee draft of this standard is currently under circulation and is being reviewed by each affiliated country’s National Committee, with a closing date for comments of September 15, 2017.

Due to the possible negative impact of this new standard on the fluorine industry, this article will hopefully shed light on the issue and help gather support to revise the scope and related "low-halogen" definition in the current Committee Draft (CD). The result will be the preservation of the long-standing good reputation of the fluoropolymer (PTFE)-based products and prevent confusion, duplication with other regulations, trade limitations, and increased costs.

A History Lesson

In 2001, during an IEC meeting of TC91 (TC52) Working Group 4, we decided that there should be a specification for FR-4 copper-clad laminates that were halogen-free. Several Japanese manufacturers were selling these laminates and prepregs around the world, but there were no specifications to conduct commercial business. Although the turnover was quite small at the time, we knew that this product line would grow.

During the meetings, data was presented that supported both the Japanese industry and the U.S. industry as far as maximum threshold limits were concerned. What we finally compromised on was 900 ppm maximum chlorine,900 ppm maximum bromine and a total requirement of 1500 ppm maximum for chlorine plus bromine. The rest of the Working Group 4 members agreed and the document was completed using the IEC process scheme for standards. IEC 61249-2-21 thus became the defining standard for FR-4 product for halogen-free (low halogen) materials.

But what about fluorine??

The rationale behind the banning of halogens was that some brominated and chlorinated flame retardants, when burned especially at low temperature, produced dioxins and other toxic products. These were bad for human health and the environment in general. To that end, the halogenated flame retardants related to these safety issues have been banned from the electronics supply chain. Other halogenated flame retardants are still in wide use because they are very efficient and do not have deleterious effects on health or safety.

In the electronics industry, the use of fluorine has been limited to those base materials comprised of PTFE resins. The fluorine is not in there for flame retardant purposes but it is intrinsic to the basic performance properties of the resin system, and yes, it does produce a UL94 V-0 flammability rating for a laminate base material when combined with woven E-glass reinforcement. As opposed to some of the brominated and chlorinated flame retardants, PTFE has not shown to be an issue safety-wise. In fact, when you think of PTFE (Teflon®) cooking utensils, you think of things that are completely inert. We eat out of them even after cooking at high temperatures.

So, at the time the IEC did not include the fluorine halogen in the halogen-free discussion, and neither did the IPC Halogen-Free Subcommittee which wrote a white paper on halogen-based materials used in our industry. They also chose to give fluorine a free pass. The title of this document is: "*IPC White Paper and Technical Report on the Use of Halogenated Flame Retardants in Printed Circuit Boards and Assemblies (Correcting the Misunderstandings on 'Halogen-Free')*" [**2**].

Once the limits had been clearly established for bromine and chlorine for base materials, IPC and JEDEC proposed a joint standard that would define other elements of the electronics supply chain including connectors, components, soldermask, conformal coatings, electronic housings and cases as well as power cords. This document was named " *IPC/JEDEC Joint Standard 709 and the title was, "J-STD-709 Definition of Maximum Limits on the Low-Halogens Bromine & Chlorine Used in Materials for Certain Electronic Components and Assemblies*" [**3**].

Notice anything missing in this title? There is no reference to fluorine. This document was later published only by JEDEC and not by IPC. However, the title and contents only referred to restrictions on chlorine and bromine content. A fluorine requirement was not added here because it did not pose a threat to health or the environment. There is also specific reference as to why fluorine and iodine were not included in the JEDEC standard in the Annex C (informative) titled: *"Clarification for including only bromine and chlorine in the definition of low-halogen materials."*

The IEC Technical Committee 111 picked up the JEDEC document and published it as a *PAS (Publicly Available Standard)—"PAS 63015: JOINT JEDEC/ECA STANDARD JS709B Definition of 'Low-Halogen' For Electronic Products"* and made it a part of their standards for publication.

The JEDEC document was imported as an IEC standard directly due to cooperation between JEDEC and IEC. But once published, the TC-111 members decided to re-write the already published standard and began an IEC New Work Item Proposal.

The second draft of this document is now being circulated through the member countries for comments. Whereas IPC, IEC TC91, JEDEC and JPCA all address the environmental standards by limiting bromine and chlorine in base materials, PWBs, assemblies and final electronics, the new proposed TC 111 document below also puts fluorine in *"just because it is in the halogen column of the periodic table."* Base materials made from PTFE have never, to my knowledge, had any issue with health and environmental concerns. In fact, fluoropolymers possess low inherent hazard and unique functionality to multiple industries, including health care, food contact applications, aerospace, chemical processing, building construction, automotive, electronics, energy, environmental protection, and outdoor & technical apparel.

The Bottom Line

If this proposed document were in fact approved by the member countries and published by IEC, it would essentially outlaw PTFE-based materials from use in electronics. The title of this document is "*Definition of Low Halogen Materials used in Electronic and Electrical Products*." The exact requirement statement in it is as follows:-

Materials defined as "Low Halogen" shall contain less than 0,9% (by mass) total elemental halogen content (F+Cl+Br+I) and meet the thresholds of all halogenated substances in IEC 91 62474 database. The standard is in the Committee Draft Phase which means it is being circulated for comments to all the IEC TC111 member countries. The deadline for comment submission is September 15, 2017.

The only recourse is to contact your country's IEC National Committee and the IEC TC111 representatives, and the sooner the better.

For a copy of the draft document, please email doug@essextechnologies.com.

References

[**1**].International Electrotechnical Commission, information on IEC TC 111.

[**2**] IPC white paper: IPC-WP/TR-584A, final draft May 2007.

IPC/JEDEC STD-709 (copy of proposed standard for ballot,

[**3**] reference only, since revised.

Stephen Tisdale has been involved in the electronics industry for 41 years and engaged in standards activities in IPC, JEDEC and IEC for most of his career.

Doug Sober is the president of Essex Technologies Group and may be reached by clicking here.

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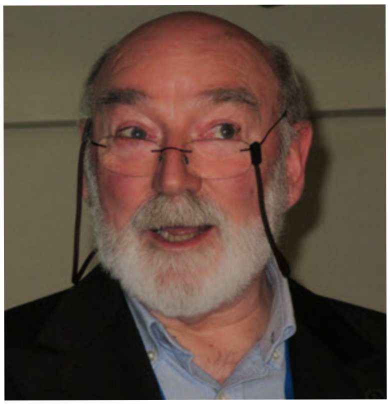
Review of :-

Institute of Circuit Technology Hayling Island Seminar 2017

by **Pete Starkey**



ICT Technical Director
Bill Wilkie

Andrew Barlow

Although it is reached by crossing the water over a long road bridge, it is not obvious that Hayling Island, on the south coast of England, is really an island because it is effectively surrounded by natural harbours: Langstone to the west and Chichester to the east. Nevertheless, Hayling Island has become established as the annual venue for an exceptionally popular:-

Institute of Circuit Technology Seminar.

This year's event had a well-chosen and varied programme featuring presentations on process chemistry and R&D consortia, a discussion of controversial standards proposals and a review of the experiences of commissioning new technology in a start-up factory. As ever, ICT Technical Director **Bill Wilkie** did a superb job of organising the seminar, welcoming all present, introducing the presenters and moderating the proceedings.

Electroless nickel immersion gold finishes have been used on PCBs for over a quarter of a century. The deposition mechanism has been progressively de-mystified, and development continues. Since MacDermid joined forces with Enthone in late 2015 to form MacDermid Enthone Electronic Solutions, the collective expertise of the partnership has been engaged in further research. In the knowledge that Revision A to the IPC4552 specification set an upper specification limit for gold thickness and allowed a lower average gold thickness if good deposit distributions could be achieved, they set out to establish a capable process which would offer potential savings in gold metal consumption. **Andrew Barlow** described the outcome of this collaborative project, a new proprietary chemistry branded Affinity ENIG 2.0.

He explained that, as gold was deposited by galvanic displacement in the classical ENIG process, the electroless nickel was subject to corrosion from air. And this effect increased with the age of the nickel bath. Key to the new process was a surfactant that inhibited the corrosion and yielded a significantly more uniform gold deposit, even after multiple metal turnovers of the nickel chemistry. The structured development programme had taken a Quality Function Deployment approach to defining and meeting customer needs and was based on six-sigma methodology and statistical process control to minimise process variation. The result was very low panel-to-panel and feature-to-feature variation in gold thickness, which provided a major opportunity for reduction in operating cost.

Barlow demonstrated with standard distribution curves that in accordance with IPC4552 Revision A, which allows a minimum gold thickness of 1.58 microinches at three standard deviations below the average thickness, a tighter gold thickness distribution translated directly to cost saving, and in an actual case study showed that this saving could be almost 30%. MacDermid Enthone were offering to cooperate with customers in joint evaluation and analysis programmes to quantify the benefits of the Affinity 2.0 process.

Steve Payne
ICT Vice-Chairman and Manager of European Operations for **iNEMI**, the International Electronics Manufacturing Initiative

Steve Payne, ICT Vice-Chairman and Manager of European Operations for iNEMI, the International Electronics Manufacturing Initiative, discussed the 2017 iNEMI Roadmap. He explained that iNEMI was a non-profit industry-led consortium of over 90 global manufacturers, suppliers, industry associations, government agencies and universities. It offered its members roadmaps and collaborative projects, together with forums and workshops.

The iNEMI Roadmap was unique in the electronics industry, giving an outlook for the following ten years, updated every other year, with global participation and covering the full supply chain for electronics manufacturing with input from over 500 contributors representing more than 350 companies and organisations. It had become recognised as an important tool for defining the "state of the art" in the electronics industry as well as identifying emerging and disruptive technologies, and helped OEMs, EMS providers and suppliers to prioritise investments in R&D and technology deployment, as well as influencing the focus of university-based research and providing guidance for government investment in emerging technologies

There were two categories of working group: Product Emulator Groups, which covered the "key attribute" needs of the aerospace and defence, automotive, high-end systems, internet-of-things, medical, consumer and office, and portable and wireless product sectors, and Technology Working Groups which forecast evolutionary and revolutionary changes for technology and business infrastructure areas, and identified potential gaps between product sector needs and technology capabilities.

In his first example, Payne discussed the 2017 Roadmap for the internet-of-things product sector, for which two principal market segments of interest were wearables and industrial. The wearables market, with devices worn directly on the body, was perhaps the most visible and with the total world population expected to grow to 7.6Bn by 2019, offered a very large market opportunity. Wearables included smart-bands - focused on activity tracking, identification and gesture control functions, smart watches - particularly as accessories for smart phones, smart glasses and devices enabling virtual or augmented reality, as well as industrial occupational applications. Entertainment and gaming were strong market drivers. The industrial internet-of-things segment offered huge opportunities for connected devices in energy management, industrial controls, safety, quality control, supply logistics and manufacturing control. The roadmap included technology examples and 10-year market forecasts

Critical gaps identified included establishing confidence and assurance on aspects of security, reliability, safety and privacy, ensuring inter-operability between IoT components, particularly across domains, and synchronization across components. And it was clear that the supporting standards lagged far behind applications. There were technology challenges in flexible electronics, batteries and low power high performance processing. Regarding PCBs, the roadmap featured a spreadsheet of key attributes and cost expectations, projected over 10 years.

Payne showed similar roadmap illustrations for medical, and aerospace and defence sectors, before going on to discuss collaborative projects, an example of which was an active initiative aimed at minimising PCB warpage in the assembly process to improve SMT yield. In his summary, he described the iNEMI Roadmap as an essential tool for strategic decisions for businesses in the electronics sector, looking forward at the technology requirements for all market sectors and relevant to PCB fabricators, suppliers and users. It identified gaps where research was needed and facilitated collaborative projects to address some of those gaps.

It was the publication of **Doug Sober**'s article in PCB007 on July 10th this year that threw the cat among the pigeons: "Mr. Laminate Tells All: PTFE is about to be banned by IEC TC111" (http://pcb.iconnect007.com/index.php/column/105891/mr-laminate-tells-all/105894)

Doug reported that Technical Committee 111 of the International Electrotechnical Commission proposed a new standard, IEC 63031, defining low halogen materials used in electronic and electrical products, which, if approved, would essentially outlaw PTFE-based materials from use in electronics. The standard was at the Committee Draft Phase, which meant it was being circulated for comment to all the IEC TC111 member countries, and the deadline for comment submission was September 15, 2017.

It was the fact that, other than standards committee members, the PCB industry in general was unaware of the details of the proposal, and was enormously grateful to Doug for making a public issue of it.

Jim Francey
Sales Manager Northern Europe for Optiprint

Bill Wilkie invited **Jim Francey,** Sales Manager Northern Europe for Optiprint, to chair an open discussion on the possible consequences, should the proposal be accepted. There was a lively debate around the fact that PTFE was such a ubiquitous material in electronics and electrical engineering, with a unique functionality for which there was generally no practical alternative, that its prohibition would have a huge impact on the electronics industry, and might also set a standard for others such as health care, aerospace, chemical processing and, ironically, environmental protection.

The national committee representing IEC in the UK, hosted by the British Standards Institution, had made its submission before the deadline with the following comments:

"Unless there is scientific evidence that a total mass of halogens greater than a particular value (e.g. 0.9%) is environmentally hazardous then there should not be such a limit contained in the document."
"Typically, environmental restrictions are based on the properties of a compound / substance rather than the elements forming that compound. Consequently we do not see, unless there is evidence to the contrary, why a limit on elemental halogens is valid."
"IEC 62474 (Material Declaration for Products of and for the Electrotechnical Industry) contains declarable halogenated compounds that are identified to cause concerns to human health and the environment. It makes sense to use the IEC 62474 database as the single source of halogens that are under this low halogen definition."
It remains to be seen what might be the outcome.

Steve Driver,
CEO of the
Spirit Circuits group

Introduced by Bill Wilkie as "*the prince of the presentations, the lord of the lecture, the doyen of the done deal*", **Steve Driver**, CEO of the Spirit Circuits group, gave the eagerly awaited final paper – a review of his adventures in Romania and in particular his experiences with the Mutracx "Lunaris" ink-jet etch-resist printing system.

He began by referencing and acknowledging the ICT Annual Symposium 2013, when Stuart Hayton's presentation "The Innovator's Dilemma – a real-world example in PCB imaging", had first stimulated his interest in this potentially disruptive technology. Apparently Driver as a schoolboy had a reputation for being disruptive – difficult to imagine! Whatever, he defined a disruptive technology as one that could displace an established technology and shake up the industry, or a ground-breaking product that would creates a completely new industry. As an example he quoted the decline of Kodak from a dominant position in traditional photographic film to filing for bankruptcy protection as a result of underestimating the disruptive potential of the digital camera. And he commented that selling a disruptive concept was not easy –

customers did not always know what they needed and preferred the safe bet of hanging on to existing revenue streams and not risking new avenues of opportunity.

But never afraid of taking a calculated risk, Driver's avenue of opportunity arose when he committed to establishing a start-up PCB factory in Romania, and he summarised his reasoning in choosing Lunaris. In particular, he was effectively starting with a blank canvas – a new factory and new staff, with no pre-conceived ideas of how to make a PCB. The capability of the machine matched his needs and suited his business model of agile manufacturing with reduced lead times. And it offered substantial environmental benefits, which were to his advantage in negotiating permissions and consents to manufacture with the Romanian authorities. Additionally, the machine had the advantages of a small footprint and low power consumption, and it was manufactured in Europe, with local support.

The machine was now in production in Spirit's BATM Systems factory, Romania's only volume PCB facility, currently processing about 350 panels per day and it could deliver in excess of 70 good prints per hour, with plans to increase this to 100.

Driver gave a candid review of his experiences, most of which were very positive. Training and support has been excellent and his operators, with no previous experience in PCB manufacture, found the machine simple and straightforward to use. Printing was a proven process and the reliability of the machine had been good, with excellent engineering support from Mutracx. Data preparation and transfer were particularly straightforward, and his CAM engineers had very quickly become expert. Maintenance and upkeep of the machine was an ongoing learning process, for both BATM Systems and Mutracx.
Two major challenges had been encountered, one concerning panel handling and one concerning surface preparation.

The Lunaris had originally been designed as an inner-layer printer, when panel flatness was not an issue because the thin material was held securely on a vacuum table during the printing operation. But BATM Systems were processing 1.6mm rigid material, and if panels were not perfectly flat, or had burrs from panel-cutting or damaged corners from rough handling, a safety mechanism designed to protect the print-heads stopped the machine. BATM's material suppliers were now aware of the requirement for flat, burr-free panels.

The condition of the copper surface had been observed to have a significant effect on ink adhesion, and pre-cleaning tended to increase ink adhesion to a point where stripping became a problem. BATM Systems were working with their suppliers of laminate and ink to study these effects, optimise the process and establish practicable operating conditions.

Production was predominantly single-sided and the factory was currently dedicated to producing PCBs for LED applications, generally with white solder mask and an OSP solderable finish. All the chemistry from the etching and cleaning lines was treated, regenerated and recirculated in a closed loop system.

Driver was delighted to report that the factory had achieved ISO 9001:2015 accreditation with no non-conformances, and took the opportunity to thank his equipment, material and process suppliers. "The support and interest is humbling, encouraging and appreciated. For Mutracx to continue to be successful the whole supply chain needs to understand the needs of the industry change. Disruptive technologies will disrupt the status quo and bring new challenges to the supply chain and the organisation. Default standards such as IPC are out dated and new supply specifications are needed. Open minds and collaboration with suppliers and customer will make change possible."

Bill Wilkie wrapped up the seminar, thanking the presenters for their contributions and delegates for their attention. Especial thanks went to MacDermid Enthone Electronic Solutions for their generous sponsorship of the event, which brought together a substantial cross-section of the UK PCB industry for another significant learning and networking opportunity.

Pete Starkey
I-Connect007
September 2017

Bill Wilkie
Technical Director and Organiser

British Standards Institute and the Institute of Circuit Technology

The Institute has a BSI page on our website and sponsors a number of Members on BSI committees. Len Pillinger, Dennis Price, Emma Hudson and Andy Pritchard(EPL 501)all lend their expertise on various subjects to BSI.

Dennis recently noticed something strange going on with IEC TC111 and unearthed an article by Doug Sobers about the flawed logic of trying to limit the use of fluorine in the Electronics Industry for the sole reason that it was a halogen. We sent the article to our members and it caused quite a stir, mainly among members who knew the background of the evangelical environmental movement to limit the use of brominated flame retardants.

Jim Francey, one of our fabricator members, was asked to lead a discussion at the recent Hayling Island Seminar and Dennis was able to supply much of the background information.

Jim was able to cover the background and bring us up to date with the latest information from BSI and hopefully, we have raised the right sort of objections to see this proposed legislation stopped in its tracks.

What did become apparent from some of the questions, and was also evident in my introduction, was the fact that the majority of the audience didn't know anything about the threat and were not regular observers at the BSI page on our website.

This is not a new phenomenon, but it is one we need to address if we want our membership to be alerted to events which could have a disruptive effect on our Industry.

Bill Wilkie
Technical Director and Organiser

Corporate Members of The Institute of Circuit Technology October 2017

Organisation	*Address*	*Communication*
Adeon Technologies BV	Weidehek 26,A1 4824 AS Breda, The Netherlands	+31 (0) 76-5425059 www.adeon.nl
ALR Services Ltd.	Unit 9 Thame Business Park ,A1 Thame, Oxon OX9 3XA	01844 217 487 www.alrpcbs.co.uk
Anglia Circuits Ltd.	Burrel Road, St.Ives, Huntingdon PE27 3LB	01480 467 770 www.angliacircuits.com
Atotech UK Ltd.	William Street, West Bromwich. B70 OBE	0121 606 7777 www.atotech.com
CCE Europe	Wharton Ind. Est., Nat Lane, Winsford CW7 3BS	01606 861 155 www.ccee.co.uk
ECS Circuits Ltd.	Unit B7, Centrepoint Business Park, Oak Road, Dublin 12, Ireland	+353-(0)1-456 4855 www.ecscircuits.com
Electra Polymers Ltd.	Roughway Mill, Dunks Green, Tonbridge TN11 9SG	01732 811 118 www.electrapolymers.com
The Eurotech Group	Salterton Industrial Estate, Salterton Road Exmouth EX8 4RZ	01395 280 100 www.eurotech-group.co.uk
Exception PCB Solutions	Alexandra Way, Ashchurch Business Centre, Tewkesbury, Gloucestershire. GL20 8NB	01684 292 448 wwwinfo@exceptionpcbsolutioncom
Merlin PCB Group *(was Falcon Group)*	Hawarden Industrial Park, Manor Ln, Deeside, Flintshire, North Wales, CH5 3QZ	01244 520510 www.merlinpcbgroup.com
Faraday Printed Circuits Ltd	15-19 Faraday Close, Pattinson North Ind. Est., Washington. NE38 8QJ	01914 153 350 www.faraday-circuits.co.uk
Graphic plc	Down End, Lords Meadow Ind. Est., Crediton EX17 1HN	01363 774 874 www.graphic.plc.uk
GSPK (TCL Group)	Knaresborough Technology Park, Manse Lane Knaresborough HG5 8LF	01423 798 740 www.gspkcircuits.ltd.uk
Invotec Group Ltd	Hedging Lane, Dosthill , Tamworth B77 5HH	01827 263 000 www.invotecgroup.com
PMD (UK) Ltd.	Broad Lane, Coventry CV5 7AY	02476 466 691 sales@pmdgroup.co.uk
Rainbow Technology Systems	40 Kelvin Avenue, Hillington Park Glasgow G52 4LT	01418 923 320 www.rainbow-technology.com
Spirit Circuits	22-24 Aston Road, Waterlooville, Hampshire PO7 7XJ	02392 243 000 info@spiritcircuits.com
Stevenage Circuits Ltd	Caxton Way, Stevenage. SG1 2DF	01438 751 800 www.stevenagecircuits.co.uk
Ventec Europe	1 Trojan Business Centre, Tachbrook Park Estate Leamington Spa CV34 6RH	01926 889 822 www.ventec-europe.com
Zot Engineering Ltd	Inveresk Industrial Park Musselburgh, B19 EH21 7UQ	0131-653-6834 www.data@zot.co.uk