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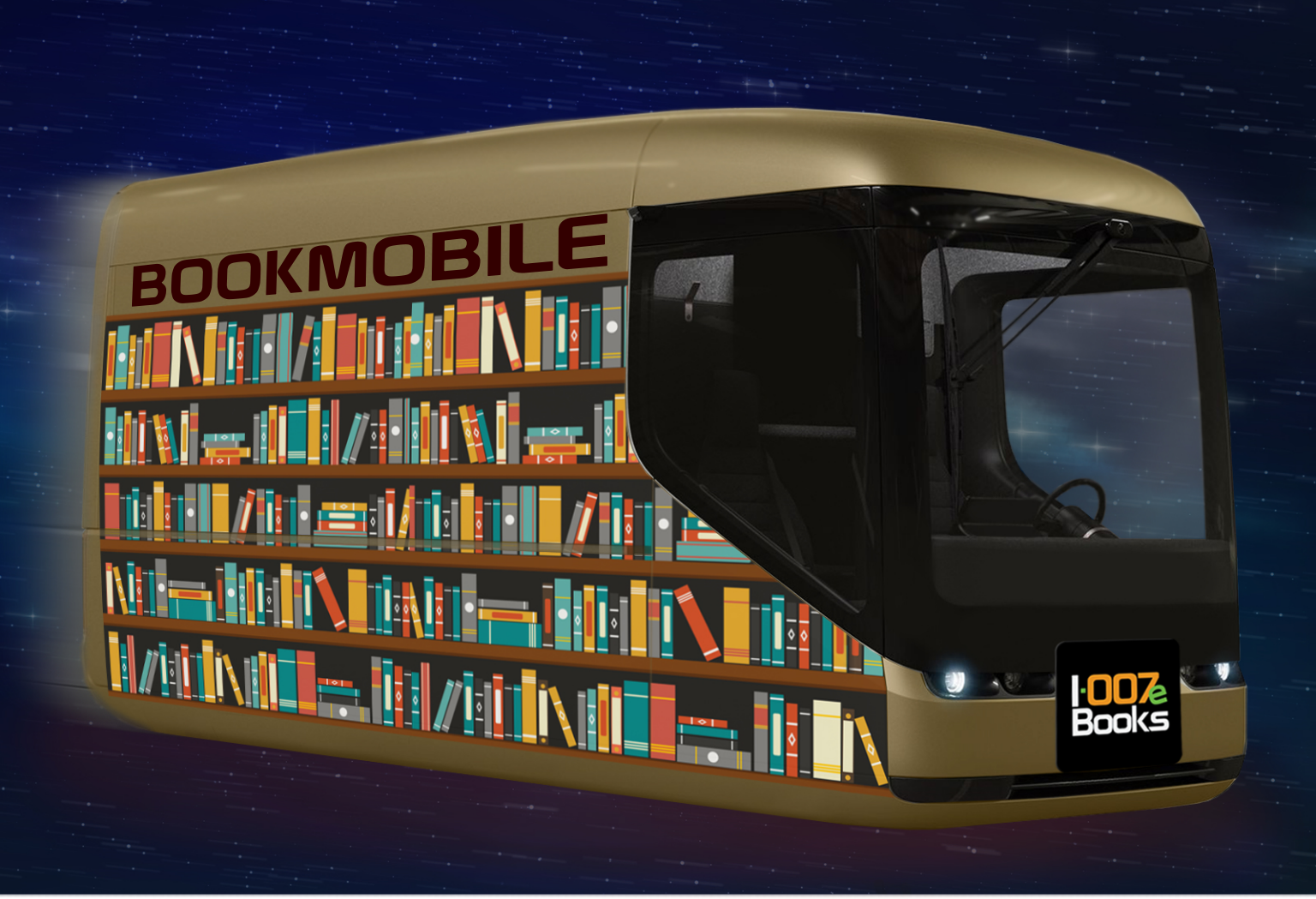

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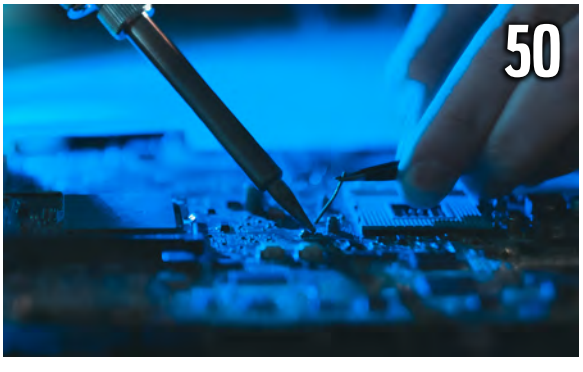

CFX: The Foundation of Industry 4.0

The PCB assembly industry is edging closer to the true vision of Industry 4.0. With IPC's Connected Factory Exchange (CFX) standard—a common machine communications standard for the electronics assembly supply chain—electronics manufacturing is on its way to become even smarter. This issue of *SMT007 Magazine* looks at the latest developments in the CFX standard and its overall impact on the PCB assembly process.

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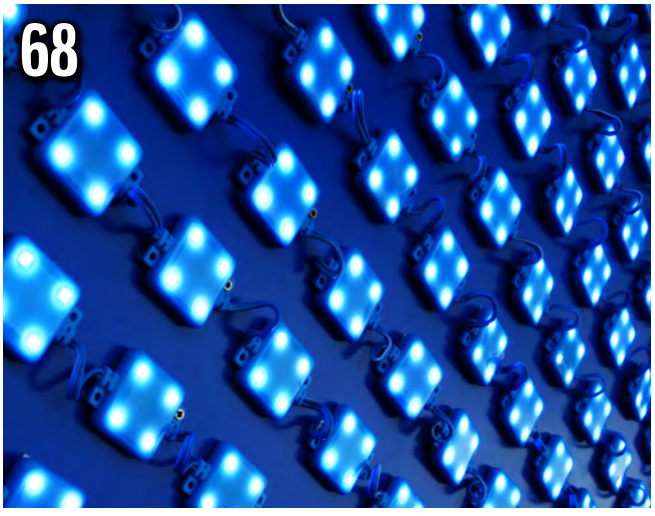

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CFX: The Data Train is Now 'Boarding'

On the Surface

by Nolan Johnson, I-CONNECT007

Transitions happen. We grow, change and evolve. Time moves forward, as do we all, like it or not. It's an honor to relieve Stephen Las Marias as managing editor of *SMT007 Magazine*. Stephen has contributed much to this publication. I have some big shoes to fill as Stephen takes his talents into his next assignment as managing editor for I-Connect007's newsletters.

I may be new to the magazine, but I'm not new to the industry. I joke that I have a serial number from Tektronix somewhere on my body, given that my mom and dad met at Tek HQ. As a teenager, I was fortunate to watch PCB fabrication emerge as an industry first-hand. My dad worked in Tek's first PCB fabrication facilities; years later, he retired from Merix Corporation.

As for me, I received a degree in computer science and launched my career in 1984 writing software for a little-known 200-person Tektronix spin-off called Mentor Graphics at the time (now Mentor, a Siemens Business). Years later, my CV includes stints at industry names such as: ESI, Tektronix, Brooks Automation, GE, and Sunstone Circuits. My areas of responsibility over the years have included software development, user interface design, hardware installations, customer technical training, product management, marketing communications, sales department management, and strategic planning.

I'm no stranger to transitions. The common thread, though, has been telling stories through my work. So, with no further ado, let's tell some stories!

There's a technical transition underway in the electronics manufacturing industry, which we explore in this issue of *SMT007 Magazine*. The Connected Factory Exchange (CFX)

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communication standard, under development with IPC, continues to gain acceptance in the industry. CFX helps lay the groundwork for smart factories through a standardized factory-wide communication standard. While CFX is making great progress, there are still some challenges to overcome as equipment suppliers bring Industry 4.0 principles to fruition in printed circuit manufacturing.

We explore it all in this issue, kicking off the with "The Truth About CFX." Michael Ford brings us up to speed on the history of CFX and looks ahead at what happens next.

We also bring you a conversation with IPC's Dave Bergman who discusses CFX developments, the differences between line control and factory control (Hermes and CFX), IPC's CFX demonstration events, and upcoming developments in the standard.

In a feature interview, David Fenton from Blake Europlacer shares the high level of industry acceptance he sees, the ongoing shift away from proprietary formats amongst equipment manufacturers, and the road to wider customer acceptance.

We conclude the CFX discussion with an interview with Larry Chen of TRI, a Taiwan-based equipment manufacturer, about how CFX and test equipment interact.

While Industry 4.0 will bring certain benefits, smart factories won't eliminate the need for smart design decisions and materials planning. Good engineering must still happen. To that end, our columnists and the technical team at Alpha Assembly Solutions help with that conversation.

The team at Alpha Assembly Solutions share their recent research into controlling solder voids for applications that must manage thermal issues.

Eric Camden's column digs deep into a few manufacturing defects examples that could improve over time with CFX.

Electrolube's Jade Bridges looks at the do's and don'ts for thermal management materials, providing critical insight into the selection, application and planning of thermal management for your products.

As we all move forward into our future, I welcome your feedback, readers. Together, with your comments and suggestions, we can have the right conversations about the industry here on the pages of *SMT007 Magazine*. You can always contact me. **SMT007**

Nolan Johnson is managing editor of *SMT007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing. To contact Johnson, click here.

Mycronic Discusses Industry 4.0

At the recent NEPCON South China 2018 event in Shenzhen, Clemens Jargon, VP for Global Dispensing and Asia at Mycronic, discusses the challenges that customers face on their journey towards Industry 4.0, and how Mycronic is addressing these issues.

From jet printing to solder paste inspection, to pick-and-place, Jargon talks about their total solutions that aim to help customers take their production to the next level.

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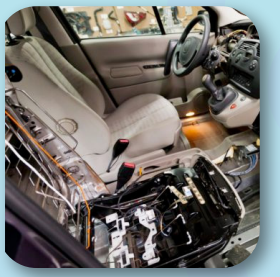

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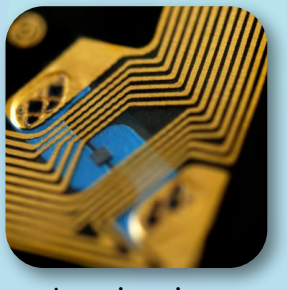

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CFX: Building the Foundation for Industry 4.0

Feature Interview by Stephen Las Marias
I-CONNECT007

Starting at productronica 2017, and then on to IPC APEX EXPO 2018, SMT Hybrid Packaging 2018, and What's New in Electronics (WNIE) Live 2018, IPC showcased the Connected Factory Exchange (CFX) initiative in action. The CFX Showcase provided a technical demonstration operating in real time with standardized machine data delivered from participating exhibitors through the cloud and onto visitors' cellphones. What's more interesting is that each showcase was supported by more than 25 vendors who have stepped up to create the world's first conversion of a show-floor into a digital factory shop-floor.

In this interview, Dave Bergman, VP for international relations at IPC, discusses the latest developments with IPC's CFX standard, including key highlights, impact in the electronics assembly industry, and what's next.

Stephen Las Marias: David, give us a brief overview of CFX. What is it and what are the expected benefits?

Dave Bergman: CFX is a messaging format that provides the foundation for smart factory. At its base level, several IPC standards committees IPC have created a messaging concept in which each individual machine or part of the manufacturing line can be broken down into its smallest steps; those steps, while they probably have an internal machine code, include a goal to have that machine code or software communicate out in a common language. If I'm trying to speak English and you're trying to speak Spanish, and there's no interpreter, we're going to struggle. The objective of CFX is to provide the interface in the machine-to-machine communication. It's a standardized messaging format for electronic manufacturing and beyond.

The aim of CFX is to make it easier for companies to create smart factories, and smart factories refers to anything from manufacturing software running a plant and being able to communicate with the line, but also the machines talking to one another. There has been for some time a vision of manufacturing lines being self-correcting. Self-correction can only take place if your machines can speak to each other, and CFX is intended to help that.

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Las Marias: Apart from smarter factories, what else is driving the need for CFX?


Dave Bergman

Bergman: There are several factors. One of the factors is an increased drive to efficiency, to increase productivity. If you have a smart factory, you can have your staff work in other areas while your machines are solving some of their own problems. What's also driving it is the need for flexibility. For example, if I'm an EMS company or an assembly manufacturer, and I want to have a piece of equipment from vendor A, and a different vendor for my second piece of equipment, I'll have a variety of suppliers. I want a way for all of them to communicate easily. If I want to bring in a new piece of equipment, I want to reduce the time that it takes me to have that piece of equipment integrated into my manufacturing environment.

Right now, much of the software interfaces that need to be added to have your new equipment work in the manufacturing line takes a lot of custom coding. The very fact that so many equipment manufacturers are willing to work together, it's because their customers are driving and say, "We need this flexibility. We recognize the industry is going to be faced with different equipment from different manufacturers speaking different languages. We need a common language." That's what's driving the demand for CFX.

Las Marias: What are the technical challenges, if any, in adopting CFX?

Bergman: This is an interesting question. Adoption, not to adopt. At some point in time, if I have 20 pieces of equipment, and six of them speak CFX and 14 of them don't, that's a problem that must be dealt with in some fashion if I'm expecting to see all the benefits of CFX. I think that would be true in any standard that you're putting in place. I don't see that that is an overwhelming barrier to implementation. There will be some startup related issues as people are bringing things in. There are legacy machines that people will have to go back and work on CFX for some of their legacy machines.

Our vision is that if CFX becomes widely adopted as we expect, new machines that are going to be out on the marketplace will already have CFX built into them. So for legacy equipment, there will be some conversion time to bring those things into use. Other than that, I don't see major technical challenges. CFX is intended to be a feature-rich standard.

Smart factories that do in-depth analytics as to what's going on in the manufacturing environment requires a lot of data. That data can be collected in all the steps from all the devices, as everything has connectivity, and bandwidth and storage is getting cheaper and cheaper. That is not a significant barrier, but there are certain pieces of equipment out there, and conveyors are one example, where they don't have a lot of memory storage. They are simple and can only take messages of a certain size because that's all that was required of them. Whether that would change in the future or not, I don't know, but in its current configuration, there are certain devices that struggle to push the messages that CFX might send. We have been talking with the Hermes standard group to find ways that CFX and Hermes can work together to solve that particular issue.

Any time you're trying to implement something new, you're going to bump into individual challenges that need solutions; this is one that's been identified, and we think we have solutions for it.

Las Marias: During the CFX demo at IPC APEX EXPO 2018, I was able to talk to some of the manufacturers who participated. They were saying that Hermes is for the machine-to-machine connectivity whereas the CFX is for the messaging format for these machines,

which is why I don't think they're competing, in a way.

Bergman: They serve different purposes. We have been discussing this for some time because both standards are industry-driven standards. They're intended for somewhat different purposes, though there are portions that overlap. When IPC and the SMEMA Council merged in the late 1990s, we had a series of standards, and the SMEMA Council created IPC-SMEMA-9851, which was the connectivity of machines for line control. So that one manufacturer's piece of equipment can tell the next one that something is coming. Simple messages like, "I'm sending a board. It's coming down the line. Be ready to receive." The other one says, "Okay, I got it. It's coming."

In those cases, a lot of it was hard-wired. The Hermes standard was intended to change that to software to make it easier for modification. Again, it was still intended for line control, not for factory control. Hermes doesn't pull information out of the manufacturing line for any kind of analysis. It's intended to control the manufacturing line. That's an excellent purpose, and because of that focus, Hermes messages are very light or small, which is a benefit because now the Hermes standard can be used with a conveyor. If the messages are small, the conveyors can handle the message size and do their job. We are looking to create messaging within CFX to take advantage of that capability of Hermes.

Las Marias: What about from the equipment manufacturers? What would be the buy-in so that they will install the CFX standard in their machines?

Bergman: You'd think it would be counterintuitive; at least when we started the initial discussion for creating CFX, I didn't expect the equipment manufacturers would want to work together at all; basically, if I'm an equipment company, I'm helping my customer to be able to be more flexible in their choice. They're not tied to me. I said it would never work, because really, if I'm selling a piece of equipment, I want people to buy everything from me. However, when we held our first CFX meeting and I walked into a small meeting room in Las Vegas at IPC APEX EXPO, we had 80% of the world's supply of equipment in one tiny room. Something had changed. Or at least, my perception was I was wrong in my previous assumption that they wouldn't work together.

I believe the customers are driving this, that they are demanding this flexibility. In the end, I think that the equipment suppliers recognized they don't want to get blamed every time there is some little adapter that goes wrong, or somebody makes a change in a custom-written software solution and their equipment gets blamed. They don't want that headache each time. The advantage is you eliminate all those. You have one common language, and they're in control of the messaging. You take all of these custom-written software applications and eliminate the need for them. I think that offers everyone, both sides, the equipment suppliers as well as the customers, a significant cost savings long-term. It was clear from their participation and their demand that we're doing something good when we started down this path.

We have 250 people on the CFX committee right now in the U.S. We have a separate committee that's discussing the same topic in Chinese in our Asia Pacific office, ninety-something people there and growing. More people are saying, "This can really help our manufacturing operations if we can make this a reality." I believe now it would be really tough for somebody to say, "I don't really have a plan to do anything with CFX," because the customers are going to drive it.

Las Marias: Dave, the CFX was showcased at APEX earlier this year, and then you also did a demo at the recent SMT Hybrid Packaging Event in Nuremberg. What are the importance of those demonstrations? And how did the industry react?

Bergman: In all my years at IPC, it's probably within my top five coolest things that IPC has ever done. This is an industry first.

We were able to, at a manufacturing show, have 22 competing companies communicate in a common language and have their output viewed on people's cell phones. We had an analytics tool that enabled them to communicate to the cloud and have people monitor those devices on their cell phones. We were not able to find any other instance where this had happened, so it was like an industry first. We ran some 44 pieces of equipment. We had 800,000 messages delivered during the week, and it was nearly flawless. I don't really know that we had any real downtime.

What was even more exciting is the ability to play at this level and come in; the barrier was extremely low. We were only using a small subset of CFX, so it was only a handful of messages. When finished, the standard will be much more capable with many more messages, on the order of 25- to 30-fold. Companies were able to come in within a week and were able to participate in the demonstration. No real long lead times. They came in, it was easy for them to implement, turn on, and jump in. That was the exciting spot. At productronica in November last year, we were asked by one equipment manufacturer if we could do the demonstration at IPC APEX EXPO. Within three months, we got 44 pieces of equipment running in an application and being able to be seen by thousands of people.

That was the exciting part. A short turnaround time, 20 some companies that participated, 44 pieces of equipment, hundreds of thousands of messages, and it was almost flawless.

Las Marias: In one of my previous interviews, one company said they were just made aware of CFX two weeks before the show. What they did is really focused on it, and in just two days, they were able to implement the standard to be able to join the demonstration.

Bergman: It's just unprecedented. It's really been exciting. Europlacer has jumped in with both feet, and it's been great because now they've given us some feedback. They are pushing hard for implementation, and so they are finding that, "Okay, we need to tweak this, we need to tweak that." Recognize the fact that they are implementing a draft. The standard still hasn't been voted on, so we have what we believe is good content, but it hasn't gone through complete review and voting and such. They're working on that and they've been able to say, "This worked great for us. We need to tweak this here." They have been really excited.

I met with them at Nuremberg, and they were really excited. They had four or five other questions, which led us to make some tweaks in the standard to identify some holes that they had worked as they were trying to do this implementation. I expect more of that to happen as companies push harder. We can't think of everything as we're writing the standard. We're giving it our best shot, but somebody is going to come up and say, "Okay, I ran into a jam here. How do I handle this?" All right, we step back, figure out how to do it, and then we put a release out. We have had already, as we build awareness of this, content developed where we did not expect it.

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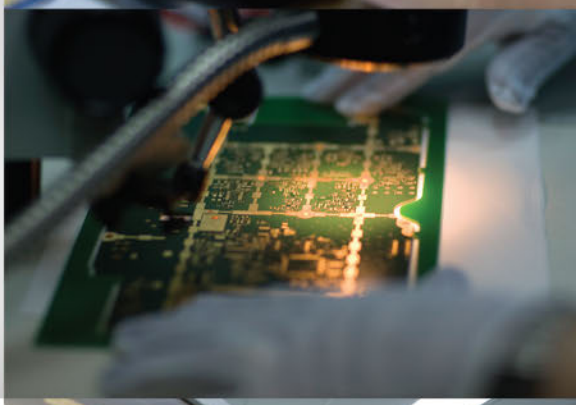

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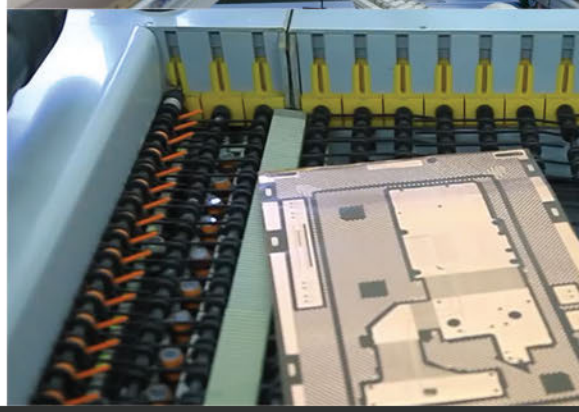

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Somebody came in and said, "Hey, this is what I need for my application," completely out of the blue. They wrote a messaging update, they inserted it in the open-source software development site that we have on GitHub, and the feedback that I had from some of the committee members is, "This is pretty good stuff. We didn't even think of it, yet somebody has created some new messaging." I think that long-term, I am excited for what CFX might become. The concept of breaking the manufacturing operation down into a standard format and to deliver that message in a secure protocol, it doesn't have to just stop at electronics manufacturing.

As the awareness is built for this, somebody has started from another manufacturing environment to ask, "Can this be used to manufacture widgets?" We don't see why not. The concept of breaking manufacturing equipment down into its element parts and writing it in this protocol, there's nothing specifically unique or limiting it to just electronics. It's very possible that CFX could be used to build other things like mechanical parts, automobiles. Who knows? We'll see.

Las Marias: Dave, would you say digitalization is one technology enablers for CFX to come to fruition?

Bergman: Absolutely. The ability to monitor what's going on on the shop floor, to be able to have one piece of equipment tell another one, "Hey, something is going wrong. That product you just put through," I'm now a camera, and I'm telling the machine before it that says, "Hey, something is wrong here. You need to make an adjustment." Then at the factory level, I can be monitoring. Somebody calls me up and wants to know where is their product in my manufacturing line, and to be able to see that simply. All of that is facilitated by CFX.

Las Marias: There's a plethora of industry trends right now pushing for smarter manufacturing. We've got Industry 4.0, Internet of Things (IoT), etc. Where does CFX sit among those trends?

Bergman: I thought about that, and first I thought it sits in the middle; but, I think CFX provides the solid foundation. Industry 4.0 is a visionary statement or a visionary term. To be able to create that vision, you need a solid foundation. You need to be able to reach down and understand what's going on to have a factory that can manufacture and really be self-adjusting without devices that are communicated.

I would say smart manufacturing and Industry 4.0 are almost similar terms. I would say that CFX is the foundation using the IoT where the devices are able to be accessed, and to have the tools to meet the vision of smart manufacturing, which is Industry 4.0.

Las Marias: I understand one of the benefits of CFX is also traceability.

Bergman: There should be ways of gathering data on what is being built, what is going in. Since you're pulling information from the line and storing it in your manufacturing system, you should be able to track everything that is being put on the board, what's happening to it, before it's sent to the customer. I should be able to collect data on the order going in. I should be able to pull information on all the component lots that are being used in the boards. I should have all the information; any faults in the machinery while it was going down the line; and all the temperatures that were used during the manufacturing environment.

This is the advantage of being able to pull information from the manufacturing line and storing it in some type of manufacturing execution system (MES). CFX is not the MES. It facilitates that. There is a layer of intelligence that needs to be present on top of CFX. CFX is the foundation. The applications that facilitate the traceability, or collect all the information to make traceability possible, CFX makes that easier.

From a traceability standpoint, the fact that you can see what is taking place—and your manufacturing line is sending all those messages—and those can be collected, that would lead to the ability of maintaining trace-

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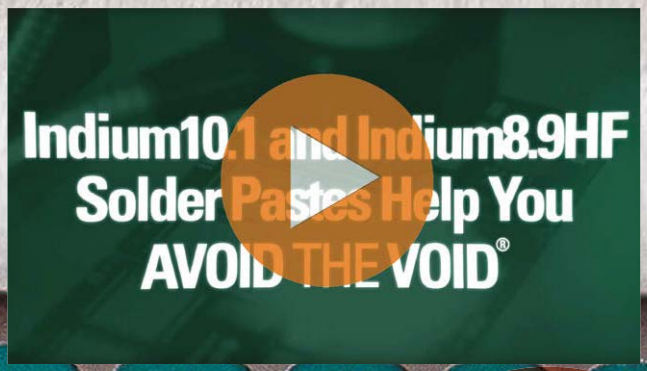

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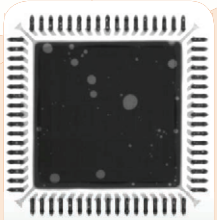

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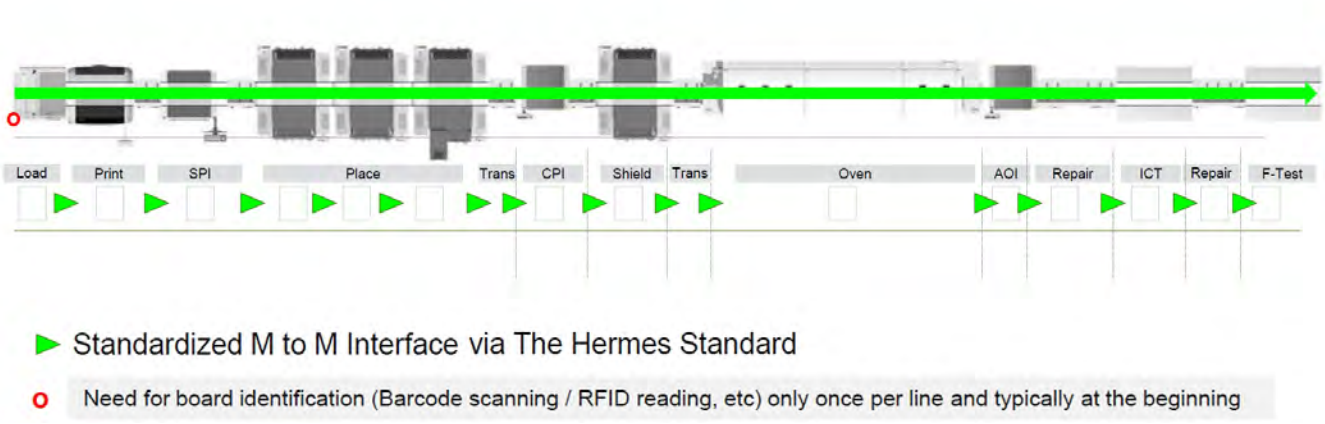


ability, but you still need that MES that is pulling that. If the messages are there and there's nothing pulling it or storing it, you have no traceability. The fact is the messages are there; if you put in some layer of software that pulls them, you gain significant benefits for traceability and manufacturing parameters.

Las Marias: How many companies are now supporting the standard?

Bergman: We have a Supporters tab on our CFX website. I think it's as high as 50. However, one of those is the Hermes Standard Initiative, because they, as an initiative group support, see the benefits of collaboration between Hermes and CFX, and so they've added their logo under the CFX Supporter. We have probably 30 or 40 members overlap, and so we pick up another 30 companies there. Maybe we're at 75-80 companies right now.

And I'm actively asking the question. In my opinion, if you're trying to start a movement, you're trying to build a critical mass. The more companies that I can get to say, "We think this is important to our business," even if they're not implementing it tomorrow, but they believe it's important to their business, I want to add their logo. That will show the next guy. I'd like 500 logos on that page. I'll get them at some point. I'm happy with the start, but I'm out actively asking.

I was in Germany recently. I was asking, "Look, one of my things I'm asking you for, I'd like to see your logo here as a partner." We will be doing more of that going forth.

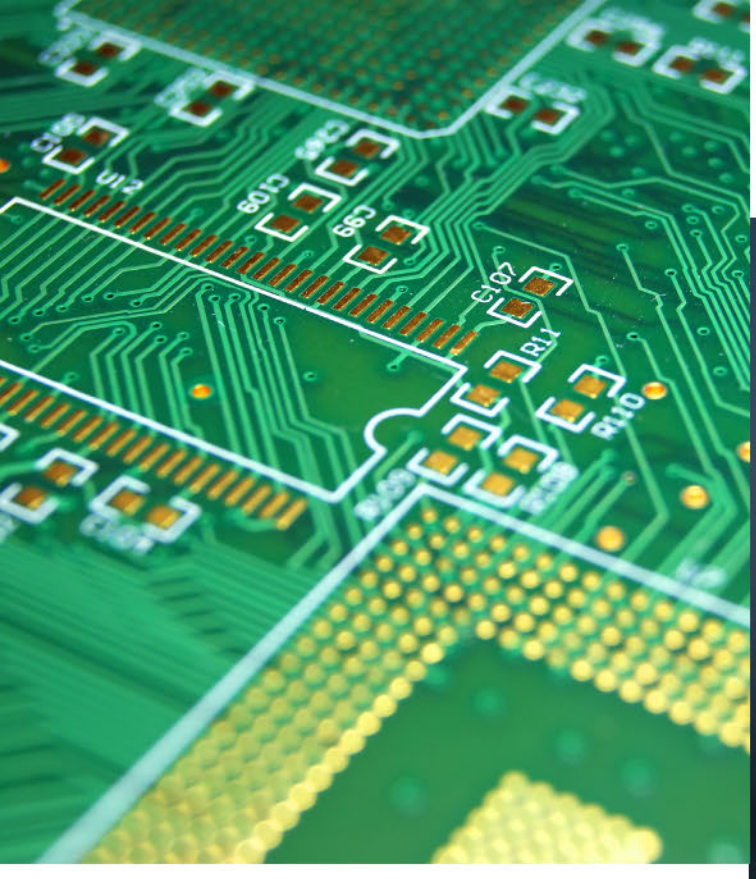
Las Marias: And there are more than 300 committee members now for the CFX?

Bergman: It's pretty close. The individuals, I think, in our committee here that I have are around 250. I have another list in China. There are a few overlaps, but I think they're close to 100, so that's probably close.

Las Marias: The initial draft of the CFX standard was developed in record time. What does that show the industry?

Bergman: I think it's pretty quick, as well. Actually, we spent a lot of time analyzing and trying to make the initial choice, and I probably wasted six months going down the wrong path, because we thought it was the right path and it turned out not to work. In reality, I'm probably at about a year and a half, which is pretty fast in the scheme of consensus building standards. What it shows is that there is significant frustration or demand for change, or to be able to implement something that should save money. This is a money-saving standard. There will be implementation cost, but the long-term savings are really significant.

What's fascinating to me, because we had talked about committee counts, is that we have companies from everywhere. We have U.S. companies, we have European companies, we have companies from Japan, from South Korea, from China, from everywhere that are participating. I have guys who are coming up that have a piece of equipment, but they want to output CFX. They're writing in a completely



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different format in Python. I didn't even know what Python was; I had to look it up. They said, "I need to get my hands on the standard. How can I participate?"

The advantage of getting into a common language is really a driver, because I think the real exciting stuff, if you want to see how the industry will change, watch it change after CFX is out. CFX is not the whiz-bang stuff. It is the foundation, the common language. People are going to build amazing houses on top of the CFX foundation. In a year or two, when smart factories are out there, and you got machines that are self-adjusting, these are things that were on the technology roadmaps by INEMI.

We had a vision that this machine could tell another one that there's some kind of problem going on, and what needs to be fixed. We're really close to that happening, and that had to be close to 20 years ago. I think what will be really exciting is what the industry will look like in a couple years once this language is out and people start to take their creativity, which was once spent on trying to write adapters for each individual machine, they can now turn their focus on creating factory execution systems that take advantage and that can be truly intelligent. It is going to be cool.

Las Marias: What's next for CFX?

Bergman: We will probably be in awareness-building mode for the next several years. I'm hoping that as I add logos, everyone will be telling their friends so that it's not just dependent on me to be making presentations. I think that the industry will hear a lot more once it's out. Awareness-building is important, and then as we report on demonstrations, then I think we'll really get the ball rolling.

Las Marias: Dave, what do you want our readers to know more about when it comes to CFX?

Bergman: I guess what's interesting in this is that I have not really been deeply involved in a software-developed or software-written standard, so this is a little bit of a new experience for me. We have had key committee members work hard to lower the barrier of entry. When you get the feedback from people that this is what they've been doing for years, working with machines and machine software, and they're stunned by how easy it is to implement. They're just like, "Wow, if I had known that it was this easy, I would have probably tried to do this six months ago."

With the support of some key members, the barrier to play and the barrier to get engaged in this, and maintain an open-source industry standard, has really been fun to watch. I'm really looking forward to seeing the first really smart factory reported on, or maybe I'll get to tour one. Somebody to say, "We've implemented it. Come out and have a look." That's something that I'm really looking forward to.

Las Marias: Dave, do you have anything that we haven't talked about that you think we should be talking about?

Bergman: I think we've covered it well. Certainly, I think it's important to say that I'm doing the talking, but there's a lot of people that are key to this effort. Aegis Software, Heller Industries, Flex, and now IBM have leadership positions within the CFX effort and have contributed their companies' time and resources to make this a reality. Then, there are hundreds of companies now that I can go to and see people that have bought into the wave that's coming.

IPC is facilitating this change, but it's not on our own. It's as an association with a lot of companies and a lot of members doing a lot of good work. We look forward to helping them achieve the vision, which is Industry 4.0.

Las Marias: Great. Thank you very much again for your time, David.

Bergman: You're welcome, Stephen. It's good to talk to you. SMT007

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MilAero007 Highlights

ERAPSCO Inks $64.6M in Navy Sonobuoy Contracts ▶

Sparton Corp. and Ultra Electronics Holdings plc announce the award of subcontracts valued at $64.6 million to their ERAPSCO joint venture for the manufacture of sonobuoys for the United States Navy.

Michael Clarke Named CEO of Sanmina ▶

Michael Clarke, a member of the board of directors of Sanmina Corp. since 2013, has been appointed the new CEO of the company effective October 1, 2018.

API Names Michael Schwarm Global VP of Sales and Marketing ▶

API Technologies Corp. (API) has named Michael Schwarm as vice president for global sales and marketing.

John Karkoski to Lead Zentech's Mil-Aero and Space Market Initiative ▶

John Karkoski has joined Zentech Manufacturing Inc. as director of business development for the military and aerospace markets.

IEC Electronics Names New CFO ▶

IEC Electronics Corp. has appointed Thomas L. Barbato as senior vice president of finance and CFO.

OSI Systems Reports Record Q4 FY 2018 Revenues ▶

OSI Systems Inc. has reported revenues of $287 million for the fourth quarter of fiscal 2018, an increase of 14% from the $252 million reported for the fourth quarter of fiscal 2017.

Circuitronics Promotes Ken Mount to Quality Manager ▶

Ken Mount, a Certified IPC Trainer and a Lean Six Sigma Green Belt with expertise in 5S, 5S + 1, and DMAIC, has been promoted to quality manager of Circuitronics.

Nortech Systems Approves Stock Repurchase Program ▶

Nortech Systems Inc.'s board of directors has approved another installment of a stock repurchase program similar to the company's inaugural repurchase program that expired last month.

Infinite Electronics Names Laurie Addison as VP of Marketing ▶

Infinite Electronics Inc. has named Laurie Addison as vice president of marketing for the company.

ACDi Celebrates Milestone with $10,000 FCPS Donation ▶

American Computer Development Inc. (ACDi) has presented a donation of $10,000 to the Frederick County Public Schools (FCPS) to mark a major milestone in the firm's history—its 10,000th design order. The donation is targeted to support STEM—science, technology, engineering and math—programs and inspire students to pursue STEM careers.

Nortech Systems' CEO Rich Wasielewski to Retire ▶

Rich Wasielewski, who has been the president and CEO of Nortech Systems Inc. since 2014, will be retiring.

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The Truth About CFX

Accelerating Tech–Insights from the Smarter Factory

Feature Column by Michael Ford, AEGIS SOFTWARE

A great milestone in digital assembly manufacturing has been reached by having the IPC Connected Factory Exchange (CFX) industrial internet of things (IIoT) standard in place with an established, compelling commitment of adoption. First, it's important to understand how we got to this point. Second, we will look ahead to the not-too-distant future, where Industry 4.0 solutions within digital smart factories will become a reality that is available and accessible to everyone without any risk of vendor dependency or technology obsolescence.

CFX To Date

CFX started as an idea from senior members within IPC who long recognized the inevitable need for a factory-wide communication standard. Having seen the fate of several attempts at standards from various areas within the industry come and go over many years, this was not something for the faint-hearted—especially considering the fiercely competitive nature of industry vendors. The very first CFX group meeting at 2016 IPC APEX EXPO attracted an impressive attendance from numerous competing vendors across all disciplines. Prior to CFX, such a situation would surely have become somewhat rowdy. However, the meeting was the first sign of the magic that CFX would bring. Competitors sat together in agreement with the common intent to change the industry for the better.

Over time, critical elements of the CFX standard were put into place. The initial goals—to include all active manufacturing and supporting processes, as well as be completely plug and play—seemed quite ambitious at the time.

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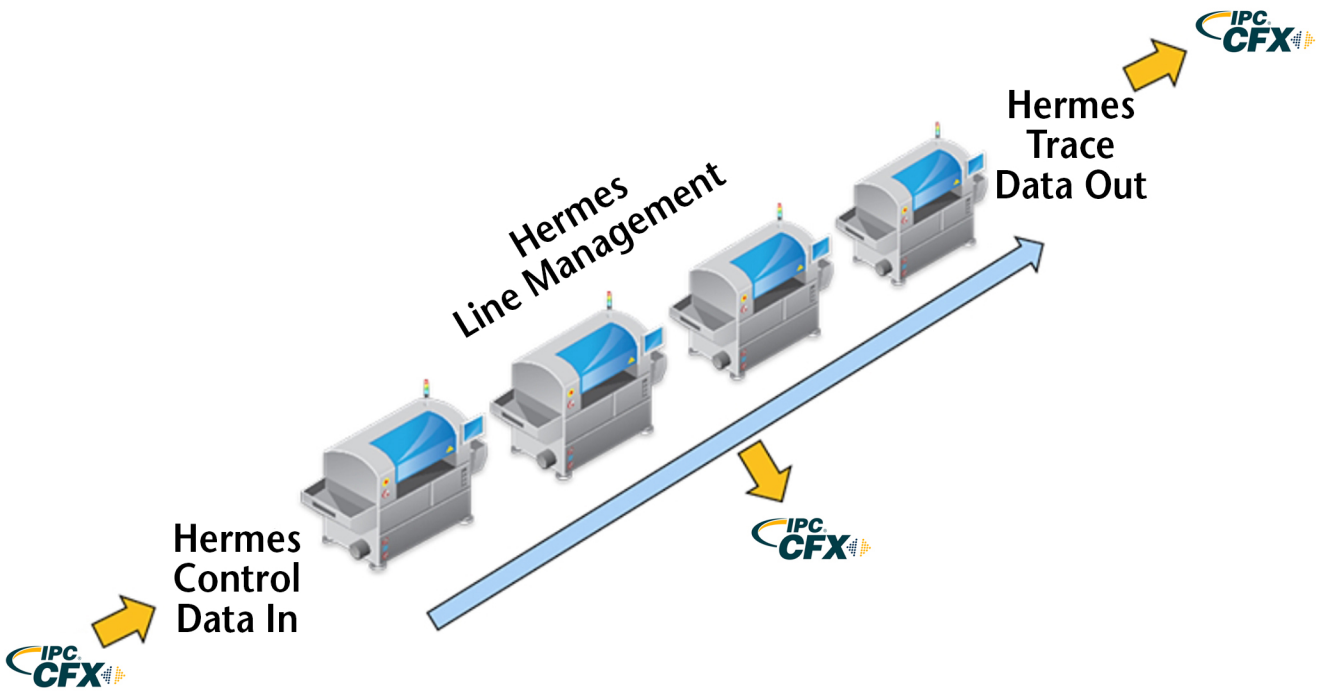


It was critical to create a standard that would fulfill the needs of smart, modern manufacturing in the digital factory with true Industry 4.0 functionality. This was the common expectation from everyone's customer base, whether or not they could articulate what they wanted.

The analogy of an IIoT standard being like the cellphone brought the message home for many people. Having a standard that governs how telephone handsets from different vendors work on standard networks allows us to communicate freely, which equates in CFX as the protocol and data-encoding methods that were selected. The third critical piece—which no other standard has been able to completely define—is the language used. It does not work to a cellphone conversation where the two parties speak different languages and cannot understand a word the other is saying. For true plug and play, all parties have to communicate with a common language.

In the case of CFX, the decision on the protocol was contentious, as there were a small number of realistic options and the support for each was strong. However, the requirements for CFX were quite clear. The protocol had to be secure and have encrypted data options when sending data externally—for example, to the cloud. A data compression facility also needed to be available to reduce data-rate requirements. Real-time operations, such as machines, did not have to care whether anyone or everyone was receiving their messages. Thus, a "send-it-and-forget-it" facility for broadcast messages, featuring a message broker, was a must.

In addition, a direct point-to-point connection for immediate command and response messaging was also required. As a consensus, the AMQP v1.0 protocol—having proven itself in the banking industry—was seen as the only logical choice that addressed all of these requirements. The availability of open-source, free-of-charge AMQP v1.0 brokers also fell completely in line with the open principles of the standard. Data encoding was a far simpler decision with JSON being accepted pretty unanimously, so messages could be read by humans and yet also be efficient in a modern format already familiar to web developers.

Having these elements decided, the work then fell on the data content definition. There had not been a precedent for the definition of data content on the assembly factory shop floor. Very few people have ever gained a complete understanding of all the various content areas across manufacturing that need to be defined. A wide cross-section of experts in the industry was needed to describe events and param-

eters of processes across all technologies in a detailed, yet neutral, way. A breakthrough idea within the CFX team was to create groups of messages of related data content that were logical base topics that defined a granular discrete system or machine capability rather than creating specific messages for each machine type. The topics were created to be used as building blocks, so that any machine or transactional process on the shop floor—past, present or future—could be precisely modelled by putting together the relevant topics.

Kicking off the content definition for each of the defined topics, as well as the more detailed subtopics, was a challenge at first. Being the first to contribute to the message data creation was daunting, especially for those whose focus had been predominantly internal on specific areas of technology. In many areas, non-expert driven examples of parameters were created in order to set the precedent and stimulate feedback. It was easier to comment, correct, modify, and enhance something rather than create it from scratch. While it is expected that the CFX content definition will continue to evolve in terms of scope and detail, the first release is complete in the most important ways and ready for mainstream adoption.

Demonstrations

By the end of 2018, four IPC-sponsored demos of CFX will have taken place: IPC APEX EXPO, in San Diego, California U.S.; SMT Nuremberg (Germany); What's New in Electronics Live, in Birmingham U.K.; and LEAP Expo, in Shenzhen (China). It has been satisfying to see so many people travelling from afar to see CFX for the first time. The look on people's faces is priceless when they read a simple QR code armed only with their smartphone and immediately have live, multi-vendor standard production events and statistics on their screens without any software installation or configuration.

As part of the design mantra, CFX messages deliver facts about production, which provide data to be used to create whatever production metrics and views are required. What is available in the cloud for the CFX demo is a simple sample to drive the imagination. CFX works equally well on a specific line within a factory, in a cloud environment, or all three simultaneously if desired. Flexibility is a key value. The preparation for the demos went very smoothly as participants were invited to use the open-source, .net-based CFX Software Development Kit (SDK) created alongside the detailed message documentation that is a part of the standard. The experience of creating CFX support for the trials has been revolutionary in itself. There is no need for business trips or difficult technical discussions. Simply follow the documentation and have the demo software in the cloud—provided everything that was needed for confirmation of correct operation—with just a few hours work. The demos themselves worked the first time for everyone without any glitches throughout the events. This has contributed to building confidence in and familiarity with CFX for all involved.

Applications

With the creation and release of the initial version of the CFX standard now behind us, there is now some exciting work to continue. A great example of this is a triple closed-loop system I saw in China that featured feedback from solder paste inspection (SPI) to the screen printer for compensation of deviations in the printing process as well as related correction for the placement of SMT parts on PCBs. This was all checked and confirmed by automated optical inspection (AOI), which also provided accurate feedback and any compensation needed in the placement process. Use of the closed-loop software resulted in a tenfold decrease of defects occurring in the line—an incredible result. The software itself looked great and was highly responsive.

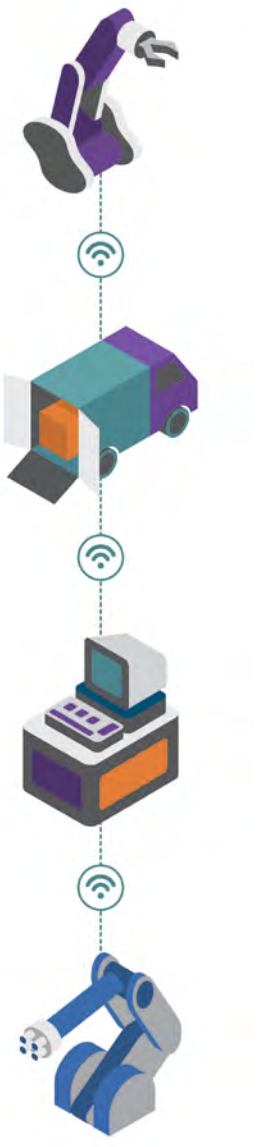
The bad news was that this result was achieved using bespoke machine interfaces. A lot of time and effort had been spent working with different machine vendors to create the interfaces required, which had significant costs to all concerned. The person in charge of the software at the manufacturing company knew that for the rollout of the closed-loop solution to the other lines in their company—most of which had different

machine combinations and configurations—many more custom machine interfaces would have to be developed.

The development team realized that through the adoption of CFX, the closed-loop software would work equally well on any line configuration with the need to develop just one interface, which would then provide the required data connections on a plug-and-play basis. For machine vendors involved in these kinds of initiatives with different advanced requests for MES data by customers—an average of 30 or so supported bespoke interfaces they each have—this could all be replaced with one standard interface. The use of CFX also results in faster deployments with fewer issues, which reduces sales cycle times.

Further benefits include how the omni-directional nature of CFX provides access to data both upstream and downstream on the line, and from the factory as a whole, such as work-order management and material logistics information. One small example of the latter is getting a heads-up about sizes and rotations of actual materials received. This could be helpful in the event that the material manufacturer changes. Any need for program adjustment could be made automatically at material replenishment without having to stop the machine or risk quality issues. CFX enables solutions to work together in any smart factory from different vendors at all levels and across all disciplines of the manufacturing operation.

CFX applications do not stop at machines. They support transactional processes, such as material logistics, and provide information to humans within the digital factory. The key flexibility of CFX created through the use of augmented reality (AR) enables the performance of multiple roles within the factory.



CFX and MES

One key area of change that both CFX and the Industry 4.0 mandate is at the manufacturing execution system (MES) layer. What originally evolved as a visibility and control extension of enterprise resource planning (ERP), generic MES systems across many manufacturing industries have remained focused on the management of manual tasks and require a significant amount of manual data capture. Some MES solutions have evolved to adapt data from assembly machines through the development of several complex bespoke interfaces that store acquired data in some form of a database ready for processing and use.

The value of this legacy data is limited by the completeness and reliability of the original machine interfaces, as well as the ability of the MES application to translate the proprietary data received to create consistent meaning. The application of IIoT represents a different approach for data exchange than the way in which the majority of bespoke database driven solutions have been architected. IIoT data is immediate and triggers actions and responses, as well as passes normalized event information into a database. A more modern, digital MES platform with an emphasis on real-time visibility and awareness of the manufacturing operation is essential. This is a significant change of paradigm for in-house solutions, externally developed and customized point-solutions, and generic MES platforms.

For many legacy systems, it will have to be enough to utilize CFX to get legacy data in a more efficient way. But the real potential of CFX lies in being a key part of a new generation of augmented decision-making algorithms. Extremely few of these exist so far. Start-up companies are fast-tracking new

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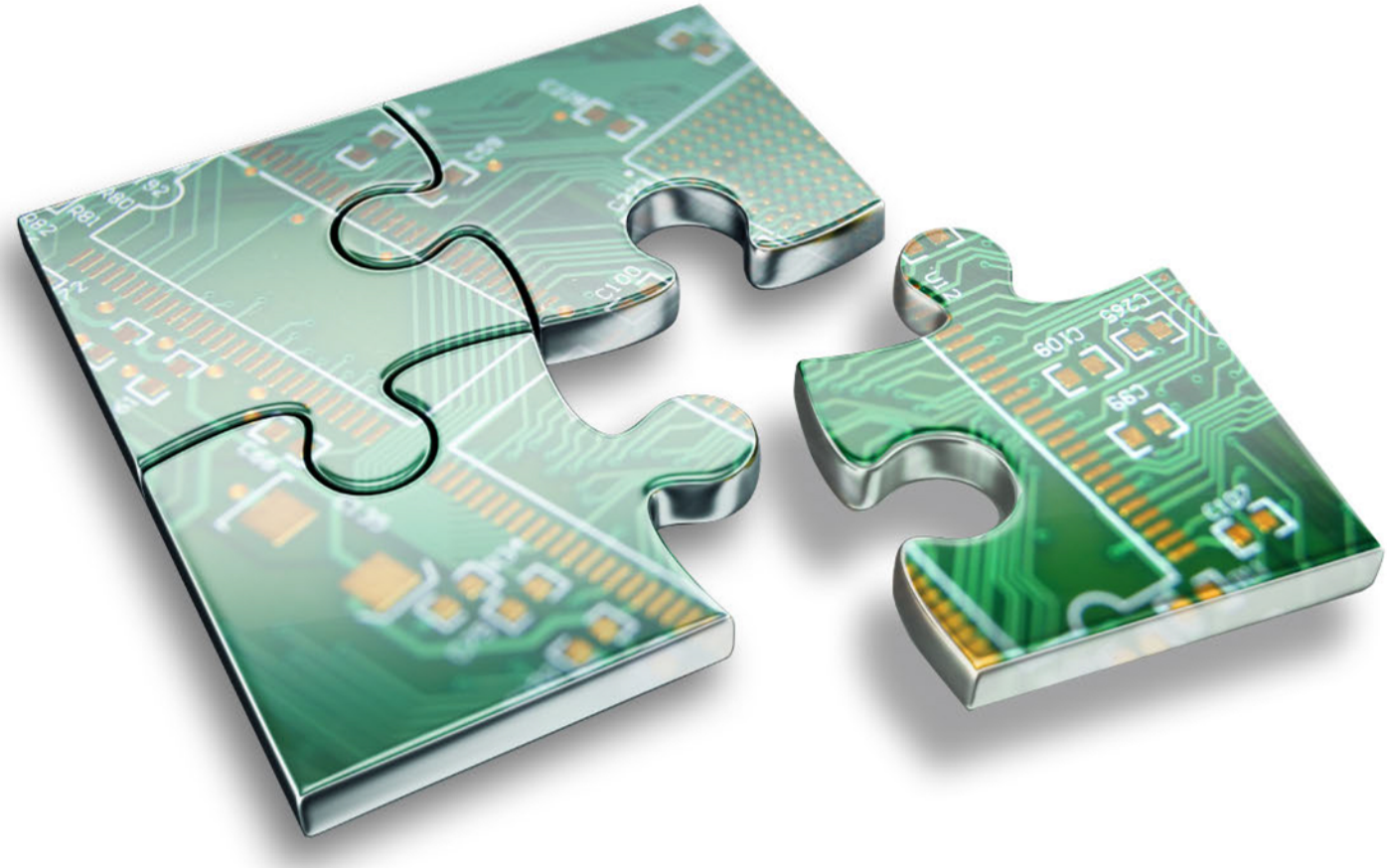

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so-called IIoT solutions into the market without the depth to include definition of production environment. The basic requirement is for there to be a true IIoT-orientated MES platform that provides the mechanisms to digitally model products, define processes and configurations, and shift patterns, work orders, tools, material flows, etc. The base infrastructure component of MES has never been sexy because it does not seem to create value for many, but it is invaluable in driving and enabling Industry 4.0 features.

CFX does a great job by allowing communication and sharing of all of these basic MES requirements through IIoT data exchange, but there needs to be a point of authority. The modern digital MES solution at the factory level is the most effective place from which Industry 4.0 functions are orchestrated. For in-house developers, the development of the infrastructure would easily represent a five-year project, and for external customized solutions, a rather intimidating fixed-cost barrier for entry.

Therefore, it is not expected that individual manufacturers will develop the core MES software to create their own smart factories from scratch, even with CFX. The smart move is to utilize a CFX-driven digital MES platform specifically created for the IIoT-enabled factory. This will provide well in excess of 90% of the immediate smart factory needs. The remaining 10%, which traditionally has been fulfilled by customized development or the need to change the operation, can now be easily provided through extensions to the system based on CFX. Examples include the support for bespoke functional test machines, where the simple integration of the CFX SDK can make the machine a fully functional and operational part of the off-the-shelf MES. Other bespoke requirements, such as integration with specialist processes or practices, can be supported through simple add-on applications, as can irregular requirements coming from specific implementations of ERP. Where the extension of CFX may account for less than 10% of the whole installation, it removes more than 90% of the typical perceived pain of complete MES adoption in terms of cost and lead-time to both operation and value.

The Smart Factory of the Future

The recommended approach for a new smart factory of the future is very simple. The first choices to make include selecting standard equipment that supports CFX and most satisfies the needs of production in terms of capability, flexibility, and monetary value. For existing factories that intend to become smart factories in the future, it is necessary to check and confirm with existing equipment suppli-

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ers about the availability of CFX on existing machines. Even if native support will not be available, there are likely to be several choices of simple and inexpensive ways to retrofit CFX support by third parties. This ensures that there will be only one interface for all visibility, management, and control on the shop floor.

The critical second choice is the selection of an MES solution founded on principles of CFX IIoT utilization that is ready to provide live augmented and automated decision-making at a factory level. Interoperable Industry 4.0 solutions will work based on the digital factory infrastructure provided by the MES platform itself supporting vendor-based solutions on the machine and line level should provide a sophisticated, yet simple, smart factory infrastructure based entirely on CFX. Production, performance, quality, materials and supply chain, maintenance, planning, and cloud analytics can all take place on the same platform and share the same backbone of IIoT information as one flexible real-time operation. This is the essence of having factories capable of responding to the current and future needs of the market and being able to manufacture to order without significant loss of productivity compared to mass production.

Who Wins with CFX?

Everyone wins with CFX, which is why CFX-based IIoT solutions are sustainable. Over time, machine vendors will eliminate the need for the development and support of bespoke interfaces for customers and be able to utilize CFX in every case. Machine vendors will also have access to data from the line and factory and provide added-value Industry 4.0 functions. Solution providers will have access to complete, accurate, and timely data, which is the critical necessity for the creation of smart artificial intelligence (AI) software for manufacturing as mandated by Industry 4.0. IT teams in manufacturing will have clear opportunities to adapt and manage bespoke processes and functions that drive real value to satisfy specific unique manufacturing operational needs based on CFX data exchange.

Therefore, the reach is extended to all corners of the factory that were previously out of reach by legacy MES solutions. The manufacturing operation itself is complete and ready for instant reactions to changing customer needs without the risk of execution issues or optimization and productivity losses and the need to stockpile finished goods in the warehouse to appear flexible. Costs are saved in manufacturing, warehousing, and distribution, including eliminating the risk of depreciation in the value of "produced-but-not-yet-sold" goods. Investment in further automation driven by AR technology, such as the enhanced role of human operators, becomes cost-effective and immediately contributory to the business model. The factory of the future can be realized with technology created and available today. **SMT007**

Michael Ford is the European marketing director for Aegis Software. To read past columns or contact Ford, click here.

Rehm Sees Growing Demand for Vacuum Soldering

Ralf Wagenfuehr, plant manager of Rehm Thermal Systems (Dongguan) Ltd, speaks with I-Connect007's Edy Yu about the developments in the company's convection reflow soldering system, which features a vacuum module, aimed at addressing the increasing demand for vacuum soldering.

He also discusses their software developments, as well as how they are helping their customers toward their Industry 4.0 journey.

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Supplier Highlights

Strengthening the Joint with a Revolutionary New Low-Temp Solder Paste ▶

I-Connect007 Editor Patty Goldman interviews one of Alpha Assembly Solution's solder process experts, Traian Cucu, who has played a key role in the development of Alpha's innovation new low-temperature solder paste process.

KYZEN: Cleaning with Data ▶

In an interview with I-Connect007, Tom Forsythe, executive vice president for KYZEN, provides an update on KYZEN Analyst and describes how it has evolved into an Internet 4.0 solution with the ability to increase performance and life of the chemistry.

Inspection and Design for Testability ▶

Matthias Müller of Goepel electronic talks about test and inspection technologies in the automotive industry, design for testing (DFT), and the benefits technologists can gain from DFT.

A New Standard for Standards — From Data to Information ▶

The main challenge we have today with our manufacturing standards is that they are deterministic, such as the 30% maximum void per ball for X-ray inspection of BGAs—which determines if a BGA assembly passes or fails. This article proposes a new perspective on setting pass and fail thresholds in the manufacturing line.

iNEMI White Paper: Mitigating Creep Corrosion with Effective Test ▶

The International Electronics Manufacturing Initiative (iNEMI) has published a white paper, "A Cost-Effective & Convenient Approach to Creep Corrosion Testing," that details how the iNEMI qualification test development for creep corrosion project created a qualification test to determine whether PCB assemblies are likely to develop creep corrosion.

MIRTEC Enters Tech Collaboration Agreement with YXLON and The Comet Group ▶

MIRTEC has entered into a technical collaboration agreement with YXLON, a company of the Comet Group, to explore and expand upon synergistic applications within the SMT electronics manufacturing industry.

Alpha Assembly Solutions Wins Two Awards at SMTA China South 2018 ▶

Alpha Assembly Solutions received two awards—"The Best Presentation of Technology Conference One" and "SMTA China Oscar Paper 2018"—at 2018 SMTA China South Conference.

BEST Releases Electronics Component ID Poster ▶

BEST Inc. has released a new teaching tool for soldering instructors—the BEST Inc. component identification poster.

Electrolube's UK and India Operations Collaborate to Develop 12 New Resins ▶

Technical experts from Electrolube's UK and India operations have worked closely to create the new resin products, strategically placed to meet the demands of local manufacturers and the requirements of the Indian government's National Policy on Electronics.

Mycronic Forms Learning Center with NuFlare and D2S Using NVIDIA Tech ▶

Mycronic together with NuFlare Technology and D2S with support from NVIDIA, today announced the formation of the Center for Deep Learning in Electronics Manufacturing (CDLe) in San Jose, California.

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Understanding the Benefits of CFX

Feature Interview by Stephen Las Marias
I-CONNECT007

David Fenton is the group customer support manager for Blakell Europlacer. He is responsible for all of the service teams worldwide, including in China, Germany, Italy, France, the U.K., and U.S.

In this interview with *SMT007 Magazine,* Fenton discusses technical challenges and the impact of the IPC Connected Factory Exchange (CFX) initiative on the PCB assembly industry, and what manufacturers can expect from this electronics assembly connectivity standard.

Stephen Las Marias: David, what has been your experience so far while working on and supporting CFX?

David Fenton: There has been talk around Industry 4.0 and smart factories for many years. Until very recently, we felt that it was just a lot of noise. Nobody knew what to expect out of Industry 4.0, and then other companies started to release their own standards under the Industry 4.0 banner. Europlacer stood back, listened, and waited to see what would happen.

Then, we had an opportunity to listen to Michael Ford of Aegis Software in one of the exhibitions. We became interested in what they were doing with the IPC CFX standard. We realized Aegis was taking it very seriously, and that they had the power of IPC behind it. We've been working with Aegis for many years, so we know them very well. Once we saw they were involved, we started following the CFX standard to see how it was going. We regularly contact Michael. When we saw the original draft standards from IPC, we realized it was a standard that should be very easy to implement for our programmers, and could be a truly global standard. Thus, we started working with Michael and made some test code using a program provided by Aegis. For me, that was the key to making this work.

Aegis has done a lot of the groundwork to make it simple for vendors like Europlacer to take part in CFX. We had test codes up and

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running within 48 hours with receipt of the software development (SD) kit from Aegis. We realized this was going to be easy for us to do, so why not try it?

We have seen it gain traction. Vendors are being added to the list all the time, and we realized some of the big players were going down the CFX route. Then, we had the demonstration at IPC APEX EXPO, which went off without a hitch. The cloud server worked well and required minimal effort. We recently participated in the demonstration at SMT Hybrid Packaging Nuremberg, which also went very well.

In all of these cases, we used a cloud server provided by Aegis and IPC. Recently, we've gone out on our own such that we don't necessarily need to involve any third party if the customer wants an entirely internal system without a cloud-based interface. We've taken that product standard further to have an in-house broker system. Again, it was relatively easy to develop. We also recently had an industry open day where Michael talked about Industry 4.0 and CFX. At the same time, we were able to demonstrate the Europlacer system in our facility.

David Fenton

That's where we are today. We've offered to help IPC create messages for pick-and-place equipment. They are always looking for vendors to help construct the format of CFX to add new messages all the time. By getting in first, our messages will become a part of it. By doing this, we felt there would be less work for our programmers. If we'd gone down a path that wasn't included in the standard, we would need to recode that. Volunteering on the committee writing the message standards will help us in the future.

We can also customize the messages to a certain degree for our equipment. For example, we have multiple heads on the machines. The standard as it existed didn't have any facilities to create messages for multiple-headed machines or give information on an individual head's performance. We have sent those unique messages to IPC. Hopefully, they will be accepted to the draft standards.

Las Marias: What do you think is the challenge that CFX is trying to address?

Fenton: That is an interesting question because I am not sure that customers know they have a challenge yet. CFX is still an industry standard that is ahead of the demand. We have many customers worldwide, and it's not something that is on their radar. The more we promote it, the more they realize there is a need. It's slightly backward. As far as our customers in the small-medium-end markets are concerned, they have never pushed us for this type of data gathering until very recently.

However, the challenge is that it would hopefully sell and be able to take in data from anybody's machine—not just Europlacer's—and display it on a standard dashboard without having to write custom front-end data for the dashboards. Over time, the challenge will be to combine data from multiple vendors into one common platform.

Las Marias: What can you say about the state of interest in CFX?

Fenton: To be perfectly honest, it is lower than I thought. We saw hundreds of people over the course of the previous show, and when we spoke with the various demonstrators, engineers, and salespeople, very few attendees had asked about CFX or Industry 4.0. At the moment, I still think it's a bit of a tick box that the industry needs to promote the benefits.

As the months go by, people will start to real-

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ize what CFX can do. Our customers are still confused as to what Industry 4.0 can do. CFX is not something that is as important to them as machine uptime, speed, and productivity.

Las Marias: In a nutshell, how is CFX impacting the PCB assembly industry and what are its benefits?

Fenton: Once the data gathering is established, the customer will be able to look at their overall efficiency, overall equipment effectiveness (OEE), underboards, bridges, and first-time yield, among others—which is something that they struggle with at the moment because the data is not in a standard format.

If they look at the OEE data from their automated optical inspection (AOI) machine, printer, or oven, they have to gather separate types of information and may have several different dashboards or ways to read the data. Overall, the effect of CFX will be to make productive decisions easier because users will be able to look at factory-wide statistics as opposed to individual machines. As a result, users will be able to turn the data from individual machines into a picture of what their overall factory efficiency is. I see this as the primary benefit. If you make something easy for a customer, they will start to use it, and then they'll see the benefit of making changes in material handling or operator training. This is the type of thing where they will be able to make small changes to their methods and see the data immediately from any machine in the factory.

Las Maria: What about traceability?

Fenton: Traceability suffers the same problem. Europlacer has been doing traceability outputs for many years, but it's in a proprietary format to us. It's available as a text file or a database that is read by our system. I am sure the other vendors also have propriety ways of outputting traceability.

Again, this means the factory is effectively divided into different sections for traceability. Although a user might read the same barcode on the PCB—such as a PCB barcode in the printer—they can extract that traceability data from the printer. The board then travels through to the pick-and-place machine, using the same barcode. They can then extract the traceability for that data in another format, and go into the oven, and the AOI machine, etc.

What they have now is a factory broken into small modules of traceability where they have to piece the history together. For example, if a company has a recall, they can see the serial number of the board but will have to manually search through different data formats to find out what happened to that board since the time it was bought.

The beauty of CFX is that you will have all the traceability data in the same format, which means it can go into the same system that connects to the central database. CFX would make searching for the history of that faulty product much easier.

Las Marias: What would you like to see in the CFX standard and why?

Fenton: We recently created a small list of questions—less than five areas—so there isn't much else that we want to see addressed. One thing we did notice was the lack of clarity on multi-headed machines. The CFX standard, as it is currently, takes an overall machine's performance. In other words, it says the machine has stopped, is in production, or is idle. One thing we thought that was glaringly missing was if Head 1 is stopped, Head 2 is missing, and Head 3 is in idle mode—all important information if you are starting to look at real-time maintenance monitoring or error messages, for instance. There's more benefit in knowing which head is doing what than just thinking of the machine as a large box, so that was a significant suggestion.

For certain accessories, such as electrical test and glue dispensers inside the pick-and-place machine, the standard pick-and-place messages were not adequate to monitor the performance of those sub-pieces inside the equipment. If it was a gluing machine, then there were CFX messages available, but we asked IPC to improve the standard as far as

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the pick-and-place machine. They've been very helpful in working with us to hopefully include the few changes we requested.

Las Marias: How is Europlacer helping customers in their Industry 4.0 journey?

Fenton: The main help we give them is taking the standard, guiding them down that route, and preventing them from going off on a tangent. Some of our customers have dipped a toe in the water and started to create their own wish list. They've come to us and said, "Can you output this data and that data so that we can read it over our network?" What we said is, "If you hold on for a few months, we'll give you a better solution." It's not much help at this stage, aside from providing guidance

and letting them know what's coming. As I've said, many of our customers don't know CFX is coming because the standard isn't concrete yet—we are still developing the code. I would hesitate to say we are helping our customers go down the digital route path at the moment, although we are offering guidance and knowledge as to what's coming around the corner.

Las Marias: Most manufacturers have been very upbeat of their performance, which is a continuation of the strong sales they achieved last year. What trends do you think are driving this optimism in the industry?

Fenton: That's a good point because that is what our data shows—we expect growth to continue. There's also going to be a lot of growth in the Far East. There always is. In our core markets—European, U.S., and U.K.—we see growth in our customers being fueled by bringing work back in-house. The reason many customers are bringing it back in is the cost of transportation is high. The amount of time to freight and ship parts to China or the Far East and get them back again is extensive, and the industry is moving so fast that sometimes changes are made to the product while it is on the ship. This is a big problem for them, along with losing control of the quality.

Another problem we are starting to see now due to massive growth—and it may be self-limiting in the end—is there seems to be a global shortage of products from components to the hardware to make the machines. Lead screws and linear rails are in massively short supply, and some components have been pushed back to around 60 weeks for lead time, which is worrisome for machine manufacturers.

Las Marias: The components shortage is one of the supply chain issues that I have seen a lot in the industry lately.

Fenton: It is very real.

Las Marias: And a 60-week lead time?

Fenton: We have even been quoted an 80-week lead time on a basic part, such as linear rails, and it often gets pushed back again halfway through. The whole machine-building industry is in turmoil at the moment because of this. Our customers are also reporting long lead times on the individual surface-mount components. Together, these two issues may limit this massive growth until the structure is put in place by the chip manufacturers and equipment manufacturers.

Las Marias: Is there anything else we haven't talked about that you think should mention, David?

Fenton: The only thing that may be confusing is the Hermes standard lurking in the background. Some people think is an opposition

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standard to CFX. I spoke to David Bergman of IPC at the SMT Hybrid Packaging Nuremberg about this, and they agree that there is still a level of confusion between CFX and Hermes. However, it is my understanding that they talk on a regular basis and it will be a partnership. The intended outcome—I am not sure if this has been set in stone yet—is that the Hermes protocol will be used for machine-to-machine communications, while the CFX protocol will be used to extract data from all the machines in parallel. I've asked IPC to create a clear and concise statement on the future partnership on Hermes and CFX, and I am waiting to see that statement.

At productronica, there were many leaflets being given out about the Hermes standard, and it came across as an Industry 4.0 standard—a competitor—but it isn't. This one argument may be holding CFX back. There is still confusion between Hermes and CFX, but they are going to work together, which still needs clarification from IPC.

Las Marias: That's right. Thank you very much again, David.

Fenton: Perfect. Thank you! **SMT007**

The Hermes Standard Becomes IPC-HERMES-9852

IPC has recognized The Hermes Standard to be the next generation solution to "the SMEMA Standard" IPC-SMEMA-9851. Accordingly, The Hermes Standard was assigned an IPC naming code: it can now officially be referred to as IPC-HERMES-9852.

Modern, open, and based on TCP/IP and XML, IPC-HERMES-9852 is designed to replace the obsolete SMEMA standard for the transfer of board-related information. It was developed and introduced to the market by The Hermes Standard Initiative, an independent and open group of leading vendors of SMT assembly equipment. The IPC-HERMES-9852 includes all features of SMEMA regarding board handover but addresses a far wider range of additional requirements related to board handling. In fact, IPC-HERMES-9852 combines leading edge technologies and established standards into a completely new generation solution.

Since The Hermes Standard was released, both IPC and The Hermes Standard Initiative share the same understanding that The Hermes Standard moves in the right direction to bring digitization to the PCB flow management. It was clear to all that the previously existing standard IPC-SMEMA-9851 cannot be simply "enhanced" to meet the requirements of an Industry 4.0-environment. Having looked into the details of The Hermes Standard specification, everybody agreed that this new standard provides what it takes to be a suitable next generation solution for SMEMA, offering a migration path into the world of "smart factories".

There was a very close cooperation between IPC and The Hermes Standard Initiative from the very beginning. This was set forth when it was found that the new IPC standard for vertical integration, the IPC Connected Factory Exchange (CFX), and The Hermes Standard are a perfect match when it comes to fully integrated communication in a mixed vendor SMT factory.

Having an official IPC naming code does not change anything in the nature of The Hermes Standard itself. Both IPC and The Hermes Standard Initiative are convinced that further deployment of the standard will be strongly accelerated by maintaining the concept of a free and open standard.

(Source: IPC)

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Risto Puhakken, President, VLSI

MEPTEC continues to cover leading-edge topics in semiconductor packaging with its Fall 2018 Symposium ***"Heterogeneous Integration: The Path Forward."*** Industry leaders will present the latest updates on technical and business issues related to integration of different types of semiconductor devices. This field has been identified as the next critical area for the semiconductor industry to continue to advance, as progress via Moore's Law scaling becomes increasingly cost-prohibitive or prevented by insurmountable technical challenges. With progress in many areas, cost and performance benefits are finally being realized, and previously impossible combinations of devices are now possible.

Don't miss this unique opportunity to get up to speed at MEPTEC's symposium "Heterogeneous Integration: The Path Forward" on December 5, 2018 in Milpitas, CA.

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Electronics Industry News and Market Highlights

Low-Price Segment Contributes about 50% Revenue to Global Smart Speakers Market ▶

The global smart speaker market was pegged at $4.3 billion in 2017, and is expected to accrue a sum of $23.3 billion in 2025, growing at a CAGR of 23.4% from 2018 to 2025.

Seven Technologies to Reach Mainstream Adoption Within the Next Two to Five Years ▶

Speech recognition will reach the plateau of productivity within the next two years and six other technologies will reach mainstream business adoption in the next two to five years, according to the 2018 Gartner Inc. Hype Cycle for the digital workplace.

India PC Market Registers Yearly Growth Driven by Strong Notebook Demand in 2Q18 ▶

India's traditional PC market shipments posted a 28.1% growth year-on-year, with shipments totaling 2.25 million units in the second quarter of 2018, according to IDC India's Quarterly Personal Computing Devices Tracker.

Printed Electronics Market to Reach $65B by the End of 2024 ▶

The global printed electronics market registered a revenue of $25.4 billion in 2015 and is expected to expand with a CAGR of 11% from 2016 to 2024, according to a report by Transparency Market Research.

Global Production Volume of Smartphone to Grow by 6% QoQ in 3Q18 ▶

The global smartphone market has been growing in the second quarter of 2018, driven by the launch of new models by Chinese smartphone brands and the brands' strong sales in overseas markets, according to TrendForce.

Growing Data Demand to Drive Digital Factory Market to $111 Billion in 2026 ▶

The digital factory market will grow at a compound annual growth rate of 35% to reach $111 billion in 2026.

India Server Market Posts On-Year Revenue Growth of 15.9% to $353.1 million in 2Q18 ▶

The overall server market in India witnessed a year-over-year increase of 15.9% in terms of revenue to reach $353.1 million in the second quarter of 2018.

Shipments of Digital Media Adapters Quietly Grow, Opening the Door to the Smart Home Ecosystem ▶

The worldwide market for smart home devices grew by 38.5% to 130.1 million shipments in the second quarter of 2018.

Russia Rides Smartphone Wave, But Importers Wary of New Sanctions ▶

The average sales price slipped marginally over the first quarter of the year but was still a third higher than a year ago, at $241. Total market volume including feature phones was 9.37 million units, and market value at retail prices without VAT was around $1.7 billion.

Personal Computing Device Market to Shrink by 4% in 2018 ▶

The personal computing device market is expected to continue to decline and shrink to 383.6 million units shipped in 2022, with a five-year compound annual growth rate of -1.5%.


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Are You Connected to Reliability?

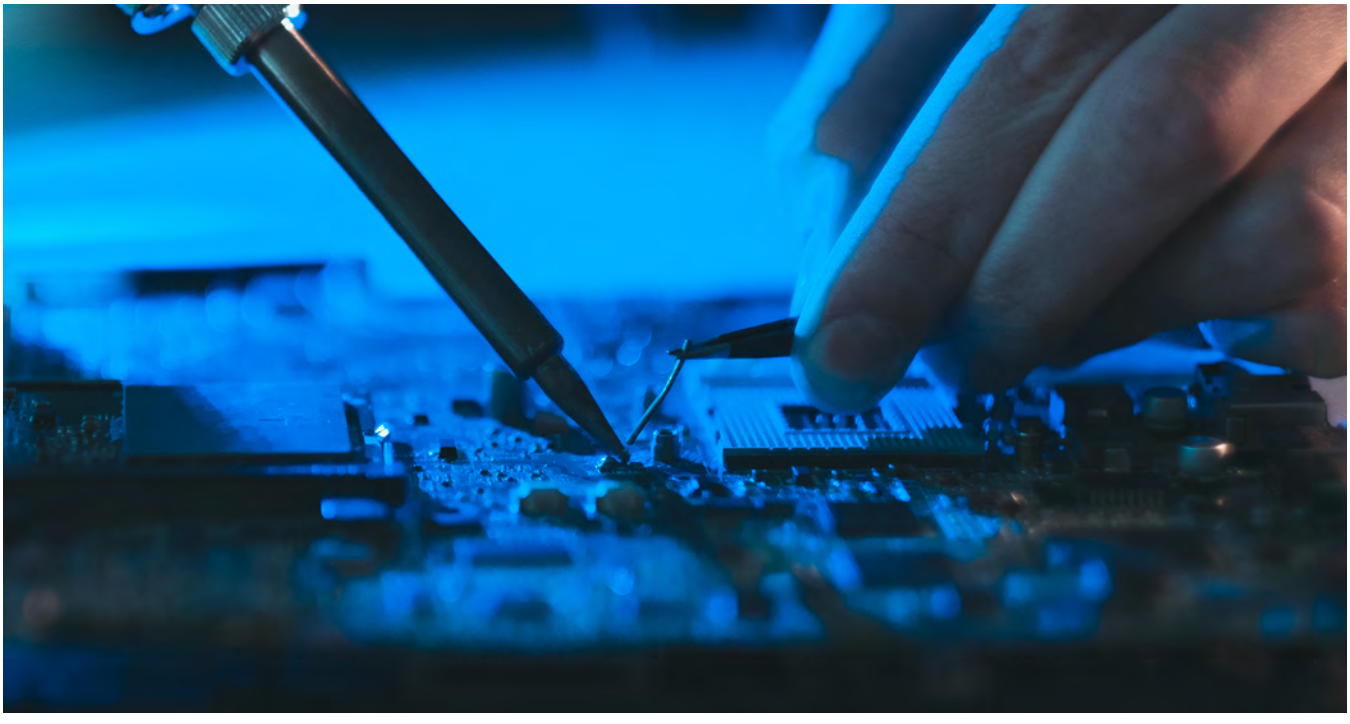
Quest for Reliability

Feature Column by Eric Camden, FORESITE

The topic this month is the Connected Factory Exchange (CFX)—the IPC initiative for manufacturers to become smart factories. From my understanding, the underlying thought for CFX is communication from business to machine and machine back to business. CFX will help streamline parts of the assembly process related to supply and projected throughput. But how will CFX help with reliability?

As someone who works more often on the back end of the assembly process diagnosing failures or qualifying the assembly process to specific requirements, I have no idea. I can tell you that in both of those avenues, communication is key. The need for communication between every operator on the floor can be a critical difference between a reliable piece of hardware and one that presents some level of unexpected performance. Every time an operator does something out of the ordinary in the assembly process, doesn't make a note of it in a way that can be traced back to the PCBA by its serial number, and that piece of hardware comes back for a performance issue, it is very easy to be lumped into the dreaded "no trouble found" (NTF). Since I don't have a strong tie to speak directly to reliability and CFX, I will instead cover a few things not commonly communicated, which can cause performance issues.

Touch-up soldering is something I have seen many times during regular process audits. The assembly comes off the reflow or wave solder equipment, and the inspector sees something that doesn't meet the requirement. Easy fix, right? Just grab some wire and fix the solder



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12 - 24 Layers Expedited Lead Time	48 Hours	72 Hours	48 Hours	-
Filled Via in Pad Technology				
Standard Lead Time	15 Days	15 Days	15 Days	20 Days
Expedited Lead Time	2 - 3 Days	4 - 5 Days	2 - 3 Days	5 - 7 Days
HDI Technology				
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Figure 1: Liquid flux used for rework.

joint. However, the problem with this particular solder joint is the fact it ties to a large thermal mass, so a little wire won't do the job. The operator can fix this by grabbing a bottle of flux from the bottom drawer to help that solder to do its job.

The problem is this becomes a different rework process than what is in the work instruction. While the solder joint is now acceptable, the amount of flux residue could be drastically different than what is typically present after using only a cored wire solder. When a bottle of flux is used to help speed up the normal rework process, you will see an increase in the amount of active flux residues. Figure 1 shows how liquid flux migrates into the neighboring component, and if there is no contact with the soldering iron, it will remain conductive and corrosive. Further, Table 1 shows the high levels of ions on the surface of the PCBA, which significantly increases the risk for electrical leakage and/or electrochemical migration.

The secondary risk is increased contact time with the solder iron to the PCB. This can cause internal delamination within the fiberglass and if your board is multilayer—which it probably is—delamination can cause connectivity issues between the internal interconnects, such as vias and ground pads. If the deviation from the standard touch-up process isn't communicated in some form, the failure mode will most likely remain a mystery upon the return of the hardware to the failure analysis (FA) lab.

The next issue you might see on a semiregular basis is called the "third shift issue" that occurs when you see a group of boards with performance issues processed within a single shift. In general, the third shift has less oversight from production managers than the first or second shift, so the chances of deviations from the normal process occurring and not being documented are higher. I am not saying the operators on the third shift are any less qualified to build production assemblies, but the lack of oversight sometimes leads to a lack of reporting issues and "creative" resolutions. Don't get me wrong—creativity is important—but can be devastating to the reliability of your hardware. The documentation of any deviation from the normal assembly process is paramount to track any returns and root causes of failure.

One other issue more often seen on the third shift versus other shifts is ramping up the belt speed to meet an expected production number. This is sometimes done when the expected numbers of boards to be produced isn't lowered when the number of operators is reduced. I wrote about this in a previous column (so I won't go into the full details now), but when you increase the belt speed of any piece of assembly equipment, the quality will suffer

Sample Description	F^-	Acetate	Formate	Cl^-	NO_2^-	Br^-	NO_3^-	PO_4^{2-}	SO_4^{2-}	WOA
PTH Rework	0	6241.59	0	819.36	0	83.63	2.80	10.07	3.23	647.58
SMT	0	1537.43	6.86	70.92	0	22.34	4.67	17.25	30.89	435.34

Table 1: Ion chromatography data showing active flux residues.

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from active flux residues, insufficient hole fills, and ineffective cleaning, among other issues. I want to reiterate that I am not saying all failures are related to those working the third shift, but these problems seem to be communicated to quality managers or documented for future reference less often.

When a failure comes back to an internal or external lab for inspection, it is much easier to diagnose the root cause if the full process is communicated and documented. With a fully documented procedure from the kitting process to final packaging, you can communicate in a language of reliability. SMT007

Eric Camden is a lead investigator at Foresite Inc. To read past columns or contact Camden, click here.

Study Demonstrates New Mechanism for Developing Electronic Devices

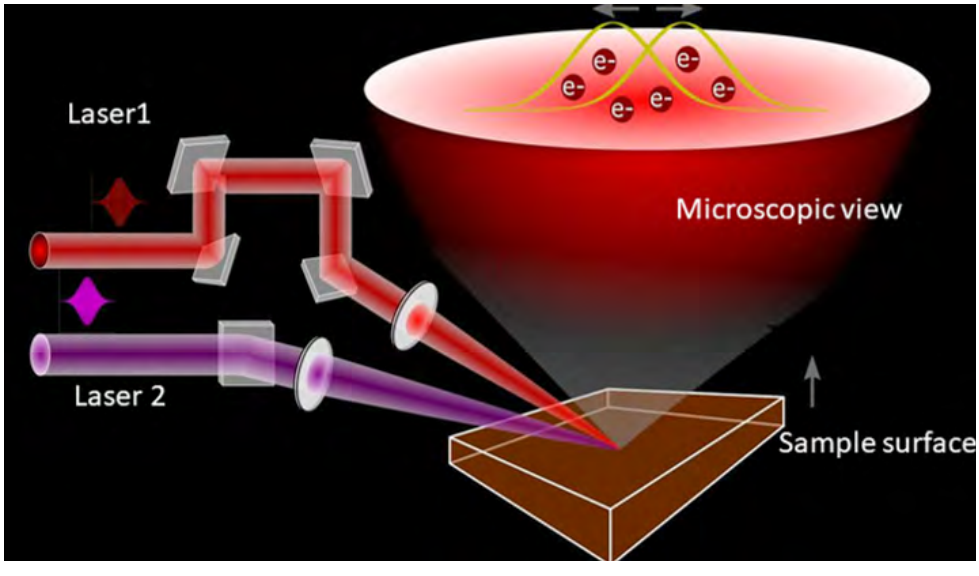
Scientists from the Femtosecond Spectroscopy Unit led by Prof. Keshav Dani at the Okinawa Institute of Science and Technology Graduate University (OIST) have demonstrated a new mechanism that can potentially allow the control of electrons on the nanometer spatial scale and femtosecond temporal scales using light. The study has been published in the journal Science Advances.

Dr. E. Laine Wong, a recent PhD graduate at OIST, and her colleagues have used a physical phenomenon called surface photovoltage effect to induce electric fields on the material surface, allowing them to direct electrons to flow in opposite directions.

"By making use of the nonuniform intensity profile of a laser beam, we manipulate the local surface potentials to create a spatially varying electric field within the photo-excitation spot. This allows us to control electron flow within the optical spot," says Dr. Wong.

Using a combination of femtosecond spectroscopy with electron microscopy techniques, Dr. Wong and her colleagues made a movie of the flow of electrons on femtosecond timescales using a technique known as pump-probe spectroscopy, allowing them to study the dynamics of the excited electrons at a very short time scale. The combination of an electron microscope then further provides the scientists with the spatial resolution required to directly image the movement of the excited electrons even within the small area of the laser beam spot.

The findings of the study are promising to control the movement of electrons beyond the resolution limit of light by utilizing the spatial intensity variations of the laser beam within the focal spot. The mechanism could therefore be potentially used to operate nanoscale electronic circuits. Prof. Dani and his team are now working towards building a functional nanoscale ultrafast device based on this newfound mechanism.



(Source: Okinawa Institute of Science and Technology Graduate University)

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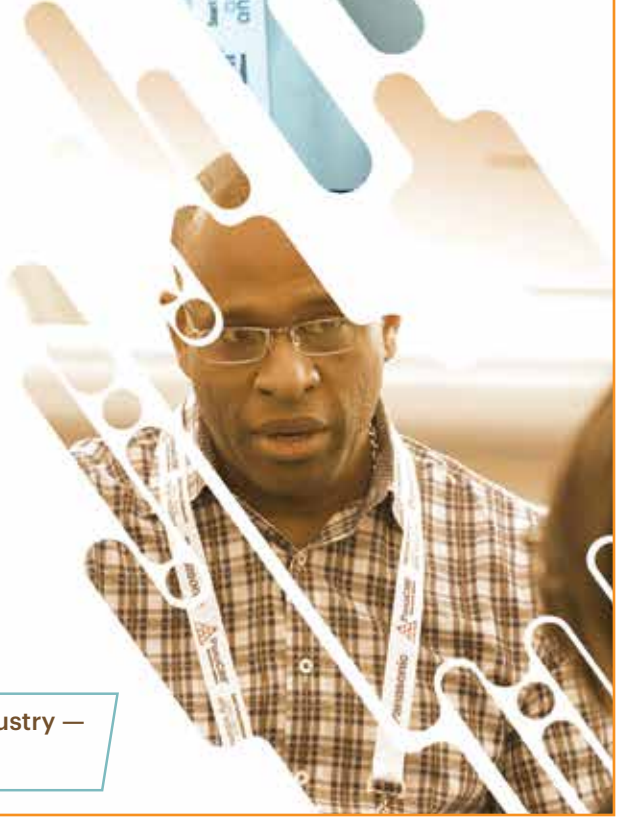

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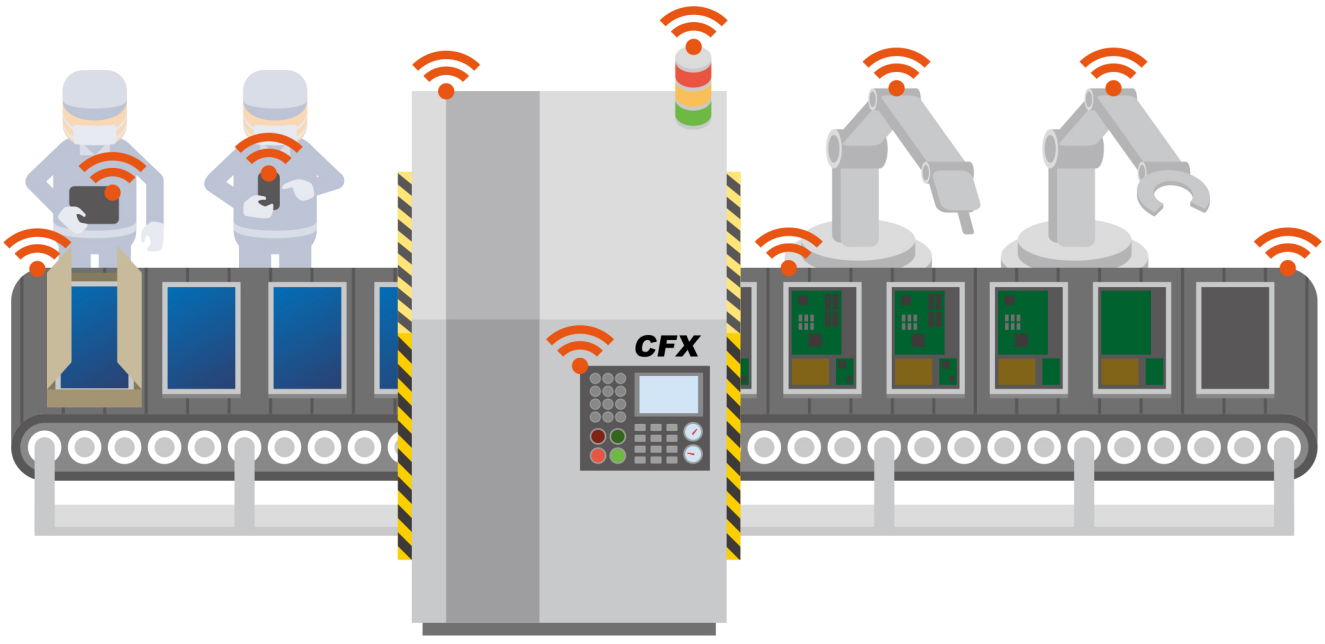

Challenges and Opportunities with CFX

By Stephen Las Marias
I-CONNECT007

Test Research (TRI) is a Taiwan-based manufacturer of PCB assembly inspection and test equipment such as AOI, SPI, AXI, and in-circuit testers. Larry Chen, global marketing supervisor, speaks with *SMT007 Magazine* about how the company is supporting IPC's Connected Factory Exchange (CFX) initiative, the user interest on the standard, the challenges, and his outlook for CFX.

Stephen Las Marias: How is the company supporting CFX?

Larry Chen: We are seeing the strength of the Industry 4.0 trend, so we have developed a real-time inspection management system for managing production activities such as in-test results. We also have hardware systems that support closed-loop connections. TRI has also contributed with research on some actual projects on CFX through integration of software and hardware.

Las Marias: What do you think is the challenge that CFX is trying to address?

Chen: Actually, we believe that the CFX is a powerful standard. For example, our SPI machine is connected to a printer, but different customers have different brands of printers, the same with an AOI equipment connected at the end of a reflow oven. Different brands of machines may have different issues. So, if we have to feedback the results with other brands of inspection machines, this is the kind of challenge that a customer is facing, apart from the different interfaces of the machines.

Having more machines with different brands will be a big challenge, but based on TRI's experience, we have a real application and we are working with our customers on improving their overall interface. That's our role.

Las Marias: From your perspective, what is the level of interest from the industry when it comes to CFX?

Chen: Based on the feedback we received during the recent shows such as productronica, IPC APEX EXPO, and SMT Hybrid Packaging, there is a certain hype; we got many inquiries from customers targeting these kinds of applications. We believe CFX has provided a standardized method for vendors to work

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together. And so, even if there are different brands, a generalized approach will be very helpful for users. If they adopt CFX or Hermes, they can easily see their different machine and inspection and production results, thus helping to improve their productivity and performance of their product line. These are what the users are looking for. In recent exhibitions, TRI has demonstrated support by taking part in the CFX demo.

Las Marias: Larry, what are the current challenges when it comes to adopting CFX?

Chen: Customers have different interfaces between machines from different vendors; we believe the connectivity of these machines could be a challenge. The CFX standard has been developing for only a few years—while we expect it to grow, it will be challenging at first to integrate with all of the machines. However, TRI is making it more user-friendly to help users improve their connectivity.

Larry Chen

Las Marias: How is TRI helping its customers in their Industry 4.0 journey?

Chen: TRI has developed a system that helps trace productivity and also inspection results to help customers improve their machine connectivity and production quality. Actually, TRI is the only vendor that provides the complete inspection solutions for the EMS production line, including SPI, AOI, X-ray, in-circuit testers, manufacturing defects analyzers and functional testers.

For the benefit of the customers, TRI's inspection systems provide inspection results from the beginning to the end of the production line. Our software can also help track the history of the products and provide reports for the user.

To achieve Industry 4.0 connectivity, the focus is on factory automation, so it's very helpful for managers to utilize TRI solutions to track their production and also to improve their production processes. This will help them streamline their workforce and make their production smarter.

Apart from CFX, we are also working with companies such as Fuji, Panasonic, DEK, and ASM, to develop standards focused on Industry 4.0. We believe that these kinds of activities are toward a mutual benefit in trying to help customers succeed in Industry 4.0.

Las Marias: What would you like to see in the CFX standard and why?

Chen: Actually, we believe that it will take some time to persuade our customers to adopt this approach; also, we believe that having a more user-friendly interface, sufficient supporting resources and documents are necessary, because we have to work with our company internally, and also our customers, to implement the standards.

We believe that the CFX standard is very promising; it was initiated by IPC, so it expected to become one of the most adopted standards worldwide. We are very interested to be more involved in the standard development. We hope to work more with the IPC CFX committee and to grow together with our partners.

Las Marias: Is the integration of the CFX standard into your machines difficult?

Chen: Actually, we have just started integration, and the standard is just at its initial stage, so we are still working on it, and we hope as it gets more mature, and we get more knowledge on this area, we are looking forward to more customers joining with us. Right now, we are on the verification stage on the integration of CFX in our machines.

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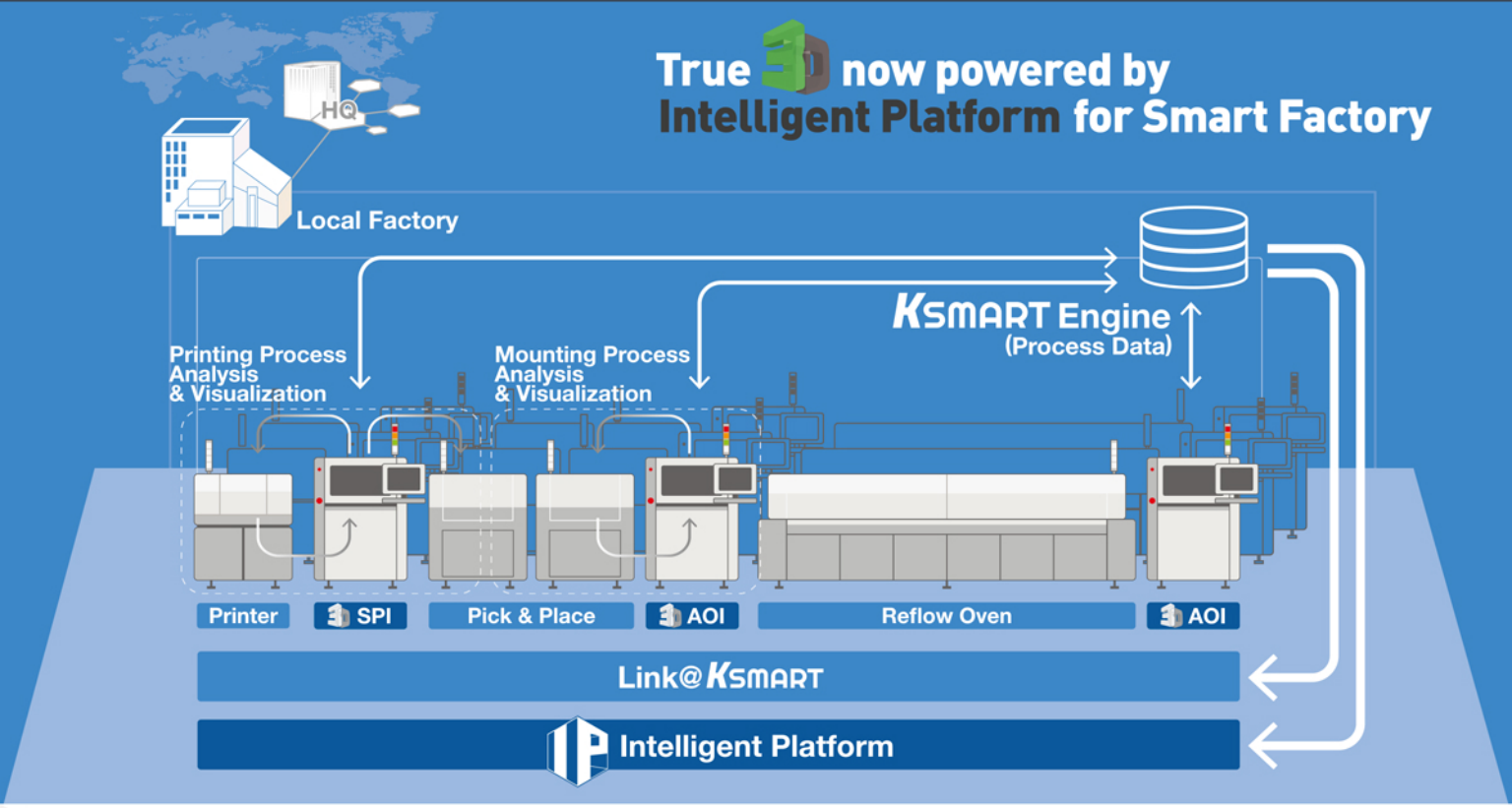

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Las Marias: Larry, can you name a megatrend or two that is or are having a huge impact right now in the PCB assembly industry?

Chen: We believe the Internet of Things (IoT) will be a very important trend that's making things connected to the internet. Another trend is 5G—the fifth generation of communications standards, as well as artificial intelligence (AI).

The inspection machines and production machines should be linked and integrated, as it is important for them to be able to communicate. We think that IoT, 5G, and AI are the megatrends that will make the Industry 4.0 realistic and more mature, and also to have a fully automated PCB assembly industry. We believe these trends will have a huge impact.

Another issue is the miniaturization of electronics and components, driven by the development of more compact devices such as wearable devices, tabs, and even phones. We believe this will have a big impact in the PCB assembly industry, and as such inspection will be a critical factor in ensuring the quality of the products.

Las Marias: What do you think of the state of the CFX in the next year? Do you see it being widely adopted?

Chen: I think more and more users are becoming interested in CFX. For example, if customers are thinking of making their factories smarter, CFX will be the solution. We believe it will be widely adopted in the following years, and therefore we will keep working with the CFX committee—and we are getting better. We believe that TRI will be a very strong player in the CFX field, as well as in supporting factory automation.

Las Marias: Thank you very much, Larry.

Chen: Thank you. SMT007

KAIST Develops VRFB with Longer Durability

A research team from the Korea Advanced Institute of Science and Technology (KAIST) developed a new vanadium redox-flow battery (VRFB) with 15 times greater capacity retention and five times longer durability–an excellent candidate for a large-scale rechargeable battery with no risk of explosion.

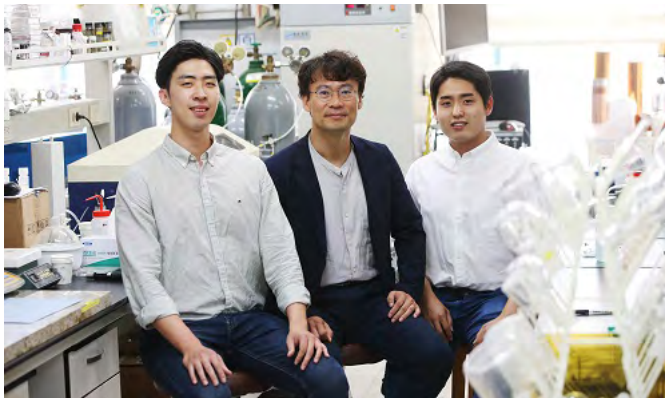
One of the key factors in the development of VRFBs is the membrane that will minimize energy loss. Many attempts were made but such materials caused chemical degradation, leading to shortening of the battery life.

To develop a membrane with pore sizes smaller than the hydrated size of vanadium ions yet larger than that of the protons, the research team led by Professor Hee-Tae Jung and Professor Hee-Tak Kim from the Department of Chemical and Biomolecular Engineering implemented a graphene-oxide framework (GOF) membrane by cross-linking graphene oxide nanosheets. They believed that GOF, having strong ion selectivity, would be a good candidate for the membrane component for the VRFB. The interlayer spacing between the GO sheets limited moisture expansion and provided selective ion permeation.

The GOF membrane increased the capacity retention of the VRFB, which showed a 15 times higher rate than that of perfluorinated membranes. Its cycling stability was also enhanced up to five times, compared to conventional hydrocarbon membranes.

Professor Kim said, "Through this research, we showed that nanotechnology can prevent this crossover issue and membrane degradation. I believe that this technology can be applied to various rechargeable batteries requiring large-scale storage."

(Source: Korea Advanced Institute of Science and Technology)



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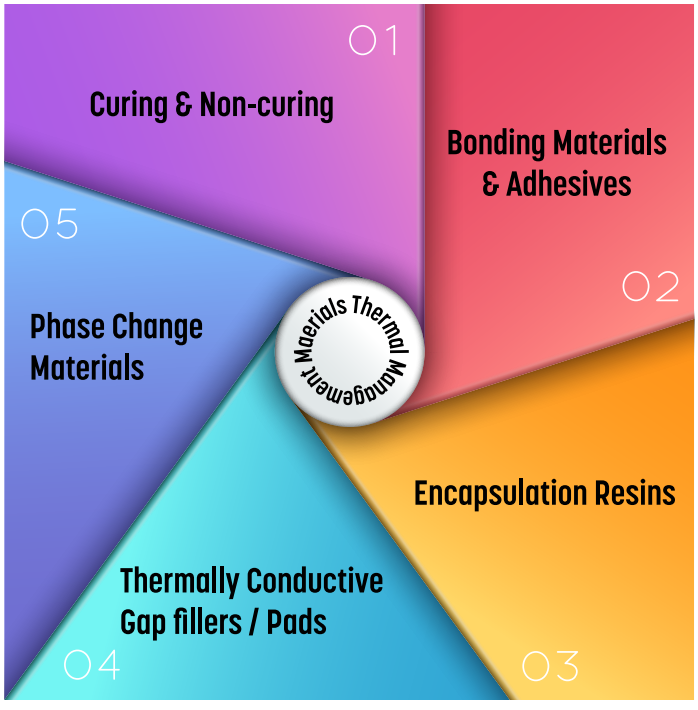
Do's and Don'ts of Thermal Management Materials

Sensible Design
by Jade Bridges, ELECTROLUBE

Selecting a thermal management material that is broadly applicable to a particular electronic assembly and its predicted operating conditions is a good starting point; however, as with many of these things, the devil is very much in the details! There are a host of available materials and methods to choose from—all of which serve a variety of purposes depending on the physical constraints of the application, such as environmental considerations, severity of duty, component layout, geometry of the assembly, etc.

Generally, the first questions you should ask yourself are, "What type of thermal management product should I apply and what should I look out for when applying it?" There are five main groups of thermal management materials that can be broken down further according to variations in their material chemistries and formulations. These include: curing and non-curing pastes, bonding materials/adhesives, encapsulation resins, thermally conductive gap fillers/pads, and phase change materials.



Non-curing pastes, for example, are ideal for applications where rework may be required. They use different base oils to provide a range of desirable properties, such as the wide operating temperature range offered by silicone-based products. Recent advances in non-silicone technologies have seen the introduction of products offering higher thermal conductivity with significantly reduced oil bleed and evaporation weight loss.

Generally, non-curing products should be applied as thinly as possible with minimal excess. The product must also be well mixed to avoid oil bleed. The golden rule is to not be tempted to apply thicker layers. It doesn't improve the results and may even prove problematic. Remember, the thickness of the thermal interface material becomes the rate-determining step; the thicker it is applied above the minimum amount required, the slower the rate of heat transfer will be.

If rework is likely to be unnecessary over the life of the assembly, then you might consider

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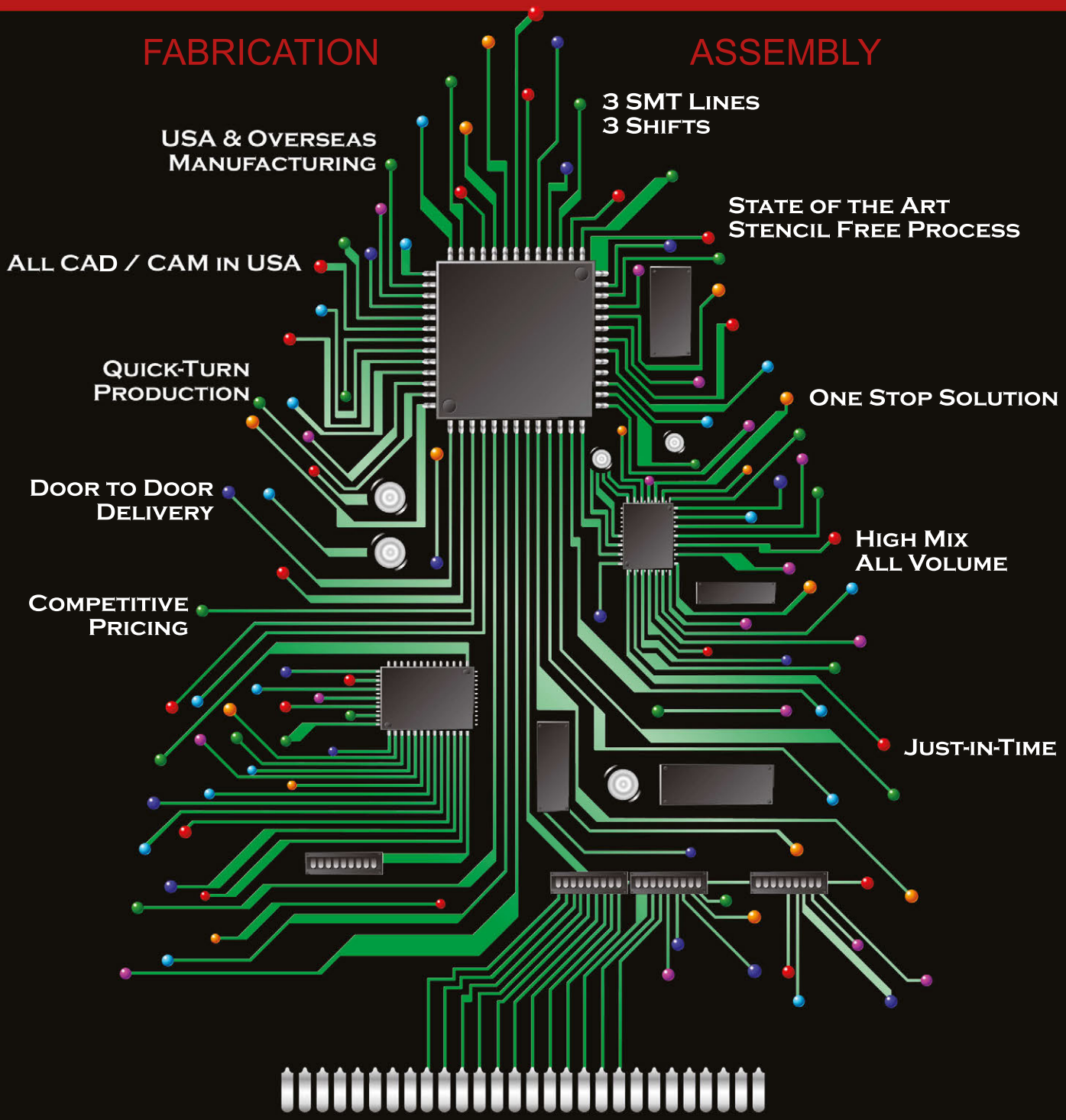

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using a curing/bonding thermal management product. However, for curing products or those that have a solvent for application purposes, you must consider the working time of the product. For example, if the product touch-dries rapidly, it may not be suitable for stencil printing as the cured product may block the screen.

For example, if the product touch-dries rapidly, it may not be suitable for stencil printing as the cured product may block the screen.

To bypass this problem, check that the screen mesh size is suitable for the particle size of the paste and that the screen will be able to cope with the thickness of paste required. Moreover, if you are using automated dispensing equipment, the dot profile and quantity of paste should be considered to ensure that the minimum amount of material can still be applied.

A bonding thermal interface material may be required if a heat sink needs to be held firmly in place without the use of fasteners. In this case, it is important to get the bond strength right or the heat sink will likely become dislodged if the assembly is subject to shock or high-amplitude vibration. Another alternative is to use thermal gap pads, which are pre-cut to size and manually mounted without mess or waste, and without the need for dispensing equipment. Gap pads do not move during thermal cycling, so they tend to not suffer pump-out, which is common with some thermal pastes.

The thing to remember with pads is that they provide a thicker interface layer and tend to have a higher thermal resistance. Pads work best for applications where there is a pressure exerted on the interface that minimises the bond line and ensures maximum contact with the gap pad. This pressure forces the pad material into the air pockets, which effectively reduces the thermal resistance.

Another option for managing the transfer of heat away from electronic devices is to use a thermally conductive encapsulation resin. These products are designed to offer protection from environmental attack and allow heat generated within the device to be dissipated to its surroundings. Encapsulation resins often incorporate thermally conductive fillers to boost their thermal performance, while the base resin, hardener, and other additives can be altered to provide a wide range of options.

Where encapsulation resins are concerned, the entire PCB is likely to be covered and the amount of resin needed will be determined by the protection level required as well as other factors, such as the weight and volume gains contributed by the resin. You will also need to ensure that there are no air voids within the cured resin because this will compromise its electrical properties and thermal transfer performance. As with all resins, check that the mix ratio is adhered to and the product is mixed well using an air-free mixing method.

Next, you should consider the substrate and intended bond line thickness. What is the condition of the substrate? Is the gap size at the interface known? Contact surfaces vary, as do contact pressures. The most important thing is to have no air trapped at the interface because air is a poor conductor of heat. Even minute amounts of air entrapment at the interface due to poorly mating surfaces, inaccurate application of a thermal interface medium, or gaps wider than calculated can reduce the efficiency of thermal transfer.

Determine whether your application is one that requires a thinly applied thermal interface material, such as a paste, or whether a thicker gap filler is required, which would normally be applied to a thickness greater than 500 microns. With any thermally conductive material, you can ensure that the interface between device and heat sink is completely filled and that all air is displaced by applying a quantity of the

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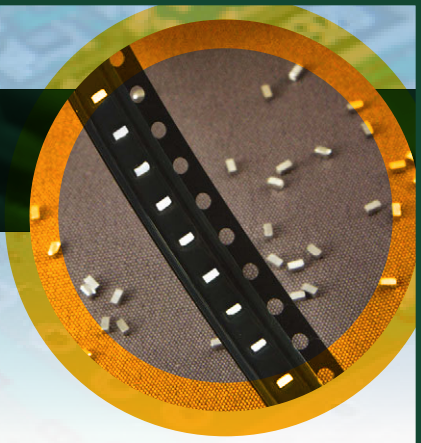

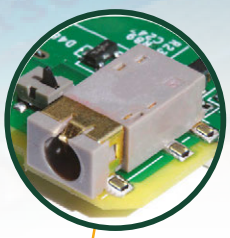

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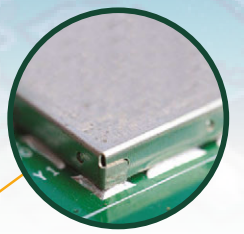

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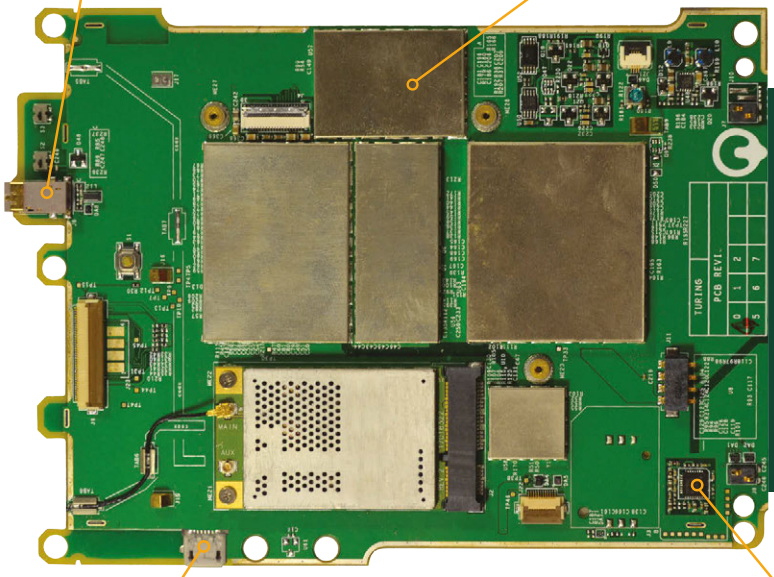

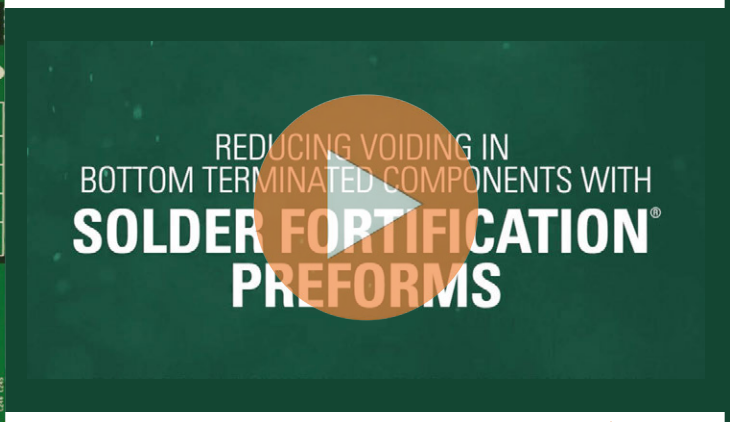

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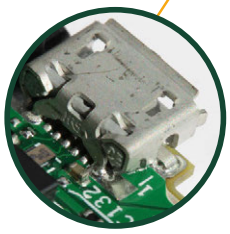

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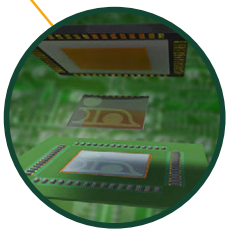

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compound to the centre of the mating surface of the device or the heat sink. Next, bringing the two together will displace any excess material as mating pressure increases.

Finally, consider your preferred method of application. Will you use manual methods, such as syringes, or be semi- or fully-automated methods with state-of-the-art dispensing equipment? Screen printing may be another option to consider. As with the materials themselves, if you are making decisions on application technique, always seek expert advice to help and guide you to the correct product and the easiest application method. The goal should be a streamlined production process and provision of efficient heat transfer both in initial application and final use. **SMT007**

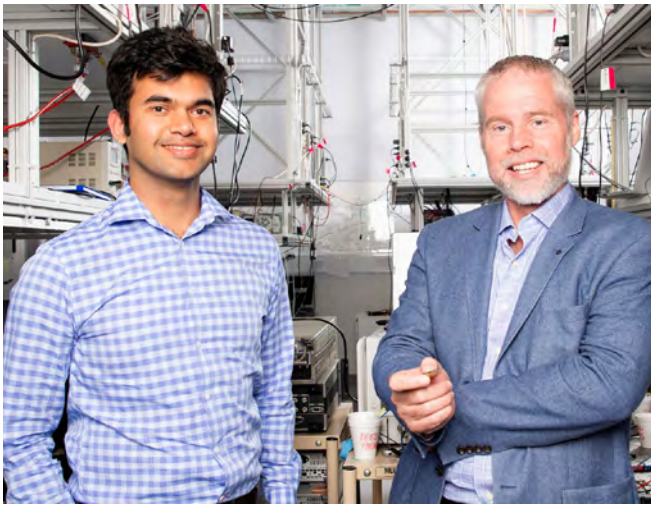
Jade Bridges is global technical support manager at Electrolube. To read past columns from Electrolube, click here. To download your copy of Electrolube's micro eBook, *The Printed Circuit Assembler's Guide to... Conformal Coatings for Harsh Environments,* click here.

Photonic Chips Harness Sound Waves to Speed Up Local Networks

Scientists at the University of Sydney have, for the first time, developed a chip-based information recovery technique that eliminates the need for a separate laser-based local oscillator and complex digital signal processing system. This is seen to significantly increase the speeds of communications networks.

"Our technique uses the interaction of photons and acoustic waves to enable an increase in signal capacity and therefore speed," said Dr. Elias Giacoumidis, joint lead author of a new study. "This allows for the successful extraction and regeneration of the signal for electronic processing at very-high speed."

The incoming photonic signal is processed in a filter on a chip made from a glass known as chalcogenide. This material has acoustic properties that allows a photonic pulse to 'capture' the incoming information and transport it on the chip to be processed into electronic information. This removes the need for complicated laser oscillators and complex digital signal processing.



Dr. Amol Choudhary (left) and Sydney Nano Director Professor Ben Eggleton in one of the photonics labs at the Sydney Nanoscience Hub.

"This will increase processing speed by microseconds, reducing latency or what is referred to as 'lag' in the gaming community," said Dr Amol Choudhary from the University of Sydney Nano Institute and School of Physics. "While this doesn't sound a lot, it will make a huge difference in high-speed services, such as the financial sector and emerging e-health applications."

The photonic-acoustic interaction harnesses stimulated Brillouin scattering, an effect used by the Sydney team to develop photonic chips for information processing.

Group research leader and Director of Sydney Nano, Professor Ben Eggleton, said, "The fact that this system is lower in complexity and includes extraction speedup means it has huge potential benefit in a wide range of local and access systems such as metropolitan 5G networks, financial trading, cloud computing and the Internet-of-Things."

The study is published in Optica and was a collaboration with Monash University and the Australian National University.

(Source: University of Sydney)

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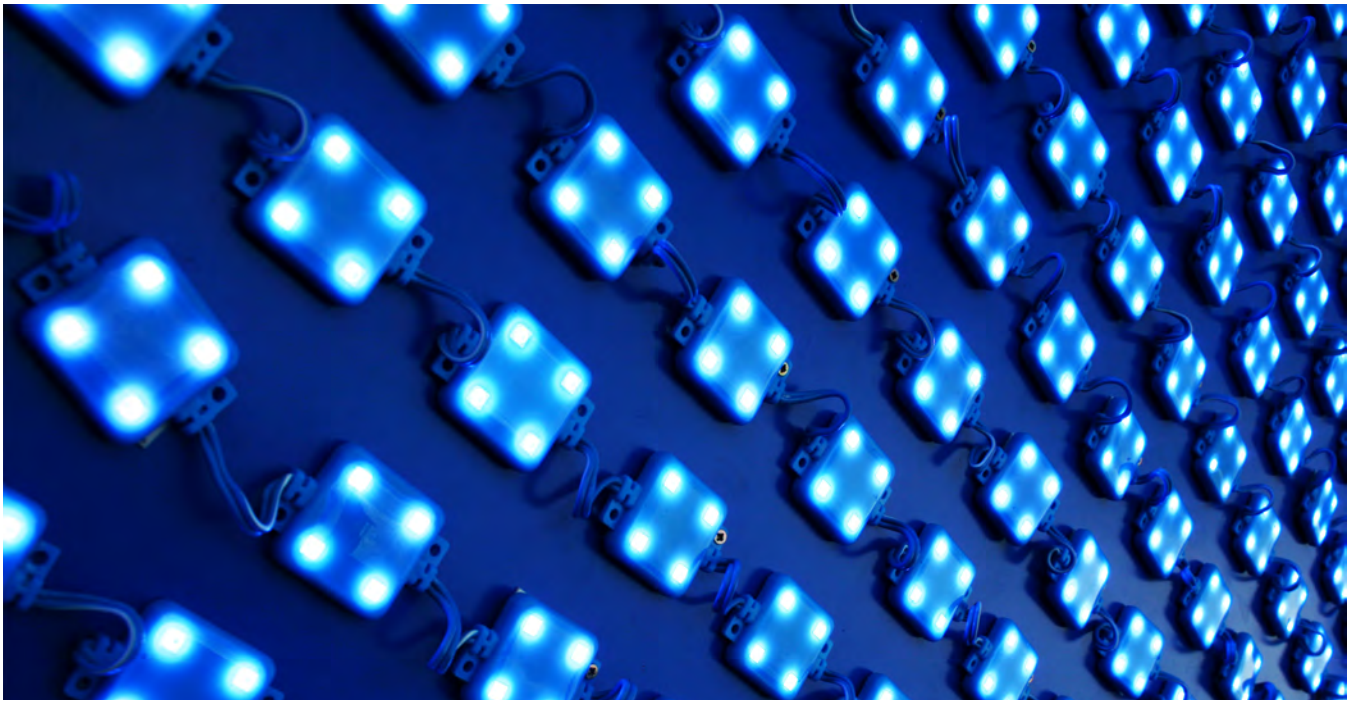

Process, Design and Material Factors for Voiding Control for Thermally Demanding Applications

Article by Ranjit Pandher, Matthew Siebenhuhner, Gyan Dutt, Mitch Holtzer, T.W. Mok, Amit Patel
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Abstract

Solder voiding is a common phenomenon across all semiconductor packaging and electronic board assemblies. Voids are a troublesome defect in assemblies created using surface mount technology. Voids can interfere with electric signals, can be insulators when heat dissipation is required, and they can also be the source of crack propagation and early failure of an assembly when occurring near the pad surface. The acceptable levels for voiding vary upon on the end-application and environment it's used in. In the case of thermally demanding harsh environment applications such as automotive and outdoor LED lighting void control is required in order to optimize the performance and extend the lifetime of these components. The lower the voiding on these thermal and electrical pads, the better the connection to the PCB and subsequent layers.

There are many factors that influence void frequency and size. This study focuses on several process, design and materials selection considerations which control or potentially reduce voiding to meet industry and end-market acceptance criteria. More specifically, package design, reflow profiles, and solder paste chemistry are discussed in the form of application studies. Commercial mid-power PLCC and high-power ceramic LED packages on aluminum metal core PCBs additionally BGA, D-Pak, and MLF on FR4 PBCs were used for these case studies.

Introduction

The global acceptance of LED-based light sources has propelled the energy efficient technology to enter numerous markets and end applications including high power lighting segments. Examples include exterior automotive headlamps, roadway/street lighting, industrial high bay lights, architectural and entertainment lighting. As a result, customer expectations of maintaining efficiency, govern-

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ment regulations, safety, and reducing overall systems/replacement costs are important to satisfy the adoption rates.

For these high reliability and lifetime requirements, it is critical to have excellent assembly interconnect reliability to address the above needs.

The role of interconnects in LED Level 1 (chip/die attach) and Level 2 (package on board attach) is fundamentally to:

- Convey power and information efficiently and reliably over the rated life
- Thermal management—get the heat out faster and reliably over the rated life.
- Enable more light output, consistently, for longer time for the same package and system footprint.
- Capable of being processed under robust processing conditions i.e. multiple reflow assembly.

Voids, which are pockets of trapped gasses from solder flux, can cause issues for electric signals, can act as thermal resistors when heat dissipation is required, and they can also be the source of crack propagation and early failure of an assembly. Figure 1 depicts large area voids in the bulk solder layer. The phenomenon of void occurrence is a complex system; there are many factors that drive various levels of voiding. Examples include: chemistry,

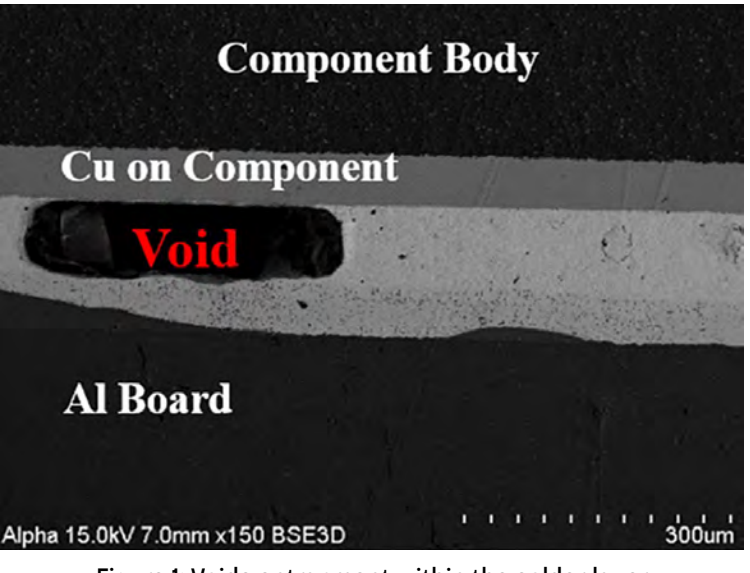

Figure 1: Voids entrapment within the solder layer.

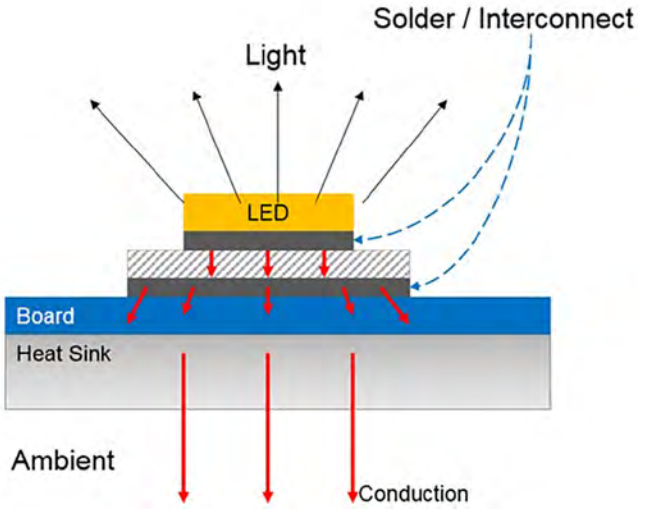

Figure 2: High-power LED heat path.

reflow profile, volume of material, solderable pad finish and design of the component pads (thermal and electrical).

For level 1 LED chip attach assemblies the use of traditional solders can be seen as an advantage from both ease of processing and cost. However, the importance for thermal management is critical for high and ultra-high power LEDs. The junction temperature in the LED increases with increasing drive current. Since more than 50 % of electrical input power is dissipated as heat due to efficiency droop at high drive currents in LEDs, this rise in the junction temperature reduces the light output by increasing the probability of non-radiative recombination causing drop in efficiency and rated lifetime. Therefore, the dissipated heat needs to be removed from the junction in order to maintain the light conversion efficiency and light output from the High Power LED package. The various components in the heat flow path in a High Power LED package are shown in Figure 2.

Additionally, for Level 1, the requirements for processing LED packages with solder-based die attach on boards as a Level 2 assembly requires multiple soldering reflow capability. With multiple reflows of the same solder bulk layer, this may increase the levels of voids impacting the overall reliability of the stack at the Level 1 layer.

For Level 2 package on-board assemblies LEDs are becoming more integrated with vari-

ous traditional IC components such as BGAs, D-Paks and MLFs being directly mounted on the same board. This is driven by the need for lighting systems to go beyond general illumination providing more complex features such as control, sensing and modulation. Large area voids can create issues in the electrical signal or generate cracks due to thermal cycling/fatigue thus need for a more robust, low voiding interconnects are required at the Level 2 layer.

Experimental Procedure – Design Case

There are a variety of LED designs used in the industry ranging from design structure/size and package materials i.e. ceramic and plastic. The goal of this experiment is to observe the effect of voiding based on three varying structures with the key difference being the pad geometries. For example, a 2-pad design where the anode and cathode are symmetrical, a 3-pad high aspect ratio design where the central thermal pad is slightly larger in terms of total area and lastly, a 3-pad design where the central thermal pad is significantly larger in terms of total area when compare to the anode and cathode. Table 2 shows the total area and construction of the LED pads.

ASSEMBLY MATERIALS & COMPONENTS

Substrate

The substrate used in this study is a custom designed aluminum core PCB. The particular details for this board are shown in Table 1.

LED Components

For this study, three commercially available high-power LEDs were selected with varying pad geometries. The parameters for anode, cathode, and thermal pad dimensions for the LEDs are listed in Table 2. All dimensions are in millimeters. The LEDs were chosen to emulate common packages selected in high and ultra-high-power assemblies.

Solder Pastes

A commercially available no-clean solder paste was used for this study known using a type 4 particle size SAC-based alloy (38–20 Particle size in µm (80% min. between)).

PROSESS AND TEST METHOD

Equipment Processing Details

Solder paste printing was done using DEK Horizon 03iX printer with a 4 mil thick laser cut stainless steel stencil with a 1 to 1 ratio of aperture size to pad size. Stencil printing parameters used for all solder pastes are shown in Table 3.

Reflow Soldering

The soak reflow profile was used in this study shown in Figure 2 the temperatures are displayed in Table 4.

SMT Parameters	Process Conditions
Print Speed	1 inch/sec.
Print Pressure	1.25 lbs/inch of blade
Stencil Release	0.02 inches/sec.
Stencil Thickness	4mil

Table 3: Print conditions.

Details	Metal Core PCB
Metal Core	Aluminum
Surface Finish	ENIG

Table 1: Test vehicle details.

LED Design	Anode (mm)	Cathode (mm)	Thermal Pad (mm)
LED A	1.35 x 3.2	1.35 x 3.2	N/A
LED B	0.5 x 2.7	0.5 x 2.7	1.0 x 2.7
LED C	1.2 x 0.67	1.2 x 0.67	1.77 x 2.80

Table 2: LED pad dimensions (mm).

Line Speed	Zone	#1	#2	#3	#4	#5	#6	#7	#8	#9
23.0000 (in/min)	Length (in)	12.60	12.99	13.50	13.31	15.39	16.61	12.99	22.99	16.02
	Upper (°C)	170.0	220.0	210.0	185.0	195.0	255.0	265.0	55.0	55.0
	Lower (°C)	170.0	220.0	210.0	185.0	195.0	255.0	265.0	55.0	55.0

Table 4: Reflow profile used in study.

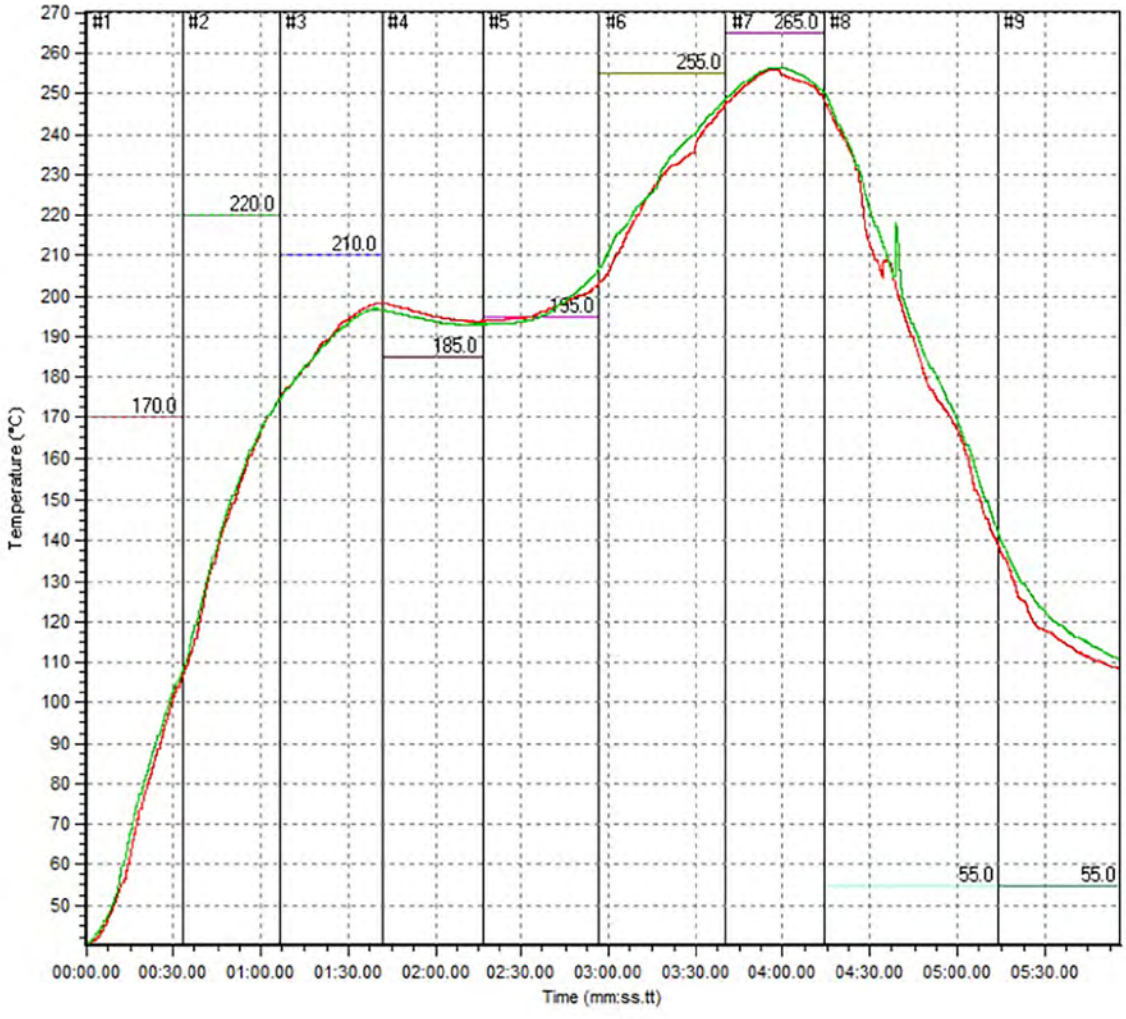

Figure 3: Reflow profile, visual depiction.

Test Method

To measure and quantify the voiding performance of the varying pastes and LED pad layouts, the assembled and reflowed boards were loaded into an X-ray analysis unit and programmed to quantify the area of each void as a percent of the total pad area and the number of voids under the package.

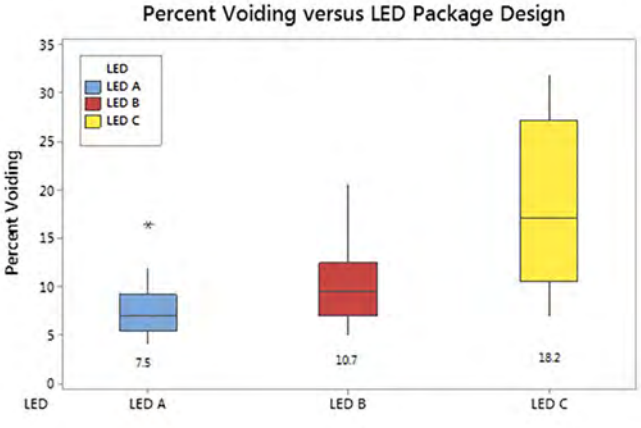

Figure 4: Percent voiding versus LED package design.

RESULTS AND DISCUSSION

Results

The results of this study are shown in Figure 4.

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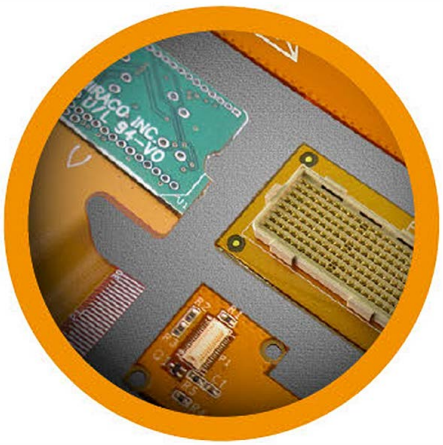
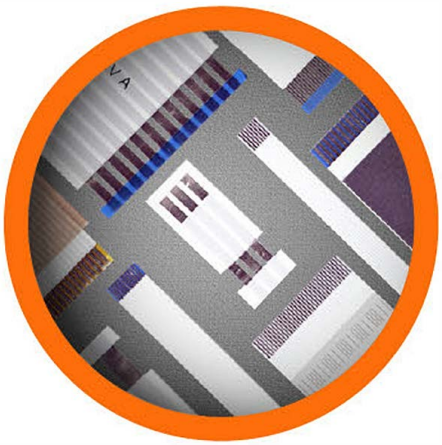


Flexible Printed Circuits



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LED Design	Anode (mm)	Cathode (mm)	Thermal Pad (mm)	Difference in Thermal Pad vs. Electrical Pad (mm2)
LED A	1.35 x 3.2	1.35 x 3.2	No Pad	0
LED B	0.5 x 2.7	0.5 x 2.7	1.0 x 2.7	1.35
LED C	1.2 x 0.67	1.2 x 0.67	1.77 x 2.80	4.15

Table 5: LED design dimensions and difference in thermal vs. electrical pads.

Discussion

From the experimental results, it is evident that solder pad design influences the level of voiding for a given package. The selected packages, which have the largest physical difference of pad area and asymmetry in design, create the highest levels of voiding. This is directly related to the total volume of solder deposit for a particular LED package. Table 5 depicts the pad variance for a given design.

It is known that having different solder volumes on the same board makes it very difficult to adjust reflow profile setting that balances the activation and evaporation component. A smaller volume consumes the activator faster than a larger volume, which also requires a much longer soak profile to remove the diluents/solvents in the flux system.

Experimental Procedure – Process Case [1]

Adjusting the reflow profile is a very common starting point in order to optimize the level of voiding. In the first set of experiments, multiple solder paste formulations were subjected to various reflow profiles. The profile variations included preheat soaks, and time above liquidus. All reflow profiles were created using a seven-zone convection oven using no nitrogen. An in-house developed test vehicle, based on a 0.062 thick FR4 laminate, finished with OSP/Copper pads was used. The test vehicle includes BGA, D-Pak, and MLF devices.

Test Method

Voiding was measured with a Nikon Metrix XT V160 2-D x-ray machine. In each case, altering the profile had an effect on the observed level of voiding.

Varying the Preheat Profile

Two reflow profiles with different preheat settings. The first is known as a straight ramp profile, where the test vehicle's surface temperature increases at a near linear rate of +1.5°C per second up to a peak temperature if 245°C. The second profile has a slightly faster ramp up (+1.56°C/second) to approximately 160°C, then the assembly is allowed to "soak" at temperatures between 160°C and 184°C for approximately 60 seconds, followed by a moderate (0.96°C/second) ramp up to a peak temperature of 240°C.

RESULTS AND DISCUSSION

Results

Figure 5 shows the effect the two reflow profiles on a BGA 256 device using one solder paste. Both the solder paste alloy and the BGA spheres were made with SAC 305 alloy.

Discussion

The soak profile resulted in over 30% of the 265 BGA I-Os having no voids. With the straight ramp profile, fewer than 10% had zero voids.

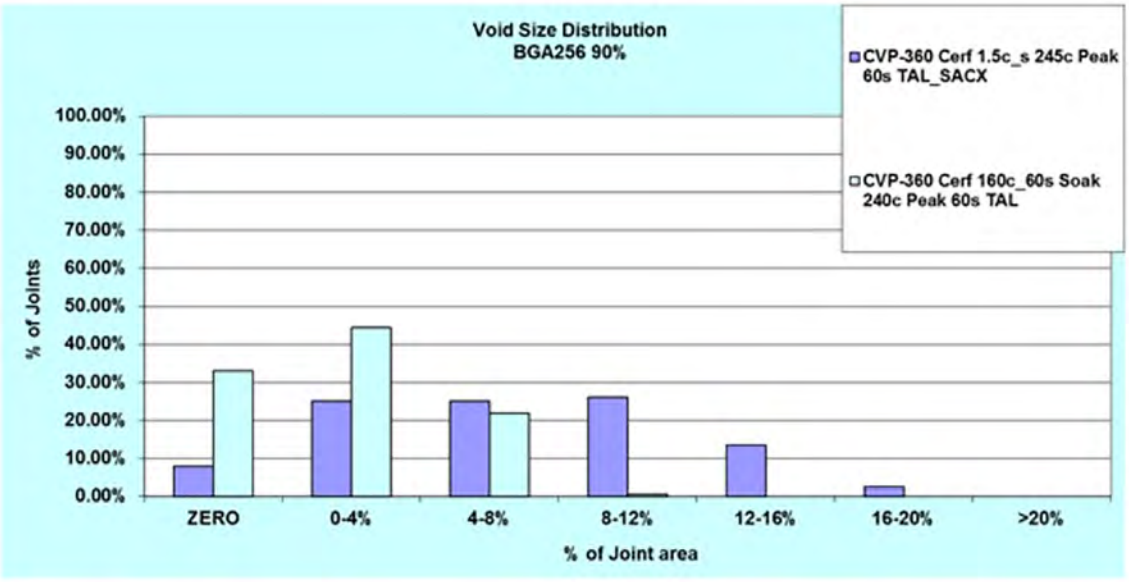

Figure 5: Voiding results.

The soak profile had zero BGA joints with more than 8% by area, voiding, whereas over 10% of the straight ramp profile results had voids between 12% and 16% of the area. The result of adding a preheat soak and a slower ramp rate to the peak temperature significantly reduced the extent of voiding in BGA components when compared to a fast ramp to peak temperature.

Extending Time Above Liquidus

Another adjustment to the reflow profile that has proven to reduce voiding is extending the time above liquidus. This is especially effective with large surface area components like MLFs, DPAKs, TO-252 and other bottom terminated components (BTCs).

In order to verify the effect of the impact of extending the time above liquidus the concept was captured on video using a reflow simulation.

Test Method

A solder paste deposit was placed on a large metalized surface. A piece of glass was placed over the deposit. The video camera captured the image of the solder paste as it went through a reflow profile. Images were captured at key temperatures of the reflow profile to explain the formation and elimination of voids.

RESULTS AND DISCUSSION

Results

The formation of gas bubbles from the evaporation/boiling of organic solvents can readily be observed. This outgassing before the alloy reaches liquidus is an explanation for the reduced levels of voiding seen when a soak preheat profile replaces a straight ramp preheat. A greater volume of the gas producing solvents are driven off before the solder spheres melt and coalesce in a liquid phase; see Figure 6.

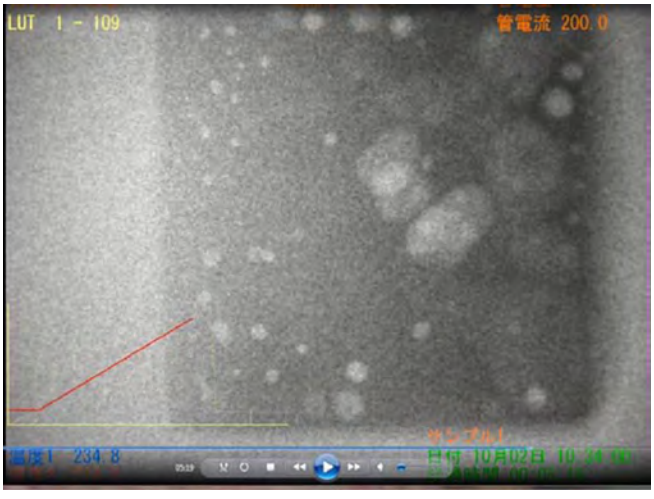

Figure 6: Outgassing during a straight ramp reflow profile at 155°C.

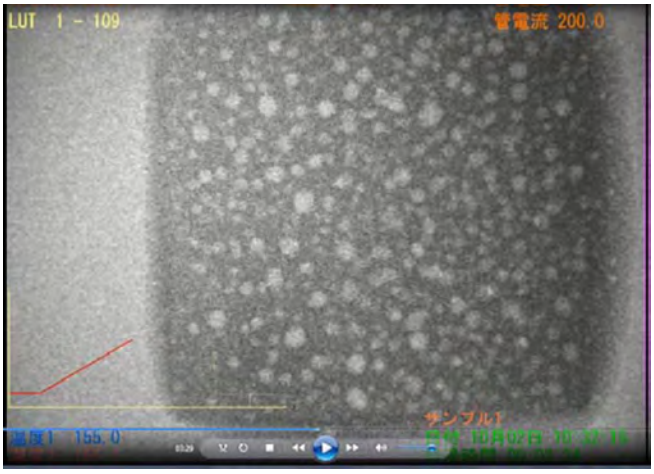

Figure 7: Large voids photographed as solder reaches liquidus.

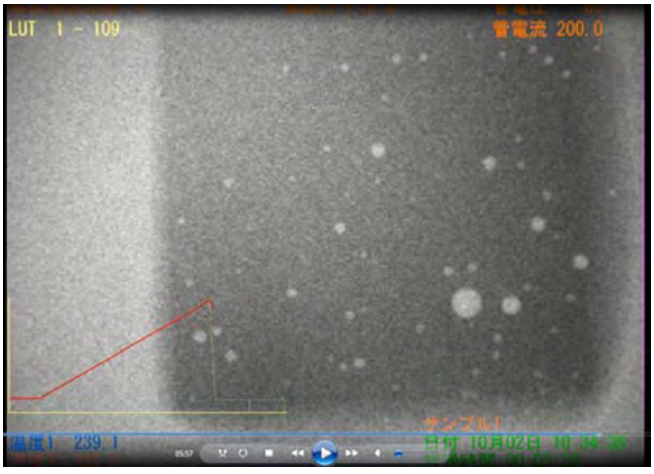

Figure 8: Reduced voiding after extended time above liquidus.

For the next stage of the profile the voiding changes noticeably; see Figure 7.

Rather than the smaller, yet high frequency voids seen at 155°C, now there are much larger pockets of gas between the component and board. If the solder is allowed to freeze, the pockets will remain in the bulk solder. While the component/solder/board stack up shown in Figure 7 is above the liquidus temperature of the solder, the vapor bubbles are mobile due to Brownian motion forces caused by the heat input from the reflow simulator. If these air pockets reach the outer boundary of the top component, the gas is released and the void disappears. Once the void disappears, there is no source of new gas entrapment (as long as the peak remains below 242°C in the presence of copper). This is how an extended time above liquidus can greatly reduce the amount of voiding under a bottom terminated component. Figure 8 shows this result.

Discussion

Adjusting the reflow profile is a very easy way to reduce voids. Using a soak pre-heat profile reduces voiding in BGA devices. Keeping the peak temperature below 241°C reduces voiding in BGA and BTC components. Increasing the time above liquidus reduces voiding in BTCs as well.

Experimental Procedure – Chemistry Case

Solder paste chemistry is a highly proprietary subject. However, there is significant experimental evidence that shows the presence or absence of various useful ingredients in solder paste do have a major influence on voiding this example can be seen in Figure 9. The following case looks at two solder paste chemistries and its impact of voiding under the same the process and conditions.

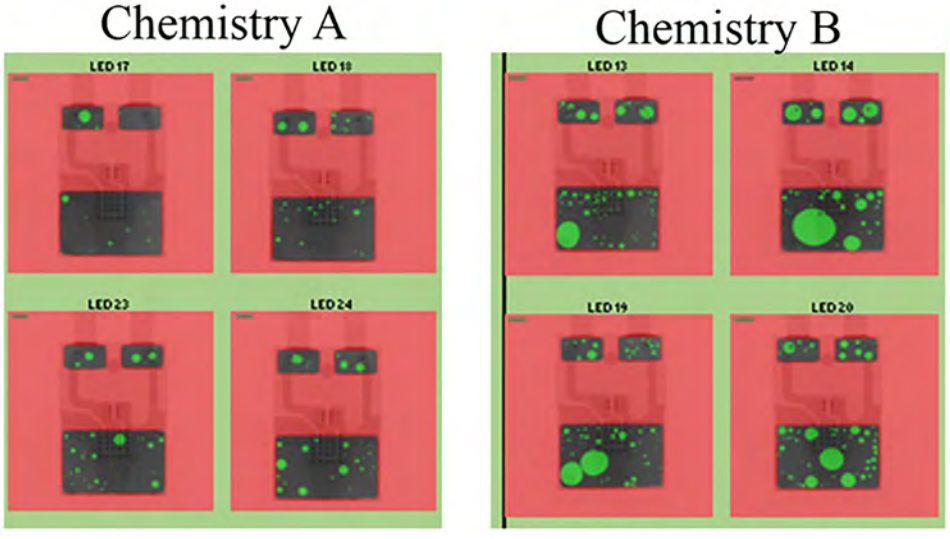

Figure 9: Difference in solder chemistries vs. voiding.

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Douglas C.H. YU, Ph.D.
Vice President, Research and Development
Taiwan Semiconductor Manufacturing Company

Monolithic versus Heterogeneous Packaging: Where Does the Future Lie?
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Conference Questions:
Jenny Ng
jenny@smta.org

Parameters	Metal Core PCB
Metal Core	Aluminum
Surface Finish	HASL

Table 6: Test vehicle details.

SMT Parameters	Process Conditions
Print Speed	1 inch/sec.
Print Pressure	1.5 lbs/inch of blade
Stencil Release	0.02 inches/sec.
Stencil Thickness	5mil

Table 7: Print conditions.

ASSEMBLY MATERIALS & COMPONENTS

Substrate

The substrate used in this study is a custom designed aluminum core PCB. The particular parameters for this board are detailed in Table 6 below.

LED Components

For this study, a commercially available ceramic LED was selected. Details of the LED are show in Figure 10.

Solder Pastes

Two commercially available no-clean Lumet solder pastes were used. Paste A has been formulated from the ground up to deliver low voiding while Paste B served as the standard control.

PROCESS AND TEST METHOD

Equipment Processing Details

Solder paste printing was done using DEK Horizon 03iX printer with a 4 mil thick laser cut stainless steel stencil with a 1 to 1 ratio of aperture size to pad size. Stencil printing parameters used for all solder pastes are shown in Table 7.

Reflow Soldering

Using the learnings from the Process Case, a soak reflow profile was generated the conditions are 180-200°C/90s Soak 255°C Peak 80s TAL Figure 11 shows the profile.

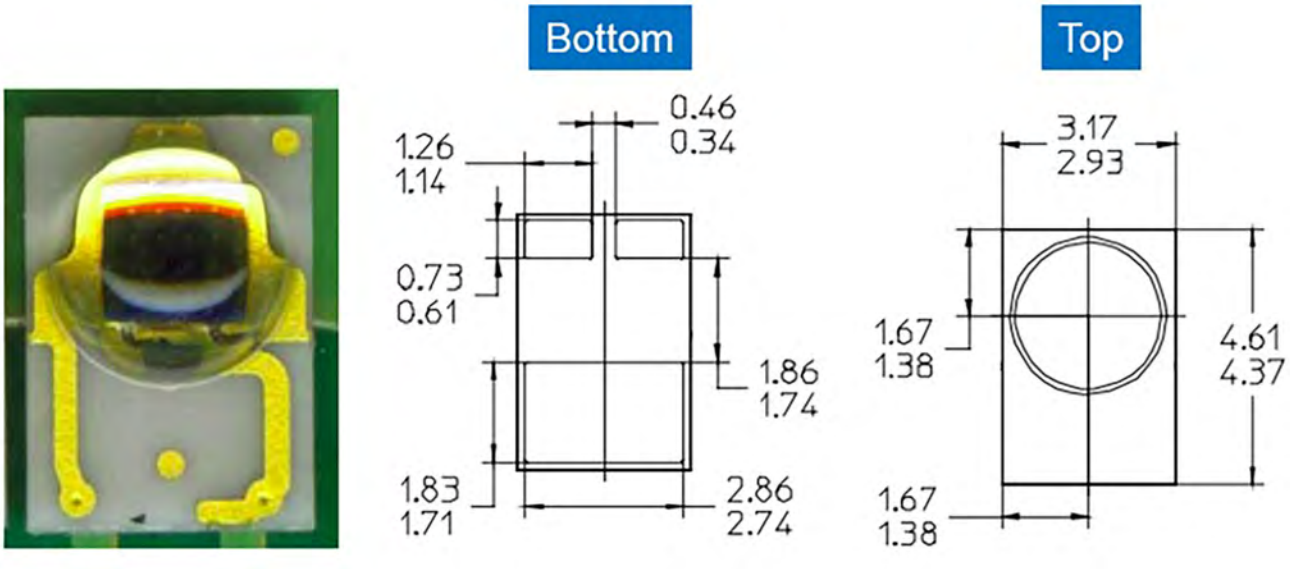

Figure 10: Commercially available ceramic LED package.

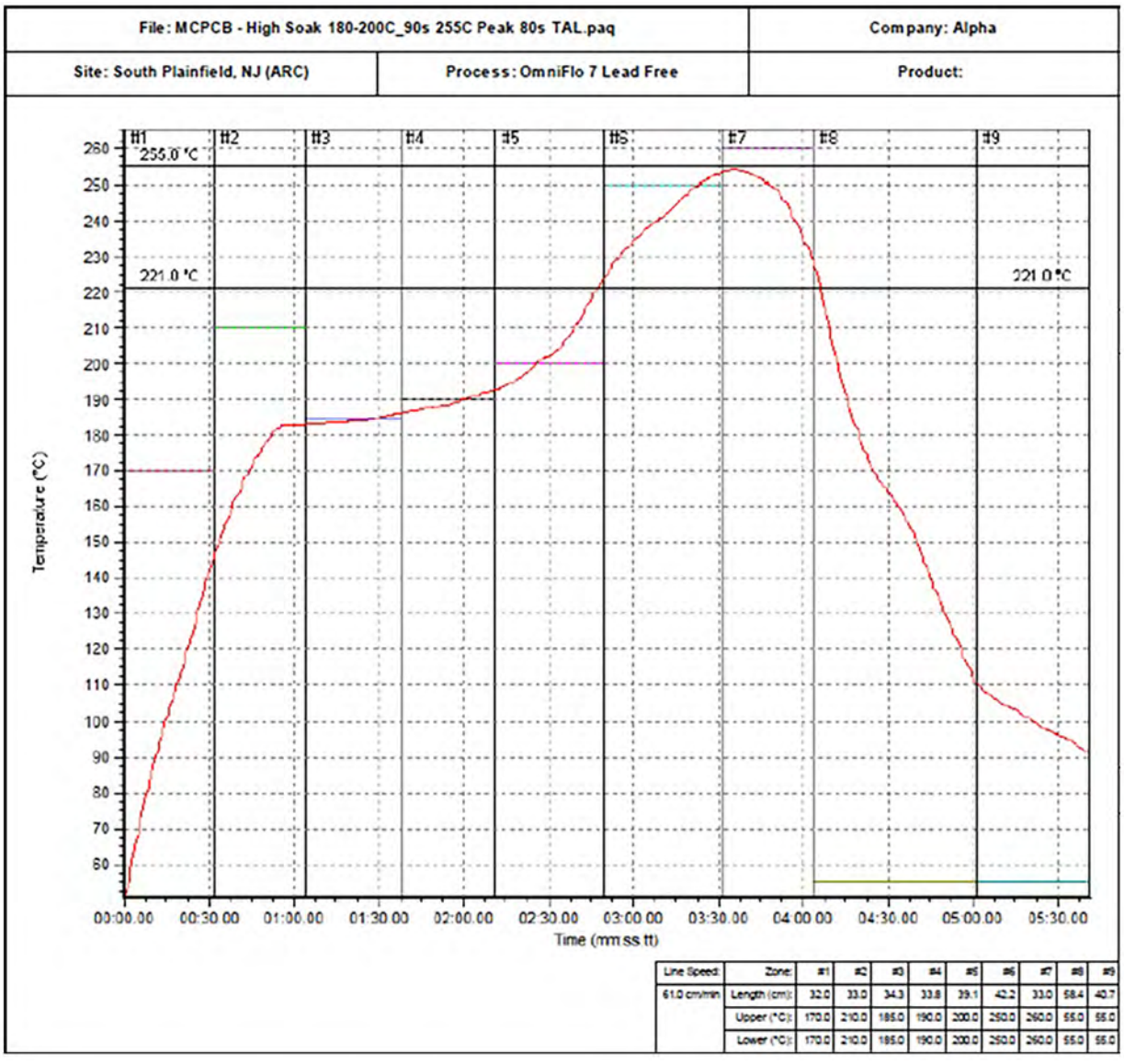

Figure 11: Reflow profile, visual depiction.

Test Method

To measure and quantify the voiding performance an X-ray analysis unit was programmed to quantify the area of each void as a percent of the total pad area and the number of voids under the package. Figure 12 shows the areas under study.

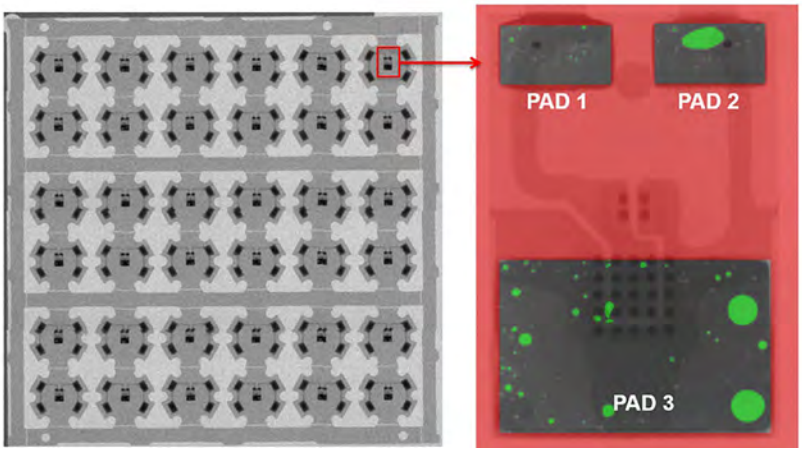

Figure 12: X-Ray image of soldered ceramic-based LED package.

RESULTS AND DISCUSSION

Results

The results of this study are shown in Figure 13 and Table 8.

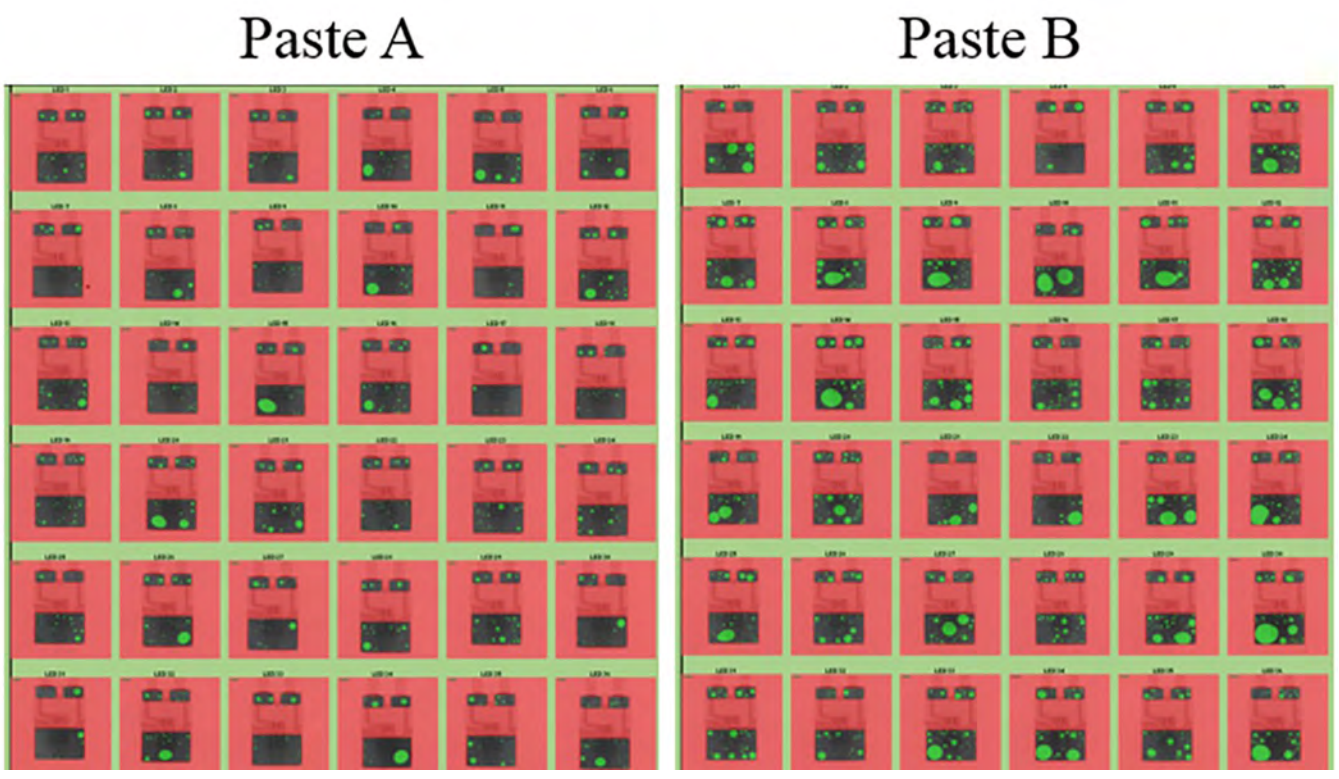

Figure 13: X-ray voiding images of paste A vs. paste B.

Paste	Sample Size (N)	Avg. Number of Voids	Total Void Per Area (%)
Paste A	N = 72	57	10
Paste B	N = 72	92	19

Table 8: Voiding size and frequency.

Discussion

Paste A indeed provides better voiding under the same processing conditions. Paste A produced 40 percent lower number of physical voids and provided an average of 9 percent voiding per total area when compare to 19% for Paste B. The presence or absence of various useful ingredients exist for both Paste A and Paste B which can impact voiding in either direction as seen in the results. As a general guideline, it is important to understand the trade-offs between a paste that delivers low voiding and the other paste characteristics that could be impacted. This decision will be dependent on the acceptable voiding criteria for a given application / customer requirements.

Conclusions

Voids are an area of concern for the long-term durability and functionality of electronic devices. Voids near or at the interface of surface mount technology (SMT) component input/outputs (I/O's), or the circuit board substrate can be highly probable initiators of crack propagation, leading to the high possibility of a field failure. Also, voids are very good insulators of heat, leading to thermal issues with heat sinks and thermal pads often used in LED packages.

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There are many factors that influence void frequency and size. This study showcases serval design, process and chemistry impact on voiding.

There are many drivers for LED designs today. Particularity the design of solder pads both influences the thermal, electrical and mechanical characteristics of the LED package. The impact of pad symmetry which is directly related to total solder volume can influence the voiding performance.

Adjusting the reflow profile is a very easy way to reduce voids. Using a soak pre-heat profile reduces voiding in BGA devices.

Increasing the time above liquidus reduces voiding in BTCs as well.

Solder paste chemistry also has a significant effect on voiding. **SMT007**

Editor's Note: Originally published in the proceedings of SMTA International 2017.

References

1. M. Holtzer, T.W. Mok, "Methods of Reducing or Eliminating Voids in BGA and BTC Devices" SMTA Penang - MY March 2016.

Matthew Siebenhuhner is an applications engineer for Argomax and die attach solutions at Alpha Assembly Solutions.

Gyan Dutt is global portfolio manager for die attach, and technical marketing manager for LED at Alpha Assembly Solutions.

Mitch Holtzer is the director of Americas Reclaim Business of Alpha Assembly Solutions.

T.W. Mok is an applications engineering manager for Asia-Pacific at Alpha Assembly Solutions.

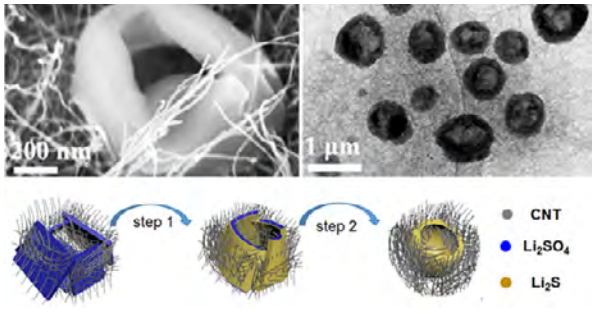
Ranjit Pandher is the R&D manager for LED and semiconductor soldering products at Alpha Assembly Solutions.

Amit Patel is no longer with the company.

Using Donut-shaped Lithium Sulfide for Higher Performing Batteries

There has been an intense research conducted for developing lithium-sulfur (Li-S) batteries with high energy density because lithium-ion batteries (LIBs) only allow for a very short travel distance of electric vehicles per charge. However, Li-S batteries are still unable to provide a longer lifecycle due to the poor reversibility of the lithium metal cathode.

To tackle this issue, a research team from the Korea Advanced Institute of Science and Technology (KAIST) led by Professor Hee-Tak Kim from the Department of Chemical and Biomolecular Engineering used lithium sulfide (Li_2S) cathodes and combine them with graphite anodes to enhance energy density and lifecycles for the batteries.



Yet, Li_2S is costly and, so far, there has not been an electrode architecture and electrolyte design that enables a longer lifecycle between the graphite anodes and lithium sulfide cathodes. To address this, the team produced a doughnut-shaped Li_2S cathode active material from low-cost Li_2S developed from raw materials. They have also developed a Li_2S ion battery with a graphite anode and Li_2S cathode using a high concentration salt electrolyte.

Through this technology, the team achieved 30% higher energy density than that of conventional LIBs and secured a lifecycle of more than 600 cycles. This doughnut-shaped lithium sulfide-based electrode can be manufactured using low-cost raw materials and a single heat treatment process. The electrode can also be applied to existing LIBs.

(Source: Korea Advanced Institute of Science and Technology)

UPCOMING Programs

October 19, 2018
Bannockburn, IL, USA
Assessing the Health of the Defense Electronics Industrial Base Industry Workshop

October 24, 2018
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November 6, 2018
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November 6–8, 2018
Odon, IN, USA
The Pb-Free Electronics Risk Management (PERM) Council Meeting No. 38

November 13–14, 2018
Bloomington, IN, USA
IPC Counterfeit Electronics Symposium: Methods For Detection And Best Practices For Avoidance

November 13–15, 2018
Schaumburg (Chicago), IL, USA
IPC/SMTA High-Reliability Cleaning and Conformal Coating Conference

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Wisdom Wednesday — Results of PCB Technology Trends Study
30 minute webinar — FREE for IPC Members only

November 28–29, 2018
Brussels, Belgium
IMPACT Europe

December 5–7, 2018
Shenzhen, China
HKPCA International Printed Circuit & IPC APEX South China Fair

December 12, 2018
Wisdom Wednesday — SNEAK PEEK into IPC APEX EXPO Professional Development
30 minute webinar — FREE for IPC Members only

January 26–31, 2019
San Diego, CA, USA
IPC APEX EXPO

May 14–16, 2019
Hanover (Baltimore), MD, USA
IPC High Reliability Forum

For more information, **visit www.IPC.org/events**

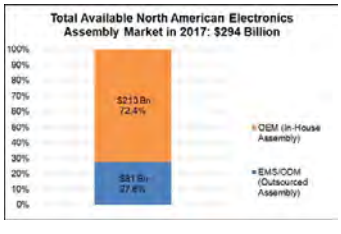
Recent Highlights from SMT007.com

1 Riding Out the Electronic Components Crisis is No Longer an Option ▶


Neil Sharp

As market demand outstrips manufacturing capacity, the fallout from the components crisis is now predicted to extend well into 2020, and beyond.

2 New IPC Report Assesses Growth Potential in North American EMS Industry ▶



The North American EMS industry has penetrated only about 28% of the total available market based on what OEMs in the region could outsource. Forecasts contributed by New Venture Research predict steady growth for the EMS industry through 2022, both globally and in North America.

3 IPC and SMTA to Present High-Reliability Cleaning and Conformal Coating Conference ▶

IPC—Association Connecting Electronics Industries in partnership with Surface Mount Technology Association (SMTA) will host the High-Reliability Cleaning and Conformal Coating Conference on November 13–15 at the Chicago Marriott in Schaumburg, Illinois.

4 Z-AXIS Achieves ISO 9001:2015 Certification ▶

Z-AXIS Inc. has achieved ISO 9001:2015 certification, establishing that its quality management system meets the most current standard of the International Organization for Standardization (ISO).

5 Syrma's New Bawal Facility Serves India's Electronics Markets ▶

This new commitment of over $10 million over the next three years is designed to fortify Syrma's market position among high-growth domestic electronics markets within India, including automotive, industrial, aerospace, defense, and health tech verticals.

6 SMTC Opens Supply Chain Center in Phoenix ▶

SMTC Corp. has opened a supply chain center in Phoenix, Arizona, as one of several key initiatives in its ongoing drive to deliver "best-in-class" vertically integrated supply chain services in support of its expanding base of customers and strong year-over-year growth opportunities.

7 SMTA Welcomes New Board Members ▶

The SMTA has released its election results for the global board of directors for the term beginning during SMTA International 2018.

8 TIBCO and Jabil Collaborate on Industrial IoT Solutions ▶

TIBCO Software Inc. and EMS firm Jabil Inc. have forged a strategic relationship to deliver innovative industrial IoT (IIoT) solutions for leading brands.

9 IPC Issues Call for Papers for Third Annual IPC High Reliability Forum ▶

IPC—Association Connecting Electronics Industries invites engineers, researchers, academics, technical experts and industry leaders to submit abstracts for IPC High Reliability Forum to be held May 14–16, 2019 in Hanover (Baltimore), Maryland.

10 Computrol Adds Laser Marking with ASYS INSIGNUM 2000 Laser ▶

Computrol Inc. has purchased and completed the installation of an ASYS INSIGNUM 2000 Laser for PCB marking.

For the latest news and information, visit SMT007.com. Subscribe to our newsletters or premium content at my I-Connect007.

Career Opportunities

Pssst! Are You Looking for Someone?

Place your notice in our Help Wanted section.

For just $500, your 200 word, full-column—or, for $250, your 100 word, half-column—ad will appear in the Help Wanted section of all three of our monthly magazines, reaching circuit board designers, fabricators, assemblers, OEMs and suppliers.

Potential candidates can click on your ad and submit a résumé directly to the email address you've provided. If you wish to continue beyond the first month, the price is the same per month. No contract required. We even include your logo in the ad, which is great branding!

To get your ad into the next issue, contact:
Barb Hockaday at barb@iconnect007.com or +1.916.608.0660 (-7 GMT)

I-Connect007
GOOD FOR THE INDUSTRY

smt007 pcb007 pcb design007

Career Opportunities

PCB DFM Engineer

Apple products are as alluring on the inside as they are on the outside. Inside our products are some of the world's most challenging consumer PCB assembly and flex designs. Imagine yourself as a select member of the team that brings these assemblies from concept to high-volume manufacturing.

Key Qualifications

- At least 5 years of experience with printed circuits, including hands-on process engineering experience
- Creativity and curiosity about materials science and electronics packaging at all levels
- Deep knowledge of industry specifications, especially IPC and JEDEC specifications
- Understanding of the relationship between manufacturing processes and printed circuit defect conditions, especially latent defects
- Ability to travel overseas for up to 25 percent of your time

Primary Responsibilities

- Maintenance of PCB design guidelines for all Apple products as well as the technology road map and acceptability specifications
- Establishment and maintenance of the supplier site/material/technology qualification matrix
- Direct responsibility for all PCB-related quality issues and excursions
- Providing mentorship to product designers on available PCB technologies and materials

Education

BS or higher in Materials Science or Mechanical, Chemical, or Electrical Engineering

apply now

Senior Manager, Flex/PCBA DFM

On this team, you'll be responsible for new product development, sustaining products and failure analysis while leading and mentoring design, process, and quality engineers and managers. You'll collaborate cross-functionally with Product Design, Electrical Engineering, strategic suppliers, and contract manufacturers to ensure the manufacturability of Apple products and maintain Apple's high standards for quality.

Key Qualifications

- At least 10 years of experience, with 5+ years of experience as a senior manager or director
- Experience managing other managers is preferable
- Experience in design and manufacturing, preferably in the electronics fabrication and assembly industry
- Deep technical knowledge complemented by a good sense of how engineering decisions impact business concerns
- Excellent communication skills, from extemporaneous discussion to synthesis of detailed technical reports and distillation to executive-level presentation

Primary Responsibilities

- Development of several design engineers and first-level managers
- Primary escalation point to resolve blocking issues related to design release, design spec compliance, or production process problems
- Engagement with vendor senior management to set expectations and to communicate feedback
- Highlighting all project risks to executive management and identifying, evaluating, and recommending the best path to resolution

Education

BS or higher in Materials Science or Mechanical, Chemical, Electrical, or Industrial Engineering

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Career Opportunities

American Standard Circuits
Creative Innovations In Flex, Digital & Microwave Circuits

CAM Operator

American Standard Circuits is seeking a CAM Operator for its Phoenix, Ariz., office. Qualified applicants will need experience in using Valor/Genesis (GenFlex) CAD/CAM software with printed circuit board process knowledge to edit electronic data in support of customer and production needs.

Job Requirements:

- At least 5 years' experience in PCB manufacturing
- Process DRC / DFMs and distinguish valid design and manufacturing concerns.
- Modify customer supplied data files and interface with customers and engineers
- Responsible for releasing manufacturing tooling to the production floor
- Prepare NC tooling for machine drilling, routing, imaging, soldermask, silkscreen
- Netlist test, optical inspection
- Work with Production on needed changes
- Suggestions on continual improvements for engineering and processing.
- Be able to read write and communicate in English
- Must understand prints specifications
- Must be US Citizen or permanent resident (ITAR)
- High School Graduate or equivalent

Join our Team!

Founded in 1988, American Standard Circuits is a leading manufacturer of advanced circuit board solutions worldwide. Our ongoing commitment to leading-edge higher-level interconnect technology, cost-effective manufacturing and unparalleled customer service has put us at the forefront of advanced technology circuit board fabrication.

We manufacture quality rigid, metal-backed and flex printed circuit boards on various types of substrates for many applications.

apply now

ELECTROLUBE
THE SOLUTIONS PEOPLE

Sales Development Manager

Electrolube has a new opportunity for a sales development manager covering the Midwest United States. This is an exciting role involving all aspects of sales development and account management for the Electrolube brand.

The successful candidate will have relevant experience within the electro-chemicals industry and a strong commercial background. This position will report directly to the U.S. general manager.

Applicants should apply in writing and submit a CV by clicking the button below.

apply now

Career Opportunities

Ucamco
Former Barco ETS

International Field Service Engineer located in ITALY

The successful candidate will:

- Install and service our plotters and direct imaging machines at customer sites Europe-wide
- Carry out maintenance in the field
- Frequent travel: 4 to 5 days a week, 3 to 4 weeks a month
- Assist product manager

We are looking for a team player who is:

- Strongly customer-oriented and experienced in on-site support
- Accustomed to travel, and willing to travel frequently
- Motivated, independent and enterprising
- Technically-minded with training/background in electromechanics/electronics
- Experienced with software (setup, configuration, and usage of Windows-based CAM front-end software and Linux-based RIP software)
- Fluent in Italian and English (German and/or French is a plus)
- An analytical thinker
- Capable of problem solving

The right candidate will be a valued member of a friendly, team-oriented, growing international company that is a leader in its field, dedicated to excellence in all it does. Dynamic and fun, the company offers a great working atmosphere, and this new position is forward-looking and open, with plenty of opportunities for enterprising individuals whose results could be rewarded with prospects for progression in technical development.

Apply to Anja Ingels after clicking below.

apply now

MacDermid Enthone
ELECTRONICS SOLUTIONS

Product Group Field Manager Waterbury, CT

Do you have what it takes? MacDermid Enthone Electronics Solutions is a leading supplier of specialty chemicals, providing application-specific solutions and unsurpassed technical support.

The position of the Product Group Field Manager will be responsible for creating and driving a strategic plan for the regional product line, including the following:

- Possess a thorough understanding of the overall PCB business, and specifics in wet processing areas
- Play an integral part in developing a commercial and technical customer strategy
- Create and deliver customer facing presentations
- Provide technical training for field staff
- Create and execute a product rationalization program
- Develop new product roll-out packages

Hiring Profile

- Bachelor's degree or 5 years' job-related experience
- Strong understanding of chemistry and chemical interaction within PCB manufacturing
- Excellent written and oral communication skills
- Strong track record of navigating technically through complex organizations
- Willingness to travel

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Career Opportunities

Role: Vice President Gardien Taiwan
TAOYUAN COUNTY, TAIWAN

Gardien Taiwan is a service provider of circuit board (PCB) quality solutions, including electrical testing, AOI optical inspection, engineering (CAM), fixture making, repair and rework. Gardien Taiwan operates service centers in Taoyuan and employs about 100 employees and is currently seeking a vice president to manage and oversee the entity.

Candidate Profile:

- Proficiency in Chinese and English (written and spoken)
- Excellent communication and organization skills
- Experience in change management
- PCB background appreciated, but not mandatory
- Management experience in internationally operating companies
- Savvy in standard office software (Word, Excel and Power Point)

If this sounds like you, please click here to send us an email with your attached CV.

About Gardien Group - Gardien is the world's largest international provider of independent testing and QA solutions to the PCB industry with a global footprint across 24 service centres in five countries and we cater to a whole range of customers, from small family owned PCB shops to large international fabricators. Gardien's quality solutions and process standards are trusted by leading high-tech manufacturers and important industries including aerospace, defense, and medical technology.

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ZENTECH

Zentech Manufacturing:
Hiring Multiple Positions

Are you looking to excel in your career and grow professionally in a thriving business? Zentech, established in Baltimore, Maryland, in 1998, has proven to be one of the premier electronics contract manufacturers in the U.S.

Zentech is rapidly growing and seeking to add Manufacturing Engineers, Program Managers, and Sr. Test Technicians. Offering an excellent benefit package including health/dental insurance and an employer-matched 401k program, Zentech holds the ultimate set of certifications relating to the manufacture of mission-critical printed circuit card assemblies, including: ISO:9001, AS9100, DD2345, and ISO 13485.

Zentech is an IPC Trusted Source QML and ITAR registered. U.S. citizens only need apply.

Please email resume below.

apply now

Career Opportunities

Manncorp™

Sales Associate - Mexico

Manncorp, a leader in the electronics assembly industry for over 50 years, is looking for an additional sales associate to cover all of Mexico and to be part of a collaborative, tight-knit team. We offer on-the-job training and years of industry experience in order to set up our sales associate for success. This individual will be a key part of the sales cycle and be heavily involved with the customers and the sales manager.

Job responsibilities:

- Acquire new customers by reaching out to leads
- Ascertain customer's purchase needs
- Assist in resolving customer complaints and queries
- Meet deadlines and financial goal minimums
- Make recommendations to the customer
- Maintain documentation of customer communication, contact and account updates

Job requirements:

- Located in Mexico
- Knowledge of pick-and-place and electronics assembly in general
- 3+ years of sales experience
- Customer service skills
- Positive attitude
- Self-starter with ability to work with little supervision
- Phone, email, and chat communication skills
- Persuasion, negotiation, and closing skills

We offer:

- Competitive salary
- Generous commission structure

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Mentor®
A Siemens Business

PCB Manufacturing, Marketing Engineer

Use your knowledge of PCB assembly and process engineering to promote Mentor's Valor digital manufacturing solutions via industry articles, industry events, blogs, and relevant social networking sites. The Valor division is seeking a seasoned professional who has operated within the PCB manufacturing industry to be a leading voice in advocating our solutions through a variety of marketing platforms including digital, media, trade show, conferences, and forums.

The successful candidate is expected to have solid experience within the PCB assembly industry and the ability to represent the Valor solutions with authority and credibility. A solid background in PCB Process Engineering or Quality management to leverage in day-to-day activities is preferred. The candidate should be a good "storyteller" who can develop relatable content in an interesting and compelling manner, and who is comfortable in presenting in public as well as engaging in on-line forums; should have solid experience with professional social platforms such as LinkedIn.

Success will be measured quantitatively in terms of number of interactions, increase in digital engagements, measurement of sentiment, article placements, presentations delivered. Qualitatively, success will be measured by feedback from colleagues and relevant industry players.

This is an excellent opportunity for an industry professional who has a passion for marketing and public presentation.

Location flexible: Israel, UK or US

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Career Opportunities

BLACKFOX
Premier Training & Certification

IPC Master Instructor

This position is responsible for IPC and skill-based instruction and certification at the training center as well as training events as assigned by company's sales/operations VP. This position may be part-time, full-time, and/or an independent contractor, depending upon the demand and the individual's situation. Must have the ability to work with little or no supervision and make appropriate and professional decisions. Candidate must have the ability to collaborate with the client managers to continually enhance the training program. Position is responsible for validating the program value and its overall success. Candidate will be trained/certified and recognized by IPC as a Master Instructor. Position requires the input and management of the training records. Will require some travel to client's facilities and other training centers.

For more information, click below.

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YOUR JOB AD HERE

For information, please contact:
BARB HOCKADAY
barb@iconnect007.com
+1 916.365.1727 (PACFIC)

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Get heat relief with low-temperature soldering!

I-007e Books

I-007eBooks.com

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Events Calendar

18th Annual NW Electronics Design & Manufacturing Expo ▶
October 3, 2018
Tektronix, Beaverton, Oregon, USA

SMTA International ▶
October 14–18, 2018
Rosemont, Illinois, USA

International Wafer-Level Packaging Conference Exhibition ▶
October 23–24, 2018
San Jose, California, USA

IMPACT 2018 ▶
October 24–26, 2018
Taipei, Taiwan

Medical Design & Manufacturing (MD&M) Minneapolis ▶
October 31–November 1, 2018
Minneapolis, Minnesota, USA

IPC Southeast Asia High Reliability Conferences 2018 ▶
November 1, 2018
Penang, Malaysia

IPC/SMTA High-Reliability Cleaning and Conformal Coating Conference ▶
November 13–15, 2018
Schaumburg, Illinois, USA

electronica 2018 ▶
November 13–16, 2018
Munich, Germany

International Printed Circuit & APEX South China Fair ▶
December 5–7, 2018
Shenzhen, China

IPC APEX EXPO 2019 ▶
January 26–31, 2019
San Diego, California, USA

Additional Event Calendars

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Coming Soon to *SMT007 Magazine:*

NOVEMBER: **MEDICAL ELECTRONICS**
A look at the opportunities and challenges in the medical electronics industry.

DECEMBER: **IPC APEX EXPO 2019: Preshow Issue**
What to expect—from new technologies and products, to demos and conferences—at the biggest event in the PCB and electronics manufacturing and assembly industries.

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