I-Connect007 GOOD FOR THE INDUSTRY

ENGINEERING SOLUTIONS FOR PCB MANUFACTURING

SMT® MAGAZINE

MARCH 2015

How to Streamline PCB Thermal Design p.18

Time to Ditch Heavy Metal for Soft Rock? An Alternate Approach to Thermal Management for LED Applications p.26

ALSO:

2015 IPC APEX EXPO Show Review p.36

THERMAL MANAGEMENT

Developments with Metallic Thermal Interface Materials

by Tim Jensen and Dave Saums, page 8

thepcblist

THE best way to find a PCB fabricator, anywhere.

Kaige Technology (Shenzhen) Co., Ltd

Shenzhen, Guangdong, China

Website | Contact Me | RFQ

KAIGE

Overview | Contact | Specs | About | Videos | Photos | Brochures | News

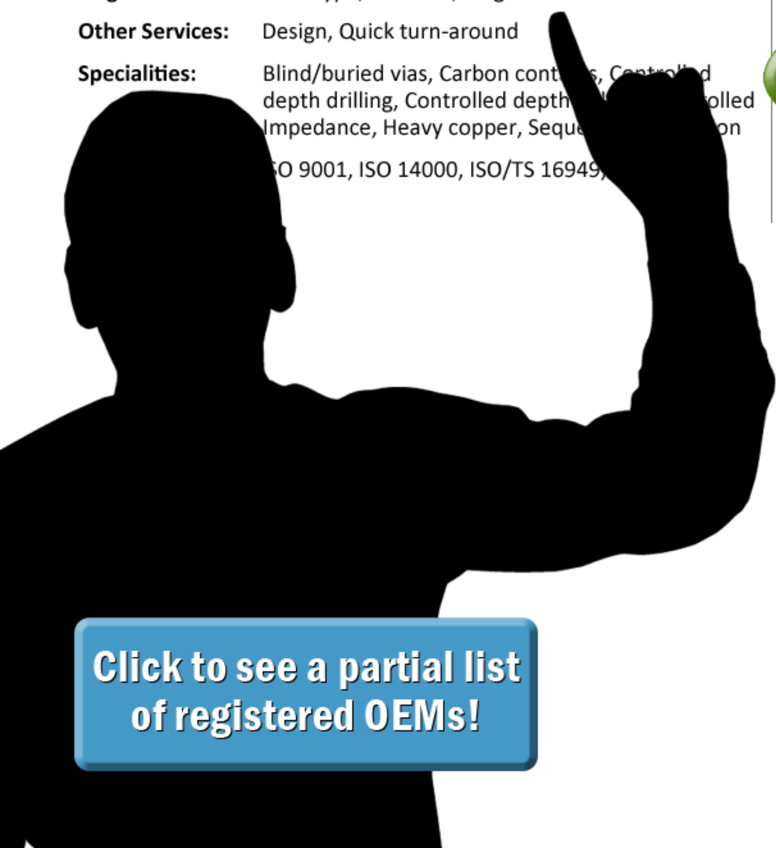
PCB manufacturer with Sales offices in US (Portland) and Europe (Spain) along with our HQ in China (Shenzhen). We also have local Area Sales Managers in various EU countries. We supply local sales and technical support for all our customers around the globe.

We offer best market prices for small, medium volumes along with unbeatable prices for high volumes. By having our own sales people strategically placed we eliminate all the intermediate companies.

Try us out, we will not fail you.

Markets:	Automotive, Communication, Consumer, Industrial
Board Types:	Single-sided, Double-sided, Multilayer
Mfg Volumes:	Prototype, Medium, Large
Other Services:	Design, Quick turn-around
Specialities:	Blind/buried vias, Carbon cont s, Controlled depth drilling, Controlled depth olled Impedance, Heavy copper, Seque on
	O 9001, ISO 14000, ISO/TS 16949

Click here to see a demo



Click to see a partial list of registered OEMs!

Why YOU should Showcase:

- Capabilities listing for advanced search functionality
- Specialties and certifications listing
- Ability to upload brochures and videos
- Quick and easy "Contact" and "RFQ" buttons
- News, web and contact links

www.thepcblist.com

www.smta.org

SMTA

2015 CALL FOR PARTICIPATION

- ❖ Share your research to industry colleagues
- ❖ Get great exposure for you and your company
- ❖ Opportunities to network

Submit an abstract TODAY for an upcoming SMTA educational program

Surface Mount Technology Association • www.smta.org • (952) 920 - 7682

Upcoming Abstract Deadlines

SMTA International

Deadline Extended: March 13th
Event: Sept 27- Oct 1
Rosemont, IL
*Paper required

Counterfeit Electronic Parts and Electronic Supply Chain Symposium

Abstract Deadline: March 20th
Event: June 23-25
College Park, MD
*Presentation Only

IWLPC – Int'l Wafer-Level Packaging Conference

Abstract Deadline: April 17th
Event: October 13-15 | San Jose, CA
*Paper required

Medical Electronics Symposium

SMTA/MEPTEC/iNEMI
Abstract Deadline: May 1st
September 16-17, 2015 | Portland, OR
**Presentation Only*

LED A.R.T. Symposium

Abstract Deadline: June 5th
Event: November 17-19, 2015 | Atlanta, GA
**Presentation Only*

All submissions must be non-commercial in nature and focus on technology research rather than a company product.

Submit your abstract online at www.smta.org
or contact Patti Coles at patti@smta.org, (952) 920-7682

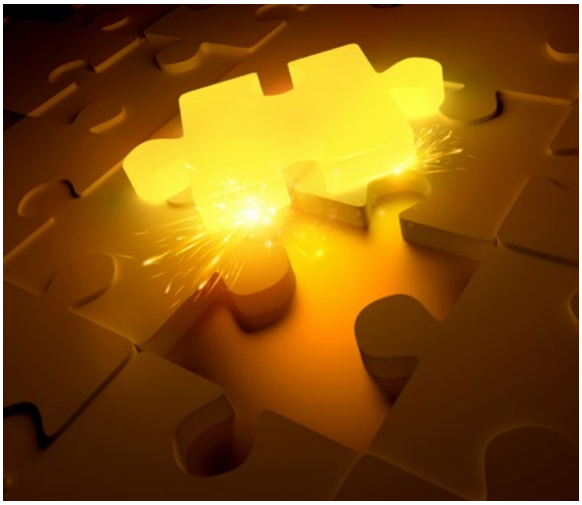
SMT MAGAZINE
I-Connect007
GOOD FOR THE INDUSTRY

Featured Content

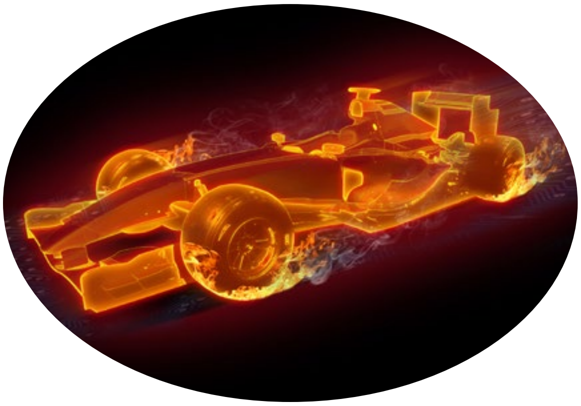
THERMAL MANAGEMENT

Industry experts from Indium, Mentor Graphics, and Alpha Circuit are on hand this month to guide us through issues related to thermal management, including latest trends, alternative approaches and streamlining PCB thermal design.

8 Developments with Metallic Thermal Interface Materials
by Tim Jensen and Dave Saums



18 How to Streamline PCB Thermal Design
by John Parry



26 Time to Ditch Heavy Metal for Soft Rock? An Alternate Approach to Thermal Management for LED Applications
by Yash Sutariya and Thomas S. Tarter

The SMT Source™

Latest News About Manncorp SMT Assembly Equipment

March 2015

BIG Savings On New Turnkey Systems

Fully-Automated, High-Mix SMT 10,500 CPH

Inline Stencil Printer AP430

3-Head Pick and Place MC-389

Conveyor CT90

Convection Reflow Oven CR-5000

3-Day Installation and Training Included*
(Travel and Lodging Expense Included)

$199,000 Value
Now Only **$169,995**
$3,442/mo. financing

Ideal OEM Production Line

Stencil Printer MC110

Pick and Place MC-400

Convection Reflow Oven CR-4000C

2-Day Installation and Training Included*
(Travel and Lodging Expense Included)

$83,500 Value
Now Only **$69,995**
$1,431/mo. financing

*US & Canada through April 15, 2015

Manncorp™

www.manncorp.com

East Coast (Huntingdon Valley, PA) 800.PIK.MANN (745.6266) • West Coast (San Diego, CA) 888.PIK.MANN (745.6266)
Mexico: 52 1 656 217 8215

MARCH 2015
VOLUME 30
NUMBER 3
www.smtmagazine.com

SMT® MAGAZINE

ENGINEERING SOLUTIONS FOR PCB MANUFACTURING

CONTENTS

SHOW REVIEW

36 2015 IPC APEX EXPO Show Review

ARTICLES

52 High-Reliability Thanks to Adhesives
by Kevin Balben

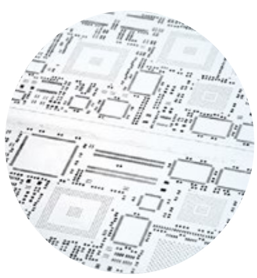
58 Industry 4.0 Initiatives
by Markus Mittermair

COLUMNS

66 A Summary of Counterfeit Avoidance: Development & Impact
by Todd Kramer

72 How to Select an Automatic Pick-and-Place Machine
by Robert Voigt

76 Adapting Stencils to Manufacturing Challenges in 2015
by Rachel Miller-Short



VIDEO INTERVIEWS

24 Bright Future/Bright Plan: Photostencil

61 Solution for High-Temperature Applications

NEWS HIGHLIGHTS

64 Mil/Aero

70 Market

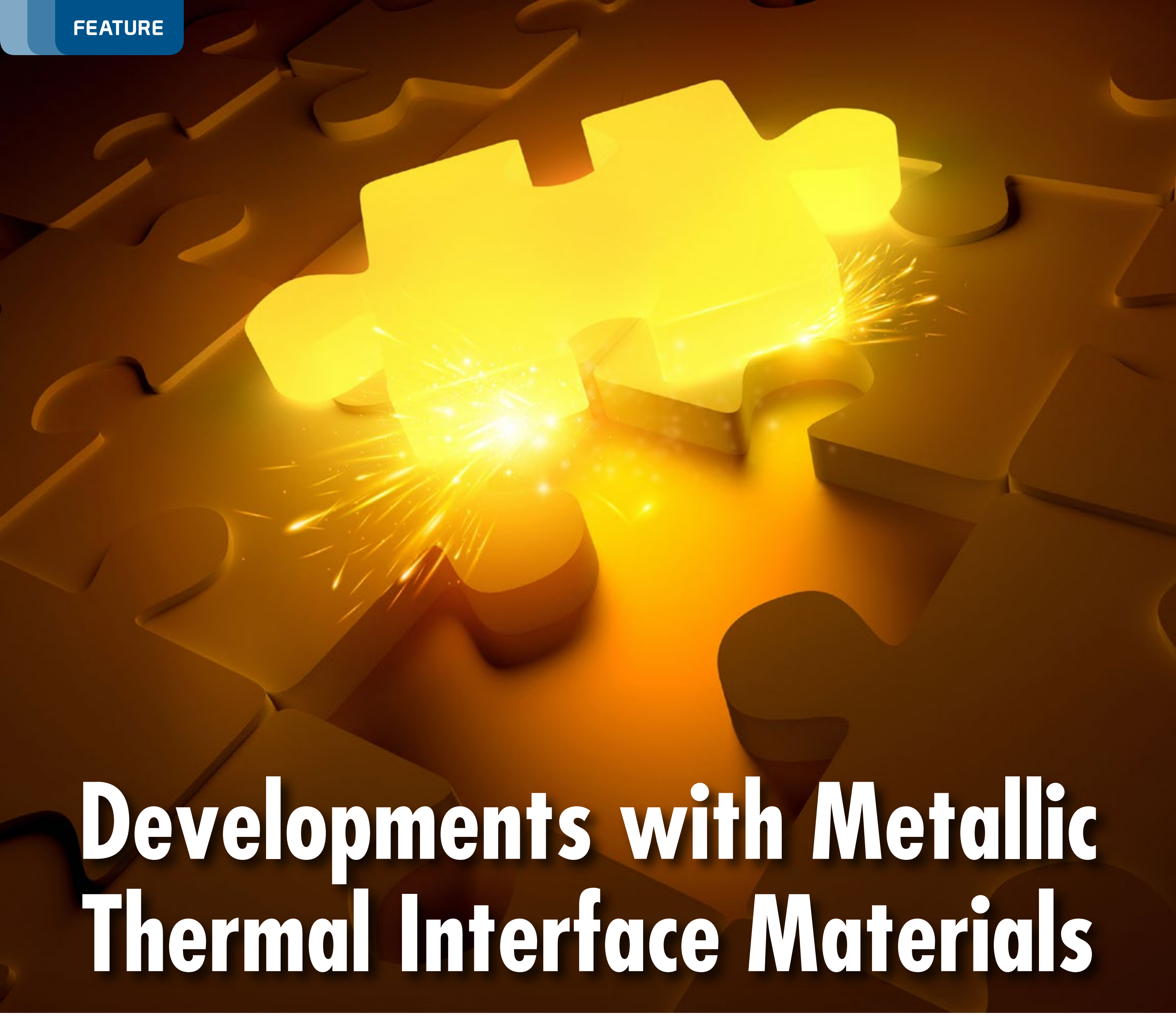
80 SMT007

EXTRAS

82 Events Calendar

83 Advertiser Index & Masthead

FEATURE



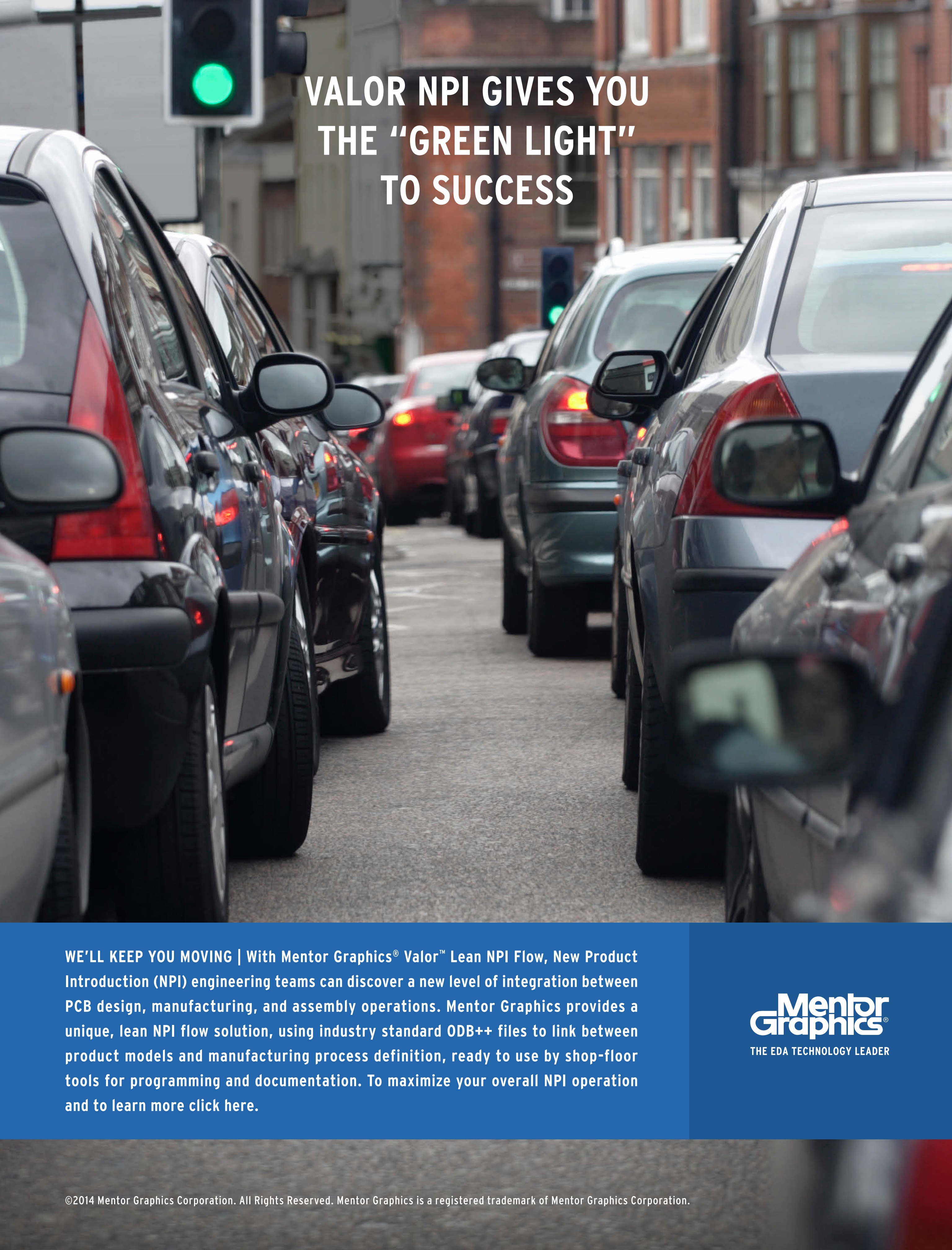
Developments with Metallic Thermal Interface Materials

by Tim Jensen and Dave Saums
INDIUM CORPORATION

Reliability of electronic modules and systems is critical. For decades, the need for temperature modulation and control has been identified as a principal factor impacting semiconductor and packaging reliability. In most electronic systems, individual semiconductors are designed, manufactured, and sold for application within a system manufacturer's product. The interface between the external mounting surface of the semiconductor package and any required thermal management component is increasingly the center of attention as efforts continue toward improving the performance and reliability of the overall system.

Thermal Interface Material Function

Thermal interface materials (TIM) provide a critical function on the external surface of the module or device and within a semiconductor package, such as a high-performance server processor module where several semiconductor die and one or more heat spreaders or a module lid are employed to provide the most effective heat transfer possible. The critical role of the thermal interface material is to improve the efficiency of heat transfer from the external mating surface of the semiconductor device and the surface to which it is attached, typi-


VALOR NPI GIVES YOU
THE "GREEN LIGHT"
TO SUCCESS
WE'LL KEEP YOU MOVING | With Mentor Graphics® Valor™ Lean NPI Flow, New Product Introduction (NPI) engineering teams can discover a new level of integration between PCB design, manufacturing, and assembly operations. Mentor Graphics provides a unique, lean NPI flow solution, using industry standard ODB++ files to link between product models and manufacturing process definition, ready to use by shop-floor tools for programming and documentation. To maximize your overall NPI operation and to learn more click here.
Mentor Graphics®
THE EDA TECHNOLOGY LEADER

cally an air-cooled heat sink, liquid cold plate, or the metal surface of some other component.

Application Interface Conditions and Impact on Thermal Performance

The ideal interface consists of metal-to-metal contact across the contact area, which would require precision machining and polishing of the two surfaces to a degree and also add significant manufacturing costs to those components. In lieu of a set of ideal polished surfaces, the efficient TIM provides a very thin thermally-conducting material which, given variation in metal surfaces, may vary in thickness through the interface. The thickness of the metal TIM at various points across the interface would be determined by several factors: the type of mechanical fasteners used to attach the device to the heat sink or cold plate, the amount of clamping force exerted, the location of the fasteners, and the degree of roughness and flatness of the two manufactured surfaces. The surface of a liquid cold plate, for example, may be a machined surface of a casting (which may expose internal voiding within the casting), the machined surface of an aluminum or copper cold plate, or the raw extruded surface of an aluminum cold plate, if no machining is specified. The mating surface of the heat sink or cold plate may also have variations due to warpage or bending (depending on the thickness), the care exercised when handling during manufacturing and assembly, and the relative clamping force applied versus the stiffness and strength of the heat sink or cold plate.

If mechanical fasteners such as screws or bolts are located only at the periphery of a large module, the flatness of the module metal baseplate can be altered as fasteners are torqued into place. This can change the physical characteristics of the interface when measured at a greater distance from the locations of the fasteners. For instance, standard power semiconductor modules, known as isolated gate bipolar transistors (IGBTs), are very common components used in electrical drives and machine tools, controlling wing flaps and actuators for aircraft, and switching devices within electrical inverters for propulsion powertrains in vehicles. Standard IGBT module footprints have industry-standard dimensions, with specified locations for fasteners, which are typically at the periphery of the device. There are also some industry designs for small modules, which include one or more fasteners in the center of the device.

Characteristics of Well-Performing TIMs

The highest-performing TIMs must be capable of adapting to varying surface conditions and the specifications of a given application. These factors include:

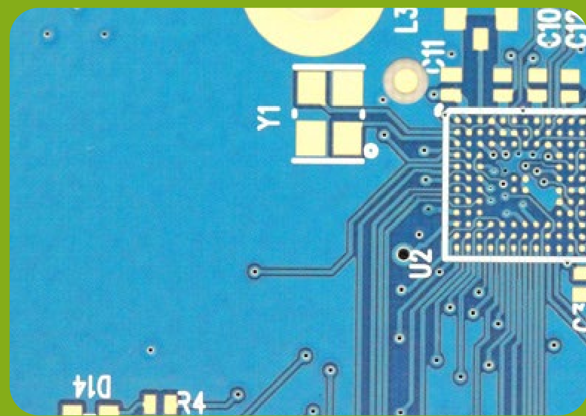
- Surface flatness of the mating surfaces
- Surface roughness of the mating surfaces
- Type, number, and placement of fasteners (screws, bolts, clips, use of ancillary components such as springs)
- Clamping force applied by the fastener mechanism
- Ambient temperature, humidity, and other anticipated environmental conditions
- Temperature variation during the operation, cyclical and non-cyclical
- Mounting attitude

A common statement in the application of TIMs is that the best interface is achieved with no TIM at all, indicating the value of metal-to-metal contact. In reality, this statement must be modified such that the best-performing thermal interface materials are:

- Applied in a relatively thin layer by design, sufficient to fill the specified gap
- Exhibit very high ability to move and conform to minor surface variations and imperfections
- Exhibit a high degree of thixotropicity of the paste or compound to avoid flowing out of the interface
- Operate for the intended life of the assembly without drying, hardening, flaking, or otherwise deteriorating

The above expectations of operational performance all involve the use of TIMs using mechanical fastening to join the two surfaces. Thermally conductive adhesives also must function under similar conditions, but generally without the benefit of high clamping forces ap-

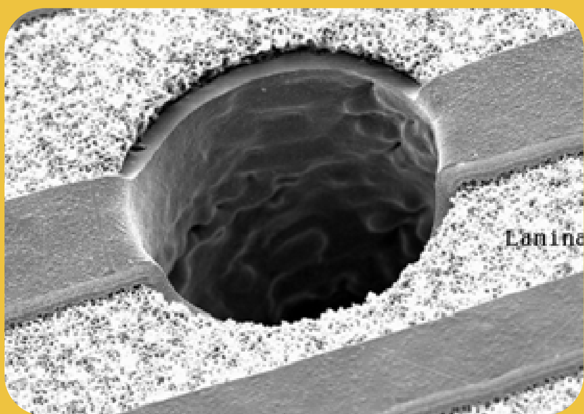
We deliver Advanced PCB Solutions!



Fine line PCB, 2 mil line /space

We have developed a unique set of processes based on electro-depositable liquid photoresist.

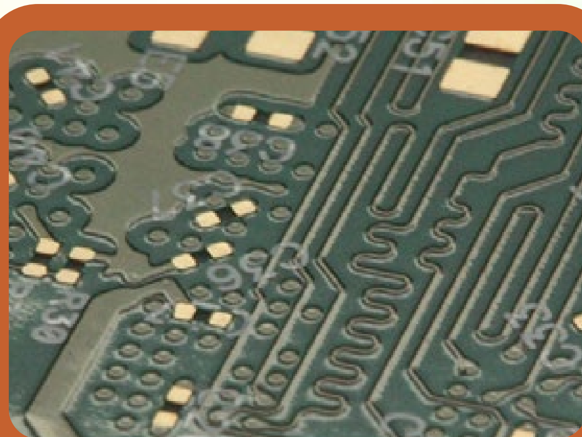
CLICK TO LEARN MORE



Landless Via Technology

We're the only manufacturer in the world to have perfected a liquid photo-imageable resist (PiP) in electrolytic form, used for all our production.

CLICK TO LEARN MORE



Impedance Tolerance <5%!

With our panel plating process combined with continuous foil lamination, our impedance tolerances are second to none!

CLICK TO LEARN MORE

Our unique processes enable us to create and deliver Advanced PCB Solutions that meet the needs of the demanding market at competitive prices!

CANDOR

CANDOR INDUSTRIES, INC.

ADVANCED PCB SOLUTIONS

www.candorind.com | sales@candorind.com | (416) 736-6306 plied by mechanical fasteners. The bulk of this discussion is focused on mechanically-clamped conditions for TIM application.

Development of well-performing TIMs must also include a set of conditions for storage, shipment, handling, assembly, and rework of the selected TIM. These conditions include specifications, which vary depending on type of material, type of electronic module and assembly, and specifics particular to a given industry market segment, such as:

- Shipping and storage temperature; humidity conditions by air, ship, truck
- Dispensability (liquid-dispensable, paste format, die-cut preform, sheet form)
- Manual placement
- Reworkability (factory rework, field rework, or both)
- Process requirements (if any) for mixing, pot life, dispensing, rework

While TIM materials traditionally have represented a very little cost in the bill of materials for a completed electronic system, the above list of operational requirements, as well as the handling, shipment, and rework requirements, presents a challenging prospect for new, well-performing material design at minimum cost.

Reliability and Failure Modes

Placing and clamping fasteners at the periphery of a module, such as a larger IGBT, can affect the gap at the interface between the IGBT module baseplate and the liquid cold plate to which it is attached. Baseplate thickness is an important factor in controlling such effects. During normal switching operation, these modules also exhibit mechanical expansion and contraction as operating junction temperatures increase and decrease. The cyclical temperature changes can affect the metal baseplate of the module, which in turn has been demonstrated to cause a mechanical pumping action at the interface. This pumping action can affect certain types of organic TIMs, such as traditional silicone-based thermal greases.

Pump-Out, Outgassing, and Run-Out

The mechanical pumping action experienced between two surfaces, such as described above with IGBT modules, contributes actively to loss of a TIM at the critical area in the interface. This phenomenon has been described in industry publications and thermal management conferences, and typically occurs with organic materials such as silicone-based thermal greases and gels and other paste forms of TIMs.

Outgassing is a reliability concern when using silicone oils as carriers, and other silicone-containing compounds. An early example of the impact of the outgassing issue, which is especially important in certain industry segments such as optoelectronics, medical electronics, and space systems, is when silicone from thermal grease is outgassed and redeposited on optical elements, such as lenses. An early internal specification, published by AT&T Technologies (today, Alcatel Lucent), prohibited the use of silicone oil-containing compounds in company manufacturing facilities. The first non-silicone-based thermal grease was introduced at that time. An increasing number of systems manufacturers continue to revise specifications to eliminate silicone compounds for reasons related to the redeposition on optical and electrical interconnects. A major power semiconductor manufacturer recently completed a major TIM testing and analysis program, eliminating the use of silicone-based TIM compounds for in-house use.

Run-out refers to the tendency of certain types of organic compounds developed as a TIM to suffer material loss at the interface due to an insufficiently thixotropic compound formulation, especially at higher temperatures, in vertical mounting orientation, or when a combination of both occurs in an application. Organic TIM formulations must be designed with the ability to remain within the interface, and a specified operating temperature range and storage (or non-operating) temperature range, including when mounted vertically.

The above three types of reliability issues apply to organic compound formulations. Specifications developed by many system OEMs include weight loss testing under the range of designed operating temperatures for new assemblies in design, as a specific analytic tool to determine whether pump-out and run-out occur.

Metallic TIM Testing to Address Failure Mechanisms

The use of a metallic TIM has been shown to provide an improvement in thermal performance through an interface, with reductions in tested thermal resistance values when compared to organic TIM compounds, such as thermal greases, phase-change compounds, gels, and other formulations. While a metallic TIM may meet certain types of application requirements, such as those where a minimal clamping force is available or where an electrically-insulating TIM is necessary, the use of flat indium foils has been prevalent for certain industry segments for decades. An example is the use of flat foils as shims beneath flange-mount RF power semiconductors for wireless and communications applications and military and aerospace systems.

A set of comparative thermal resistance test data is shown in Figure 1. This graph indicates how TIMs typically perform as pressure is increased in an assembly. The performance of silicone-based thermal greases, with relatively low bulk thermal conductivity of the compound, is dependent on a high degree of surface wetting to obtain even the relatively poor thermal resistance values at low clamping forces. The low bulk thermal conductivity of these compounds is typically less than 1 W/mK and, at the lowest pressures, the compound is relatively thick. Because metallic TIMs are solids, they do not have the ability to wet at very low pressures. This is also true of graphite sheet TIMs.

Referring again to Figure 1, the high bulk thermal conductivity of the metallic TIM, combined with the patterning applied in the Indium Corporation Heat-Spring® product, results in higher performance (measured as lower values for thermal resistance). A crossover in relative thermal resistance is achieved as pressures reach values greater than approximately 45 psi (or approximately 3 bar).

The demonstrated thermal performance of the patterned metallic TIM shown in Figure 1 has proven valuable for applications that include diode lasers, large enterprise server processor modules, power semiconductors, and RF power semiconductors.

These thermal performance improvements are also combined with other product attributes

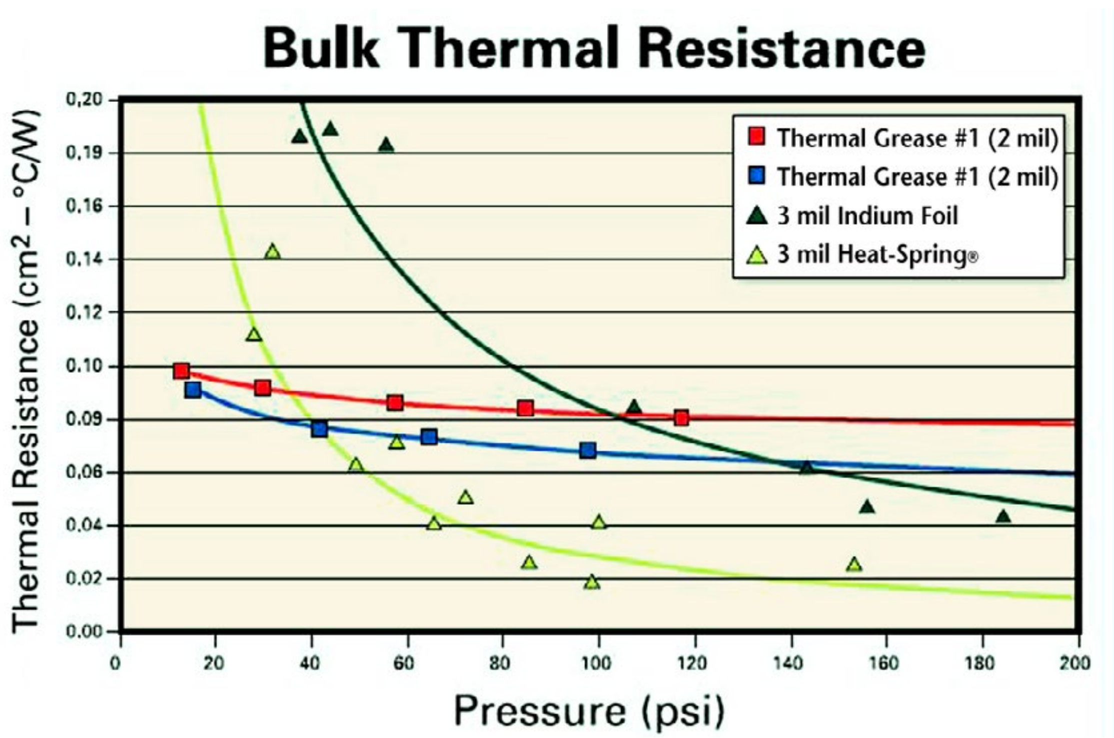


Figure 1: Developments with MTIMs.

that eliminate traditional failure mechanisms addressed above.

Indium metallic TIMs have been implemented for decades for spaceborne applications where NASA, ESA, and other space agencies have specified zero outgassing potential for any TIM.

Metallic TIMs and associated indium and metal alloy shims, also meet other system-level requirements and address these traditional failure mechanisms:

a. A metallic TIM contains no ionic contaminant, silicone oil, or other constituent subject to potential outgassing.

b. Metallic TIM products contain no organic compounds or carriers, which are subject to concerns related to pump-out, dry-out, or other separation. This is demonstrated in bake, humidity, HAST, and power cycling testing. Elevated temperature testing has shown that thermal resistance over time and temperature cycling improves as the metallic TIM continues to adapt to minute surface imperfections under clamped conditions. This is distinctly contrary to results shown with silicone thermal grease TIMs.

c. Metallic TIM preforms do not contain any compound that will run out of the interface in a vertical mounting orientation.

Additional Attributes of Metallic TIMs

While metal shims, principally manufactured as die-cut indium or indium alloy preforms, have been characterized and used in electronics system manufacturing for decades, the recent introduction of a patterned foil product as a TIM has led to increased use of these metallic TIMs for a wider range of electronics applications.

Patterning

The application of the patterning is not for cosmetic purposes. The texturing creates the equivalent of an array of compressible columns. Each of these miniature columns is available to conform to minute local imperfections on the surfaces of the interface, distributing via an applied clamping force across the mating surfaces.

The application of a metallic TIM product in an assembly, when a given clamping force is applied, results in an initial compression of the pattern columns. Each of these columns exhibits plastic flow at the yield strength until enough area of the TIM is compressed to support the load. The Heat-Spring spreads the load in a defined array. There is a time-dependent flow phenomenon that accounts for the improvement in thermal resistance over the life of the product, as the alloy continues to mold to minor surface imperfections.

> "There is a time-dependent flow phenomenon that accounts for the improvement in thermal resistance over the life of the product, as the alloy continues to mold to minor surface imperfections."

Note that different patterns have been developed for applications that require differing loads, surfaces, and TIM thicknesses. These different patterns are uniquely varied and are an additional tool in the designer's set of potential available solutions for specialized interface requirements.

Thickness and Relative Bulk Thermal Conductivity

An important attribute of metallic TIMs is that interface thermal resistance is very weakly affected by the thickness of a TIM, given the very high bulk thermal conductivity.

CTE Mismatch

Metallic TIMs can adapt to CTE mismatch requirements between two dissimilar materials or metals, including when an indium metal or indium alloy is used.

Electrical Conductivity and Performance

Metallic thermal interface materials may not be selected for any application, of course, which requires electrical isolation, such as a power transistor package with an exposed electrically-live metal tab at the mounting surface to the heat sink. This is an inherent drawback of metallic TIMs for these applications.

Electrical conductivity of a metallic TIM may, however, be a significant advantage for certain types of applications where having full electrical contact is valuable for device performance. Primary examples are flange-mount RF power transistors, where the die is mounted on a CTE-matched flange or baseplate directly in the electrical path. Signal performance of a GaN RF device, for example, may be improved with a metallic Heat-Spring TIM, when compared to the electrical performance in an identical application with a thermal grease.

Applications Requiring Strike Angle and Repeated Contact

Certain types of products have been developed to address very specific requirements in the semiconductor test and burn-in industry, where a gimbaled test head with a TIM in place on the head surface must make repeated contact with hundreds or thousands of devices under test, such as bare-die microprocessors for test and binning prior to package assembly. In these designs, the gimbaled test head requires that a TIM survive these many repeated contacts with the head surface positioned at different angles, depending on the format and size of the devices under test. This is the "strike angle" problem that has proven so difficult for so many types of TIM materials.

The relative robustness of metallic TIM materials has proven to be very valuable in these applications.

Handling and Placement

The use of a metallic TIM as a preform or shim requires a simple placement procedure, which can be either applied manually or adapted for vacuum nozzle placement. Die-cut metallic TIM preforms can be packaged in tape and reel or other easily handled formats.

Alloys, Formats, and Shapes

The Heat-Spring product family includes TIMs manufactured from indium and indium alloys; indium with a clad metal on one surface for specialized application requirements, such as semiconductor test and burn-in; and from other metals, such as tin. Use of a tin alloy can achieve a very cost-effective TIM preform. Such materials have been tested and characterized using the same thermal performance and life and reliability standards as the indium metal Heat-Spring products. A tin alloy, having a higher flow stress than indium metal, will resist flattening of the patterning under pressure. At higher clamping pressures, the load is spread more evenly and this reduces potential for substrate bowing.

Metallic TIMs, whether flat indium foils or the patterned TIM, can be die-cut to an unlimited number of footprint outlines for different package types and are made available in a variety of thicknesses.

Environmental Impact

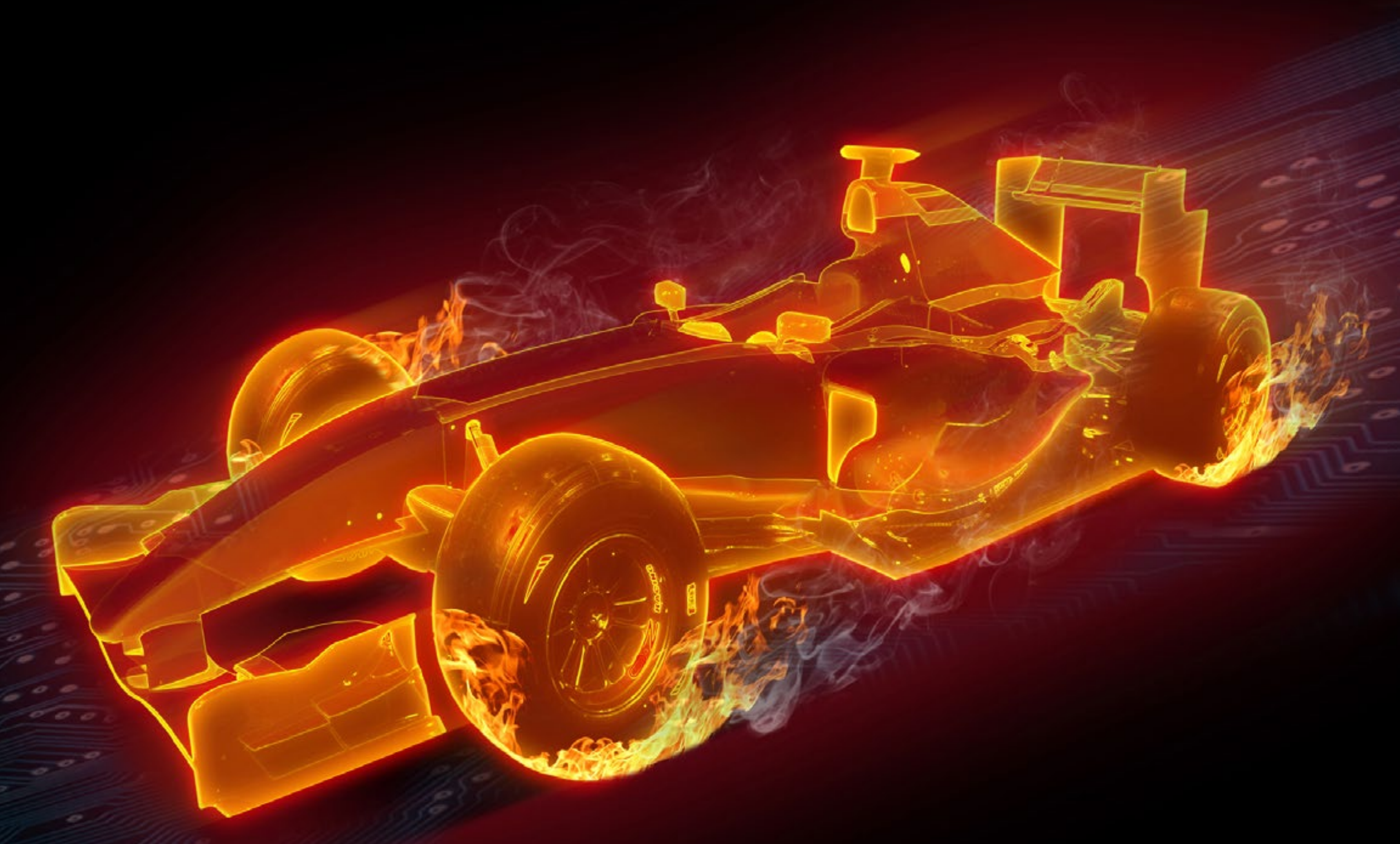
When an indium metallic TIM is selected, the material can also be reclaimed in a rework program, if processors or semiconductor modules are upgraded at a later date.

Summary

Metallic thermal interface materials have been used in electronics assemblies for decades, but typically have not been mentioned in industry discussions of thermal interfaces. Recent developments of patterned metallic interface materials, especially with indium and metals such as tin, have made additional tools available to the systems OEM thermal engineer for solving demanding thermal interface problems. These metallic TIMs have been applied in a range of applications where high performance is required, not simply as measured by thermal resistance, but also for system life and reliability in challenging operating conditions. **SMT**

Tim Jensen is senior product manager, engineered solders, Indium Corporation.

Dave Saums is an Indium Corporation advisor and founder/principal of DS&A LLC.



How to Streamline PCB Thermal Design

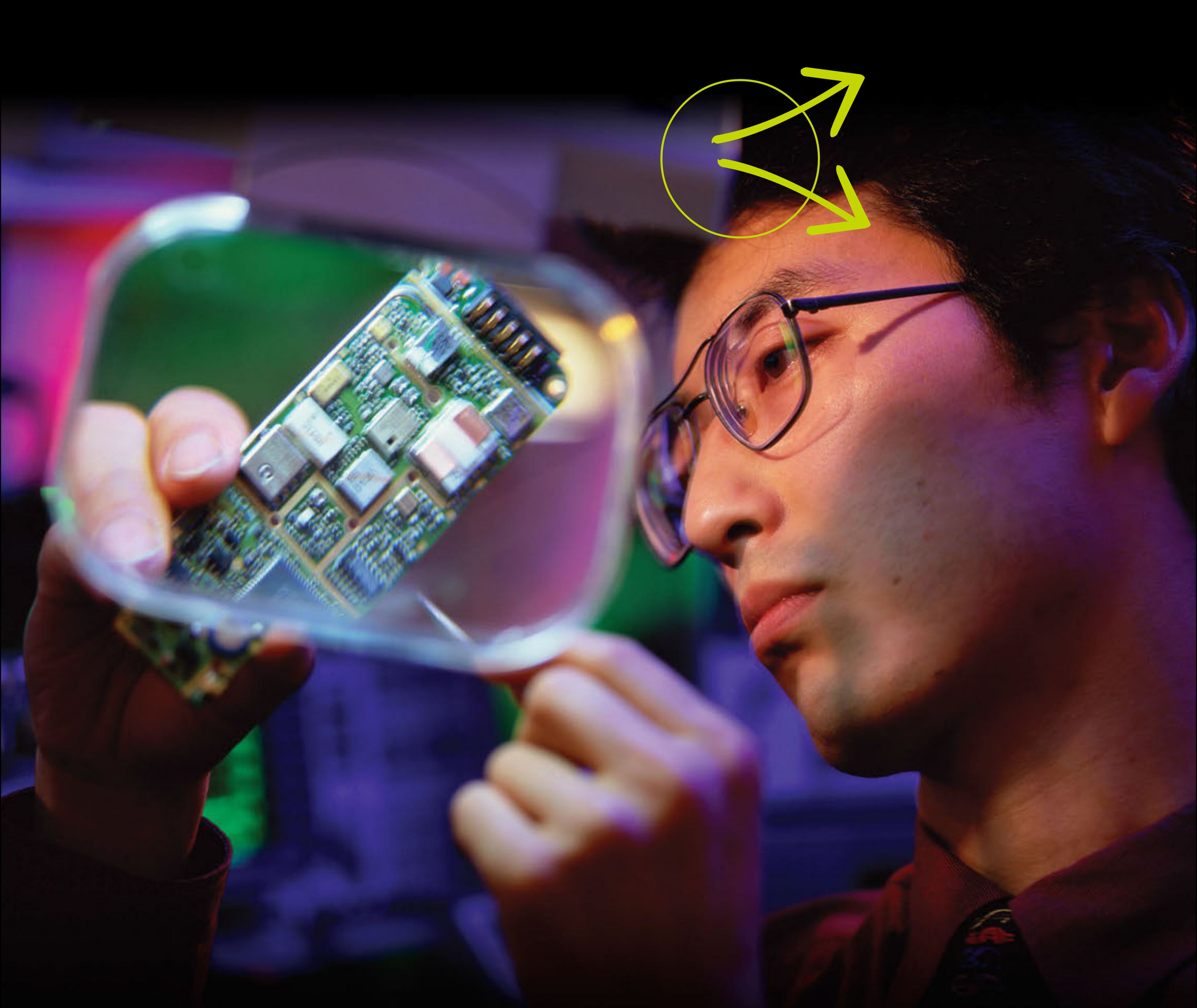
by John Parry
MENTOR GRAPHICS CORPORATION

Thermal issues with a PCB design are mostly determined during the component selection and layout phases. After this point, only remedial actions are possible if components are found to run too hot. Addressing thermal issues early in PCB design, starting at the system or enclosure level to understand the flow environment critical for air-cooled electronics, can streamline the process. Assumptions about the airflow uniformity in early design that subsequently prove unachievable can have a disastrous effect on the commercial viability of the product and meeting the market window.

Begin Before Placement and Layout

Substantial work can be done well before layout is completed within the electrical design flow. A simple representation of the enclosure[1] can provide information about the air flow profile over the board. Start by smearing the total board power over the total board surface, which will provide a temperature map that will show any hot regions that are caused by a badly distributed air flow. Treat the board as a block with an isotropic conductivity of between 5 W/mK and 10 W/mK to optimize enclosure-level air flow ahead of the PCB design.

Components inject heat locally into the board so the heat flux density into the board below a component will be higher than the average for the board. As a result, the local board



temperature will be higher than that predicted in the simulation. Refine the model before using the board temperature to estimate component temperatures. If the board temperature at any point is close to the maximum component case temperature, this limit will be exceeded once the component heat sources are represented discretely.

Guesstimate Component Power

At this stage, make a best-guess estimate of the individual power budgets for the main heat dissipating components that will be used in the design and the approximate size of those packages. This will enable describing them as footprint heat sources in the simulation, smearing the remainder of heat uniformly over the board surface.

Before Selecting the Package, Use 3D Component Models

Include some form of 3D component model in the simulation before the component selection is finalized. By feeding the thermal results back before this milestone is reached, the thermal performance will more likely be considered in the package selection criteria. Some ICs are available in more than one package style, and not all package styles perform equally well from a thermal point of view. The need for a heatsink later may be eliminated by appropriate package selection.

Component temperature, either in the form of a case temperature or junction temperature depending on how the manufacturer has specified the component, is the key measure used to indicate whether the design is thermally acceptable.

In the absence of any other information, the simplest 3D component model can be used is a conducting block. A computational fluid dynamics (CFD) thermal simulation software such as FloTHERM includes material properties that are tailored to give a case temperature prediction for different package styles. For plastic components, a thermal conductivity of 5 W/mK to 10 W/mK is recommended[2] and 15 W/mK for any ceramic components. 5 W/mK will clearly give a worst-case figure for case temperature.

The effect of the component on local air flow and, correspondingly, any downstream components is taken into account when representing the package body in 3D. Large components can shield smaller, lower profile components from cooling air. The wake formed behind a component is a region in which the same air gets recirculated, so any components in that region are likely to be hot. Try to align any rectangular components so that their long side is parallel to the primary flow direction. This reduces the overall pressure drop because the flow “sees” less of an obstruction and produces a smaller wake, minimizing the effect on downstream components.

“Include some form of 3D component model in the simulation before the component selection is finalized. By feeding the thermal results back before this milestone is reached, the thermal performance will more likely be considered in the package selection criteria. Some ICs are available in more than one package style, and not all package styles perform equally well from a thermal point of view.”

Provide the Thermal Results Back to Design

At this stage, information about the PCB’s performance can be fed back to the PCB design team. Although the simulation is relatively coarse at this stage, the principle simulation results—the airflow distribution over the board and the resulting board temperature map—are powerful tools that show what is available for cooling air and how it may affect component temperature.

These nominal component case temperature values are subject to change because they are based on an assumed layout, rough power estimates, uncertainty about package selection, unknown layer stack-up and copper distribution within the PCB, and a preliminary heatsink size and design (if already known to be necessary). However, the model is useful for investigating the effect of placement on the temperature of a component and its neighbors because adjustments can be made easily and the model re-run in a matter of minutes not hours.

The results provide some indication as to which components, if any, may need some form of heatsink, which can be investigated next. When more information is known about package selection, this helps prioritize where to invest effort in developing and redefining the components' thermal model.

Size the Heatsinks Early in Design

For any components that may be too hot, investigate how effectively a heatsink brings down the component's temperature. If the flow is mainly normal to one side of the package, a plate (or extruded) fin heatsink is likely suitable. If not, then a pin fin heatsink should be considered.

The heatsink geometry can be defined parametrically with CFD thermal simulation software. Start by making the base of the heatsink the same size as the package and investigate different numbers of fins, fin height, and fin thickness. The aim is to see if the heatsink can simply be mounted on top of the package or if a larger heatsink might be needed, which will require board real estate for the mechanical attachment (Figure 1). If so, it is essential to select an existing heatsink that provides adequate cooling performance or to design a custom heatsink before the board can be routed because the mechanical attachment for the heatsink may affect component placement.

Including the thermal resistance of the thermal interface material between the package and

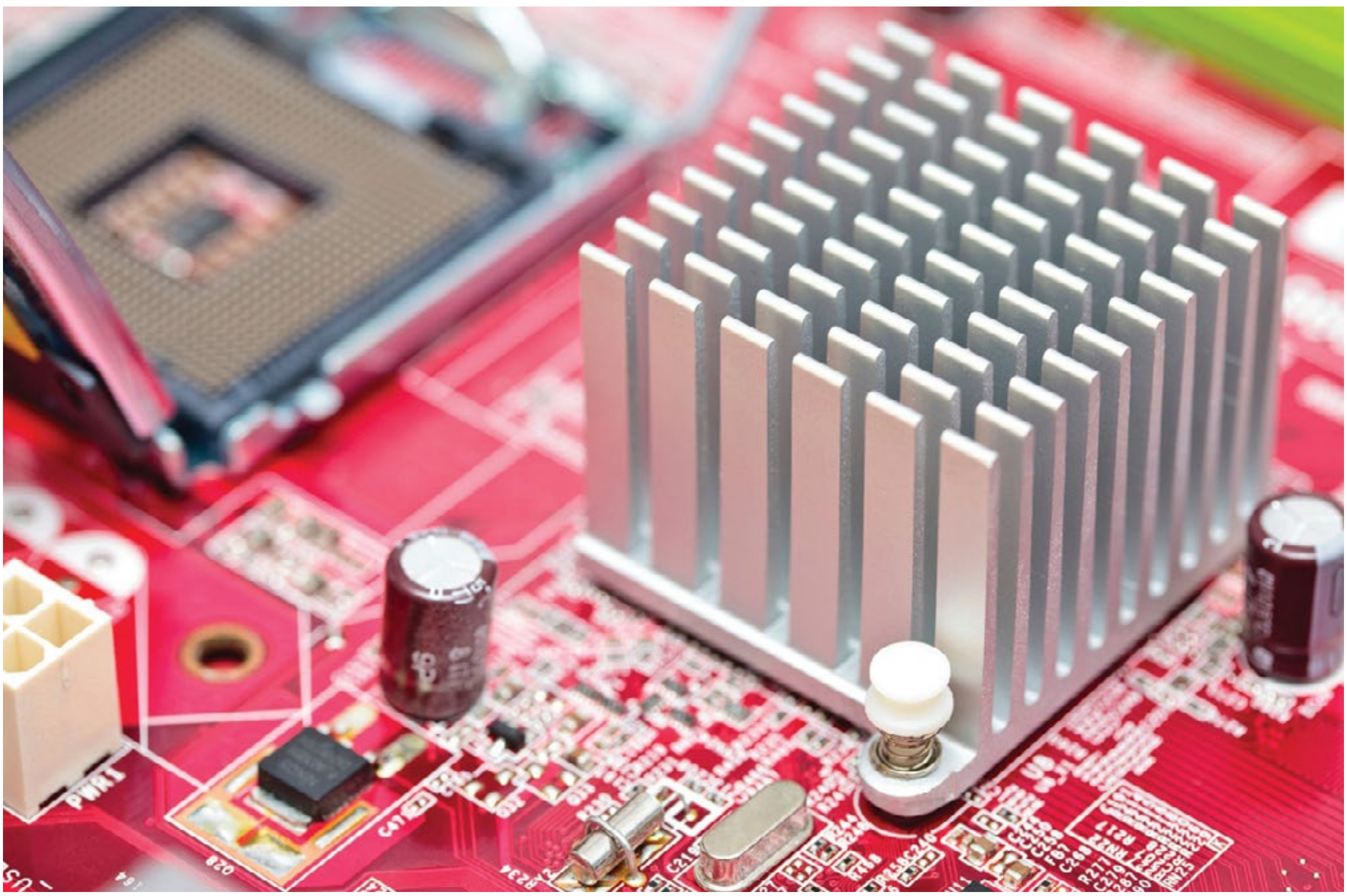


Figure 1: Example of a heatsink that extends beyond the package body with retaining pins.

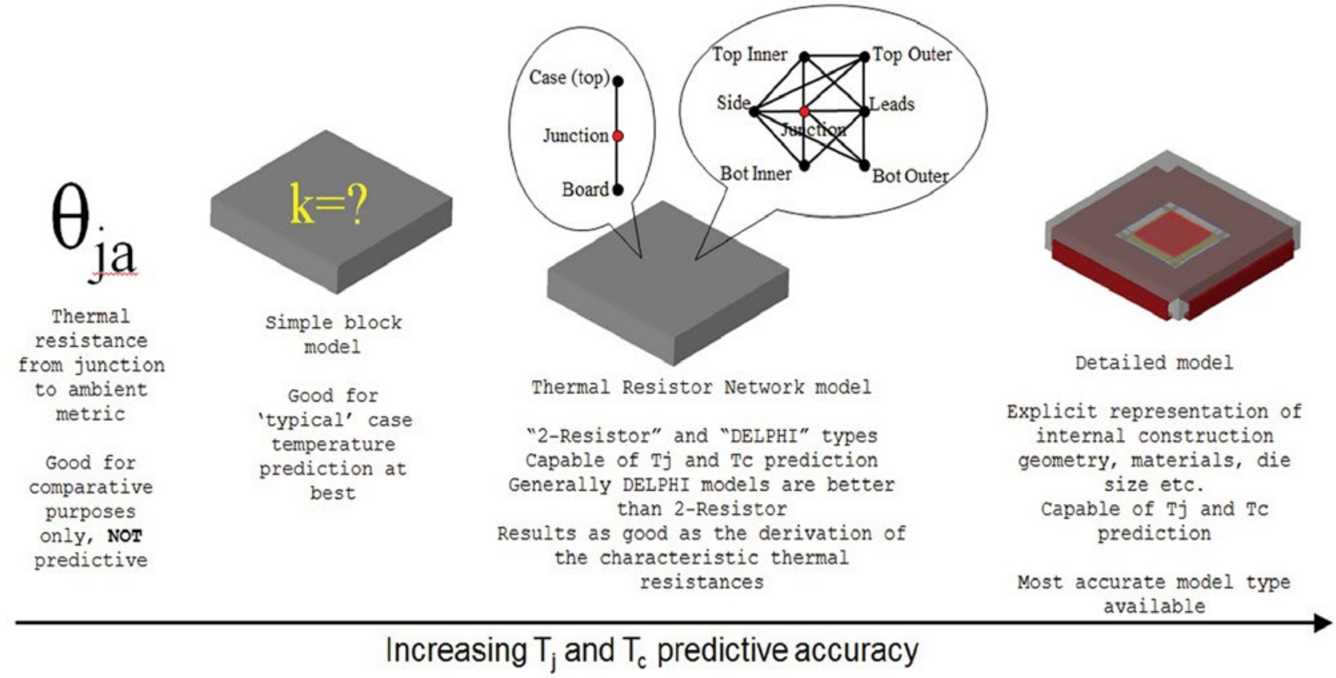


Figure 2: The package thermal information needed for good design.

the heat sink is essential. A standard thermal pad with a thickness of around 0.2 mm and a thermal conductivity of around 1.0 W/mK is conservative for early design use.

Guidance can also be given to be the design team on the most relevant thermal metrics to use to compare the thermal performance of candidate components. For components without a heatsink, the most relevant thermal metric to compare is the junction-to-board resistance[3]. For components that are expected to have a heatsink the junction-to-case resistance is the most relevant because the resistance is usually defined for the face that is in contact with the heatsink[4]. For TO-type packages, this face is normally soldered to the PCB. If both of these metrics are available, a JEDEC standard 2-Resistor model (Figure 2) can be created and the thermal model re-run to get a first estimate of junction temperature[5].

The next level up for predictive accuracy is a DELPHI model[6]. DELPHI models are better for heatsink selection than 2-Resistor models because the top surface is subdivided into inner and outer regions that have different temperatures. They can be used to initially investigate the effect of heatsink base thickness. However, for thermally critical packages that require a heatsink, a detailed model should be used.

Incorporate PCB Design Details and Import Back to EDA

Once the placement has been broadly defined, the most useful information that can be obtained after the schematic capture, but before the board is routed, is the layer stack-up of the board. Obtain an estimate of the number of each type (signal, or power/ground) of layer in the PCB, then upgrade the model of the PCB to include each of these layers individually. Before routing an estimate needs to be made for the thickness and percentage copper coverage of each non-dielectric layer.

The final step is to import component placement data from the design system to ensure that placement within the thermal tool is correct and should be re-imported whenever the layout is changed.

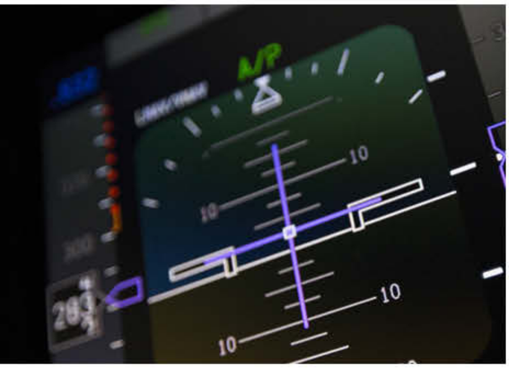
The thermal design from a mechanical perspective as well as an electrical perspective can be done in parallel. The two approaches complement one another and can lead to the thermal design closing faster, far more reliably, and with a better outcome than if thermal design is undertaken in only one flow. **SMT**

References

For more details on this process, see the paper "10 Tips for Streamlining PCB Thermal Design: A High-Level How-To Guide," Mentor Graphics Corporation.

1. "12 Key Considerations in Enclosure Thermal Design… A High-Level 'How To' Guide," Mentor Graphics Corporation.
2. Tony Kordyban, "Estimating the Influence of PCB and Component Thermal Conductivity on Component Temperatures in Natural Convection," Third International FloTHERM User Conference, September 1994, Guildford UK.
3. "Integrated Circuit Thermal Test Method Environmental Conditions"Junction-to-Board," JEDEC JESD51-8, October 1999.
4. "Transient Dual Interface Test Method for the Measurement of the Thermal Resistance Junction to Case of Semiconductor Devices with Heat Flow through a Single Path," JEDEC Standard JESD51-14, November 2010.
5. "Two-Resistor Compact Thermal Model Guideline," JEDEC Guideline JESD15-3, July 2008.
6. "DELPHI Compact Thermal Model Guideline,. JEDEC Guideline JESD15-4, October 2008.

John Parry, PhD, is electronics industry manager, Mechanical Analysis, at Mentor Graphics Corporation, and serves on the JEDEC Thermal Standards Committee.



TIME TO DITCH HEAVY METAL FOR SOFT ROCK?

An Alternate Approach to Thermal Management for LED Applications

by Yash Sutariya
ALPHA CIRCUIT CORPORATION/
SATURN ELECTRONICS CORPORATION,
and Thomas S. Tarter
PACKAGE SCIENCE SERVICES LLC

I've been writing on thermal management for LED applications for a few years now, seemingly on an endless quest to find the next best thing for LED PCBs. It's been kind of like Indiana Jones and his search for the Holy Grail, except I don't have cool bullwhip skills.

To date, we've focused on calculating thermal management needs as well as explore other alternatives to MCPCBs to achieve thermal management, such as standard plated through holes in FR4 material. I'd say at this point the industry has reached a saturation point when it comes to knowledge on how to dissipate heat (of course you never know what's around the corner).

I think now it's time to move on to a topic that we've overlooked when it comes to PCBs for LEDs: *reliability!*

I think the reason we've overlooked reliability is because it is traditionally associated with via life under thermal cycling conditions. Since most LED PCBs are single sided, this really hasn't been an issue. However, if you look above the waterline, there is another weak link—the solder joint. Some OEMs in the industry have been performing studies on the life of their LED products. While the bulbs themselves are said

to have useful lives in excess of 30+ years, they are finding out that the actual LED assemblies can fail in as little as 5–6 years.

Initial analysis is pointing to the significant X and Y axes CTE differences between the solder joint, copper circuitry layer, thermally conductive dielectric, and the aluminum. The net result of the CTE differences is a shear effect being created that can eventually disrupt the solder joint, which results in operational failure. Depending upon how accurate this information is, it could mean the start of a whole new approach to PCBs for LED applications.

Below is an abstract of a white paper written by Thomas Tarter from Package Science Services, which performed initial testing on carbon fiber and graphite based materials provided by Stablcor Technology Inc. The carbon fiber constraining cores (CFCC) materials evaluated are carbon-fiber and/or graphite reinforced epoxy cores to aid in heat dissipation, rigidity, weight reduction, and CTE control. These cores can be used independently or in conjunction with current MCPCBs to produce functionally improved heat dissipation while reducing the CTE mismatch currently present on LED assemblies.

Abstract: Introduction and Model Parameters (by Thomas Tarter)

Thermal performance for PCB structures are investigated in the form of steady-state finite-element models of various stack-ups of commonly used materials for LED applications. The models show the effect of materials used in the stack up including FR-4, aluminum, copper, graphite and CFCC. The goal of the study is to compare relative thermal behavior of typical boards modified with the enhanced core materials. The materials are inserted into standard PCB stack-up configurations as an added or replaced layer. Models are solved for maximum temperature on a 25 mm x 25 mm coupon with a 2 mm x 2 mm-square heat source. The stack up resembles substrates known as 'metal-clad' where the dielectric and topside copper are laminated directly onto a metal substrate. In addition, FR4 boards are used as a worst-case comparison. A simple stack up is used as shown in Figures 1 and 2. Figure 1 shows a typical stackup for a metal-clad assembly. Figure 2 shows the stackup with an added CFCC.

Variables used in the study include material properties and layer thickness. The primary variables are top side copper thickness/weight, dielectric thickness and base material thickness. Table 1 lists the ranges for geometry and material properties. The heat source is simulated as a planar load, directly on the surface of the top-layer copper. One watt is applied over a 2 mm x 2 mm square area in the center of the coupon. The models are solved in natural convection with an ambient temperature of 30°C.

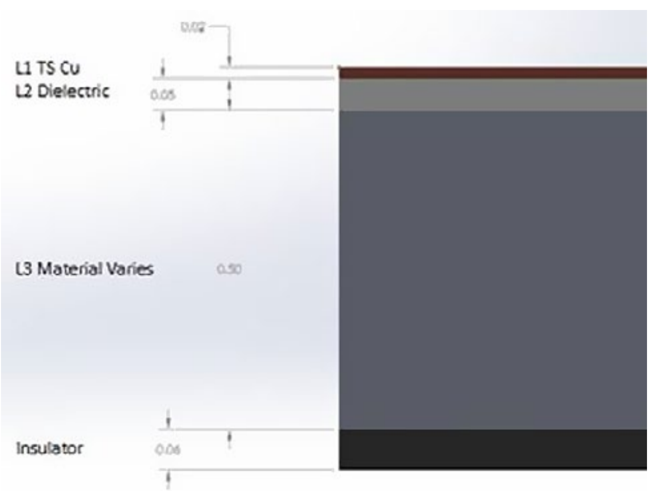


Figure 1: Typical stackup.

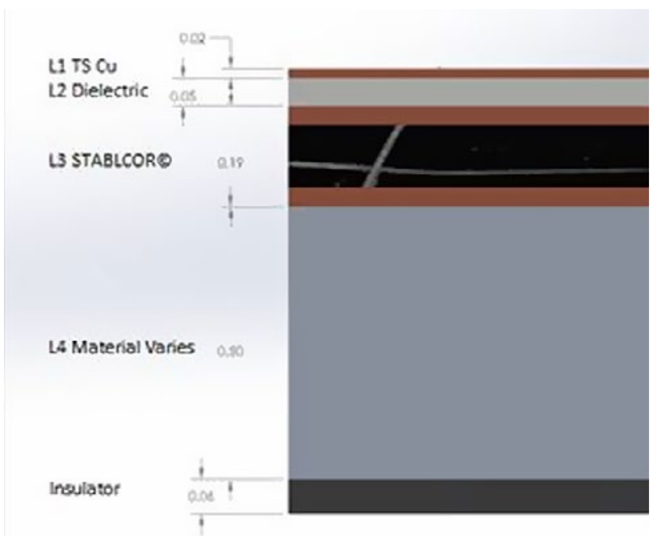


Figure 2: Inserted CFCC.

Layer	Thickness (mm)	Thicknes (in)	Material
L1 Top Side Cu	.018 - .213mm	.0007 - .0084in	Cu (1/2oz to 6oz)
L2 Dielectric	0.05 -0.15mm	.002 - .006in	Epoxy (HiK)
L3 ST-10 CFCC	.114 - .23mm	.0045 - .009in	ST-10
L4 Base	0.5 - 2mm	.02-.08in	Al, Cu, FR4
Insulation	.06mm	.0024in	Polyimide

Table 1: Model study variables.

Material	kx (W/mK)	ky (W/mK)	kz (W/mK)
Cu	390	390	390
Dielectric	2	2	2
ST-10 CFCC	75	75	0.5
Graphite	800	800	10
Base (FR4)	0.2	0.2	0.2
Base (Al)	137	137	137
Base (Cu)	390	390	390
Insulation	0.2	0.2	0.2

Table 2: Thermal conductivity.

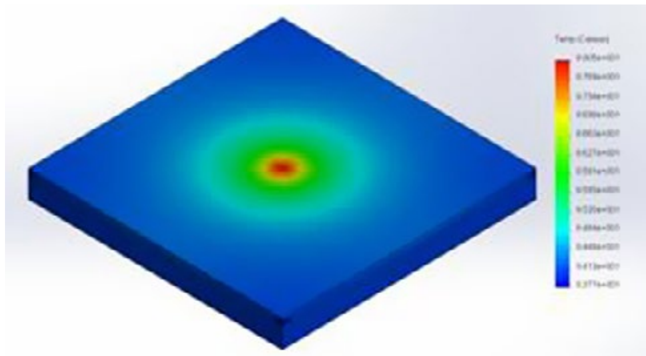


Figure 3: Typical contour plot of a solution.

Table 2 lists the thermal conductivity values of the materials used.

Results

Over 200 model cases were solved across the materials and geometries involved. Due to space limitations, a summary of the primary results will be discussed. Results are reported as maximum temperature (Tmax) for reference. Figure 3 shows a typical contour plot of a solution. In general, the greatest effects on Tmax are the thickness of the topside Cu layer and the thickness of the base. But, some interesting relationships are seen. For low-k materials the topside Cu thickness has the greatest impact. As the thermal conductivity of the base material increases the topside copper thickness has less impact. This is due to the fact that, for low thermal conductivity bases, most of the heat is being conducted away, through the topside copper layer. As the base k increases, more heat is removed through the mass of the base. Figure 4 shows the relationship between Tmax, base thickness and topside copper thickness for FR4, Al, Cu and graphite bases. The dielectric thickness is held constant at 50 µm. The X-axis of the graph is topside Cu weight and the Y-axis is Tmax. The data is grouped by material and base thickness. It is clear that the low thermal conductivity FR4 with thin copper generates the highest Tmax of around 150°C. The higher k material results show that topside Cu thickness has less of an effect than the base thickness. It could be argued that the performance of the high-k base materials can be approximated with thick topside copper. Three ounces of copper places the Tmax of the FR4 coupon at roughly 10–15°C higher than the high-k base materials. Realize also that this model uses a solid plane of copper on the topside. An actual circuit would have less than 100% copper coverage and would yield less desirable results. But, the base materials do provide 100% coverage so these values would remain approximately the same with patterned topside metal.

Figure 5 shows the same data with one 4.5 mil (114 µm) layer of CFCC (1 oz copper cladding) inserted into the stackup. Due to the

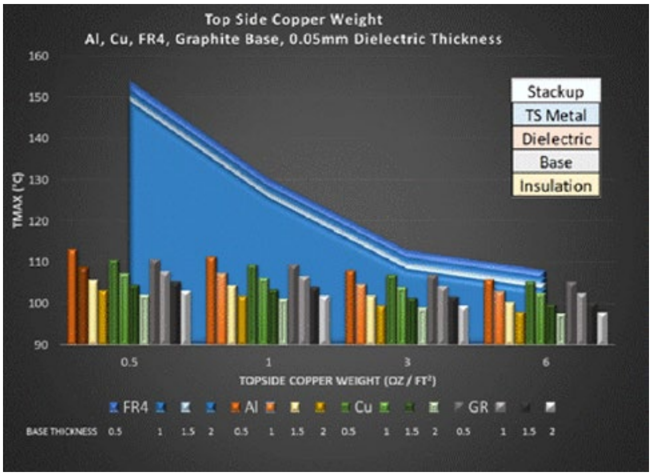


Figure 4: Standard stackup.

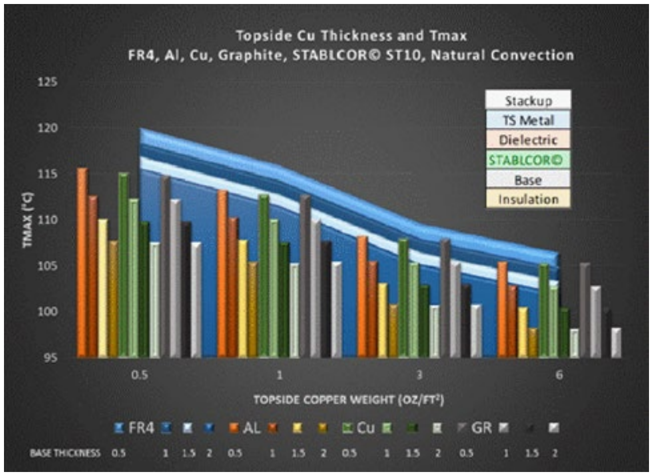


Figure 5: Stackup with Stablcor®.

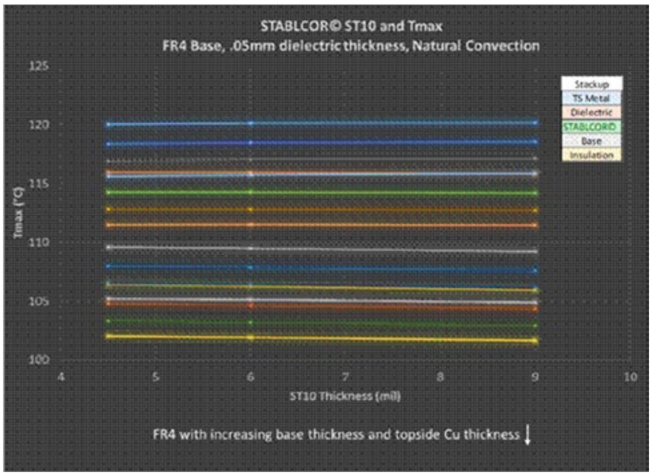


Figure 6: Stablcor® thickness.

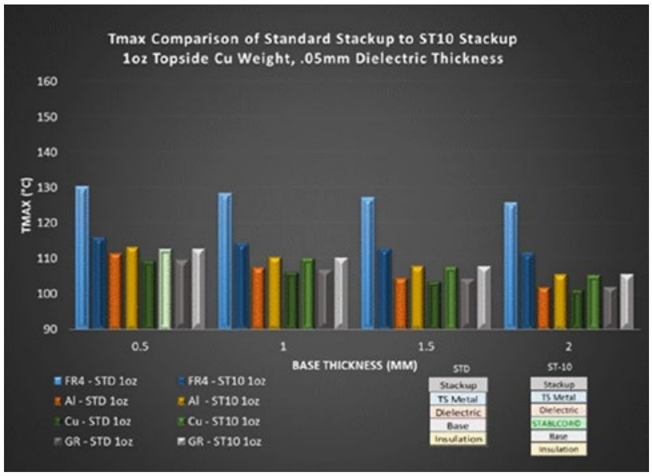
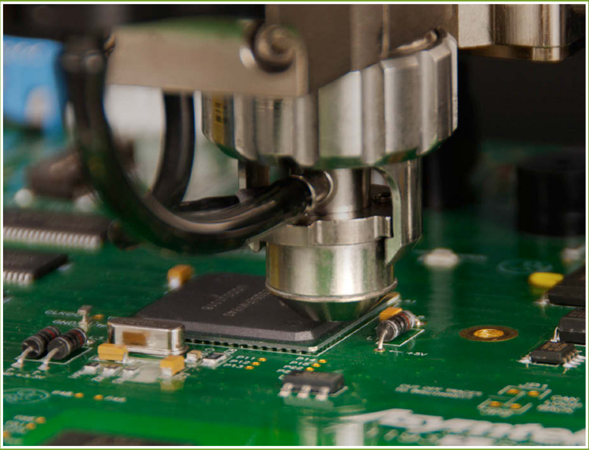


Figure 7: Comparison.

higher in-plane thermal conductivity of CFCC layer the topside Cu weight has less of an effect on the FR4 case, but more effect on the high-k base material cases. Note that Tmax for the FR4 case dropped dramatically with the addition of the 4.5mil thick layer of CFCC but that Tmax for the high-k base materials are about the same. The composite layer greatly improved the performance of the low-conductivity material.

Another interesting feature is shown in Figure 6. Here we see that regardless of the CFCC layer thickness, Tmax remains about the same. This implies that a very thin layer of the composite core is all that is needed to provide enhanced heat removal. Increasing thickness of the layer does not affect thermal performance, but will increase mechanical stability and CTE control.

Figure 7 is a summary of the data with ½ oz. topside copper and 50 µm dielectric thickness. The base thickness increases along the X-axis. The Y-axis is Tmax. One-half oz. copper is the worst case coverage, approximating patterned topside metal of higher weight. The chart shows a comparison of the materials with and without the CFCC materials inserted. The most dramatic effect is seen in the FR4 case, where the addition of the composite layer reduced Tmax by 35°C. For higher conductivity base layers of aluminum, copper and graphite, the addition of the CFCC layer increased Tmax by 2–5°C.



Achieve higher productivity and improved dispensing accuracy with non-contact jetting

Automate complex manual processes and improve your production yields

Increase throughput and enjoy more flexibility with dual-valve dispensing

Get More from your Dispensing System!

Get the maximum quality output with the Quantum® platform

Backed by Nordson ASYMTEK's award-winning global service and support network.

www.nordsonasymtek.com/Quantum

Nordson ASYMTEK

Learn **more** about the **Quantum**

Material Type	Thermal Conductivity (W/mK)	CTE (ppm.°C @ 25°C)	Tensile Modulus (MSI)	Density (g/cc)
FR-4/E-glass	0.3-0.4	16-20	3.5-4.5	1.6 - 1.8
polyimide/E-glass	0.2-0.4	15-19	3.5-4.5	1.5 - 1.7
Copper	385	17-20	12.000	8.920
CIC (Copper-Invar-Copper	108	5-6	19.000	9.900
Stablcor® Laminate-unclad (xy)	ST10 ~2* ST325 ~82*	ST10 ~4.5-6 ST325 ~1-3	ST10 ~9 ST325 ~24	1.6 - 1.65
Stablcor® Laminate-clad 1oz Cu (xy)	ST10 ~75* ST325 ~175*	ST10 ~5-7 ST325 2-4	ST10 ~10 ST325 ~25	1.65 - 1.7

Table 3: Mechanical properties.

The conclusion is that using CFCC in the stackup greatly improves the thermal performance of low thermal conductivity materials. The results suggest that a FR4 board with a single, thin layer of the composite material can approximate the performance of metal-clad boards, reducing cost, space and weight. Further heat removal can be achieved with the CFCC materials by increasing the through-plane thermal conductivity with the addition of thermal vias coupled from the topside Cu layer through the composite planes.

CTE Control

The thermal benefits are only one part of the solution. The CFCC materials are thermally and electrically conductive low CTE (2–6ppm/°C) carbon fiber sheets encased in typically 1 oz. Cu cladding. When embedded in a multilayer PCB, the low TCE of the carbon fiber core, coupled with the high tensile modulus (25MSI) of the carbon fiber, constrains expansion of the high CTE of the conventional PCB laminate layers improving long-term reliability. Table 3 shows the thermal conductivity, CTE and mechanical properties of the composite material and some commonly used materials. To realize the benefits of the material for CTE control layers should be inserted near the surface of the stackup. If the stack is a single-layer structure then one layer of material can be used. For higher layer-count boards or packages two layers can be used for a balanced stackup. Recent test results have shown that a single layer of CFCC material reduced the CTE of an FR4 board from over 17ppm/K to 10.7ppm/K, close to a 40% reduction.

Summary: Back to Yash

From Tom's analysis, it seems that there are comparable thermal performance results via alternate stackups using a variety of materials. However, when putting long-term reliability into the mix, it's critical to consider CTE properties in materials selection. While the data does not present discrete conclusions for LED applications, it does suggest that composite materials such as CFCC can provide both a thermal management solution *and* a dimensional stability solution that has not yet been presented through conventional materials. That being said, everyone's application has its own unique characteristics. As such, it would be wise to devise tests that fully simulate the conditions under which your products operate. SMT

Yash Sutariya is president of Alpha Circuit Corporation. For more information, or to contact Sutariya, ysutariya@alphacircuit.com.

Thomas S. Tarter is the president of Package Science Services LLC in Santa Clara, California.

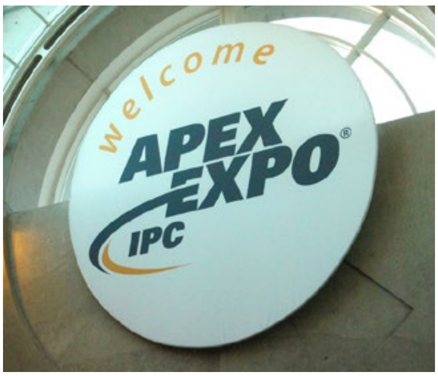
San Diego Convention Center, San Diego, California, USA

IPC APEX EXPO 2015: Tough Act to Follow

by Joe Fjelstad
SPECIAL TO I-CONNECT007

Based on personal impressions and conversations with folks met on the show floor and technical meetings, this year's IPC APEX EXPO trade show and conference was an unqualified success. The various trade show, conference and standards committees, in concert with the IPC staff, continue to raise the bar, improving the event to the benefit of members and industry participants from around the globe.

However, this year also marked, with sorrow, the first IPC APEX EXPO at which much beloved IPC staff member and industry icon, Dieter Bergman, was absent. It was tough not seeing him at the event—a feeling that was shared by everyone I met. Yet somehow, I sensed that many might have felt, as I did, that Dieter's spirit was still with us, urging us on.



In that regard, one of the highlights of APEX for me this year was an event held on Wednesday evening. It was a special tribute honoring Dieter with shared remembrances of a man, the likes of which we are unlikely to see again in our lifetimes. The well attended event was also the inauguration of the Dieter Bergman IPC Fellowship award. This new award in Dieter's memory was bestowed upon on a group of highly respected veteran IPC volunteers, each with decades of service to IPC and the industry. The inaugural award recipients included: Doug Sober, Shengyi Technology; Bernie Kessler, Bernard Kessler Associates; Denny Fritz, SAIC; Dave Hillman, Rockwell Collins; Don Du Priest, Lockheed Martin; Bob Neves, Microtech; Ray Prasad, Ray Prasad Associates; and Randy Reed, Via Systems. Each recipient was allowed to bestow a Dieter Bergman memorial scholarship upon the college or university of their choice. It

was a fitting tribute for a man who spent most of his life in service of and teaching industry colleagues around the globe.

Another highlight of the week was the induction of Gary Ferrari to the IPC Raymond Pritchard Hall of Fame. Ferrari was the first executive director of the IPC Designers Council and was instrumental in organizing and structuring the training courses that have been the backbone of design instruction for entry level PCB designers as well as the certification of seasoned ones.

A couple of other items of note caught my interest and attention. The first was a significant departure of tradition. This year's keynote session had a sponsor, eSurface. The company presented an impressively produced video which provided a visually captivating overview of their novel circuit manufacturing technology. Doubtless, it caught most everyone off guard. It was a foray into new territory for IPC and a significant break from tradition; frankly, I like such experimentation and the breaking of traditions. It could presage a future when, like the Super Bowl, such commercial productions, if done to a similar high level as this first one, could prove of as much interest to attendees as the subject of the keynote.

Finally, on the morning of the last day, there was the inauguration of IPC Town Hall, an open event, the purpose of which was to engage senior staff members, including president and CEO John Mitchell, directly with members in attendance with the intent of creating a dialog relative to what might be missing and or improved on with IPC programs and services. Discussions were lively and the challenges discussed were both real and important. I look forward to attending future such events. I think it could prove a great way for frontline members of IPC to express their desires and needs and hopefully help guide the association to improve its services to both members and the electronics industry.

In many ways new and old, the 2015 IPC APEX EXPO is going to be a tough act to follow. **SMT**

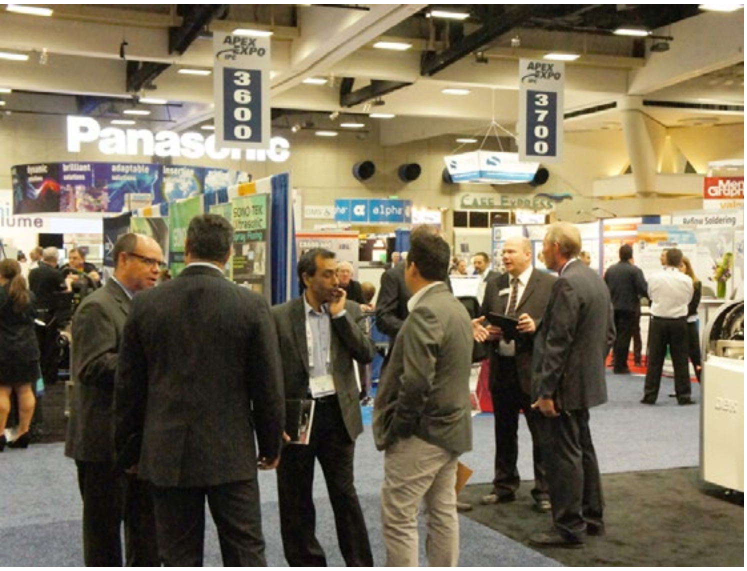
This Ice Cream's for You, Dieter

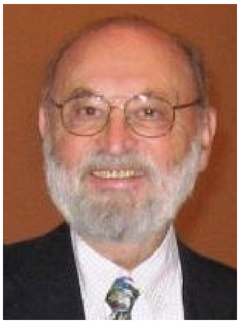
by Patty Goldman
I-CONNECT007

Another year has come and gone and so has another IPC conference and show. Doesn't seem that long since the last one, but a year is a year (well, actually 11 months but who's counting).

I'm one of those cross-over people, involved in committee meetings, the technical program and also an exhibitor at the show. San Diego is such a great venue for this, with everything right there and accessible. How pleasant to be able to quickly transfer from one area to the other. Plus, you were just a few steps from the door and could step out into the sunshine and perfect weather at any time; there were even tables set up outside (in the back) that we could use. We sure missed that in Las Vegas!

A number of people mentioned that everything seemed so…organized. The technical conference ran smooth as silk (at least that's what we saw—I know IPC staff works hard at that). Same comment for the show and show floor. It's always amazing to see the transformation from Monday night to Tuesday's opening bell. But it was really all very organized. The technical conference session I moderated was pretty much packed. The show floor was very busy on Tuesday, a little less so on Wednesday, and Thursday was exhibitors' day—where the exhibitors have a chance to conduct business with each other. I am sure much was accomplished all around.





A most notable exception to the regular programs was the tribute to Dieter Bergman on Wednesday evening. Dieter was without question the most recognized and best known person at IPC, truly the face of IPC. While most knew of him, recognized him, perhaps had met him or heard him speak, some of us were better acquainted with Dieter. We worked with him on standards activities, argued with him, had dinner and ice cream with him, laughed and argued some more, and counted him as a true friend. Many people spoke on Wednesday evening, recounting funny stories and jokes. But all had another common thread—friendship.

After this event a group of us decided on another IPC meeting tradition: ice cream! We headed out with IPC patriarch Bernie Kessler to a tiny shop in the Gaslamp District. Some of us had gone on many an ice cream outing at IPC meetings; we dragged along some newbies this time. The only rule was "no business to be discussed." And so a pleasant hour was spent and new friendships were formed, complete with the required group photo (thanks, Kelly Dack). And that's what it's all about. **SMT**

Real Time with...IPC APEX EXPO 2015

An Interview with Keynote Speaker Dr. Stanton Friedman and Publisher Barry Matties

After Wednesday's keynote, publisher Barry Matties invited Dr. Stanton Friedman, a nuclear physicist, lecturer and UFO researcher to the *Real Time with…* booth for a lengthy interview on Friedman's long career with companies such as GE, Westinghouse, and McDonnell Douglas, among others. Friedman has worked extensively on highly advanced and classified programs focused on nuclear aircraft, fission and fusion rockets and compact nuclear power plants for space and terrestrial applications. Friedman has presented at more than 600 colleges and universities and 100 organizations spanning the United States and Canada, and more than a dozen countries abroad. The following is excerpted from the complete interview conducted on February 25, 2015 on the show floor.

On ENERGY RESEARCH:

Barry Matties: I'm interested in how your career and our industry eventually intersected. Let's start by telling us about your early career, and the scope of your work in energy programs.

Stanton Friedman: From 1956 to 1959, I worked on the General Electric aircraft nuclear propulsion program at Cincinnati General Electric. In '58, we spent somewhere around $100 million. We employed 3,500 people, of whom 1,100 were engineers and scientists. In other words, it wasn't six professors and 12 grad students; it was a major effort to develop a nuclear airplane that could fly farther, longer. It wouldn't have to stop for fuel. All the programs that I worked on spent tons of money. It was all based on the premise that we were going to beat the Russians.

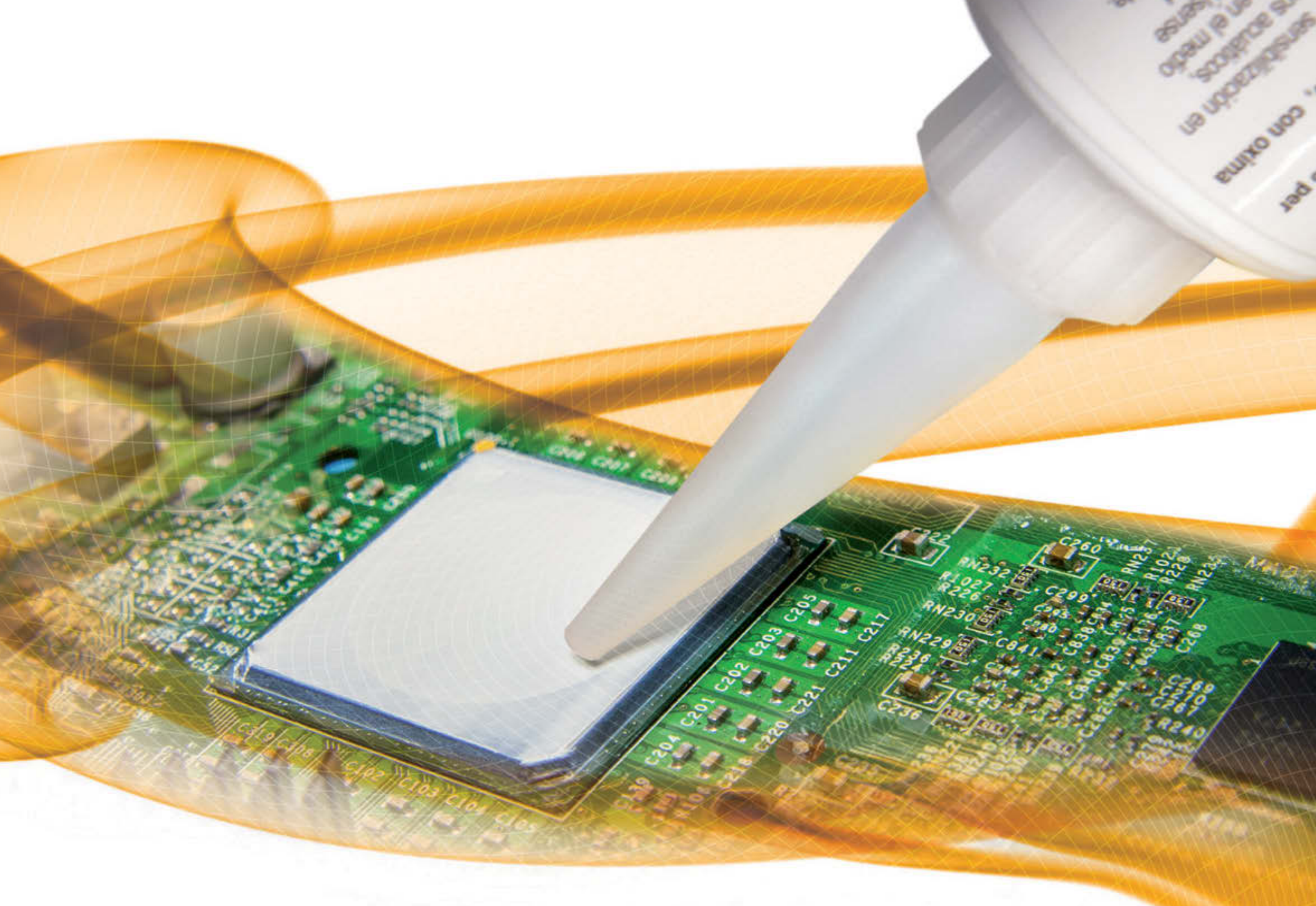
When I worked for Westinghouse, we tested a nuclear rocket engine that was less than eight feet in diameter. The power level was 4,400 megawatts, twice the power of Hoover Dam, which is a little bit larger than that. It was all government funding. Then they cancelled the program. It takes guts to pursue new technology.

Barry: There is such a fear of nuclear energy as a power source, which I don't understand.

Stanton: I don't understand it either. Nobody said, "We should get rid of all our cars because we killed over 30,000 people last year with automobiles." That's the price you pay.

Barry: I understand the catastrophe we saw in Japan, but now my understanding is, and maybe you can clear my thinking up here, that years ago the French approach was not to use rods, but balls, it seems. They turned off all the cooling. There was no melt-down.

Stanton: The nuclear industry is frankly one of the safest industries. I'm not an apologist for the industry at all. I belong to the American Nuclear Society who use double, triple, quadruple backups for things because they realize how important it is. If you're in a submarine, often in the middle of nowhere and down 1,000 feet, the alarm system better be reliable. It isn't



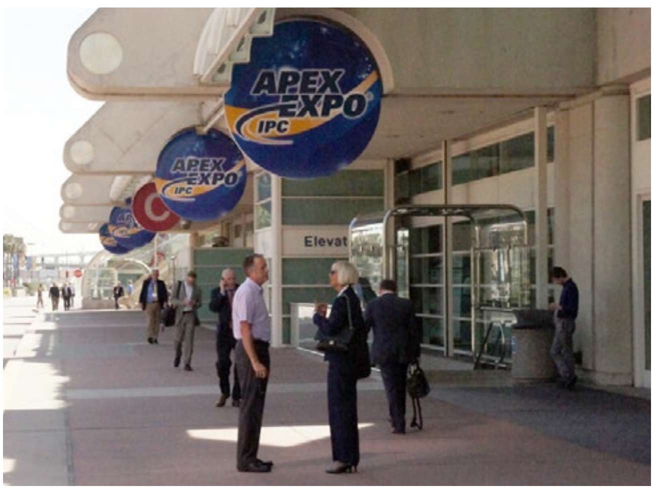
enough to say, 'It works but if something goes wrong, we'll just stop in a port and fix it.' It's not like you're driving on the highway and you need a new tire or a new battery. You're shit out of luck if these things don't work reliably.

They're designed for long life but people are shocked when I tell them, 'We have nuclear power to aircraft carriers that can operate for 18 years without refueling,' which means everything in there has to be ultra-reliable. What good is it if things break down all the time?

On TECHNOLOGY:

Barry: What is your opinion on the direction of technological progress?

Stanton: My motto, mantra, is that technological progress comes from doing things differently in an unpredictable way. The future is not an extrapolation of the past. You have to change how you do things. Some people don't realize that. I lecture at a lot of universities. I run into opposition from the nasty, noisy, negativists as I call them. You can't get here from there. It's impossible. An outstanding astronomer of the 19th century, Simon Newcomb said, 'Man will never fly in an airplane.' Two months later, the Wright Brothers made their first flight. The year before Sputnik, Astronomer Royal Sir Richard van der Riet Woolley was quoted in *Time Magazine* as saying that 'space flight is utter bilge' and that 'nobody would every pay for it. What we need is better instruments for astronomy.' Mankind has a long history of underestimating change.



On the ELECTRONICS MANUFACTURING INDUSTRY and UFO RESEARCH:

Barry: Tell me about your experience here, at our industry event.

Stanton: This industry, well, I'm intrigued to be here for two reasons. First, it's proof that technological progress comes from doing things differently in an unpredictable way because whatever they're doing today is altogether different than the way it would have been done 20 years ago. Second, this is an international meeting. At least 49 countries are represented here. I am very worried about how we look to the aliens as a primitive society when our major activity is tribal warfare. We only killed 50 million people during WWII. That's pretty sad commentary, but here I see people from all over the world. They're exchanging ideas, talking to each other, being friendly, if you will, with each other instead of each one sticking to his own thing.

We all realize there's benefit from interchange. You may lose some sales, but in the bigger picture you're better off. I'm very pleased about it. I've got an eight-year-old great-grandson. I try to envision what the world is going to be like when he grows up.

Barry: It's a real treat to talk to you today. I really appreciate your time.

Stanton: My pleasure. I've enjoyed this conference. **SMT**

IPC APEX EXPO 2015: Allow for Serendipity

by Kelly Dack
I-CONNECT007 GUEST EDITOR

"If *plan A* doesn't work, stay cool! The alphabet has twenty-five more letters…"
—*Claire Cook, best-selling author and reinvention expert*

Andy Down!

At the start of the IPC APEX EXPO, my trade show coverage mentor and Managing Editor of The PCB Design Magazine and the PCBDesign007 newsletter, Andy Shaughnessy, was horribly under the weather and I was really concerned that he would not make it to the show from his home across the country in Georgia. But while he arrived eager to begin reporting and interviews, he was able to cover only a few events before being quarantined by his I-Connect007 team out of fear of being the first media organization to accidently record a lung being coughed up on-cam during an interview. Now, while Andy looked and sounded really sick, I don't think he was at all contagious. I spent a good deal of time before the show with him strategizing for some interviews and I even dined with him at a local sushi joint. And even as I write this, days later, I still feel great. Disclaimer: I do tend to spend a lot of time with Andy at the shows so I've built up plenty of immunity points. Andy asked if I'd submit my show perspective since his was shrouded in a haze of cough remedies. (I hope you are better my friend!)

Designer Forum

Once again, I was glad to have the opportunity to attend the Monday Designer's Forum event. This year's list of speakers included Carl Schattke, a PCB design engineer from Tesla Motors, who spoke on the subject of design for success.

PCB library expert Tom Hausherr, president of PCB Libraries Inc. discussed the IPC-7531C land pattern standard and generated quite a bit of audience engagement by presenting some new ideas for PCB component identification and marking.

IPC Master Trainer Rainer Taube, from Taube Electronic GmgH and FED Germany, spoke on component mounting issues and offered some recommendations in context of IPC-7070, for which he serves as committee co-chair.

Now, my usual plans for attending any designer event are clear: hear what industry icon Rick Hartley has to say. Rick speaks out of love and experience for every topic he chooses to discuss. At previous Designer Forum events I've heard him give kudos, and I've heard him be blunt. I've watched him yell at the top of his lungs while pounding on the lectern to make a point, and I've heard him explain the need to invest in yourself to an audience so mesmerized you could hear a pin drop. So I could only imagine that his talk this year on "success through control of cost and quality" would bring the house down. But as serendipity would have it,

2015 IPC APEX EXPO Show Review

I got called out early for a previously arranged plant tour of Hallmark

Dieter Bergman Memorial Tribute

As planned, Wednesday evening I attended the memorial tribute to Dieter Bergman. I knew what to expect. I knew there would be food, drink, photos and good stories about the man Dieter. I expected tears of sadness at this gathering but felt joy for all of Dieter's friends and family when many of those who stepped up to tell a personal story about Dieter parlayed their experiences into tears of laughter from the audience. Many stories stood out about Dieter's bizarre foods affinity. As told, when travelling, Dieter made a point of sampling new foods. Some of which did a good job of upsetting his constitution. To soothe this, he and his meal-mates began enjoying a bit of ice cream after their meetings, which seem to help. Closing out an evening with ice cream quickly went from panacea to tradition for Dieter and many of his frequent companions.

After the tribute ended, a group of thirty or so people decided to continue the ice cream tradition. My good friend and PCB designer, Jack Olson, and I, who had separately decided to venture into San Diego's Historic Gaslamp District for a visit, happened to be caught waiting for a light to change when the group caught up with us and extended an invite to join them to see how the ice cream tradition is done. So it was that some of Dieter's good friends who wanted to soothe the events of the past few months, the week and the evening, did just that—and the ice cream tradition continued.

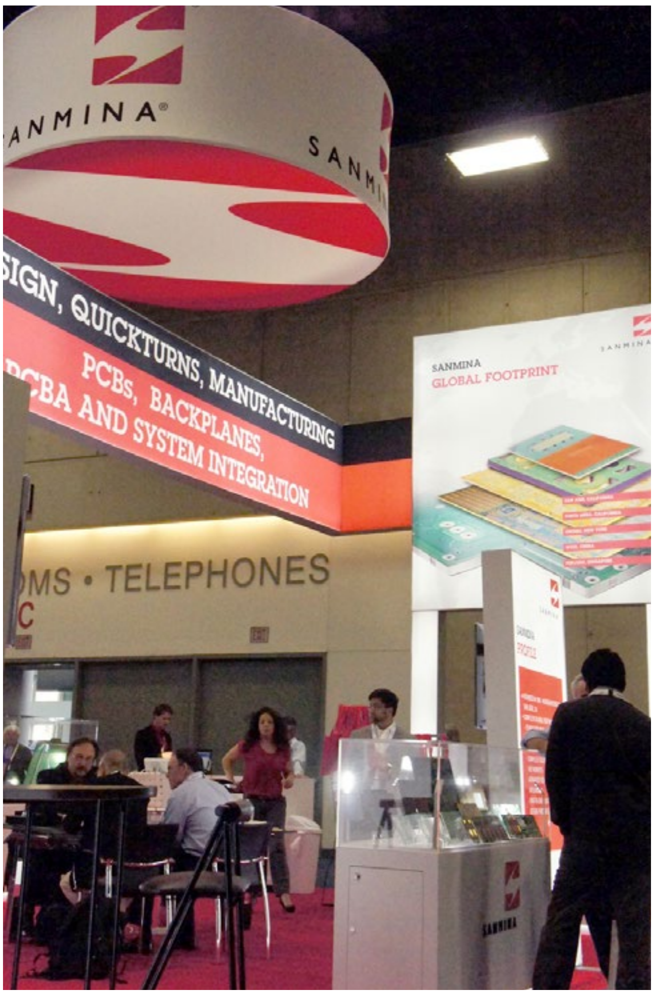
Hope to see you next year.

For Kelly Dack's complete show review, including notes on his evaluation and certification as a Certified Interconnect Trainer (CIT), and further details on Designer's Day Forum, be sure to read the March issue of *The PCB Design Magazine*. **SMT**

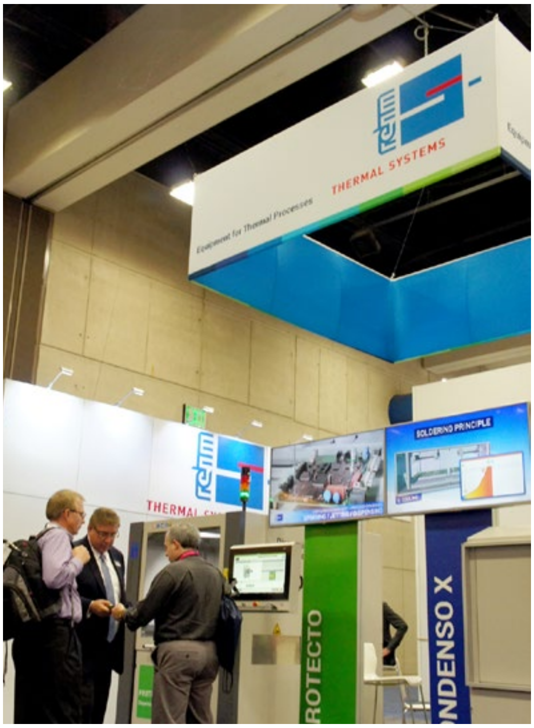
Dieter's last ice cream stand: From left: Bernard Kessler, Jo Ann Sotelo, Patty Goldman, Midge Ferrari, Gary Ferrari, (unidentified IPC member), Vern Solberg and Jack Olsen.

SHOW REVIEW

2015 IPC APEX EXPO Show Review



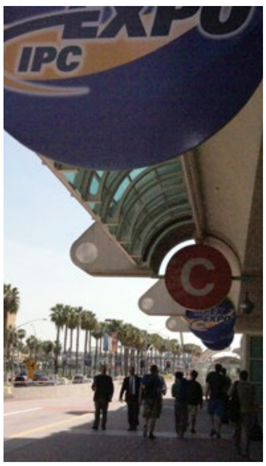
2015 IPC APEX EXPO Show Review

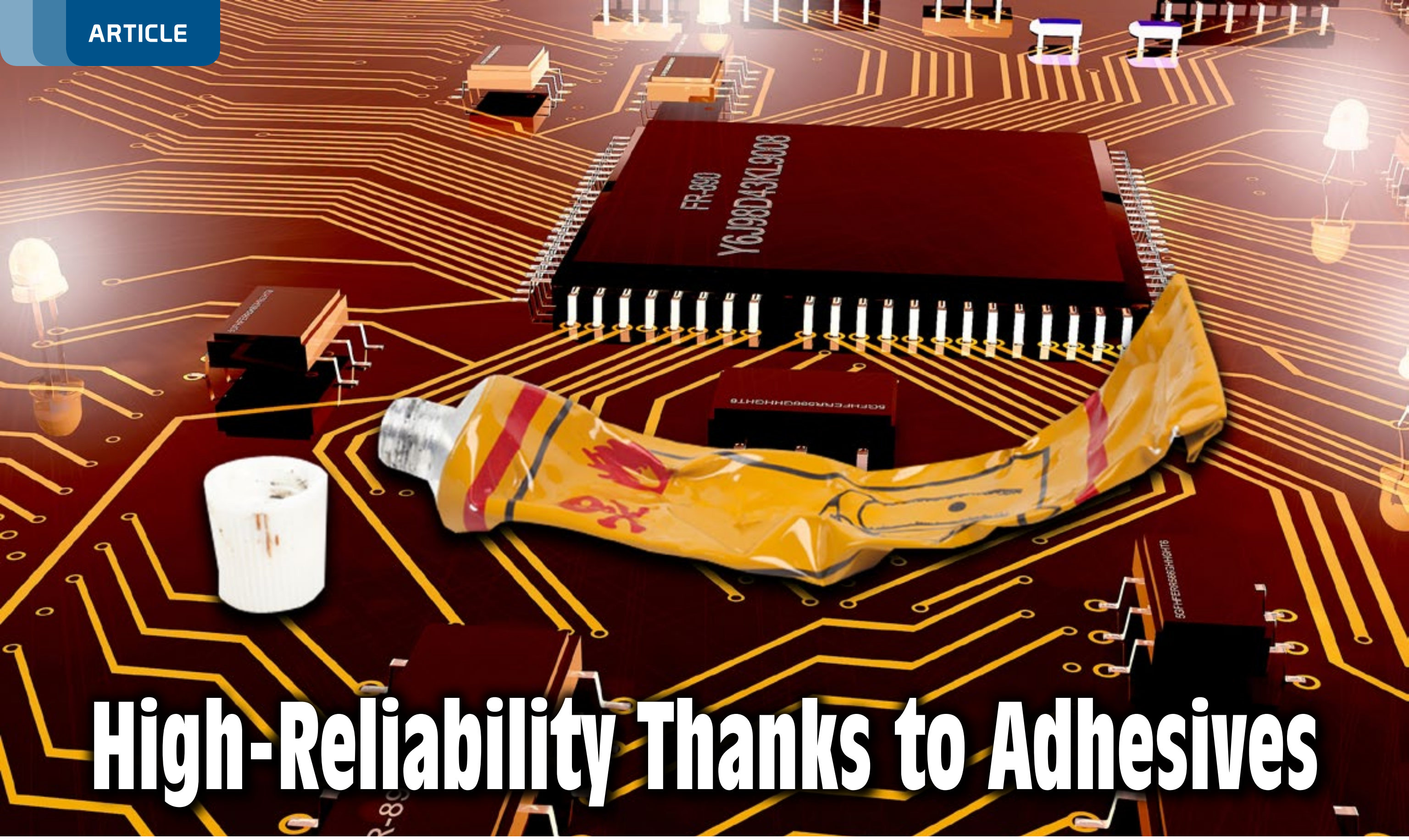


2015 IPC APEX EXPO Show Review

SHOW REVIEW

2015 IPC APEX EXPO Show Review





High-Reliability Thanks to Adhesives

by Kevin Balben
DELO

Protecting electronic components from thermal, mechanical and chemical stress is becoming increasingly important in many industries. While application-friendly packaging is one way to ensure components' stability, highly reliable encapsulants are playing a more important role as well.

DELO Industrial Adhesives' product specialist Kevin Balben explains the correct uses of today's encapsulants and compounds and clarifies the myths that surround them.

True or False?

When using encapsulants and casting compounds in electronic production, there is no alternative to heat curing in ovens.

True. While users have a choice between heat curing and light curing, the latter is used in a handful of applications including those that use connectors, switches and relays. Light curing acrylates are ideal for these applications and enable extremely short cycle times.

As soon as components are exposed to harsh environmental conditions, heat-curing epoxy resins are the only game in town. These robust products contain an anhydride hardener activated by heat. Therefore, curing requires temperatures between +100°C and +180°C.

For demanding conditions there are no alternatives to heat curing. Thermodes and induction are forms of heat curing and work faster than a normal oven, but are still slower than light curing. Users cannot always use induction or thermodes because the geometry and size of the parts may not allow it. For the most part, there is no way around air convection ovens.

Temperature and freedom from tensions are conflicting goals when trying to optimize the curing process.

True. The higher the temperature, the faster the adhesive cures. Thus, high temperatures are good for fast processes. At the same time, high tension causes a great deal of warping since the polymer network is created through heat and shrinks during cooling.

If warping is too intense, the materials should be cured at lower temperatures for a few

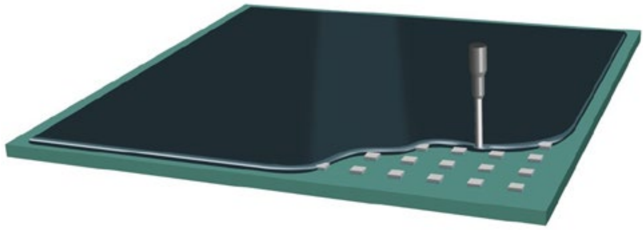


Figure 1: With new encapsulants, the whole PCB can now be encapsulated without warpage. Afterward, the PCB is sawn into single parts—much faster than encapsulating single chips.

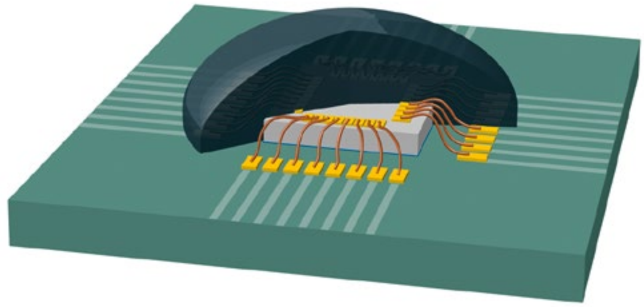


Figure 2: Glob top full encapsulation—an easy and quick process.

minutes more. Unfortunately, there is no rule of thumb, so keep in mind that every component and assembly must be assessed individually.

High reliability and efficient large-area encapsulation are correlated.

False. Due to the dissimilar coefficients of expansion (CTE) of chip (Si, 4 ppm/K), bond wire (Au, 14/Al, 23 ppm/K), bond pad (Cu, 16 ppm/K), printed circuit board (FR4 10–20 ppm/K/ ceramics 1–3 ppm/K) and encapsulant (epoxy, mostly more than 20, up to 250 ppm/K), thermo-mechanical tensions arise and may cause wire fracture, bending of the substrate (warping) or debonding of the encapsulant from surfaces wetted during encapsulation. Large-area encapsulation exacerbates this problem, making the separation/singulation of the packages by sawing more difficult.

However, encapsulants with a CTE of 11 ppm/K have recently been developed. With their low coefficient of expansion, they prevent these tensions, which significantly shortens the process time.

If high reliability is required, one-component materials are the material of choice.

True. One-component materials are the standard encapsulant used in electronic production. They are easy to use and offer better features for high-requirement applications.

This type of material tends to be less suitable for larger area applications, like those found in mechanical engineering electronics, where large volumes cannot be transported in frozen condition. Should this situation arise, two-component products are used.

Two-component products are nearly as reliable as one-component products. The major difference is that a user cannot mix two-adhesive components as thoroughly or as long as an adhesive manufacturer can on a large production scale.

Dam and fill is superior to glob top encapsulation.

True. Dam and fill is a more powerful method than glob top encapsulation as more defined shapes can be implemented. A dam is dispensed with a high-viscous adhesive. The space is then filled. Therefore, dam and fill is mainly used for large assemblies or in confined spaces. If flowing is not critical to a certain extent due to the design or other factors, a glob top can be used. This saves one process step.

Therefore, only dam and fill materials come into question for partial encapsulation.

False. In practice, partial encapsulation is often required by sensor applications where the sensor detects information under harsh environmental conditions, while the chip must remain protected. In such cases, not all parts of the chip are covered by adhesive. It is particularly important that the adhesive cures in the specified position without flowing.

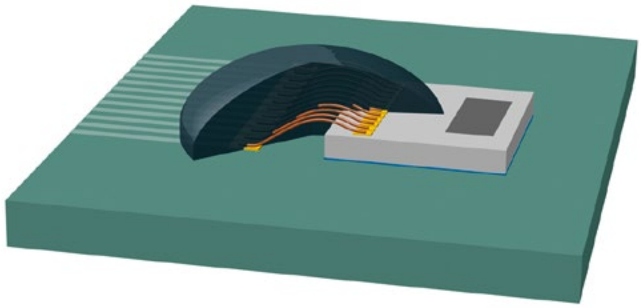


Figure 3: Glob top partial encapsulation: Although limited in terms of geometry, glob top products may even be suitable for partial encapsulation due to an optimized flow.

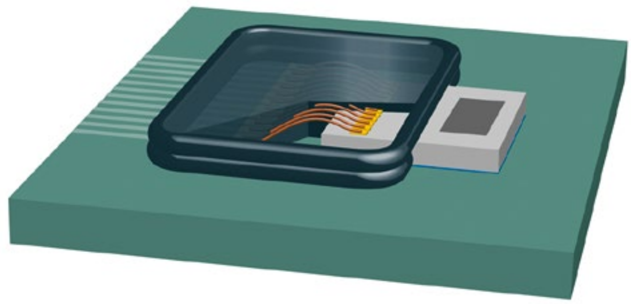


Figure 4: Dam and fill partial encapsulation. Dam and fill enables more complex and defined encapsulation designs.

Figure 5: Dam stacking: Certain systems even allow a stacking of the dams without intermediate curing.

As various dispensing patterns can be set and reliably applied, dam and fill are the most accurate and suitable for these types of applications. Yet, there may be instances where partial encapsulation with glob top products is possible—and completely sufficient—as the flow of these materials is optimized.

The special "dam stacking" procedure involves the stacking of several adhesive beads, creating a wall. The single "levels" must be cured individually.

False. Some products on the market actually require intermediate curing steps. However, certain systems can also be processed completely "wet in wet." Neither the single dams nor the entire wall must be intermediately cured, and the fill can even be dispensed before any curing takes place. Of course, this system has limits in regard to geometry, but curing the complete encapsulation in one step, results in a great increase in productivity.

Functioning under extreme conditions, the reliable encapsulation of microelectronics presents great challenges. Specially developed encapsulants combine outstanding material properties such as chemical resistance, mechanical properties, excellent adhesion, optimized dispensing and flowing properties and variable curing parameters. With their help, production processes can be designed more flexible and efficient, cutting down production costs and boosting output while receiving the highest product quality. **SMT**

Kevin Balben is product specialist at DELO.

ARTICLE

Industry 4.0 Initiatives

by Markus Mittermair
REHM THERMAL SYSTEMS

During the age of computer-controlled production sequences, abbreviations like CAM, CAD and CNC are a common part of manufacturing reality. When the term "Industry 4.0" made its first public appearance at the 2011 Hanover Trade Fair, the associated content was new to only a certain extent. The targeted results of the "4th industrial revolution" are now commonplace at many companies in the high-tech industries—and they're undergoing continuous further development.

The idea of globally networked production processes by means of which machines communicate with each other directly via the Internet of Things (IoT) and forward data acquired with sensors and learn from each other at first sounds like science fiction. Nevertheless, many of the factors which are seen as prerequisites for Industry 4.0 are already a reality. And the reassuring news is that it doesn't (yet) work without human involvement.

Industry is already working with highly complex, computer-aided, and to a much greater extent, computer-controlled processes. CNC milling machines are highly precise CAD programs that convert 2D plans into 3D models—from materials management, planning and production, right on up to sales logistics, none of these sequences would be conceivable without a computer.

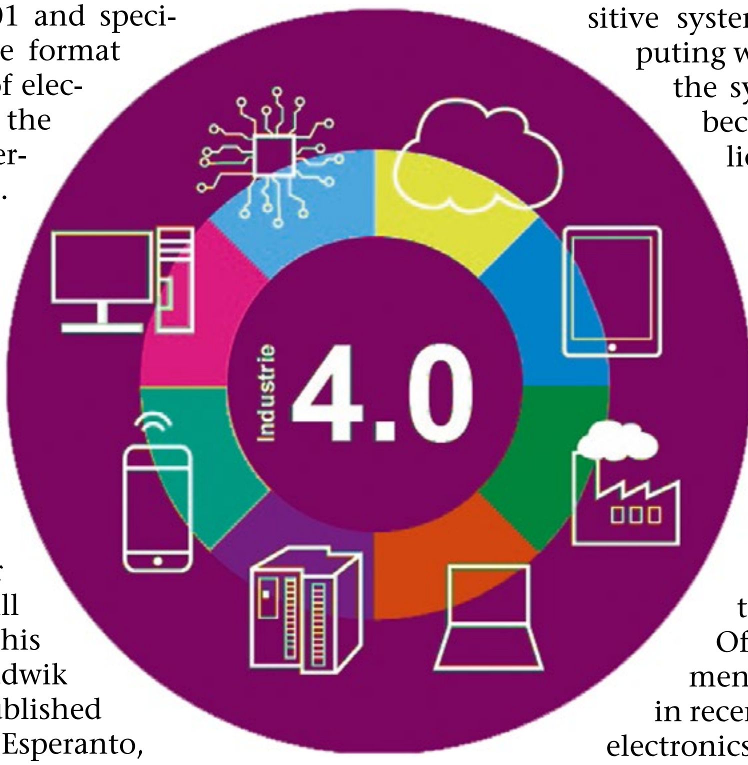
However, combining them is new. Data from processes which were logged and processed separately in the past are now collected at central computers, where they're evaluated and combined by complex software systems. Entire sequences can be fully monitored and controlled in this way. And this will now be followed by global networking of the machines?

Development of an Industry 4.0 standard is a harmonization process (i.e., worldwide standardization of technical data communication). The unmanageable amounts of data resulting from industrial data collection at various companies, which accumulate on a daily basis, the so-called big data, would have to be channeled and prepared in order to be made available as

smart data in a usable form. The experts see this as one of the major challenges. Specialists are of the opinion that the creation of an Industry 4.0 standard will take at least another 10 years.

Standards exist already which are intended to regulate certain areas of the field of electronics. For example, DIN EN 61690-2 appeared already in 2001 and specifies the data exchange format for the development of electronic circuits, namely the electronic design interchange format (EDIF). But this has nothing to do with interdisciplinary data exchange.

Worldwide standardization is incomparably more difficult than standardization at the national level. An example from another field of endeavor will help to elucidate this point. In 1887, Ludwik Lejzer Zamenhof published the fundamentals of Esperanto, which are still valid today. Esperanto was supposed to be an easy-to-learn, neutral language which would facilitate international communication. There's a community which keeps Esperanto alive, but after nearly 130 years the language has by no means become internationally accepted.



But there are international standards which everyone works with today. Where data transmission is concerned, standards like TCP/IP, LAN, WLAN and Bluetooth are now used worldwide—and the Internet wouldn't function at all without at least a minimum level of global standardization. In other areas, things continue with national standards.

But without the advanced developments of the high-tech industries required to automate their own manufacturing processes, further considerations regarding a project with such globe-spanning goals as those set by Industry 4.0 would never even have cropped up.

However, some companies are making contributions to advancing the consistent integration of computer systems into the entire production sequence during product development. They have recognized the fact that computer-aided sequences assure that conditions are held constant even in highly complex, sensitive systems. Embedded computing was routine practice at the systems long before it became a matter of public focus.

With embedded computing, the computer controller doesn't take over for the user, but rather makes it possible to manage extremely complex and variable processes in a clear-cut manner, and to keep them under control. Of course the requirements, as they've evolved in recent years in the field of electronics manufacturing, and thus PCB production as well, necessitate further development of the production systems. Processes that were very difficult to implement just a few years ago are now standard practice in daily production. Thanks to master software solutions, systems can be used more flexibly and efficiently. Machine utilization is being optimized, and good quality is assured for production output.

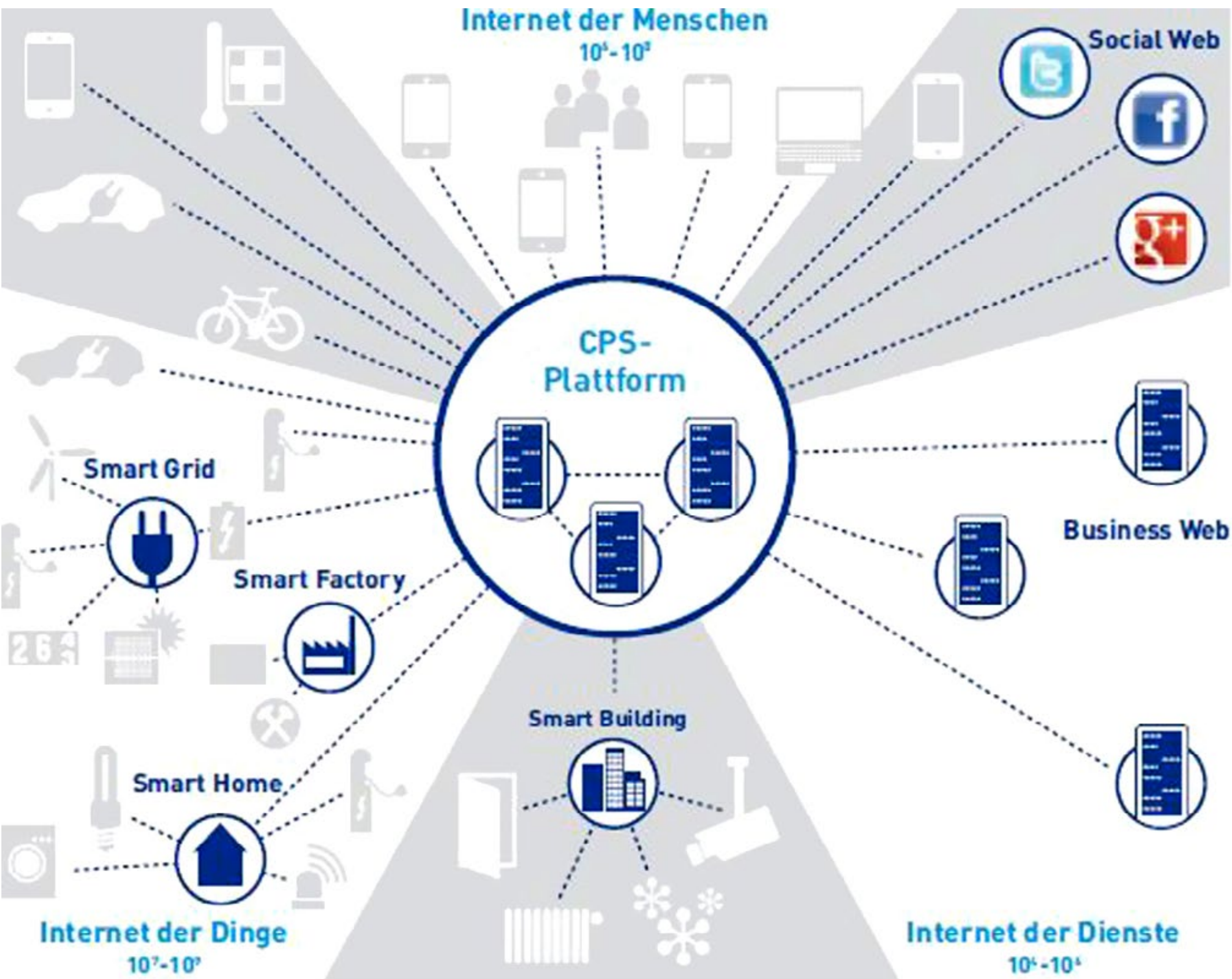
These "intelligent" software solutions ensure that equipment can be reliably controlled and monitored. It's a closed system consisting of monitoring tools and various modules, each of which completes its own individual task. Enormous amounts of data are acquired by the modules from the system, and monitored. Master software compiles the data and evaluates it (i.e., to keep the specified parameters constant for the respective manufacturing profile).

The modular system can be assembled into individualized packages and matched to the

customer's respective requirements. Custom tailored master software is available for each system type. Customizing is an extremely important factor in times of flexible manufacturing conditions. Thanks to computer control, entirely new possibilities are being created with these greatly varying software options. Manual selection of the required product profile—always a latent source of error in actual practice—can be handled with software support while the process is running. The danger of executing production processes with incorrect parameter settings is minimized.

This type of complex control opens up new dimensions of flexibility as well. For example, four production lines were set up with identical equipment at the facilities of a customer of the German reflow system company. Intelligent software solutions and linking to PPS software via the XML standard make it easily possible to administrate and optimize product change-overs, as well as energy management across all systems. A product which is manufactured today in system 1 can be run on system 2, 3 or 4 tomorrow without delay, and optimizations are suggested for the sequence and the profiles, thanks to product profiling and production control. A production profile can be accessed from any system at any time via the master software—not only at identical, but rather at similar or event different systems as well.

Where profiling is concerned, it has been teamed up with a technology partner. The profiling module from KIC enables detailed profile creation for new products. It's relatively easy to set up in just a few steps. The settings are saved



as reference values for other applications. On the basis of these values, the system is capable of making temperature suggestions for similar product lines. If the same product is manufactured again at a later point in time, and if something has been changed in the system… no problem. The controller precisely duplicates the preset conditions, or displays the differences. This is also an important factor for quality assurance. Many of today's system developers agree: this is the only way to reliably maintain current quality standards in the face of ever stricter technical requirements demanded by the market.

Integration of highly specialized software into manufacturing sequences will become more and more commonplace in the future and all over the industry.

Systems and processes will be managed, monitored, analyzed and optimized. Production work orders, product data, efficiency and status data, specified settings, archived profiles and current values are all used to control the systems, to prepare product documentation and for analysis purposes.

Data volumes are becoming larger and larger, and keeping them under control and assuring their security are crucial factors. Data security will be one of the great challenges of Industry 4.0. Global exchange of sensitive production and corporate data is still viewed with skepticism by many global players.

In the meantime, some companies, such as Rehm Thermal Systems, have long since implemented the ideas which serve as a basis for Industry 4.0 for their own internal development. The industry has to think ahead of the future. **SMT**

Markus Mittermair is in software development at Rehm Thermal Systems.

VIDEO INTERVIEW

Solution for High-Temperature Applications

by Real Time with…
IPC APEX EXPO 2015

Al Wasserzug, a senior business development executive with Cirexx, explains to Guest Editor Joe Fjelstad some thermal solutions, and talks about his white paper presentation on a circuit board tech Cirexx has developed in conjunction with Lockheed Martin.

CLICK TO VIEW

realtimewith.com

Mil/Aero007
News Highlights

Medovex Enters Manufacturing Agreement with Nortech

Jarrett Gorlin, CEO of Medoxex Corporation stated, “Nortech Systems strong reputation and capabilities in the medical device field makes them an excellent partner for the manufacturing of the DenerveX device. We firmly believe this relationship will ensure that the DenerveX device provides a reliable and effective tool for the treatment of Facet Joint Pain.”

DARPA Boosts Investment in LRASM Program

Initiated in 2009 in collaboration with the U.S. Navy and U.S. Air Force, DARPA’s Long Range Anti-Ship Missile (LRASM) program has been investing in advanced technologies to provide a leap ahead in U.S. surface warfare capability.

Saab to Support U.S. Marine Corps’ Next Gen Radar Program

Defence and security company Saab’s U.S. based company, Saab Defense and Security USA LLC, has been awarded a contract from Northrop Grumman Corporation for components and subsystems of the U.S. Marine Corps AN/TPS-80 Ground/Air Task Oriented Radar (G/ATOR) system. The order value of the contract is MSEK 247 ($32 million).

TT Electronics-IMS Facility Earns Nadcap Accreditation

TT Electronics Integrated Manufacturing Services (IMS) announces that its Fairford facility (formerly known as New Chapel Electronics Ltd) has received Nadcap accreditation for Electronics Cable and Harness Assemblies (AC7121).

Sparton, Ultra Electronics JV Nets $57M Sonobuoy Contract

Sparton Corporation and Ultra Electronics Holdings plc (ULE) announce the award of subcontracts valued at $57 million to their ERAPSCO joint venture, for the manufacture of sonobuoys for the U. S. Navy.

OSI Systems Reports Record Sales in Q2 Fiscal 2015

“We are pleased to announce strong second quarter financial results. Led by our security division, we achieved record sales and record earnings per share. With a solid pipeline of opportunities and strong balance sheet, we believe we are well positioned for future growth,” said Deepak Chopra, OSI Systems’ Chairman and CEO.

NATEL EMS Names Ducommun Star Supplier

Ducommun Incorporated today reported it has been named a Star Supplier for 2014 by NATEL EMS, an engineering solutions provider in the electronics manufacturing services industry.

Ducommun Nets $7.3M Tomahawk Cruise Missile Contract

Ducommun Incorporated has received contracts valued, in aggregate, at approximately $7.3 million from Raytheon to continue producing a variety of interconnect and electronic assemblies for the U.S. Navy’s Tomahawk cruise missile through 2016.

IDTechEx Sees Rapidly Changing $7.5B Market for Drones

Dr. Harrop, Chairman of IDTechEx says, “The biggest market sub-sector will be small UAVs that are not toys or personal, with $2 billion in sales in 2025 generating over $20 billion in benefits in agriculture, border protection, parcel delivery, logistics such as warehousing, coastguard, customs, search and rescue, medical emergency, malaria research, mine detection, protection of rare species, movie production and so on.”

Sparton Acquires KEP; Enhances Marine Market Position

Sparton Corporation announced that its wholly owned subsidiary, Sparton IED LLC completed the acquisition of KEP Marine, a $3 million revenue business, from Kessler-Ellis Products Inc. on January 21, 2015 in an all-cash transaction.

here at Hunter Technology,

we make it happen!

For over forty-five years now, we have been "making it happen" for our customers. By having an unsurpassed committment to quality. By providing the EMS services that you need. And mostly by being there for you, every step of the way. Here's what our customers are saying:

"I didn't believe that NPI and production support could peacefully co-exist. Hunter has proven me wrong."

AMD

"Hunter's engineering support is second to none. I used to think the tier 1's could only offer that level of expertise and capability. I stand corrected."

OCLARO

"I engaged Hunter with the hope of resurrecting an engineering bone pile. My expectations were greatly exceeded. Hunter is now my largest EMS Supplier."

ZONARE

"With the most challenging technology, I take it to Hunter because I know it will get done right."

NORTHROP GRUMMAN

We couldn't make anything happen without our great staff. Here are few words from the people that make it happen:

Call us today to find out what we can make happen for you!

HUNTER TECHNOLOGY CORP
Reliable. Solutions. Delivered.

+1 (408) 957-1300
www.hunter-technology.com

A Summary of Counterfeit Avoidance: Development & Impact

by Todd Kramer
SECURE COMPONENTS LLC

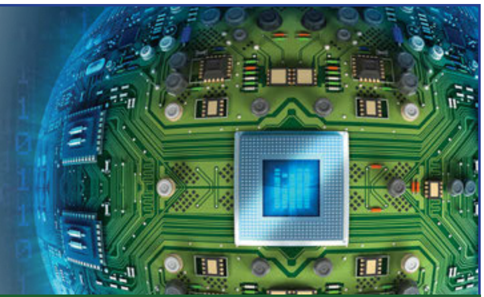
Consumers are accustomed to finding China Compulsory Certification (CCC) or CE (European Conformity) markings on products. These markings provide a level of confidence that products displaying them meet certain industry standards; inspection and tests were performed to determine whether they met prescribed standards. Consumers might be surprised, however, to learn of a gaping hole when it comes to counterfeit components or knock-offs. Regardless of the markings displayed, these items aren't covered. For the average person, it's difficult to determine if a product is authentic or bogus. Price alone isn't a reliable indicator any longer because counterfeiters of luxury items have discovered that selecting a slightly discounted price, still better than an outlet store, will entice more people to buy their merchandise than a heavily discounted price. The thinking behind this logic may be that such a huge discount only serves to reveal the item as counterfeit. Recently in the United States, a series of counterfeit avoidance measures to identify counterfeits, mitigate their impact, monitor their presence and design standards to prevent their infiltration were adopted by the Department of Defense (DoD). These standards, AS6081 and AS55553, compliment quality management programs already an essential part of the manufacturing, assembly and distribution processes. Although the implementation of counterfeit avoidance regulations improves efforts made against this rapidly growing epidemic, mitigation of this issue still remains in its infancy.

Roots of a Trillion-Dollar Problem

The International Chamber of Commerce estimates the total global value of counterfeit and pirated products could reach a $1.7 trillion by the year 2015[1] To help put this figure into perspective, the proposed DoD budget for 2015 is $495.6 billion[2]. A $1.1 trillion spending bill recently passed by Congress further demonstrates the potential impact counterfeits represent. Money from counterfeit sales fund criminal activities, terrorist organizations and destroys U.S. jobs; these are just a few examples of the impact. As Chairman of the United Sates National Committee/International Electro-technical Commission (USNC/ICEQ) and Secure Components CEO, I've worked with groups of individuals and organizations to safeguard not only U.S. consumers, but consumers worldwide. Although these efforts are growing every day, at the core of this community are people who've been in this scuffle from the beginning and continue to work diligently toward its eradication.

Like so many now common commercial applications, these efforts can be traced back to the military complex. Recognizing the growing presence of counterfeit components in U.S. systems, tracking failures to substandard parts and the opportunity older systems presented, the

IPC® ITI



ITI & IPC Conference on Emerging & Critical Environmental Product Requirements

SAVE THE DATE

June 9 • Doubletree by Hilton Fort Lee, Fort Lee, N.J.
June 10 • Hilton Garden Inn, Des Plaines, Ill.
June 12 • Embassy Suites Milpitas Silicon Valley, Milpitas, Calif.

Get current on product environmental trends…

Brush up on RoHS implementation issues (including the exemptions)…

Stay ahead of global issues impacting electronics manufacturers…

Network with peers, customers and suppliers as you discuss substance restrictions, eco-labeling, market and consumer pressures, and more…

Staying up-to-date on environmental regulations impacting the electronics industry can be a daunting task. IPC and ITI have once again joined forces to keep you ahead of the curve. At the **Conference on Emerging & Critical Environmental Product Regulations** you will learn firsthand from key officials with a direct role developing and implementing European Union (EU) regulations governing the electronics industry.

Keynote speakers Steve Andrews of the U.K. Department of Business, Innovation and Skills, and Chris Smith of the U.K. National Measurement Office (NMO) will provide the latest developments on key EU regulations affecting the electronics industry, including RoHS2, WEEE and REACH.

If you are in any way responsible for making sure your organization is in compliance with ever-changing environmental product regulations, this conference will provide the tools you and your organization need to comply with legal and customer requirements.

Registration Information:

IPC/ITI Members: $325

Nonmembers: $375

*For more information, contact **Fern Abrams**, IPC director of regulatory affairs and government relations, at **FernAbrams@ipc.org***

government examined this silent menace to gauge its depth in the supply chain. The results were staggering. Afterward, discussions with industry leaders sought to develop an outline of how best to prevent the flow of suspect components into the supply chain. One of the items that came to light was the inadvertent impact toward fostering counterfeiting that the Federal Acquisition Streamlining Act (FASA)[3] contributed to fraudulent component growth in avionics defense high-reliability products (ADHP) by permitting the use of commercially available items for designated tasks performed. Another admirable intent of FASA was to reduce program costs inherently imposed as a result of U.S. Military-standard (Mil-Std) requirements. Under the Mil-Std protocol, additional parts and processes were needed to satisfy inspection, testing and other sampling by third-party organizations creating an additional layer within the supply chain and increasing the cost of required parts. MIL-STDs tended to lag behind continuously evolving technology, preventing their use on government contracts. This was changed to allow comparable, commercial parts to be acquired for military systems. By default, this attribute opened the door to anyone with access to the consumer market or an abundance of discarded parts. Counterfeiters quickly seized upon new market segments.

Previously, where knock-off handbags were a lucrative revenue stream, now the counterfeit field grew to include the following avenues: component sales to manufacturers, hard to find part support, and recycled parts along with assemblies or end user items; all of these came with significantly bigger returns. Couple these factors with a defense complex stable of aging operational systems and the market was ripe for exploitation. With systems decades-old and original manufacturers no longer interested in making products for such a limited market, the opportunities for counterfeiting were abundant. In reaction to this niche market, many in the semi-conductor industry sold obsolescent or discontinued component product rights, manufacturing technology and know-how, which flooded the market with surplus hardware. Export manufacturing centers such as India, China and Africa, where mountains of trashed components and surplus builds sat in refuse piles, began to recycle components back into the supply chain. Commercial and critical systems, medical equipment, and mil/aero were and are supported by this same supply stream.

As the counterfeiting industry grew, government and business clashed on other points that would impact overall anti-counterfeit efforts. Restriction of Hazardous Substances (RoHs Directive 2002/95/EC) in Europe fought against a rising tide of hazardous materials showing up in many electric products. Leadership in Energy and Environmental Design (LEED), a U.S. effort started in the mid-1990s, initiated the tremendous job of convincing the construction industry, from design to property management, to be environmentally responsible and use resources more efficiently. Meanwhile, International Organization of Standardization (ISO) and AS 9000 standards coalesced various corporate quality management programs into a cohesive standard. These efforts helped to shape focus upon the world's limited resources, its sensitive environmental conditions and quality management issues.

With counterfeit avoidance standards in place, efforts began to shift to refining the definition of what is considered "counterfeit," sharpening its application, monitoring and enforcement. Leading much of this refinement phase are many of the same pioneers now working through regulatory organizations such as USNC/IECQ, a national committee representing American interests at the international level. The ECC Corporation is the USNC/IECQ administrator and works to ensure that electronic components, related materials, and assembly suppliers are compliant. The Counterfeit Avoidance Mark Alliance, organized by ECC Corp., is a non-profit participant of the United States National Committee chartered to address component quality and reliability assessment requirements of the electrical, electronic and electromagnetic component industry. It is by applying resources like these, specifically focused on the identification, mitigation, monitoring and design standards, that substandard, obsolescent and questionable third party suppliers are filtered from the supply chain.

In the shadow of regulatory organizations, a growing list of companies have sprung up to supplement both sides of this dilemma, such as companies equipped to validate components and obsolescent parts to original design specifications in accordance with current counterfeit avoidance standards.

There is a myriad of suppliers ready to peddle whatever hardware the market demands. Unfortunately, this mix includes companies merchandising discarded components. So much of the failed, out of spec, broken and substandard parts that manufacturers no longer support are shipped as trash to countries like India, China and Africa, where a lucrative industry thrives on recycling this rubbish into what looks like new parts. Surplus inventory and discontinued product lines find their way into supplier warehouses and are then bought at a discount, with the intent of taking advantage of desperate customers trying to keep legacy systems operational. In both situations, the customer loses while the supplier purchasing inventory cheaply reaps big returns at their expense. The customer is then left with both highly expensive and unsafe, faulty systems placing all at risk. Project costs escalate as excessive rework, unscheduled maintenance or upgrades are required to address inconsistent performance specs or failure.

Although counterfeit components and substandard products get plenty of attention in military, aerospace and medical fields due to their costly impact in human life, it's important to point out the severe impact substandard parts and assemblies play in everyone's life. While CCC or CE markings give comfort to a growing legion of skeptical consumers, there remains a layer of assurance at the manufacturing level to use only components that meet design specification. This can only be accomplished by using trusted suppliers. Counterfeit avoidance seeks to resolve the foggy mystery of untrustworthy suppliers by providing a set of requirements parts and suppliers must meet. It falls to the buyers of such parts and components to invoke requirements on such purchase orders and to report suspect parts to increase the effectiveness of this system. Safeguards are in place to filter counterfeit products, but there remains a great deal of work to fully mitigate this threat. **SMT**

Note: Portions of this article were originally published in the USNC Current, Vol 9, Number 4 (Winter 2015).

References

1. Estimating the Global Economic and Social Impacts of Counterfeiting and Piracy. ICC/BASCAP report, Feb 2011.

2. DoD News Release NR-111-14: DoD Releases Fiscal Budget Proposal & 2014 QDR.

3. FASA 2003 revision Chapter 1 Commercial Practices.

Todd Kramer is CEO of Secure Components LLC, an AS6081 & AS9120 certified independent distributor of electronic and mechanical components to the aerospace, defense, and high-reliability industries, and chairman, USNC/IECQ. To contact Kramer or to read past columns, click here.

Electronics Industry News
Market Highlights

Testing, Inspection Market to Reach $50B by 2020

The testing, inspection and certification market is expected to reach $50.44 billion by 2020, growing at a CAGR of 5.80% between 2014 and 2020, according to a new report by MarketsandMarkets.

Semiconductor Unit Shipments to Top One Trillion in 2017

Total semiconductor unit shipments (integrated circuits and opto-sensor-discrete, or O-S-D, devices) are forecast to continue their upward march through the current cyclical period and top one trillion units for the first time in 2017 according to IC Insights' forecast presented in the 2015 edition of The McClean Report—A Complete Analysis and Forecast of the Integrated Circuit Industry.

By 2020, Human Augmentation Market to Reach $1135M

Total Human Augmentation Market was valued at $91.8 Million in 2013 and is expected to reach up to $1135 Million by 2020, at a CAGR of 43.52% between 2014 and 2020.

1 Billion Cellular M2M Connections a Realistic Prospect by 2020

The 'Global M2M Connectivity and Services Forecast' looks at the rapid rise of M2M since 2013 when there were just 172 million cellular M2M connections worldwide but also projects a note of caution in the face of increasing hype around the future of M2M and the Internet of Things (IoT).

SMBs Optimism Rises; Seen to Continue Hiring

"Improved performance by small and mid-sized business is traditionally the barometer of a full economic recovery," said Craig R. Everett, Ph.D., Assistant Professor of Finance and Director of the Pepperdine Private Capital Markets Project. "But while it's true that the uptick in hiring projections and higher wages is good news for American workers, not everything is rosy."

Global Connected Car Market to Hit $131.9B by 2019

The report states that the global connected car market will achieve remarkable growth between 2013 and 2019 and rise to US$131.9 billion by 2019, registering a CAGR of nearly 34.7% during the forecast period.

BEMS Revenue to Reach $10.8B by 2024

According to a new report from Navigant Research, worldwide revenue from building energy management systems (BEMSs) is expected to grow from $2.4 billion in 2015 to nearly $10.8 billion in 2024.

By 2020, Commercial Drones Market to Reach $1.27B

The total commercial drones market was valued at $15.22 Million in 2014 and is expected to reach $1.27 Billion by 2020, at an estimated CAGR of 109.31% between 2014 and 2020.

High-End Gyroscopes to Reach $1.69B in 2019

The 2014 market for high-performance gyroscopes, which was estimated at $1.37B, is therefore expected to grow at a 4.4% annual rate to reach $1.69B in 2019.

www.smta.org/expos

2015 Expo Schedule

March 24
Dallas Expo & Tech Forum
Plano, TX

March 26
Houston Expo and Tech Forum
Stafford, TX

April 7
Intermountain Expo and Tech Forum
Boise, ID

April 15
Atlanta Expo and Tech Forum
Duluth, GA

May 5
Michigan Expo & Tech Forum
Livonia, MI

May 5
Oregon Expo & Tech Forum
Beaverton, OR

May 19
Carolinas Expo & Tech Forum
Dallas, NC

May 21
Toronto SMTA Expo & Tech Forum
Markham, ON, Canada

June 4
Huntsville Expo & Tech Forum
Huntsville, AL

June 18
Philadelphia Expo & Tech Forum
King of Prussia, PA

June 23 - 24
Counterfeit Electronic Parts Symposium Tabletop Exhibition
Hyattsville, MD

June 25
Upper Midwest Expo & Tech Forum
Minnetonka, MN

July 16
Ohio Expo & Tech Forum
Independence (Cleveland), OH

September 1
Capital Expo & Tech Forum

September 29 – 30
SMTA International Conference & Exhibition
Co-located with IPC Fall Standards Development Committee Meetings
Rosemont, IL

October 14
Long Island Expo & Tech Forum
Islandia, NY

October 14 - 15
International Wafer-Level Packaging Conference and Exhibition (IWLPC)
San Jose, CA

October 20
Austin (CTEA) Expo & Tech Forum
Austin, TX

October 20
Connecticut Expo & Tech Forum
Waterbury, CT

November 5
LA/Orange County Expo & Tech Forum
Long Beach, CA

November 12
Space Coast Expo & Tech Forum
Melbourne, FL

Sign up online to exhibit or attend!

SMTA Headquarters | 5200 Willson Road | Suite 215 | Edina, MN55424 | [P] 952-920-7682 | [F] 952-926-1819

Facebook: Facebook.com/SMTAssociation LinkedIn: Find us under groups, "Surface Mount Technology Association"

How to Select an Automatic Pick-and-Place Machine

by Robert Voigt
DDM NOVASTAR

This is the third in a series of articles designed to help buyers analyze and select SMT equipment for PCB assembly, and examines automatic pick-and-place machines, the most complex component in a circuit assembly operation. Because of this complexity, the next few columns will address different functions in this process.

Automatic pick-and-place machines are much more common than manual or semi-automatic machines, but they also have the greatest range of capabilities and cost. This column will focus on features and capabilities and include some cautions regarding reliability of low-cost machines, including:

- Production volume ranges (CPH)
- Accuracy and repeatability specs
- Pick-up and centering methods

In future columns, I will address size, machine accuracy, encoders, feeders and mechanical positioning methods.

When starting your evaluation process, there are two defining factors to keep in mind, which determine what category fits your machine needs. The No. 1 principal factor is components per hour (CPH), and the secondary factor is machine capability.

Production Volume

As in the previous column, it's constructive to start by addressing production ranges for various types of machines, since this is the No. 1 factor in your evaluation process. For purposes of comparison, since all circuit boards vary in size and complexity, we talk about volumes in terms of components per hour, or CPH. The following table offers a general guideline of machine categories defined by their CPH.

Machine Capabilities

This is the second defining factor in helping choose the correct auto pick-and-place machine for your needs. Here, we will only be talking about two aspects of machine capability: accu-

Type of System	Average CPH Range	Price Range
Manual (Hand)	0–50	$300 - $400
Manual (Machine)	75–150	$2,000–$7,000
Semi Automatic	300–1,000	$15,000–$25,000
Fully Automatic (Low Volume) Bench-Top	1,200–3,500	$ 30,000–$35,000
Fully Automatic (Mid Volume) Free-Standing	3,000–8,000	$ 40,000–$60,000
Fully Automatic (High-Speed) Free-Standing or Modular	9,000–30,000	$ 100,000+

Table 1.

the pcb list

***THE* best way to find a PCB fabricator, anywhere.**

SHENZHEN SUNSHINE CIRCUITS TECHNOLOGY CO., LTD.

Shenzhen, Guangdong, China

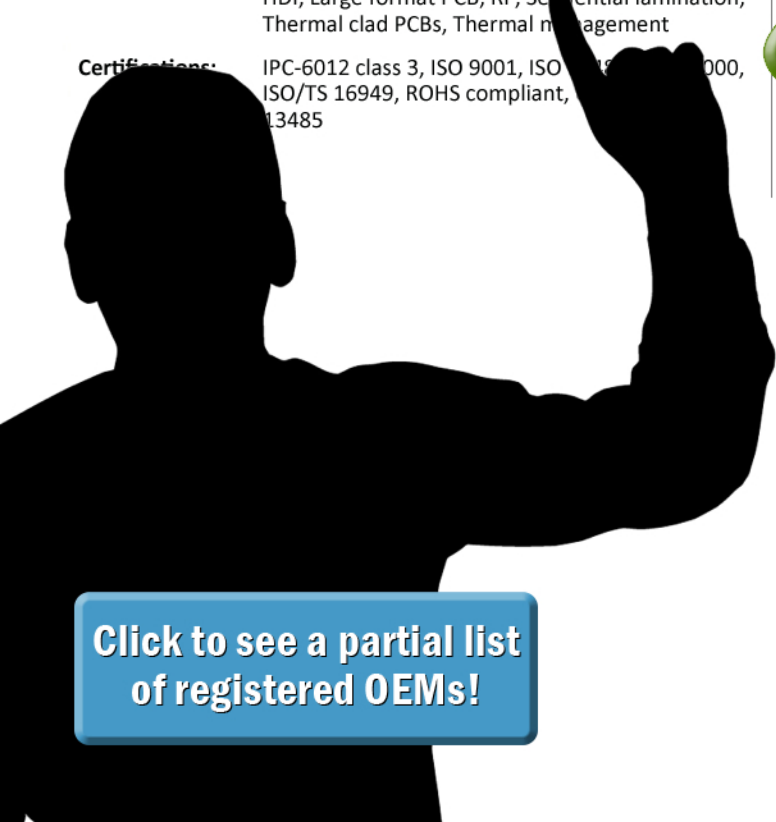
Website | Contact Me | RFQ

Sunshine PCB Group
for excellent customer solutions

Overview | Contact | Specs | About | Videos | Photos | Brochures | News

Sunshine Circuits is a world premier high mix, low to mid volume, high tech Printed Circuit Board manufacturer. We support prototype to production under the same facility. We manufacture at Shenzhen China with office in US and Germany.

Markets:	Automotive, Communication, Computers, Industrial, Medical
Board Types:	Single-sided, Double-sided, Multilayer, Flex, Rigid-Flex
Mfg Volumes:	Prototype, Small, Medium, Large
Specialities:	Blind/buried vias, Backplanes, Carbon contacts, Controlled depth drilling, Controlled Impedance, Edge plating, Filled/plugged vias, Heavy copper, HDI, Large format PCB, RF, Se ential lamination, Thermal clad PCBs, Thermal m agement
Certi	IPC-6012 class 3, ISO 9001, ISO 000, ISO/TS 16949, ROHS compliant, 13485



Featured Showcase

Click here to see a demo

Why YOU should Showcase:

- Capabilities listing for advanced search functionality
- Specialties and certifications listing
- Ability to upload brochures and videos
- Quick and easy "Contact" and "RFQ" buttons
- News, web and contact links

Click to see a partial list of registered OEMs!

www.thepcblist.com

racy and repeatability, and pick-and-place centering methods.

Accuracy and Repeatability

For production machines, we typically recommend looking for a machine with accuracy of +/- .0001" and down to fine pitch capability of 12 mil on a repeated basis. Less expensive machines often don't meet this spec.

Most low-cost machines will also not come standard with a computer or software which could help with the repeatability aspects if not the accuracy. While some may offer enhanced technology, most do not.

Pick-and-place Centering Methods

There are four methods for pick-up and placement:

1. No centering mechanism
2. Mechanical (jaws)
3. Laser centering
4. Vision centering

Method 1: No centering mechanism other than relying on the component's pick-up point for placement. In other words, the part is not physically centered after being picked up by the tool head, and if it's picked off-center on the tool, it will be off-center when placed on the board. Obviously, this is not a very accurate placement method because there is no definable tolerance. You can expect to find this method used by hobbyists or instructors, but certainly not in any type of precision production environment. There are not many options available either, and long-term reliability is questionable.

- ***Pros:*** Low cost
- ***Cons:*** Low accuracy, repeatability and long-term reliability, no options, or spare parts
- ***Size range:*** No definable tolerances

Method 2: Mechanical centering jaws or fingers. In this method, the component is picked up and moved into its center position in the X and Y axes on the pick-up head. Typically, this method is easy to set up and repeatable within +/-.001" accuracy. This centering method is generally found in low- to mid-range machines.

- ***Pros:*** Easy to learn and set up; repeatable; one of the fastest method currently available; a true "on-the-fly" system; low cost
- ***Cons:*** Physically touches the component, which may not be appropriate for certain types of parts, especially those with delicate leads
- ***Size range:*** 0201 packages up to 35 mm square

Method 3: Laser centering. In this method, the component is picked up inline with a laser beam which detects the component's center position on the tool head and recalculates the zero point of the part according to its position in the X, Y axes and rotational position relative to the head for an accurate placement on the board.

- ***Pros:*** Touchless; on-the-fly (similar to mechanical method)
- ***Cons:*** It is less reliable. There are limitations on the types of parts it can handle, such as very thin components (if they are .050" thick, they may need to be reset because of part variations, even from the same vendor); requires longer setup time, since the Z-axis (part thickness) must be defined; more costly than mechanical centering, but about the same as vision
- ***Size range:*** cannot center parts below 0402 packages or larger than 35 mm square

Method 4: Vision centering (look-down and look-up). Look-down vision will view the top of the component prior to picking it up for its pick-up location. It then calculates its center, compares it to its image file from the stored database, then picks up the component and transports it to its position on the board.

- ***Pros:*** True touchless centering; can handle odd-shaped and delicate components; accurate to +/-.004" capability
- ***Cons:*** Typically longer setup times due to

the need to teach the vision system how to identify part images that are stored in the machine's database; a slower method of centering due to time slice required for processing; vision is more costly than the mechanical method; for look-down vision, the part may move from its pickup point to its placement on the board
- ***Size range:*** 0402 to 15 mm

The look-up vision method is the most accurate centering method available. The component is first picked up from the pick-up area, moved to a camera station that looks at the bottom of the component, and calculates its center position.

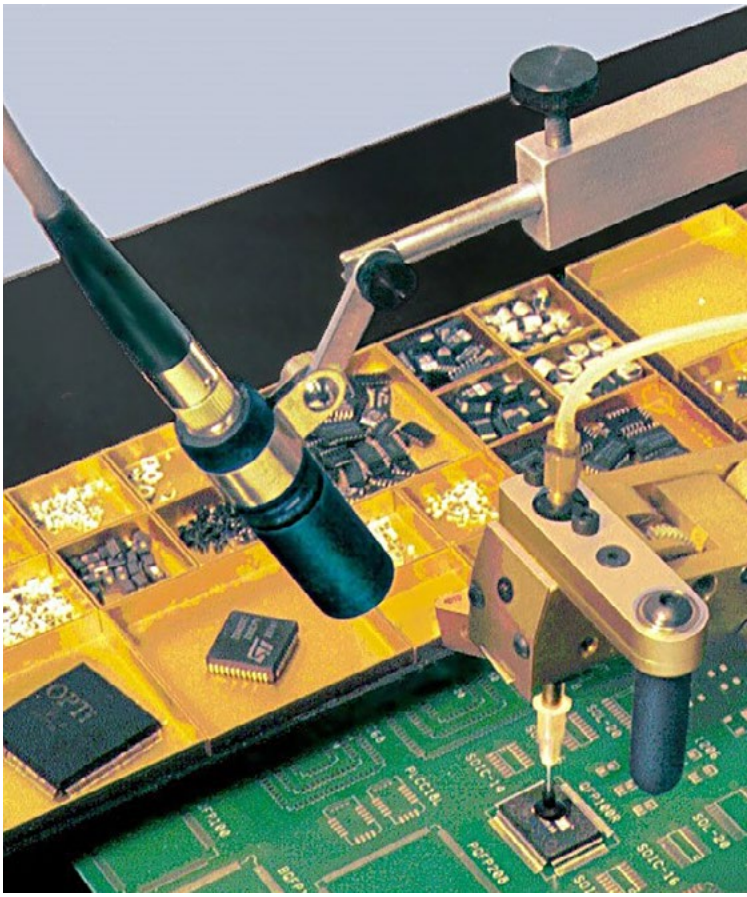
- Pros: True touchless centering, handles delicate components; accurate down to +/- .001" positioning capability
- Cons: Typically, a longer setup time due to the need to teach the vision system how to identify the image that is stored in the machine's database; a slower method of centering due to processing time; Vision is more costly than the mechanical method
- Size range: 01005 to 50 mm (can see smaller and more detail)

The pick-up and centering method you choose will have a great deal of influence on the quality and speed of your production needs, along with how to relate this accuracy back to the machine. But that's just the beginning. In the next column, we'll continue our next chapter on pick-and-place machines by reviewing:

1. Mechanical positioning methods
2. Feeders (number, type, etc.)
3. Encoders (rotary vs. linear)
4. Software

Vendor Support

When evaluating any type of SMT machine, consider factory support as one of the most important assets of your purchase. The best way to learn how a company treats its customers is by word of mouth. Talk to several customers to find out how happy they are with the machine, the seller, and the support they provide. Where



is the manufacturing plant? Can they help troubleshoot alignment issues over the phone? Do they offer field service? Do they have spare parts in stock for immediate shipment? While there isn't much of a used market for manual, machine-assisted or enhanced manual pick-and-place machines, it's still a good idea to ask your supplier about their older machines in the field, and if down the road, spare parts are available, and about their capability to customize a spare part if the machine becomes obsolete. Ask what the expected life-cycle of the product is. The industry standard is seven years. Remember, there is a difference between a true manufacturer and an equipment supplier or distributor. **SMT**

Robert Voigt is VP of global sales at DDM Novastar Inc. He may be reached at rvoigt@ddmnovastar.com.

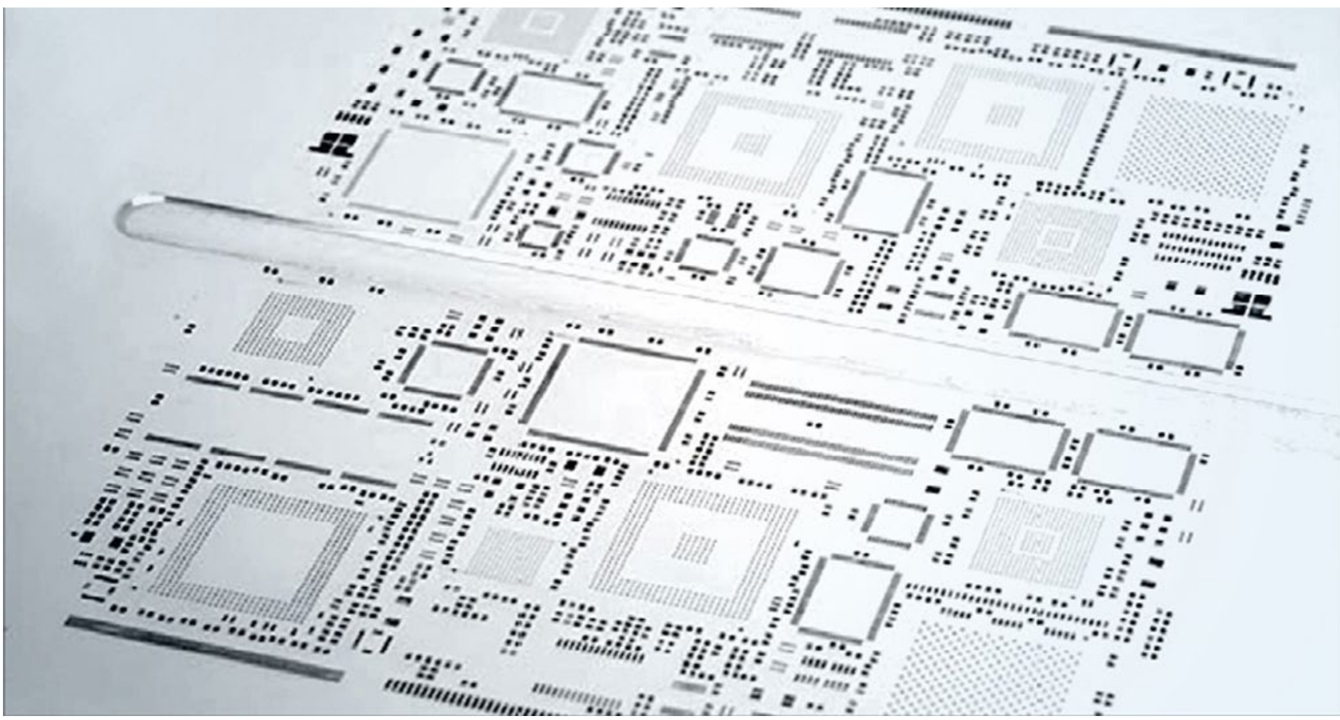
Adapting Stencils to Manufacturing Challenges in 2015

by Rachel Miller-Short
PHOTO STENCIL LLC

Now that we're well into 2015, we can take a look back at the 2014 stencil market and explore our expectations for 2015. In general, 2014 was a solid year with year-over-year growth in volume. Component sizes continued to get smaller, with 01005 components no longer a rarity, but a regular occurrence. Shrinking components have been accompanied by shrinking spaces between the components. This combination of small components and spacing constraints has continued to challenge stencil manufacturers. Combine that with boards that contain both 01005 components and standard size components, and the stencil manufacturers have had to head back to the lab to find ways to accommodate these challenging parameters.

In the solder paste printing process, the squeegee blade delivers solder paste into the stencil aperture as it travels across the stencil surface. When the board separates from the stencil the solder paste in the stencil encounters a competing process: solder paste will either transfer to the pad on the PCB or it will stick to the inside of the aperture walls. The smaller the area ratio (the area of the aperture opening divided by the area of the inside aperture wall; the generally accepted guideline is area ratio > .45, depending on technology), the more difficult it is to achieve complete paste release.

To achieve good paste release with apertures small enough to accommodate 01005 components, manufacturers have experimented with different stencil materials and technologies. The material the stencil is made from determines the size of the aperture and the smoothness and exactness of the aperture walls. The need to satisfy the more rigorous printing requirements of finer pitch components leads to a natural hierarchy of stencil technologies based on the application. The hierarchy advances through the tech-



IPC 2015 Programs

April 29–30
IMPACT 2015: IPC ON CAPITOL HILL
Washington, DC, USA

May 13–14
IPC Technical Education
Fort Worth, TX, USA
Professional development courses for engineering staff and managers:
- DFX-Design For Excellence (DFM, DFA, DFT and more)
- Best Practices in Fabrication
- Advanced Troubleshooting

June 9
ITI & IPC Conference on Emerging & Critical Environmental Product Requirements
Fort Lee, NJ, USA

June 9–10
IPC Technical Education
Chicago, IL, USA
Professional development courses for engineering staff and managers:
- DFX-Design For Excellence (DFM, DFA, DFT and more)
- Best Practices in Fabrication
- Advanced Troubleshooting

June 10
ITI & IPC Conference on Emerging & Critical Environmental Product Requirements
Des Plaines, IL, USA

June 12
ITI & IPC Conference on Emerging & Critical Environmental Product Requirements
Milpitas, CA, USA (San Jose area)

September 27–October 1
IPC Fall Standards Development Committee Meetings
Rosemont, IL, USA
Co-located with SMTA International

September 28
IPC EMS Management Meeting
Rosemont, IL, USA

October 13
IPC Conference on Government Regulation
Essen, Germany
Discussion with international experts on regulatory issues

October 13–15
IPC Europe Forum: Innovation for Reliability
Essen, Germany
Practical applications for meeting reliability challenges like tin whiskers, with special focus on military-aerospace and automotive sectors

October 26–27
IPC Technical Education
Minneapolis, MN, USA
Professional development courses for engineering staff and managers:
- DFX-Design For Excellence (DFM, DFA, DFT and more)
- Best Practices in Fabrication
- Advanced Troubleshooting

October 28–29
IPC Flexible Circuits-HDI Conference
Minneapolis, MN, USA
Presentations will address Flex and HDI challenges in methodology, materials, and technology.

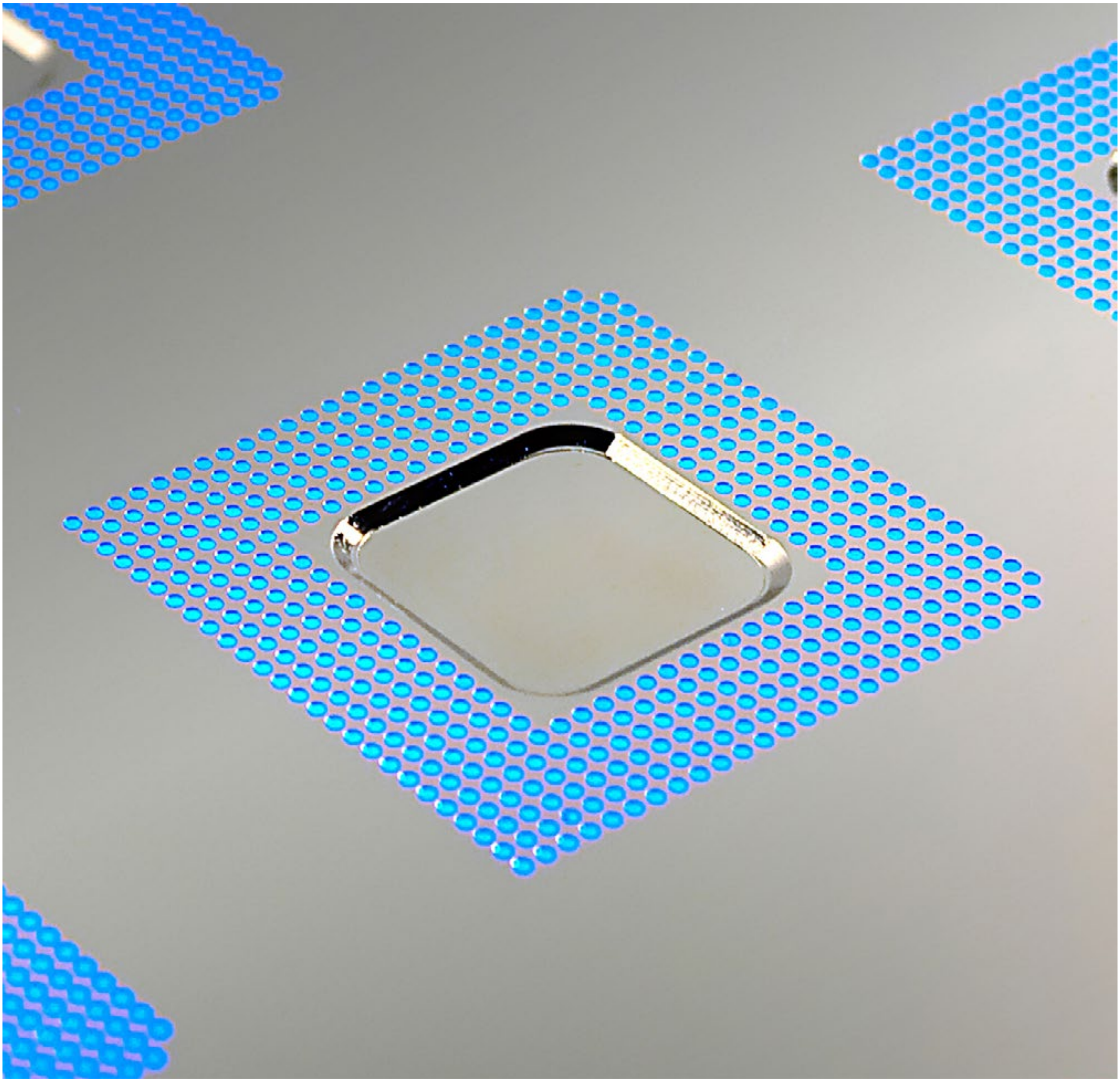
November 2–6
IPC EMS Program Management Training and Certification
Chicago, IL, USA

November 4
PCB Carolina 2015
Raleigh, NC, USA

December 2–3
IPC Technical Education
Raleigh, NC, USA
Professional development courses for engineering staff and managers:
- DFX-Design For Excellence (DFM, DFA, DFT and more)
- Best Practices in Fabrication
- Advanced Troubleshooting

December 2–4
International Printed Circuit and APEX South China Fair (HKPCA & IPC Show)
Shenzhen, China

Questions? Contact IPC registration staff at registration@ipc.org or +1 847-597-2861



nologies, starting with laser cut and reaching to electroformed and electroformed NiEx stencils, which are used for very fine pitch SMT and wafer bump applications. It was discovered that the smoother walls associated with electroform stencil technology provide better paste transfer and that good paste transfer can be achieved at lower area ratios. The electroformed product lines can address additional application needs such as .1 mil increments in stencil thickness requirements. In fact, good paste transfer has been achieved with area ratios as low as .42 with electroformed stencils.

For 2015, we will see the gamut of stencil types. Laser cut stencils will be used for more R&D and simple low-volume products where the components are larger; the solder paste deposit doesn't have to be as exacting, and where the boards are relatively uniform. Laser cut stencils have become quite commercialized and can be purchased in many places at a relatively low price. They fill the need for companies that want off-the-shelf stencils they can get quickly.

Electroform stencils will still be used extensively for 20 mil- to 12 mil-pitch SMT applications and chip components like 0201 and 01005. We have seen a recent increase in the requirements for two-level PCBs with components on both levels as well as the need for step stencils to accommodate boards with different size components. Both of these types lend themselves to electroform stencils. In addition, electroform stencils are being used in the semiconductor process for µBGAs, flip chip, and wafer bumping so cleanrooms are being required for the manufacture of electroform and NiCut stencils to ensure the cleanliness of the stencils throughout the entire manufacturing process.

> **"Extensive print studies have demonstrated that NiCut stencils have paste transfer efficiencies better than normal laser cut stencils and just below electroform stencils, yet at a lower price than electroform stencils."**

Most stencil types create the aperture by removing stencil material through processes like chemical etching or laser cutting. Electroformed stencils are created through an additive process, building up material thickness atom by atom. This keeps the inside release edge of the stencil perfectly smooth, but it is a significantly more time-consuming and expensive process. We saw in 2014 that manufacturers needed the printing results that could only be obtained with an electroform stencil, but couldn't afford to wait the extra time for them to be manufactured. This desire to secure stencils immediately is continuing, so stencil manufacturers are looking for other materials that give the same results as electroform stencils, but are less expensive and have a fast turn-around.

One such stencil that has recently been developed is the NiCut stencil. It delivers the quality advantages of an electroform stencil, but doesn't need the time to "grow." NiCut stencils give excellent results for fine pitch components including BGAs, QFNs, and resistor networks. They deliver the quality advantages of an electroform stencil, but with faster turn-around time. This technology is being used for step stencils. Extensive print studies have demonstrated that NiCut stencils have paste transfer efficiencies better than normal laser cut stencils and just below electroform stencils, yet at a lower price than electroform stencils.

When components are small and close together, it is difficult to deposit the right amount of solder paste. Too much solder paste can cause defects such as bridging, solder balls, and short circuits, but too little paste can cause loose components, faulty connections, and failures in the field. It is difficult to examine a solder joint with the naked eye and even many inspection machines can't discern all areas of the component or solder joint. This has given rise to a growth in the solder paste inspection equipment market. 3D inspection equipment is being employed to capture all sides of the solder joint, which provides feedback as soon as the paste has been deposited instead of when the board is at the end of the assembly line.

Stencil manufacturers will also continue to address these challenges with new post-processing finishes that are being developed to make solder paste release from the stencil, and cleaning, easier. Reducing waste, the coating helps release the paste from the very small apertures and walls. Reduced cleaning has many advantages. Cleaning takes time, negatively affects the environment, uses valuable resources, and requires the purchase of cleaning products, thus increasing the total cost of ownership of the equipment.

Past Short Scoop columns have shown results of a research study comparing the print performance of electroform and laser cut stencils and another study to determine if a 3D electroform stencil, in just one printing step, could be used to print both levels of a two-level board with cavities. Research will continue in these areas. **SMT**

Rachel Short is vice president of global sales and marketing at Photo Stencil LLC. To read past columns or to contact the author, click here.

News Highlights from SMT007 this Month

1 California Congressman Mike Honda Discusses American Manufacturing

Barry Matties, Publisher of I-Connect007, sat down with Congressman Honda, who represents District 17 in the Silicon Valley, and talked with him about American manufacturing, infrastructure, education and some of the current thinking in America. According to Honda, "The policies we pass and the things we do in D.C. that negatively impact our economy...a lot of those guys who don't support some of the positive things we want to see happen don't really understand that it impacts their districts, their social services, health and business."

2 MIRTEC Receives Fourth Service Excellence Award

Brian D'Amico, President of MIRTEC Corp., stated, "We at MIRTEC take pride in providing the most technologically advanced inspection systems to our valued customers. Furthermore, we recognize how important it is to back these exceptional products with a strong sales and service organization." Click to watch related video from RealTime with…IPC APEX EXPO 2015.

3 Exception EMS Optimistic for Growth After Management Buyout

Exception EMS has concluded a management buyout (MBO) of its institutional investor by the Senior Executive team, led by CEO Mark O'Connor.

4 JEDEC & IPC Update Component Assessment Standard, J-STD-020E JEDEC

Solid State Technology Association and IPC today announced the publication of an update to J-STD-020, Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices.

5 IMI's 2014 Revenues Up 13%; Expects Growth to Continue

"The year 2014 was a banner year for IMI as we outperformed the EMS industry's single-digit growth rate and our financial targets. Our global presence and market diversity took advantage of the recovery of the international markets and electronics segments," says Arthur Tan, IMI president and chief executive officer.

6 Key Tronic Enjoys 46% Revenue Growth in Q2 FY 2015

As expected, the company had a strong sequential improvement in operating efficiencies. For the second quarter of fiscal year 2015, gross margin was 8% and operating margin was 2%, up from 5% and (2%), respectively, in the first quarter of fiscal year 2015.

7 CTS Reports Earnings Growth, Progress on Business Wins

"We are pleased with the results for 2014. We delivered strong earnings growth despite softer than anticipated sales," said Kieran O'Sullivan, CEO of CTS Corporation.

8 NOTE's 2014 Sales Up 6% Despite Weaker Sales in Q4

"In 2014, we advanced against the competition on a fairly stable European market. We regard our sales performance in Q4 as a temporary decrease, our strong order backlog at year-end indicates a positive volume performance in 2015," says NOTE President and CEO Peter Laveson.

9 NEPCON China 2015 Puts Spotlight on Materials

NEPCON China 2015 will take place in Hall 1 of Shanghai Expo Center from 21–23 April 2015. The event will feature the latest technologies and products in SMT, surface welding, electronic measurement, automatic electronic production, static electricity prevention, and new materials.

10 Flextronics, STMicro Develop Plug-In Charger Platform

"We're happy to have partnered with the ST team in jointly developing this revolutionary charger platform with zero no-load power consumption," said Nate Vince, president of Flextronics Power. "Flextronics is focused on driving innovation and delivering high-quality and energy efficient power for our customers as they compete in a highly dynamic market."

EVENTS

For the IPC's Calendar of Events, click here.

For the SMTA Calendar of Events, click here.

For the iNEMI Calendar, click here.

For a complete listing, check out *SMT Magazine's* full events calendar here.

FPD China 2015
Shanghai, China
March 17–19, 2015

Puget Sound Advanced SMT Chapter Tutorial Program
March 17, 2015
Puget Sound, WA

Process Optimization and Defect Elimination for PCB Assembly
Webinar: March 18 & 25, 2015

Shining a Light on LED Technology
Webinar: March 19, 2015

Dallas Expo & Tech Forum
March 24, 2015
Plano, Texas, USA

Houston Expo & Tech Forum
March 26, 2015
Stafford, Texas, USA

PUBLISHER: **BARRY MATTIES**
barry@iconnect007.com

PUBLISHER: **RAY RASMUSSEN**
(916) 294-7147; ray@iconnect007.com

SALES MANAGER: **BARB HOCKADAY**
(916) 608-0660; barb@iconnect007.com

MARKETING SERVICES: **TOBEY MARSICOVETERE**
(916) 266-9160; tobey@iconnect007.com

EDITORIAL:
GROUP EDITORIAL DIRECTOR: **RAY RASMUSSEN**
(916) 294-7147; ray@iconnect007.com

MANAGING EDITORS: **LISA LUCKE**
(209) 304-4011; lisa@iconnect007.com,
and **ANDY SHAUGHNESSY**
(770) 315-9901; andy@iconnect007.com

TECHNICAL EDITOR: **PETE STARKEY**
+44 (0) 1455 293333; pete@iconnect007.com

MAGAZINE PRODUCTION CREW:
PRODUCTION MANAGER: **SHELLY STEIN** shelly@iconnect007.com
MAGAZINE LAYOUT: **RON MEOGROSSI**
AD DESIGN: **SHELLY STEIN, MIKE RADOGNA**
INNOVATIVE TECHNOLOGY: **BRYSON MATTIES**
COVER: **SHELLY STEIN**

SMT® (Surface Mount Technology) is published by BR Publishing, Inc., PO Box 50, Seaside, OR 97138

March 2015, Volume 30, Number 3 • SMT© (Surface Mount Technology©) is published monthly, by BR Publishing, Inc.

ADVERTISER INDEX

AIM Solder.......................... 41
Blackfox.............................. 29
Candor Industries................. 11
Dragon Circuits.................... 25
Dymax................................ 19
Eagle Electronics.................. 17
EasyBraid............................ 23
EE Technologies.................. 55
Electrolube.......................... 43
Electronic Interconnect......... 35
EPTAC................................ 45
Heraeus.............................. 27
Hunter Technology............... 65
I-Connect007...................... 61
Imagineering......................... 7
IPC.............................. 67, 77
Manncorp............................. 5
Mentor................................. 9
Miraco Inc.......................... 53
Nordson ASYMTEK.............. 33
P Kay Metal........................ 37
Portus................................ 13
SMTA............................ 3, 71
Super Dry........................... 39
The PCB List.............. 2, 57, 73
Transition Automation.......... 31
US Circuit........................... 59

Coming Soon to *SMT Magazine:*

APRIL:
Soldering Technologies

MAY:
Paste Printing & Component Placement

JUNE:
Test & Inspection