FOUR WAYS TO REDUCE VOIDS IN BGA/CSP PACKAGE TO SUBSTRATE CONNECTIONS

THE RUSH TO CLEAN NO-CLEAN

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  Presented by Keith Bryant, Nordson DAGE

- Exploring the Complimentary Technologies of AOI and X-Ray
  Presented by Nordson YESTECH

- Four Ways to Reduce Voiding in BGACSP Packages To Substrate Connection
  Presented by Ravi M. Bhatkalm, Vice President, Energy Technologies, Cookson Electronics

- Plus more to be announced!

Day Two: LED technologies

- Quality dispensing for tight CIE and narrow side-view LED
  Presented by N.Shivakumar, regional manager for Nordson ASYMTEK in India

- Improving Reliability of LED Assemblies
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SMALED 2011 is organized by Global SMT & Packaging and Global LEDs/OLEDs magazines. This year's conference chairman is Pradeep Chakraborty. More information on the event can be found at smaled.com.
Global SMT & Packaging 

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**Editorial**

The India Semiconductor Association (ISA) has undergone a makeover.

Ms Poornima Shenoy, the president, from 2005 onward, has now moved on, giving way to PVG Menon, a former member of Philips and NXP.

The reign of Poornima Shenoy is best remembered for the revival of the Indian electronics and semiconductor industry.

Back in 2005, there was hardly any system in place that talked about the Indian semiconductor industry. Of course, there were some Indian electronics and semiconductor firms, albeit small.

At that juncture, the industry was deliberating whether India should focus on design services, and if yes, then, which route should be followed? This debate continued for a couple of years, till the time 2007 arrived. Even I, among many, was pleasantly surprised when the ISA came up with SIPS, or the Special Incentive Package Scheme, better known as the Indian Semiconductor Policy.

At that point of time, I had just returned from Hong Kong, excited by the prospects that SIPS held for India.

A few weeks prior to the announcement of SIPS in 2007, an Israeli delegation was in town, looking to develop business in India. A few of them even sounded upbeat about SIPS.

Now, all of this really excited me, as one could see all the possibilities in front of India. One felt that, should SIPS 2007 go well, India could be in for a great ride in electronics manufacturing and in the semiconductor space. India, back then, was on the threshold of major initiatives in electronic systems and manufacturing.

It was in this context, he said that electronic system design and manufacturing can propel the industry toward energy efficiency. The time has come to show India’s might.

So, that leaves a major challenge for PVG Menon to handle!

Some questions that need to be answered are: what are other countries doing to favor industrialization in this space, and how they are benefiting from the same? This will help strengthen the policy, while making it relevant for every stakeholder or beneficiary.

Should the government give incentives to companies to create semiconductor manufacturing capacities on Indian soil, instead of buying re-furbished and lower cost equipment at previous generation technology nodes?

There is talk about extending the policy till 2015. Three years seems too short a time for developing a capital-intensive industry of semiconductor manufacturing. It takes time for big investment decisions to be made, and it is just about started happening, is another remark.

The India semiconductor story has so far been something like this: Lots of high-end designs are being done here. Lot of key decisions are being made out of India. The talent pool is very much present and intact, and growing! We are leaders in design services and embedded, make no mistake.

Now, do we need any semiconductor fabs at all? You decide and let me know!
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the latest forecast was reached by the industry group Semiconductor and Electronics Industries of the Philippines Inc. (SEIPI) at a recent meeting of members in Cebu City.

“In Cebu, they said it’s going to be a negative 5 percent because Japan has not recovered from the impact of the disasters and the US is experiencing a little weakness. Both resulted in a weaker picture of exports as a result of lower supply and weak demand of electronics and semiconductor products. Japan has stopped buying.”

SEIPI expects electronic shipments to normalize by the third and fourth quarter.

**Everett Charles Technologies appoints technical marketing director for Asia**

Everett Charles Technologies—Electrical Test (ET) has appointed Vincent Yu as the technical marketing director for Asia. William brings valuable business experience to help ECT-ET expand its Asian market presence. Vincent will be based in Taiwan, where he will oversee the company's marketing and technical customer support efforts. [www.ectinfo.com](http://www.ectinfo.com)

**Freescale opens India R&D center in Hyderabad’s Special Economic Zone**

US-based Freescale Semiconductor has set up its India research and development centre in Hyderabad to drive innovation and development of solutions for the company’s new platforms.

The company has established its centre here to take advantage of India's cost advantage and easy availability of technically skilled manpower.

Activity at the new facility is expected to deliver solutions that enhance Freescale's platform for applications including data center, security appliances, mobile wireless infrastructure and small business networking among other leading edge technologies. [www.freescale.com](http://www.freescale.com)

**Philippine electronics exports face 5% decline in 2011**

Exports of electronics and semiconductors are likely to drop 5 percent in 2011 due to the impact of the Japan tragedy and weakness of the US economy. This is a reversal from the growth in 2010 and well below the projected 8 to 12 percent growth for the year.

Trade Secretary Gregory Domingo said

**TAILYN COMMUNICATION COMPANY LTD. ADDS SMT LINE**

Tailyn Communication Company, Ltd., an advanced electronics manufacturing services (EMS) provider, has enhanced its manufacturing capabilities with the addition of a new surface mount technology (SMT) line. The line includes a DEK/ Horizon solder paste printing machine, Panasonic CM602 high speed mounter, Panasonic DT401 multi-function mounter, a Heller 1912EXL nitrogen reflow oven and a TRJ 7500 serial AOI unit. The combination of additional equipment and faster placement speeds increases production capacity by 89 percent.

**INKTEC OPENS DEDICATED PRODUCTION FACILITY FOR THINFILM MEMORY**

Thin Film Electronics' memory production partner InkTec, headquartered in Ansan, South Korea, has opened a new dedicated production facility for Thinfilm Memory. In 2009, Thinfilm and InkTec were the first in the world to produce polymer memories at large scale using roll-to-roll printing. The new, upgraded facility has a production capacity of 10 million tags of Thinfilm Memory per month, and will support production of passive array memory. Thinfilm and InkTec will also work on the development of addressable memories, which combine memory and logic in an integrated device. [www.thinfilm.no](http://www.thinfilm.no)

**PVG MENON APPOINTED PRESIDENT OF INDIA SEMICONDUCTOR ASSOCIATION**

India Semiconductor Association (ISA) has appointed PVG Menon as its new president. Menon brings with him an excellent combination of domain knowledge, focus towards membership promotion and a flair for industry relevant research. In this role, Menon would be responsible for overseeing the operations of ISA and will work as a member of its Executive Council on strategic issues related to the growth of the semiconductor and the electronics industry in India.

**Panasonic to start production in India at Haryana’s Jhajjar facility by Nov. 2012**

Japanese electronics major Panasonic will start production from its upcoming manufacturing facility at Jhajjar, in Haryana, by November, 2012. Panasonic India, a 100 per cent subsidiary of Japan-headquartered Panasonic Corporation, is in the process of investing USD 200 million over a five-year period on the facility, dubbed the Panasonic Techno Park.

The company also said it will increase its overall workforce in India to 12,650 employees by the end of this year from the current strength of 10,500 employees. [www.panasonic.co.in](http://www.panasonic.co.in)

**Sales of television sets expands in Southeast Asia in 1h2011**

The television market in Southeast Asia expanded in the first six months of 2011, compared to the same period last year, with consumers having spent over US$2.1 billion on 6.33 million units.

According to GfK Asia, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam contributed to an overall industry growth of 16 percent and 11 percent respectively in value and volume terms.

It also said the latest retail audit report reflects continuing demand for LCD sets which achieved nearly 30 per cent more in value sales over the first half of 2010, making it the key driver of the overall television industry across Southeast Asia.

**Global Sources’ fall electronics shows to feature over 3,800 booths**

Exhibitor booths at Global Sources’ electronics trade shows, scheduled to run Oct. 12-15 at the AsiaWorld-Expo in Hong Kong, have been sold out. The co-located China Sourcing Fairs: Electronics & Components, Security Products, Solar & Energy Saving Products and Korea Sourcing Fair: Electronics & Components will feature over 3,800 booths, a 15 percent increase from last fall.

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**INKTEC**

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**PVG MENON**

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“Our electronics shows continue to attract the world’s top buyers and this is driving demand for exhibitor space at our shows. This year, we sold out all booths two months ahead of the shows—which is earlier than any of our previous fall electronics events,” said Tommy Wong, president of Global Sources Exhibitions.

While the majority of exhibitors for the October 2011 event are from mainland China, buyers can also have the opportunity to see competitive electronics products from other production centers including Hong Kong, Taiwan, South Korea, Malaysia, Japan, India, the Philippines, Australia and Italy. www.chinasourcingfair.com

RS Components debuts industry’s first rewards programme for Malaysia customers
RS Components, a high service distributor of electronics and maintenance products and the trading brand of Electrocomponents plc., has launched a new rewards programme that is available exclusively to its business-to-business customers across South East Asia. RS Components is the first in its industry and one of the first business-to-business players to pioneer a rewards programme on a regional scale for its customers.

“RS REWARDS” is a loyalty programme that promises to deliver more value to customers who purchase frequently from RS Components. The programme has been rolled out in Singapore, Philippines, Thailand and Malaysia. Response to the programme has been very positive. www.rs-components.com

Morpho’s Indian subsidiary Syscom wins award as “Best Exporter Electronic Hardware”
The Indian subsidiary of Morpho (Safran group), Syscom Corporation Limited, has been honored as Best Exporter in the electronic hardware sector for the year 2009-2010. This selection was made by the Noida Special Economic Zone (NSEZ), based on the outstanding export performance of the company in that period. The award ceremony was attended by all units operating in the NSEZ. www.safran-group.com

DuPont to open new Global Innovation Centers
DuPont plans to open new global Innovation Centers, with the first in Asia Pacific. The two Innovation Centers opening this month include one in Korea, servicing the electronics and automotive industries, and another in Taiwan, focusing on the electronics and communications markets. Beginning in autumn, new Innovation Centers in Thailand and India also will be ready to collaborate with customers around renewable energy initiatives and innovations.

DuPont’s goal is to partner on solutions that fuel local collaboration and application development and engage customers in inclusive innovation—wherever they are in the world. www.dupont.com

Momentive to open new Business & Technology Centre in Bangalore
Momentive Performance Materials Holdings LLC’s subsidiaries—Momentive Performance Materials and Momentive Specialty Chemicals—will open a new regional business headquarters and state of the art Global Research and Development Centre in Bangalore, India.

The new facility will be located on a two-acre plot in the second phase of Bangalore’s “Electronic City” and will initially house 125 associates. Research scientists based at the facility will work on new technology platforms and product development for new and existing applications. www.momentive.com

Juki Corp. appoints Robert J. Black to executive operating officer
Juki Corporation, headquartered in Tama Center, Tokyo, Japan, has appointed Robert J. Black, Jr. to the position of executive operating officer of Juki Corporation. Black currently serves as President & CEO of Juki Automation Systems, Inc., Juki’s subsidiary company located in the United States, where he will continue his duties in addition to his new responsibilities.

In his new position, Black will report to the top management of Juki Corporation where he will advise on the worldwide SMT market, strategies to continue Juki’s growth in electronics assembly and assistance to other Juki subsidiary companies.

Black becomes the first non-Japanese Executive Officer in Juki’s 73 year history. His appointment took effect July 1, 2011. www.jas-smt.com

Karbonn Mobiles to set up manufacturing in India
According to Voice & Data (voiceanddata.ciol.com), low-cost India-based handset provider Karbonn Mobiles has plans to set up a manufacturing plant by the end of this month. It is expected to begin rolling out the company’s own products—to the tune of around six lakh mobile phones a month—in August. The company is investing Rs. 100 crore for the new plant.

The company has recently forayed into international markets like Bangladesh, Nepal, Sri Lanka, West Asia and Africa along with other companies like Intex, Lava, Micromax and Maxx Mobile. It has been selling around 600,000 to 750,000 handsets a year in India.

Karbonn Mobiles is a joint venture company between Delhi-based Jaina Group which was a distribution house and the Bangalore based UTL Group, a multi-division telecom group with an annual turnover of Rs.1600 crore and manpower of 2000. www.karbonnmobiles.com

Danfoss appoints president for Danfoss India
Danfoss Industries Private Limited, which is into mechanical and electronic components and solutions, has appointed Noel Ryan as president of Danfoss India. Having been with Danfoss since 1997, an important aspect of Noel’s new role will be to establish support to the group’s growth and also ensure the companies continued expansion in the country. www.danfoss.com

Industry news

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Four ways to reduce voids in BGA/CSP package to substrate connections

Michael A. Previti, Mitch Holtzer, and Tom Hunsinger, Cookson Electronics

Introduction

Voids in solder joints are considered one of the more detrimental defects in electronic assembly as area array devices have now evolved to a point where mass production of fine pitch devices with increasing functionality are common. The factors affecting void formation are complex and involve the interaction of many factors. In area array components such as BGA (ball grid array), PBGA (plastic ball grid array) or CSP (chip scale packages), solder joint reliability between the component and the board is one of the most critical factors as finer pitches and smaller component solder sphere volumes reduce the amount of solder in the corresponding solder joint. Voids have shown to reduce mechanical robustness of the board level interconnection and consequently affect the reliability and the conducting performance of the solder joint. The effect of voids on the reliability of a solder joint depends on size, frequency and location1.

Voids are defined as cavities formed in the solder joint. Voids are largely caused by the amount of outgassing flux that gets entrapped in the solder during reflow2. Voids are essentially gas bubbles that have a much lower density than molten solder. The buoyancy of these regions causes the bubbles to rise to the top of the solder joint3. Other sources of voids can be via in pad.

The outgassing flux is typically produced by the evaporation and thermal decomposition of flux constituents getting trapped in a solder joint during reflow. Reactions of chemical constituents in the flux and substrate at elevated or solder reflow temperatures are also a common cause for gas evolution. Flux is typically a complicated homogeneous solvent-based mixture with many organic additives. Being organic in nature the boiling points and/or thermal decomposition temperatures of many constituents are less than 250°C. Other outgassing sources may be substances generated from or reactions with the substrate, component metalization, or the solder powder or sphere surfaces.

The location and the size of the voids are perhaps the key factors that influence the effect of the voids on the performance and reliability of solder joints. It has been an industry observation that voids in solder joints tend to accumulate towards the top of the solder joint (the interface between the package and the solder joint).

Size is perhaps the most critical factor negatively impacting the solder joint by becoming a source of entrapment, a stress riser, thermal barrier and electrical degradation by restricting the path of current flow. Larger voids typically reduce the robustness of the solder joint compared to small voids because the incidence of failure increases dramatically as the solder material thickness between the void and the ball exterior decreases. For example a 0.007” ball with a 50% void has approximately 0.0017” on each side of the void, while a 0.004” ball with a 50% void has only 0.001” on each side. The voids impact becomes more severe if it is near one of the bonding interfaces. Void location may be equally important as reduced cross sectional area near the bonding interfaces can adversely affect reliability. A reduction in cross sectional area, specifically when voids are located at the ball/interface attach site, current flow is restricted, shear strength is reduced proportionally to the decrease in bonded material and the solder joint stability will degrade more rapidly with increased temperature cycling. Voids near the interfaces with the greatest CTE (coefficient of thermal expansion) will degrade and fail in the shortest time.

A solder joint in an electronic assembly

This paper was originally presented at the SMTA China East Conference 2011.
Four ways to reduce voids in BGA/CSP package to substrate connections

Serves electrical, mechanical and thermal functions, the most important being the conduction of electrical signals. Inherently, the resistance of the solder joint should be as low as possible and there should not be much deviation in resistance between adjacent solder joints in order to achieve uniform conductivity. It has been observed in industry that the resistance of the solder joint will increase with the occurrence of large or many voids as the cross sectional area of the solder joint is considerably reduced. The mechanical function of the solder joint is to provide the connection and support to the component. The electronic component is continuously affected by the stress and strain as a result of the mismatch in the CTE, and the solder joint should be able to withstand all the stress and strain imposed on the component.

An active component in use can produce a significant amount of heat during its operation, and this heat needs to be dissipated to prevent overheating or cause the breakdown of the component. The conductive heat transfer through a solder joint can be modeled based on Fourier’s law:

\[ Q = KA \frac{(T1-T2)}{L} \]

Where Q is the heat transferred, K is the thermal conductivity, A is the cross sectional area of the solder joint, L is the length of the solid element and T1 and T2 are the temperature of the source and sink. It can be inferred from Fourier’s law that the heat transferred is directly proportional to the cross sectional area of the solder joint. A solder joint with voids may have a greater diameter or an increased standoff to maintain the same volume in the solder joint. However, the area of cross section may or may not be the same. A solder joint with voids may have a smaller area, which may interrupt the flow of heat. No significant reliability difference has been seen with a solder joint containing no voids or small voids. However the frequency and location of the voids in a solder joint have an effect on reliability, reducing solder joint life in thermal cycle testing. Voids that are greater than 50% of the solder joint cause a potential reliability problem causing a 25-50% reduction in solder joint life in mechanical testing.

Voids themselves may not be the root cause of failures in solder joints, but voids may provide nucleation sites for defects that lead to catastrophic failure.

**Voiding**

IPC-7095A is the IPC Specification for the Design and Assembly Process Implementation for BGAs. The IPC criteria provide three classes of acceptance criteria for both the solder sphere and the sphere-pad interface. Where multiple voids exist, the dimensions will be added to calculate total voiding in the joint. Inspection criteria used in this paper is the IPC 7095 requirement for solder joint area. Class III voids or better are the most desirable, being voids less than nine percent of the solder area.

**Assembly**

A test vehicle was assembled to focus on issues in producing CSP/BGA in a high-volume manufacturing environment. The test board used in this experiment was an existing test board designed for evaluating solder paste for processing, assembly and reliability. The test board is a 5.25 x 10.0 in., 4 layer FR-4 board. Solder mask was PSR 4000 from Taiyo. The pad finish used was Entek Plus HT copper OSP (organic solder preservative) by Enthone. The component evaluated in this study attached to the test boards were 256 IO PBGA packages with lead free spheres. These PBGA packages are (17 x 17 mm), 16 x 16 full array with 1 mm pitch and 0.51mm/20mil diameter solder spheres. These are supplied in SAC105 and SAC305 alloys. SACX Plus™ 0307 used in this test were re-balled onto the package. The solder paste used was a

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<table>
<thead>
<tr>
<th>Location of Void</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Void in Solder</td>
<td>60% of Diameter = 36% of Area</td>
<td>45% of Diameter = 20.25% of Area</td>
<td>30% of Diameter = 9% of Area</td>
</tr>
<tr>
<td>Void at Interface of Solder and Substrate</td>
<td>50% of Diameter = 25% of Area</td>
<td>35% of Diameter = 12.25% of Area</td>
<td>20% of Diameter = 4% of Area</td>
</tr>
</tbody>
</table>

Table 1. IPC 7095 requirements for void classification.

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Four ways to reduce voids in BGA/CSP package to substrate connections

High volume commercially available paste made with SACX Plus™ 0307, SAC105 and SAC305 type 4 powder. Reflow profiles run in Figures 1 and 2 were on a Speedline Omniflo 7. All voiding x-ray measurements were taken using a Phoenix Micromex-HLN.

Pad metallization and reflow atmosphere were not studied in this experiment as previous studies shown that these two factors do not have a significant effect on void formation.

Figure 2 shows the low soak profile with a 175°C soak for 60 seconds followed by a peak temperature of 240°C with total time above liquidus (TAL) of 60 seconds. The high soak profile in Figure 3 is a 160-180°C soak for 120 seconds followed by a 250°C peak temperature with a TAL of 60 seconds.

Printing volume & stencil design

The goal of the solder paste printing process either on rigid or flexible circuits is simple to understand; place the correct amount of solder paste in the correct location at an acceptable rate, twenty four hours per day seven days per week. This goal may be simple to understand but the execution of the goal requires the identification, understanding, and optimization of numerous factors that all influence how well the solder paste printing process will perform.

Four main elements define the typical stencil design: material, thickness, image pattern and aperture size. There is no single combination of these elements that can be recommended as the best choice. Instead, the various options available must be considered in the context of the overall assembly process.

One of the key elements in stencil design is to maximize the amount of solder paste that is transferred through the stencil aperture onto the printed circuit board pad. This is called "transfer efficiency." The proper stencil design will ensure the force that adheres the solder paste to the PCB pad will overcome the force that retains the solder paste in the stencil aperture. The two calculations that must be considered in stencil aperture design to maximize solder paste transfer efficiency are "aspect ratio" and "area ratio." Aspect ratio considers the ratio between the width of the aperture and the thickness of the stencil. Area ratio considers the ratio between the width of the aperture and the thickness of the stencil. Area ratio considers the ratio between the opening of the aperture (the area of the printed circuit board pad that will be covered with solder paste) and the total surface area of the aperture walls. For small components where the opening of the stencil is approaching or equal to the area of the walls of the aperture, area ratio is a vital calculation to design a stencil that will print well with minimum aperture clogging and maximum solder paste transfer efficiency.

An aspect ratio of 1.5 or greater and an area ratio of 0.6 or greater are required to insure maximum solder paste transfer efficiency and minimum aperture clogging.

The main factors that affect solder paste printing are its rheology, tackiness, and powder particle size and shape. For example, Type 4 solder paste is typically required for pitches under 0.4 mm. This is based on experimentation that has shown that four or more solder particles are needed to span the stencil aperture to achieve consistently good solder paste deposition. Similarly, with 0.3 to 0.4 mm pitch, the stencil openings should be between 0.005" and 0.008" wide.

Since Type 4 paste has solder particles <0.0014", this criterion is statistically met. Recommended paste types, based on lead pitch, are provided in Table 3.

Paste selection and processing parameters have been observed as critical factors affecting void formation and subsequent solder joint reliability. Figures 4 & 5 show the effect of a ten-percent aperture reduction resulting in reduced volume of solder paste transferred to the corresponding pad.

<table>
<thead>
<tr>
<th>Pitch</th>
<th>Pad Size</th>
<th>Aperture</th>
<th>Stencil Thickness</th>
<th>Aspect Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>µm</td>
<td>µm</td>
<td>µm</td>
<td>µm</td>
</tr>
<tr>
<td>0.025</td>
<td>635</td>
<td>0.015</td>
<td>381</td>
<td>0.0012</td>
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<tr>
<td>0.020</td>
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<td>0.012</td>
<td>305</td>
<td>0.008</td>
<td>203</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Table 2. Recommended sizes, pad width and tolerance.
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Four ways to reduce voids in BGA/CSP package to substrate connections

and its affect on voiding performance. The ten percent volume reduction resulted in much lower voiding results in all cases using the same solder paste and three reflow profiles. Thus stencil design and printing parameters are critical factors in reducing voids. Figure 5 shows that size and level of voids are lowered significantly by reducing solder paste volume by approximately ten percent compared to Figure 4 under identical reflow profiles. Solder paste reduction is not seen as a drastic measure to reduce voiding as the largest volume of the solder for the joint comes from the sphere of the package being attached. However, a typical solder paste is 50% by volume flux, so the 10% reduction in solder paste volume has a larger affect on total flux content used in forming the metallurgical joint.

**Flux composition**

It is empirically observed that for the same reflow profile, different flux formulations have different voiding performance. For an identical flux formulation, different reflow profiles will yield different voiding performance. In almost all cases, a lower peak temperature profile will yield better voiding results than a higher peak temperature profile\[5\]. This is generally accepted as the boiling points and reaction temperature of a fluxes constituents will be further from their boiling points and reaction temperature in a lower peak temperature reflow process compared to a reflow profile having a higher peak temperature.

Another technique in flux composition evaluation is to evaluate specific components of a flux system separately and examine their direct effect on voiding based on various concentration levels. In these tests the voiding data is compared to alternative substances that may be used and run under identical conditions. Figure 6 shows an example of the difference between two different activator levels in respect to voiding keeping the reflow temperature at a 240°C peak. This provides clear evidence that different activator systems need to be evaluated when considering voiding as one material clearly shows less voiding than an alternative material. Figure 7 shows the voiding levels measured of the same flux composition run at two different reflow peak temperatures of 230°C and 240°C. Figure 7 provides evidence that peak reflow temperature has an effect on voiding and that selecting materials with specific sublimation and boiling characteristics should be kept in mind.

Figure 8 shows the behavior of a specific constituent (Activator 1) in a DSC (differential scanning calorimeter). Using a DSC measuring a single substance on a specific substrate, the reaction temperatures, boiling points and any subsequent weight loss at a specific temperature can be measured to evaluate potential voiding of a flux's constituents. This information can then be used to determine if the flux activator would be a source of voiding in a final solder paste formula. Employing the same methodology using a flux's complete activator system can also be employed. This compensates for assumptions based on boiling point depression of mixtures or...
unintentional reactions of these complicated systems.

**Reflow profile**

The critical reflow profile parameters that are responsible for voiding are preheat temperature, ramp-up rate and peak temperature.

During this study all were varied within the allowable process limits to verify if voiding could be minimized. Reflow profiling and controlling ramp rate and peak reflow temperature are generally accepted as known methods of managing voiding in SMT and semiconductor package assemblies. The need for proper setup of the oven profile to limit temperature extremes and thermal shock to components and PCB is also known. Unfortunately this is the limit of process control in many reflow processes. Many electronic assemblers ignore the potential for variance in solder joint quality due to variations in the reflow profile. Additionally, many manufacturers desire to achieve higher production volumes without increasing floor space may develop profiles that increase reflow oven belt speed to increase throughput. This leads to a reduction or elimination of the soak portion of the reflow profile.

During the reflow process, the solder paste will experience temperature gradients that will impact its chemistry, voiding and the final soldering results. Proper optimization of the thermal profile will result in a net reduction of defects and increased reliability of the solder joint. In the initial ramp up stage of the profile, the low boiling solvents in the flux system will volatilize. The recommended ramp up temperature for lead free SAC reflow profiles is 0.75-4°C per second and may be limited by the thermal stability of the components. Excessive ramp up temperature may at times cause explosive release of the low boiling constituents and cause solder balls or flux spattering to appear.

The soak zone may be the most critical part of the reflow profile in which to reduce voids and subsequently the greatest area where defects have their origin. If a soak temperature is excessive, the flux constituents may be depleted. The end result will be re-oxidation of the solderable surfaces, solder powder, spheres and result in defects such as head-in–pillow, voiding and improper coalescence. If the soak temperature is too low the flux may not be consumed or activated resulting in excess residues or improper solder wetting as de-oxidation has not taken place. Typical soak temperatures are usually 160°C to 180°C.

Time above liquidus (TAL) of the alloy also has an affect on solder joint reliability and defects. For SAC alloys it is recommended that a board spend approximately 60 seconds above liquidus with a peak temperature 15-20°C above its melting temperature. As an example, if SAC305 is used its melting temperature range is 217 to 220°C, the peak temperature should be in the range of 230°C to 245°C. In Figure 8, the DSC exotherm demonstrates a reaction between
the flux constituent and copper substrate at 247°C confirming at excess high temperatures other gases can be formed increasing voiding, thus excessive reflow temperatures should be avoided when targeting voiding performance.

In this study particular attention was focused on peak temperature and its affect on voiding. Besides volatilization of organic flux constituents at elevated temperatures, excessive peak temperatures can cause oxidation of the solder spheres and flux residue darkening. Excessive time above liquidus is also known to promote intermetallic growth in the solder joint causing reliability concerns. Low peak temperatures or a low amount of time above liquidus may also result in soldering defects. The issues being typically, insufficient wetting of the solder joints or flux voids within the solder joint. The reflow profile used should remain at least 30 seconds above the liquidus temperature of the alloy.

In this experiment the data in Figure 9 came from running three solder pastes under identical reflow profiles. Solder paste A was run under both the reflow profiles shown in both Figures 2 and 3 in an attempt to fine tune its optimum voiding reflow profile. In Figure 9, it can be seen that solder paste A yielded better voiding results over the other two products. This shows a solder pastes total flux system can be tuned to reduce voiding as well as the profile used affects voiding performance. Based on this study and field validation a reflow profile with a longer soak and lower peak resulted in a lower voiding system everything else being equal. This also combined with the previous flux data having higher boiling points or reaction point constituents combines in a system to reduce overall voiding effects.

**Alloy composition**

Since 2006 there has been a trend for BGA and CSP package makers to supply components with lower silver alloys. The leading low silver alloy is SAC105 with significant levels of SAC305 still being employed. SACX Plus™ 0307 & 0807 are also now being used commercially. Other alloys supplied on these packages are SAC405 and SAC387. Besides lower silver content spheres being lower cost, they are also known to have better drop shock resistance. This is typically the factor dominating their selection for hand held and consumer applications.

One of the goals of this study was to evaluate the effect of the solder sphere alloy and corresponding solder paste alloy and their total affect on voids. The study also looked at the affect of two different reflow profiles on the sphere and paste alloy matrix. Figure 10 shows the matrix of alloys studied for the sphere and solder paste. The reflow profiles used are from Figures 2 and 3.

The void analyses data focused on the alloy of the sphere and paste yielded interesting results in that matching the sphere alloy and paste alloy, resulted in most cases, in lowering voiding and void size significantly compared to mixed alloy systems. This is believed to be due to the matching melting points of the sphere and paste material during reflow. It was also observed that the high/long soak reflow profile reduced voiding in SAC105 and SAC305 combinations, but was not as pronounced with the SACX Plus™ 0307 combination.

However the SACX Plus™ 0307 spheres in all paste alloy combinations exhibited low voiding meeting class III requirements. The SACX Plus™ 0307 alloy spheres also showed excellent voiding results with SAC105 paste, meeting Class III voiding criteria. This is believed to be due to the alloys having very similar silver and tin content. In all cases with the solder paste flux formulation which was developed with a focus on reduced voiding, class III voiding levels were attained.

In Figures 11, 12 and 13, the solid line represents the data run on the low soak reflow profile in Figure 2 with a 175°C soak of 60 seconds, a 245°C peak reflow having a TAL of 60 seconds. The dotted lines in Figures 11, 12 and 13 represents the data run on the high soak reflow profile Figure 2 with a 160-180°C soak of 120 seconds, a 250°C peak reflow having a TAL of 60 seconds.

Figure 14 shows an x-ray photo of a SAC305 sphere BGA package with a SAC305 alloy solder paste. Voiding is minimal for this specific paste type, paste alloy and sphere alloy. Figure 15 is a similar x-ray showing SAC305 sphere package with a SACX Plus™ 0307 solder paste. The data suggests a high silver content alloy such as SAC305 when joined with a lower silver alloy will have a higher incidence of voiding.

**Conclusions**

Combining all four aspects of alloy matching, optimized reflow while employing stencil design and a paste developed with minimizing voiding can effectively meet or exceed Class III voiding criteria.

**Alloy**

- Matching sphere and paste alloys tends to produce fewer large voids than mixed alloy combinations.
- The number of voids between like alloys of the solder sphere and paste were also shown to be reduced.
Four ways to reduce voids in BGA/CSP package to substrate connections

**SAC Plus™ 0307** spheres have overall good performance with all paste alloy combinations meeting class III voiding requirements.

**Peak Reflow**
- Peak reflow temperature has a significant effect on voiding due to the interaction of the flux with the copper substrate at key temperatures.
- Boards with a peak reflow of 240°C produced less voiding than the components assembled with a peak reflow of 250°C.
- The total number of voids found when comparing peak temperature of the reflow were about 25-30% higher for a peak temperature of 250°C than for a peak of 240°C.
- Boards assembled using a low ramp rate of 0.75°C/sec produced less voiding than the boards assembled using a faster ramp rate.

**Flux Formulation**
- Solder paste formulation has a significant effect on voiding due to the type of chemistries used and where they become reactive with the copper substrate.
- A solder paste flux system developed for low voiding can still be affected by the reflow profile, soak and peak reflow temperatures.

**Solder Paste Volume**
- Reduced volume of paste and/or sphere reduces voiding.
- A 10% solder paste reduction by stencil design has shown to decrease BGA voiding significantly.

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**References**

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“Voiding under low stand-off components, such as QFNs, can be effectively minimized through material and process optimization. Let me show you how.”

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Conductive crystals, white residues, and decreased reliability

The rush to clean no-clean

Michael Konrad, Aqueous Technologies Corporation, Rancho Cucamonga, California, USA

Just as the little girl in the 1982 film Poltergeist eerily exclaimed, “they’re back,” the electronics assembly industry has witnessed the return of a familiar yet unappreciated process step: cleaning.

Once commonplace, then relegated to military and other high reliability applications, today defluxing has once again moved toward the mainstream. The miniaturization of electronic assemblies and their components, implementation of lead-free alloys, combined with improved quality standards and higher reliability expectations have culminated to form a growing demand for ionicly clean electronic circuits.

This paper will review the major causes of residue-related failures including dendritic growth, electrical leakage, and under-coating adhesion failures. Why we clean, what we are removing, and how clean is clean will be presented.

Keywords: Cleaning, Cleanliness, Defluxing, Electro-Migration, Electrical Leakage, Cleanliness Testing

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Let’s travel back in time, specifically to pre-1989. Before 1989, nearly all assemblies were cleaned. Components were “stuffed” into assemblies. Assemblies were soldered, leads were trimmed and assemblies were cleaned to remove the flux residues. Cleaning was an integral part of the assembly process. With few exceptions, assemblies were cleaned using one of three medias; 111 Trichloroethane, Freon TMS (or generic equivalent) or water.

The great buzzkill of the 20th century arrived in 1989 in the form of an international treaty entitled the Montréal Protocol. Apparently, these CFC-based cleaning solvents had been busy destroying the Earth’s ozone layer (Figure 1) and the United States, Canada and about nine other countries were determined to stop it. As a result, many CFC-containing products were banned under this treaty including the two major cleaning solvents used in electronics production.

Amidst the industry wide panic, fueled by several trade magazines cover pages with their countdown to the end of CFCs came a new technology called “No-Clean Flux.” More than just a technology, it was a concept. Reduce the volume, visibility and affect of residues and leave them on an assembly. Problem solved!
While assemblers of military, medical and other high-reliability products continued to remove flux residues by cleaning their assemblies (using alternative technologies), the greater commercial industry, having no specific mandate to clean, abandoned cleaning by switching to a no-clean process.

This bi-polar approach (cleaning is required/cleaning is not required) was largely successful. No-clean technology, in most cases, left behind mostly benign residues that did not negatively affect most electronics assemblies. In recent years, however, there are a growing number of commercial assemblers that have rejoined the ranks of military and medical processes and turned to cleaning. Our industry is seeing a resurgence of cleaning. Because RMA and OA flux residues have always been removed via a cleaning process, the growth in cleaning is represented by commercial assemblers removing no-clean flux residues. Because there are many times more commercial products being built compared to specifically high-reliability products, the growth in cleaning is no-clean based, hence the fact that no-clean represents the highest share of flux cleaning today.

Houston, we have a problem

As previously mentioned, there is a modern migration toward a cleaning process. No-clean processes have been in popular existence for 22 years. Why now are no-clean processes being replaced with cleaning processes? What changed?

Today, there are two primary problems associated with residues left on a circuit assembly—electrical migration and electrical leakage. These problems are hitting many assemblers hard and, in a growing number of cases, have lead to a rush to clean no-clean.

Electrical migration can occur when three key elements combine on an assembly:

- Voltage differential (power to ground). As little as 1.5 V
- Moisture
- A corrosive or conductive residue

When the three key elements are present with other factors, it is possible to experience electro-migration, commonly in the form of dendritic growth between two electrical connections on the assembly. A dendrite is a metal crystal (Figure 2) that forms as metal dissolves at an anode and is electro-deposited at a cathode. The electro-deposited metal takes the form of metal crystals.

Dendrites are harmful because they may take from 8-18 months to grow. Unless accelerated age testing (e.g., steam- age testing) is performed, it is impossible to predict the likelihood of dendritic growth until a catastrophic event occurs.

Electrical leakage

The other issue associated with assembly residues is electrical leakage. This is a particularly difficult diagnosis to confirm because the results of electrical leakage tend to be of a temporary nature. At issue is the fact that electrical leakage is a temporary problem. Its affects are witnessed only when the assembly adsorbs moisture. When the moisture is removed, the problem disappears, frequently resulting in no-trouble-found (NTF) field returns. A typical scenario goes like this: An assembly is tested and shipped to a customer in Mississippi in February. The customer begins to use the product, a hand-held portable instrument. By August, the customer notices that the instrument is not working properly and returns it to the manufacturer for inspection. Upon receipt by the manufacturer, the product is tested within the air conditioned and humidity-controlled environment of the test lab. Of course, the problem cannot be duplicated because the humidity-caused moisture has disappeared. This results in a NTF status and the product (and the problem) is returned to the customer. At issue is the flux residue that becomes more active when subjected to moisture, allowing increased conductivity to alter a product’s function but not enough to create a short.

Why now? What changed?

As previously stated, we have been using no-clean flux, mostly successfully, for 22 years. Why is our industry seeing an increase in electro-migration and electrical leakage now? The answer is simple. There are two reasons for the increase in residue-related failures. One factor is the implementation of lead-free alloys.

First, let’s consider the purpose of flux. Flux reduces oxidation during the reflow process when solder changes from a solid state to a liquid state. The flux's responsibil-
The rush to clean no-clean drain from a pad. Historically, this was not a major issue because the assembly’s pads were physically far enough apart as to leave a flux-free gap between two pads (Figure 3).

As assemblies were miniaturized and component densities increased, the flux residue would spread from pad to pad, forming a bridge (Figure 4) of residue between cathodes and anodes.

Even though no-clean flux residues are ionically weak and are hardly corrosive, the physical close proximity between components combined with excessive heat and its negative effects on flux create the perfect storm for potential failures.

**Preventing residue-related failures**

There are three proven methods to prevent residue-related failures:

1. Remove the electrical voltage. While this method is highly effective, it is absurdly unpractical.
2. Prevent assembly contact with moisture. This is commonly accomplished by the application of conformal coating. Contrary to popular belief, conformal coating, while providing an excellent barrier to fluids, does not prevent all contact with moisture. Over time, moisture can penetrate coatings, (Figure 5) resulting in residue-related failures as previously described.

   Even if coatings were to provide an effective barrier to all forms of moisture, coating manufacturers require clean, residue-free surfaces for good adhesion. Failure to provide a residue-free surface can result in coating delamination and/or under-coat corrosion.
3. Remove the residues that contribute to electro-migration and electrical leakage.

   With option #1 not on the table and options #2 and #3 all requiring cleaning, it is clear that a cleaning/de-fluxing process is the best method of preventing assembly failures due to electro-migration and electrical leakage.

**Additional benefits of cleaning electronics assemblies**

In addition to the elimination of post-reflow residue-related product failures, the cleaning of electronic assemblies, while intended for the removal of flux residues, actually provides for the removal of other contamination species. While the empha-

A robust cleaning process can eliminate all or most of the residues that become stowaways on an assembly during its journey through the fabrication and assembly processes.

**Cleaning is an all or nothing proposition**

The science of post-reflow cleaning of circuit assemblies is an all or nothing proposition. If you cannot fully clean an assembly, do not clean it. The only thing worse than assembly-related residues on an assembly is a partially cleaned assembly. There are numerous reasons for this. First, the most critical part of a cleaning process often is thought to be the wash cycle. This is not accurate. The most critical function of any cleaning process is rinse. Defluxing chemicals are highly ionic and corrosive. During a wash cycle, flux and other residues are solublized and held in solution within the wash chemical. After wash, the assembly is covered with wash solution that contains the flux and other residues. If an assembly were removed from a wash cycle without the benefit of rinse, the assembly would soon fail. Solder joints would be attacked, electrical migra-

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<table>
<thead>
<tr>
<th>Board Fabrication</th>
<th>Component Fabrication</th>
<th>Assembly Process</th>
</tr>
</thead>
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<td>Solder paste</td>
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<td>Water quality rinses</td>
<td>Flux-wave/core</td>
</tr>
<tr>
<td>Water quality rinses for inner layers</td>
<td>Deflashing chemicals</td>
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<td>Rework cleaner</td>
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Table 1. Multiple possible contamination sources.

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Reducing defects with embedded sensing technology

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Typical SMT production lines are a collection of disconnected machines performing various tasks. Errors can occur at any step during this process but often go undetected until the PWB is completed and soldered, and it is too late to do anything other than re-work or scrap it.

To prevent defects from simply passing from one machine on to the next, it is necessary to have inspections throughout the line. Better yet, sensing at different points should be linked to form a complete solution. This is especially critical in the placement phase of assembly due to the wide variety of inputs (components) and movements. The assembly system has to take up to hundreds of different components and individually place them at different locations on the PCB. This complicated task requires more thorough oversight to ensure defects are not created or passed on. Optical sensors can provide this oversight into the assembly process and offer the benefits of being fast, accurate, and non-contact.

Some of the challenges of integrating these sensing technologies are cost and space. It would be too expensive to have a complete inspection machine before and after each assembly system, and take up far too much space. New generations of optical sensors are compact enough to be embedded at key locations within the PCB assembly process, forming a complete web of error prevention.

This paper discusses the new integrated optical sensing technologies that make it possible to virtually guarantee that only good PCBs will pass through the assembly process, reducing costly rework or scrapped PCBs and improving efficiency.

**Introduction**

Electronic assembly manufacturers are under constant pressure for yield improvement and higher efficiencies as margins continue to be squeezed. Another metric that has gained increasing attention over the past several years for these manufacturers is the throughput per square foot of factory floor space. Process monitoring using optical sensor technologies has the potential to greatly improve yields and factory efficiency, but can only be practical when the benefits outweigh the additional cost and space to install and operate these technologies.

The digital camera revolution has enabled a whole new generation of cost effective, compact, high speed, and high-resolution optical sensor technologies to be developed. Compared to distributing standalone inspection systems throughout the assembly process, embedding and integrating these new optical sensors into the automated assembly equipment can be attractive from several perspectives:

- Real-time process monitoring of the actual assembly operation,
- Elimination of redundant mechanical transport systems for both the optical sensor and the PCB, and
- Reduced line length to improve the throughput per square foot metric.

In many cases, embedded optical sensing technology brings a complementary set of capabilities compared to standalone inspection systems, with each approach providing valuable improvements in yield and efficiencies. Three embedded optical sensing technologies will be discussed that provide continuous process monitoring throughout the assembly process: on-the-fly laser centering, embedded micro-cameras, and strobed imaging modules. An example assembly line is shown in Figure 1, with the locations of the various embedded optical sensors.

![Figure 1. SMT assembly line showing embedded sensor locations.](image-url)
Reducing defects with embedded sensing technology

On-the-fly laser centering technology has been available in the market for a number of years and continues to evolve and improve. With this technology, a laser stripe is focused on the component. The component is rotated as it travels from the feeder to the placement site, and the shadow of the component is measured by a detector array. The component's center, dimensions and angular correction are calculated using a tomographic reconstruction algorithm. In addition to measuring the placement offset correction, this sensing technology provides real-time monitoring of the placement to verify the component's presence immediately prior to the placement and then to verify the release of the component. Tombstone picks are also easily detected since the measured component size won't match the nominal dimensions.

Micro-camera technology that is embedded into the moving placement head has become available recently. These cameras enable real-time monitoring and verification of both the pick and place operations. The cameras are oriented to provide high speed and high-resolution images directly below the vacuum nozzles. High intensity LED illumination technology is used to freeze the effects of motion blurring. The cameras and LEDs are then synchronized with the action of the nozzles to acquire the images at the proper times.

Example micro-camera images from a successful pick operation are shown in Figure 5. Common causes for a pick error include damaged nozzles, a missing component in the tape, the feeder not advancing properly, or perhaps the cover tape didn't peel back properly.

A micro-camera image sequence starting just before component placement, at the time of placement, and just after placement is shown in Figure 6. By subtracting the “before” image from the “after” image gives an indication of the change that occurred. This “difference” image shown in Figure 6 reveals the component just placed and is a powerful technique to identify the newly placed component from all other features in the image and verify a proper placement.
Reducing defects with embedded sensing technology

New optical sensor technology—strobed imaging modules

A new optical sensor technology referred to as a Strobed Imaging Module (SIM) sensor has also recently become available. The SIM sensor incorporates an extremely fast image acquisition system and is simple to integrate for embedded applications since it can be statically mounted above a conveyor. The SIM sensor captures high resolution images as a PCB is continuously transported by the conveyor past the SIM sensor. The illumination is strobed to eliminate any affects of motion blurring. Cutaway views of the screen printer and PCB assembly machines in Figure 7 illustrate the location of the embedded SIM sensors. Cycle time is not affected as the PCB travels from the output buffer section of one system to the input buffer section of the next system. An intermediate buffer section or stack buffer with review capabilities can also be an option. If the embedded SIM sensor is not available in the screen printer, then the first SIM sensor can be located at the input buffer section of the first chip shooter.

An array of cameras in the SIM sensor captures high resolution PCB images while the PCB is in motion. Figure 8 illustrates a portion of a SIM sensor image acquisition sequence. The illumination is strobed as the PCB passes through position 1 and a rectangular image zone is acquired by an internal array of cameras. The camera fields of view slightly overlap one other and then are automatically stitched together by software to provide a seamless image. For instance, one variant of the SIM sensor includes eight 5-megapixel cameras with a rectangular image zone, or effective field of view, of approximately 30 mm x 300 mm. The PCB continues to pass through position 2, and then when it passes position 3 the illuminator is strobed and another rectangular image zone is acquired. This process continues until images have been acquired for the remainder of the PCB. Each successive rectangular image zone slightly overlaps with the previous image zone. This allows the software to stitch together all of the image zones into a single, seamless image.
A strong driving force for all of the embedded process monitoring systems presented in this paper is the reduction or elimination of any additional programming beyond that required to perform the assembly operations. Nominal component locations, orientations, package type, and sizes are all directly available to the embedded process monitoring software since this data is already required by the assembly systems. Stencil CAD data can also be provided by the screen printer to the embedded process monitoring system.

Embedded solder paste monitoring is provided using the SIM optical sensor technology integrated with a screen printer. The printing process can be monitored to assure proper solder paste coverage, registration, and ensure there are no unwanted bridges. Component presence, position, and orientation can be monitored after the PCB exits the final chip shooter and before fine pitch placement. Another unique capability provided by the embedded SIM sensor technology at this process stage is to check for stray chip components at BGA or other fine pitch sites. This is particularly valuable since these stray components cannot be detected directly by an end of line AOI system. The components placed by the fine pitch assembly systems are also monitored for presence, position, and orientation by the final embedded SIM sensor.

Figure 10 illustrates stray component detection. An image of the fine pitch site is acquired after the screen printer and before any components are placed on the PCB. The image of this site is then acquired by the SIM sensor as it exits the last chip shooter. A difference image is generated to detect the stray component and no sophisticated user programming is required to ignore the complex background information.

Conclusion

New generations of optical sensors such as on-the-fly laser centering, embedded micro-cameras, and strobed imaging modules can provide cost effective, real-time, continuous process monitoring throughout the assembly process. Catching defects early can increase yields and improve efficiencies. Costs can be reduced by not allowing errors to propagate through the assembly process where they become increasingly more expensive to correct. Of course the monitoring system should be simple to use and not create a big additional overhead, so the embedded optical sensor technologies capitalize on the component and solder paste data already available during the assembly process to reduce or eliminate additional programming. Finally, an embedded sensor network distributed at multiple locations in the assembly process dramatically improves the likelihood that only good PCBs pass through the assembly process.

The rush to clean no-clean—Continued from p. 18

How clean is clean?

This is one of the most popular questions. The military attempted to tell us in the form of WS6536, MIL STD 2000A and other standards. IPC has told us in the form of J-STD001-TM650 and other standards. The reality is that these and other standards were written in the 1970s and 1980s.

Consider the magnitude of evolution that has occurred in the design of electronic assemblies over the past 30+ years and ask yourself if you feel comfortable with these cleanliness standards. The real answer relies on another question: what happens if it fails?

A failure in a GameBoy carries far different consequences than a failure on the Hubble Telescope. Mobile phones and defibrillators each have their own unique level of consumer confidence and degrees of liability if failure occurs.

There is considerable debate about which cleaning standard and cleanliness testing method to adopt. Ion chromatography, ROSE testing, SIR, visual and other methods are all valuable tools to determine if an assembly is clean and each carry both benefits and drawbacks. While ROSE testing remains by far the most popular and accessible method of post-reflow cleanliness testing, it is not without its faults. Many assemblers rely on ROSE testing results based on the standards designed in the late 1970s (10 [g NaCl/in²]).

The fact is ROSE testers, while fast and inexpensive, are not capable of detecting all forms of possible contamination. Additionally, they assume that all detected contamination is evenly spread across the assembly. In reality, contamination frequently is concentrated in or under high-density assembly areas. For these reasons, one should consider an internal standard that is much lower than the ones published.

How clean is clean? On a ROSE tester, 0.0 is clean. Every value above 0.0 is a step toward possible contamination and related consequences.

Conclusion

Post-reflow residue-related failures are on the rise as are quality expectations. A cleaning process will increase reliability and, therefore, decrease potential assembly failure liability. Cleaning materials and equipment have evolved significantly over the past 22 years. Today’s modern cleaning materials and processes provide an environmentally responsible alternative to the processes of the last century. With the ever-decreasing size of a circuit assembly, the increasing densities of components, and the increasing demand for reliability, it is time to return “clean” to the electronics manufacturing vernacular.

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Original publication

Electronic equipment shipments grew 11% in 2Q’11 vs. 2Q’10 based upon the preliminary composite revenues of 96 OEMs producing over 50% of the world’s electronic gear (Chart 1). The second quarter of 2011 was the seventh consecutive quarter of growth in the global end markets (Chart 2). The ratio of inventories/sales remained generally in control throughout the supply chain however semiconductor inventories climbed (Chart 3) in the second quarter.

Although electronic equipment growth held in the second quarter there were certainly signs of a coming slowdown. Suppliers of components (semiconductors, PCBs and other passive devices) saw a 2Q11 downturn (Chart 4). So did military equipment vendors.

Based upon monthly electronic equipment sales by region (Chart 5), end market demand flattened in the third quarter. We can expect a traditional autumn seasonal upturn but this will likely be muted by generally weaker buying activity. Fortunately smartphones (Chart 6) and media tablets (Chart 7) are driving growth even in these difficult times.

Looking forward we appear to now be in the negative portion of the current business cycle (Chart 8). End market growth is slowing but is still positive. However suppliers further back on the supply chain should brace for more difficult times. The JPMorgan global PMI (leading indicator) points to weaker than normal months ahead for materials, electronic components and process equipment. Fortunately autumn seasonality will partially offset the slowdown until November, but year-end 2011 and early 2012 may be difficult.

We have lived through many business cycles. This one is complicated by global economic uncertainty and domestic political wrangling.

Chart 9 summarizes our colleague Ed Henderson’s recent regional growth forecasts for electronic equipment production by year.

**End markets**

**Computers & peripherals**
- Asia-Pacific PC shipments grew 13% year-on-year to 30.1 million units in 2Q’11
- Femtocell market is forecast to grow from $300M in 2011 to $1 billion in 2015.—Infonetics Research
- Worldwide Wi-Fi access point hardware, software, and services will grow to $1.34 billion by 2016.—ABI Research

**Mobile communications**
- Worldwide handset sales expanded 16.5% y/y to 428.7 million units in 2Q11; smartphone sales grew 74% and accounted for 25% of all handset sales.—Gartner
- Global smartphones sales are forecast to grow from 420 million units in 2011 to more than 1 billion in 2016.—IMS Research
- Mobile broadband device shipments are projected to climb from 100 million units in 2010 to 158 million units in 2011.—IHS iSuppli

**Consumer electronics**
- Consumer electronics sales revenue is expected to reach $190 billion in 2011.—CEA
- Global LCD TV shipments are expected to top 205 million units in 2011.—AUO Ex. VP
- Global TV shipment outlook for 2011 was reduced by 3% to 252 million units by DisplaySearch.
- India’s consumer electronics market is anticipated to grow at 18% CAGR to US$13 billion by 2014.—RNCOS
- Video game revenue fell 29% y/y to $223 million in July 2011.—NPD

**Other**
- Global wireless power market is pro-
projected to grow 85.5% annually from US$100 million in 2010 to US$ 4.5 billion in 2016.—IMS Research
• Wireless sensor networks will grow from US$ 0.45 billion in 2011 to US$ 2 billion in 2021.—IDTechEx

EMS, ODM & related assembly activity
EMS and ODM companies will produce 128 million LCD TVs in 2015, up from 65 million in 2010.—IHS INC
A1 Electronics added a Mydata MY100SX14 pick & place machine.
API Technologies received $2.7 million in contracts to produce circuit card assemblies for counter-explosive equipment under the JCREW program.
Autosplice was acquired by J.H. Whitney.
Celestica:
• received EUR 467,000 in incentives from the Spanish government for development programs in Valencia.
• received recommendation for AS9100C certification at its Suzhou, China, facility.
Compal is recruiting more than 1,000 new workers across the Taiwan Straits this year. Dynamic Manufacturing is adding a 4,000 SF expansion in Northpointe Industrial Park, in South Buffalo Township.
Elcoteq:
• laid-off 400-500 employees in Pécs, Hungary.
• President and CEO Jouni Hartikainen resigned.
• received controlled management approval from the Court of Luxembourg.
eXception integrated GOEPEL’s Boundary Scan into its Teradyne Test Station.
FCT Assembly relocated its Fort Collins, Colorado, operations to a 1974 SF facility to accommodate the company’s continued growth.
Flextronics:
• became an end-to-end manufacturing partner for production, order fulfillment, new product development and post-manufacturing logistic services for Sonus Networks.
• plans to terminate manufacturing operations in Denmark at the end of the year.
Foxconn/Hon Hai:
• acquired Cisco’s Juarez, Mexico, manufacturing operations.
• applied for a license to produce printer cartridges in Kulai in Malaysia’s Johor State.
• received a digital still camera production outsourcing contract from Panasonic.
• plans to replace some of its workers with 1 million robots in three years to cut rising labor expenses and improve efficiency.
• looking for land to build a dormitory for 3,000 new employees it plans to recruit for its planned cloud computing center in Kaohsiung, Taiwan.
• will construct a NT$100 billion Automation Park in Taichung which will accommodate machine tool, automatic equipment, robot, and solar energy factories.

![Chart 3](chart3.png)

Global Electronic Supply Chain Growth 2Q’11 vs. 2Q’10 (Preliminary)

![Chart 4](chart4.png)

World Electronic Equipment Monthly Shipments

![Chart 5](chart5.png)

Smartphone Unit Shipments to End Users World

![Chart 6](chart6.png)


Hunter Technology named Bryan McCreedy VP of sales and marketing.

IEC Electronics received a $5.2 million military and defense order for ground support equipment and unique flight systems cables and wire harnesses.

Integrated Micro-Electronics completed its acquisition of EPIQ Subsidiaries in Europe and Mexico.

Jabil Circuit inaugurated its HUF 612 million facility in Polgár, Hungary.

Limtronik added an EMS services office in Denver, Colorado.

Macrotron Systems upgraded its Silicon Valley facility to assemble PCBs with 0201 size SMT components.

pb tec named Dirk ruhstein director of sales and support for Bavaria and Switzerland.

Plexus named Jürgen Seibert senior director, business development EMEA.

Sanmina-SCI received a contract to design, manufacture and ship EarCheck medical devices for Innovia Medical.

Sievi Capital demerged its contract manufacturing unit. Its proposed new name for the contract manufacturing company is Scanfil plc.

SIT added a Mydata MY100DX4 pick & place machine at its Dutch plant.

SMTech received a contract to build Redline Communications’ RDL-3000 next generation broadband radios.

Solid Semes’ manufacturing plant received EN-ISO13485 certification for producing medical devices.

Suntron hired Michael Oliveri as VP and GM for its OSS business unit.

Surface Mount Technology entered exclusive negotiations with a potential investor for a restructuring proposal for the Group.

Tailyn added a SMT Line which includes a DEK/Horizon solder paste printing machine, Panasonic CM602 high speed mounter, Panasonic DT401 multifunction mounter, a Heller 1912EXL nitrogen reflow oven and a TRI 7500 serial AOI unit.

t-mac Technologies acquired electronics manufacturing firm FAW Electronics.

USB Electronics Systems added a new line with three Siplace SX2 machines.

VadaTech purchased two XPIi-IIT pick & place machines for its plant in Henderson, Nevada.

Variosystems is building a plant on its newly acquired 80,000 m² site in Sri Lanka.

Videoton purchased 94% ownership in Ventifilt Zrt mechanical (Hajdúnánás, Hungary).

### PCB Fabrication

**All Flex** is celebrating 20 years of business. American Standard Circuits added both new tin lead plating and hot oil reflow process.

Atotech licensed an immersion tin patent from Enthone.

Automated Circuit Design implemented MaxQ SCP software at its plant in Richardson, Texas.

Capital Electro-Circuits received ISO 9001:2008 certification.

DVEO purchased Linear Systems.

Eltek received medical equipment PCB orders valued at $490,000.

Endicott Interconnect named Warren Dannelly VP of worldwide sales.

eXception VAR hired and appointed David Fletcher strategic account manager.

**FTG Circuits**, Toronto:

- reached three-year contract with employees.
- achieved Nadcap AC7119/3.
- ggp-Schaltungen successfully qualified the LDI solder mask ELPEMER SD 2467 SM-LDI produced by Lackwerke Peters.

HannStar Board acquired 329.2 million shares, equivalent to a 25.01% stake, of its subsidiary HannStar Board International Holdings (HBI) at HK$1.25 per share.

INari Bhd is building fourth plant in Free Industrial Zone in Bayan Lepas, Penang.


Merlin Circuit installed a Dynachem a PH 8030 SmartLam 5000 automatic cut sheet laminator at its Chester facility in North Wales.

Practical Components added additional test boards for cleanliness testing and conformal coating.

Schweizer added a nickel-gold and nickel-gold-palladium line, an Interposer pick & place-system and an HDI Laser system in Schramberg, Germany.

Shax Engineering received Medical Device certificate ISO 9001 certification.

Sierra Circuits installed new equipment and chemistry techniques to produce ENePIG (Electroless Nickel—Electroless Palladium) surface finish on PCBs.

Somacis Spa achieved Nadcap AC7119/3, HDI PCB accreditation in Castelfidardo, Italy.

Unimicron:

- acquired a 35% share in RUWEL International.
- PCB subsidiary in China Trendtronic Technology has begun construction on its second-phase 60,000 m² expansion factory.
It's **LEAN**

It's **MEAN**

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Our latest creation, the TouchPrint TD2929-E “Essentials” model was created for two specific reasons, to give you lightning fast speed with accuracy you demand.

Milara has streamlined our high-end printing systems to deliver the finest quality printing the industry has yet to experience. **MEAN** because this platform is structurally stable combined with overall rigidity to ensure accuracy at high production speeds. **LEAN** because we only put in what you need to produce a high quality product and to hit the price points you require. Although lean, Milara still offers the best of our technology found in our high end system at an affordable price. Let us prove what our Essentials model will do for you.
Materials, process equipment & support services

EDA industry revenue increased 16% for 1Q’11 to $1464.4 million; PCB & MCM) revenue grew 28.3% to $140.4 million.

ACD appointed Jerry Cupples Process Manager in Richardson, Texas.

Air Products is building a new nitrogen plant at its site in the Gumi National Industrial Complex 2 in North Gyeongang Province, Korea.

Alpha’s global director of technical support Paul Lotosky passed away.

ASM Assembly Systems (formerly Siemens Electronics Assembly Systems):
- added eight additional field service engineers for 24-hour service and support.
- appointed Sven Buchholz the new head of SIPLACE’s CEE (Central and Eastern Europe) cluster.

Christopher Associates became TECHNICA USA’s exclusive distributor of OTC solder masks and inks to the electronics interconnect industry in the Western U.S.

Consona released Cimnet Systems’ Engenix v3.3 engineering solution for PCB manufacturing.

Co-Tech is boosting its copper foil production capacity by 150 metric tons by end of 2011.

Datest purchased an Akila XR-3 x-ray inspection system from Christopher Associates.

DEK:
- appointed Eszter Galántai as one of the European distributor managers for its Electronics Assembly Division.
- licensed a VectorGuard stencil system to Great Lakes Engineering.
- named Brian Smith GM for electronic assembly (Americas) ; Jim Price regional sales manager for electronic assembly (US West Coast) and Mike Burgess process support products sales manager (North America).

Digitaltest achieved ITAR certification.

Dow Electronic Materials received “First Prize—Excellent Dow Team Award” from Multek.

Ellsworth Adhesives named Dymax its distributor in Australia.

Eltraco Group split into two companies: Eltraco A/S and SMT House AB.

EMC Technologies acquired Specon.

Everett Charles Technologies appointed Vincent Yu technical marketing director for Asia.

Henkel Electronic Materials introduced pressureless silver sintering technology.

Illinois Tool acquired Teknek.

Isola:
- appointed Robert Chaney president—Americas.
- joined the Electronic Industry Citizenship Coalition.

Nordson:
- acquired Value Plastics.
- DAGE opened a repair and calibration facility in Suzhou, China.
- MARCH and Science College of Donghua University partnered on a R&D laboratory to develop plasma applications in manufacturing.

NSCC acquired the flexible laminate business from Mitsui Chemical.

ShineMore Technology is expanding its monthly production capacity of aluminum-based CCLs from 20,000-30,000 units to 100,000 units by the end of 2011.

Speedprint appointed Assembly Resource as its representative for northern California, FHP Reps as its representative in Mexico, central and southern Texas and Puerto Rico and TechSystems as its sales representative for Southern California and Baja territories.

Technic released Technistan HTM 4089, a High Throw Matte (HTM) tin sulfate process engineered to increase yields in advanced printed circuit boards.

Technica began distributing Hitachi Chemical’s photosensitive materials for PCB fabrication industry.

Techspray expanded its cleaning test lab to include batch cleaning, ultrasonic cleaning and vapor degreasing.

Tektronix acquired Optametra.

Viscom named Dirk Schwingel CFO.

Vishay promoted Dieter Wunderlich to executive VP, COO, and Johan Vandoorn to executive VP, CTO.

Vitronics Soltek USA moved to new headquarters in Hampton, New Hampshire.

Semiconductors & other components

Worldwide semiconductor revenues are projected to grow at a 6% CAGR from $303 billion in 2011 to nearly $378 billion in 2015.—IDC

IC Insights lowered its 2011 worldwide semiconductor industry growth forecast from 10% to 5% and 2011 IC market forecast from 10% to 4%.

Global DRAM industry revenue was approximately US$8.1 billion in 2Q’11.—DRAMeXchange

Global NAND flash memory revenues fell 9% q/q to US$4.88 billion in 2Q’11.—DRAMeXchange

India’s semiconductor consumption will grow 15.5% to $8.2 billion in 2011.—Gartner

High brightness LED shipments are expected to grow from <100 billion in 2010 to >135 billion in 2011.—The Information Network

Silicon wafer shipments increased 5% to 2.392 billion square inches in 2Q11.—SEMI

Worldwide PC microprocessor unit shipments declined 2.9% q/q in 2Q11 and revenue declined 4.0% q/q to $9.49 billion.—IDC

Semiconductor equipment sales are projected to grow 12.1% y/y to $44.33 billion in 2011.—SEMI

North America-based manufacturers of semiconductor equipment orders (3-month average basis) fell 4.4% m/m to US$1.55 billion in June 2011.—SEMI

Walt Custer is an independent consultant who monitors and offers a daily news service and market reports on the PCB and assembly automation and semiconductor industries. He can be contacted at walt@custerconsulting.com or visit www.custerconsulting.com.

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Activities vs Results

Reflow Oven

Activities
Temperature control, flux management, static pressure, heat transfer rates, fan speed, side to side variations, preventive maintenance, conveyor speed, exhaust variations, cooling zones, safety features, power management, PC control, user interface...

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East perhaps, or maybe west? The industry has already “gone south” recently, that was not a good direction. Trying to predict future industry directions and not just expanding on current ones is not easy, especially considering the vast diversity of products, locations, business models, and end-customers’ changing needs. Some of us, however, have to do this on a regular basis. Anyone that provides solutions for the industry needs time to develop their products. These products are best aimed at solving future needs, not necessarily current ones. For sure, we cannot ignore current needs or pains, but if we are to make a real difference, we need to aim further forward.

Where is the industry now as compared to a year ago, or even five years ago? Has anything fundamentally changed? Probably not so much for most companies. Perhaps then, predicting the future is going to be a little easier than we imagine. Or perhaps, the industry has been rather stagnant of late, repeating cycles in slightly different ways with slightly different tools. Time now though to look into the future, to look forward to some real improvements and innovations.

Here are my top five directions that the industry may take in the future.

**Direction #1: upstream & downstream**

These are actually two complementary directions. The worst kind of problem in manufacturing is an unexpected one. Take the case of new product introduction (NPI). The priorities for design are to make the best product they can in terms of functionality, style, cost, etc., with some regard for manufacturability. In reality though, how can the design team and their tools know the exact capabilities and constraints of the manufacturing facility that will build the product? Consideration is based on a very simple assumption model at best, if at all.

Looking from the other point of view, a contract manufacturer has the request to build a new product. The risk is in the quotation process. If there are extraordinary or simply unknown requirements that affect the manufacturing process, it may be too late before these are discovered, which can lead to significant excess costs, especially if found late in the introduction process. This is a significant issue of New Product Introduction and is simply due to an absence of communication between design and manufacturing.

There are two directions of potential benefit then. Upstream, the design team having access to an advanced set of information through specialist tools that represent more specific manufacturing constraints, can optimize the design for real-world manufacturing. Downstream, using the same family of tools, the manufacturing engineering team get a clear “heads-up” of all of the key information that they need to be aware of, to accurately and confidently cost and prepare the processes for the NPI. Creating solutions to the issues upstream and feeding vital information downstream in an intelligent way,
A guy walks into a bar. “A beer?” OK, it could have been any other beverage, but beer is fine, so, “which do you have on draught?” Billions of purchase decisions are made by all of us every day (sorry for lack of a punch-line there, by the way). We each enjoy some degree of freedom of choice in the products that we buy.

Well, almost. Targeted advertising campaigns influence us more than we care to admit, but still we go for what appeals to us: it is the definitive demand for products. The demand signal at this stage is pure and clean, reflecting exactly what the customers need.

A lot of science goes into the understanding of demand patterns, especially, for example, in the food and drink industry where shelf-times are short, competitive elements between major stores are high, and people get upset when they cannot get the food they want, especially in times of difficult weather conditions. The algorithm to supply fresh bread to stores is very much dependent on a daily weather check for example; if snow, then deliver at least 2 times more than normal.

Electronic products also have a demand pattern that is actually very predictable. What manufacturing sees of this demand signal however is not the “pure demand signal” that is seen at the point of sale. Particularly towards the end of life of products, manufacturing sees a square wave demand pattern, on or off, boom or bust, as the logic inside the traditional distribution systems struggles to cope with contradicting needs. The product price is falling, the value of stocks in the various warehouses is plummeting, run it down, run it out, but, hang on, we are still selling products, we need more! Product lines have died out “prematurely” due to this distortion of the demand pattern. How can manufacturing optimize their planning based on such chaotic forecasting?

The future direction has to be to purify the demand signal from point of sale to manufacturing, allowing a much more managed schedule and process planning. Today’s tools, founded on principles dating back to the 1970s, have been quite challenged already as lead times between manufacturing and the shelf have been forced to decrease. Time now for a change, a new tool set founded most likely on the principles of “lean thinking” and the pull system are far more viable today given the reliable real-time communication capabilities. How hard can it be?

Direction #2: A little more planning with that?

Direction #3: The environment—turn those lights on!

Lights are there for a reason. You use them to see clearly when it’s dark. Lights avoid nasty accidents. Common sense? So why are the “lights off” in manufacturing?

Significant losses in manufacturing are continuously being ignored, or at best, tolerated. Go into manufacturing sites and look around to see how many machines are actually running. Don’t just look at the sea of green lights, they are only there for the “boss”. Count how many of the production processes are actually adding value making products. Fewer than you might expect. There are reasons of course, mostly excuses actually.

Reporting is based largely on the acceptance of these excuses—sorry—reasons. The true underlying productivity is something that no one seems to want to talk about—as if competitiveness and the drive for efficiency over the years have not been enough to make us want to improve. Now we have a new consideration, the environment.

The sustainability of our lives and lifestyle is rapidly increasing in importance, to the people who matter most, the customer. It is not just about hazardous materials and recycling, it is about energy efficiency. Consider the estimated 50%-70% of energy that manufacturing operations “throw away” due to inefficiency of the operations. Think of the excess CO2 emissions. Think of the increase of taxes being imposed on industries in order to regulate such emissions. This has become a new direct cost. It’s time to re-think how energy is used. Use the right machines for the job, keep them fully utilized, plan more effectively, it is the same story as in the past, but now moving it up to another level. Turn the lights on!

Today’s comprehensive CIM/CAM solutions provide an unprecedented ability for electronics manufacturers to have incredible visibility into their manufacturing operations. Operational Intelligence (OI) to provide active feedback of improvement opportunities, and Business Intelligence (BI) to report the full extent the view of the manufacturing operation is a very realistic expectation. Use the information from the machines, create visibility of the whole operation and use it to proactively manage, taking out the inefficiencies and questioning the excuses. The CIM/CAM tools that are available today have certainly evolved from their initial form into a critical tool that should be in every electronics manufacturer’s arsenal—a small investment of energy for a very significant reduction. No more excuses please!

Direction #4: Get lean on materials

The investment in materials remains the highest single cost in electronics manufacturing. Holding materials at a manufacturing site cannot be avoided most people would say, but actually, why do they need to be there? Of course, if materials were missing, production would stop. If we want to have flexibility, we need to keep materials for any product that we may choose to manufacture in the immediate future.

The lead-time on most materials is such that we need to maintain a certain defined stock on site, in terms of number of days of product production. The long proven ERP/ MRP systems take care of all of this for us, which is fine.

Now, look into a typical manufacturing operation and divide up the materials that need to be there according to what we’ve just defined, and what materials are there for some other reason. In most cases, the actual inventory is two to four times the actual needed amount. On investigation, this is mainly due to internal inventory inaccuracy. Accuracy means quantity and location of materials.

Due to the inaccuracies, material preparation and storage processes have gradually grown up to ensure that the machines should never stop due to lack of materials. This has been quite the normal process no doubt since the first artificial “internal” materials shortage was discovered. What happens now works, but at a cost that is quite crippling for a business.

It starts with the money invested in the excess materials. There is also the overhead to manage such large stocks, move them, store them, the space, the warehouse organization, the line stocks, the many kits that are prepared in advance, the security of materials to ensure they don’t go “missing in the night”, and the inevitable fire-fighting operation when it is found that they have. (Breathe!).

There is yet more; the MSD control issue of stock as it ages, the lack of ability to
Future industry directions

They have technology and have made—Global SMT & Packaging South East Asia—September/October 2011

Future industry directions

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Figure 2. Mixing machine and tool vendors should result in optimum performance, not introduce roadblocks.

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change the production plan at short notice due to the huge potential work to re-factor all of those kits. (Breathe!)

There is still more! The hidden causes of the material inaccuracies that continue to accumulate and inevitably will be noticed. These now manifest themselves as the need for very significant write-offs of materials after very disruptive stock-takes, which need to happen frequently in order to sustain the operation. Does this still sound like a good idea?

Yet manufacturing operations are so sensitive to stoppages due to lack of materials that this area is like a sacred process that it seems few dare to question, or attempt to change the procedures. Recently, however, with the availability of lean material management tools specifically designed for electronics manufacturing, some companies now enjoy a revolution in the way materials are managed. Through the use of these tools, the majority of the excess materials have been eliminated. It is a quiet revolution; those who have gone ahead have achieved a very significant advantage over their peers. At some point, as understanding and realization develop, lean material management is going to gain huge momentum: a very strong industry direction for the future.

Direction #5: Close the door and enjoy the open door policy

SMT machine vendors are to be admired. They have technology and have made investments that are put into their products, which do things that today seem to defy the laws of physics. The marketplace for such machines is, and has always been, fiercely competitive—so much so that there has been no successful standardization of engineering or performance data to feed or manage these machines.

Vendors successively introduce key new features that create new demands on the data they need and generate. There is value, and certainly there is customer demand for the machine vendors to provide related software to support the complex NPI process preparation, as well as provide data for performance analysis and traceability. Sometimes, machine vendors are pushed to provide functionality that strays outside of the comfort zone of the machine itself. The data and supporting systems are almost always proprietary to each vendor. Vendors cannot support each other’s machines due to the competitive issues. Vendors also are very careful not to expose themselves to issues outside of the area of the machines, since the wish-list of most manufacturers is long and complex extending into the supply chain, quality management, and even total plant performance and traceability.

Standards in the industry have come and gone over the years. One area is the way the machines communicate through some standard interfaces. A great idea on paper, but this is little more than “pipe definition.” What is the flavor or meaning of the data that flows through the pipe? How the data can be turned into information at the other end combining it with other stuff coming out of other pipes remains the real issue.

There are the standards related to data and reporting that define how to turn data into information. These are very difficult to implement due to the different data streams available and the requirement to mix data from several different disciplines—manufacturing, test, quality, materials etc. For many, they have little meaning or are too complex to follow. For these and other reasons, the standardization of the SMT manufacturing environment has never been successfully realized in comparison say to that of semiconductor manufacturing.

How are SMT manufacturers supposed to optimize their operations when they have a mix of different vendor equipment? Some machine vendors use this as a tactic to create loyalty to them as a single supplier. While there are benefits to this, it also introduces restrictions and risks. The future direction here is to find a new way to provide the benefits of standardization.

Close the door now on attempts to blindly standardize and open the door to a more sophisticated approach. This is an approach where an intelligent manufacturing system solution has the breadth and capability to understand and combine all aspects of manufacturing into a single environment. The environment has to be open and available to encourage machine vendors to integrate into the platform in such a way that also allows them to continue to provide their solutions within their comfort zone to their customers.

There are strong benefits here for the machine vendors as well as the manufacturers. There is still today a natural resistance for machine vendors to become dependent on third parties and also for them to allow the customers who are single, or at worst dual vendor sites, to have the barriers removed potentially for other third parties to come in. Such barriers are artificial; the customers of the machines may argue that machine vendors should compete on the merits of their machines and not create artificial costs and barriers for them. A rise in such sentiment would lead to significant market pressure on machine vendors to re-evaluate their positions.

Today already, a small selection of key machine vendors are providing the tools with which manufacturing system solutions providers can fully integrate the machines into a standard manufacturing environment. The direction is indicated, now we need to move forward.
Kyzen specializes in precision cleaning chemistries for electronics, advanced packaging, metal finishing and aerospace applications. Our industry expertise and dedicated customer support provide integrated cleaning process solutions that meet any cleaning challenge. We offer a risk-free product trial that allows your business to witness Kyzen’s results at no charge. Contact us today to learn how Kyzen can streamline your cleaning process.

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Interview—
Raminder Singh Soin, QUAD Electronics

QUAD Electronics is a premier product life-cycle management company in Hyderabad, India. Since inception, collaborative partnerships and ground breaking solutions have converged to enable customer’s success. QUAD deliver unparalleled quality and support to original equipment manufacturers (OEMs), transforming thought leaders to market leaders.

In an exclusive interview with Pradeep Chakraborty, Raminder Soin, chairman and managing director of QUAD, highlights the company’s capabilities and offers his take on the Indian electronics industry.

Please provide an overview of QUAD Electronics. What are the key areas you are working in?

QUAD Electronic Solutions Pvt Ltd. is the premier and only product life cycle management (PLM) company in India in the field of electronics. We are an Indian company with a global DNA. We are based out of the city of Hyderabad, in the southern part of India.

We provide a full range of PLM services to some of the biggest OEMs globally. We are a Tier-2 company with processes at par with those of Tier-1 companies. It is this unique value proposition of ours which prompted some of the prestigious names in the industry to associate with us for their global manufacturing requirements. We have demonstrated our competitiveness on both price and quality, vis-a-vis global players.

QUAD numerically connotes “4”—which represents the core domains of design, manufacturing, fulfillment and after-market services. We serve as an extended supply chain to our customers, managing their procurement of components/parts from preferred (least cost, good quality) vendors worldwide, leveraging economies of scale.

At present, the markets we serve are communications, consumer, industrial, enterprise and networking, power, and defense.

QUAD operates a network of five sites in India—two in Hyderabad and one each in Vishakhapatnam, Vijayawada and Tirupathi. Apart from these locations, QUAD also has an office at Manchester, UK, for catering to its European clientele.

QUAD offers its customers a unique
blend of global processes and local delivery, which supplements its knowledge of the Indian business scenario.

What has QUAD recently done in electronics specifically? What's planned ahead?

In the recent past, QUAD has added another feather to its cap by way of getting the world’s largest computer peripherals company to manufacture in India, with QUAD. Also, we now offer our manufacturing solutions for telecom products catering to the European markets. We have also started manufacturing of tablet PCs for a global player. The plan ahead is to target inorganic growth for QUAD and spread our footprints into other markets. We would also be focusing on venturing into the automotive, aerospace and medical segments, with increased focus on solutions for the defense space.

Healthcare and medical are said to be key segments for India. What has QUAD been doing in these areas?

As far as the medical segment is concerned, we presently do not cater to this segment. However, we do plan to add a customer in this space by 2012.

What are you doing in enterprise and networking sectors? Please elaborate.

We have started manufacturing of tablet PCs, which has already put us into the enterprise and networking space. We intend to grow this business further.

What is your take on the Indian power electronics scenario for 2011-12 and beyond?

This is a growing sector, and the demand for these products is increasing at a rate greater than 20 percent year-over-year in India. The plan ahead is to target inorganic growth for QUAD and spread our footprints into other markets. We would also be focusing on venturing into the automotive, aerospace and medical segments, with increased focus on solutions for the defense space.

Healthcare and medical are said to be key segments for India. What has QUAD been doing in these areas?

As far as the medical segment is concerned, we presently do not cater to this segment. However, we do plan to add a customer in this space by 2012.

What are you doing in enterprise and networking sectors? Please elaborate.

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What is your take on the Indian power electronics scenario for 2011-12 and beyond?

This is a growing sector, and the demand for these products is increasing at a rate greater than 20 percent year-over-year in India.

How do you see the electronics industry in India performing in 2011-12 and beyond?

As per recent market reports, the Indian electronics market presently stands at a value of $40 billion. This is slated to increase to a mammoth $400 billion by 2020, vis a vis the global market at $1.7 trillion.

The present domestic production is around $20 billion—about 50 percent of the domestic demand! Domestic companies can expand the production to $85 billion by 2014 and to $320 billion by 2020. This would constitute a very significant contribution to the GDP, at 20 percent for 2020, at par with other economies. There is a clear upward trend for the appetite of electronics goods in India and the signs are very encouraging in turn for EMS players catering to OEMs.

Has enough has been done about the Indian electronics industry? What more needs to be done?

The Indian electronics industry continues to grow at a healthy pace. A significant and interesting statistic to note is that India’s import bill for electronics is projected to be bigger than its import bill for oil! Taking cognizance of this, the Indian government has taken serious steps to encourage Indian electronics manufacturing going forward. The National Manufacturing Policy has recently got an in-principle approval from the central government. This policy calls for radical measures in Indian manufacturing, in order to create sustained development for this country.

However, concrete steps have to be taken in order to create an ecosystem for components in India. This should be the top-priority going forward, in order for Indian electronics manufacturing to have a strong and sustained growth. Also, the government needs to ease customs clearance procedures for BHT/SEZs for a faster TAT.

What are your expansion plans? What are your biggest challenges currently?

Our plans for the future are aimed at dominating the PLM space in India and to grow our business globally through both organic and inorganic means. The biggest challenges we see going forward are the lack of a supply chain ecosystem and access to low-cost funding.

Are there any plans to enter the solar business?

At present, the solar space in India is very crowded, with not a very significant demand in India. With the National Solar Mission (NSM) in place, we would evaluate the developments in this sector in the near future, and then strategize on what areas to target in this space, if lucrative.
Scavenging in today’s manufacturing operations

Harold Hyman, VJ Electronix

Scavenging, site dressing, residual solder removal. What is in a name? “That which we call an onion, by any other name would smell as strong” (apologies to the immortal bard). And, regardless of the name you give it, the objective is the same—namely, the cleanup of remaining solder after a component (particularly a BGA) or RF shield has been removed from a PCB. This article describes the various methods that are available and discusses the pros and cons of each.

Introduction

There are numerous ways of performing this operation, bearing in mind that all soldering becomes more critical when dealing with lead-free alloys and elevated temperatures.

Using a Soldering Iron and Solder Braid or Wick. This method is cheap, relatively fast and does a reasonably good job, although it requires a skilled operator, is difficult to control and suffers greatly from inconsistency. It also is quite labor-intensive.

Manual Vacuum Scavenging, which also is labor-intensive, is performed with hand tools or on a rework system and uses a special concentric convective heating/suction tool that melts the solder and sucks it off the PCB. This approach is a non-contact method that alleviates the problems associated with conductive tools, but it still relies on a skilled operator to perform the lateral movements.

Automatic Scavenging uses the same procedure as the manual approach except that the lateral motions are motorized and some form of height sensing automatically sets the gap between the tool and the surface of the board, resulting in a damage-free, high-reliability solution to the cleanup requirement.

Comparisons

Hand Scavenging with Soldering Iron. This relies on the capillary action that causes liquid solder to “wick” along a piece of copper braid. Heating is done with a soldering iron that, together with the braid, is positioned on the solder to be removed. If done correctly, with suitable application of flux, this operation can effectively remove solder from pads or conductors on a PCB. Millions of successful hand scavenging operations are performed daily. However, a great deal of skill is required and the correct tools and materials are essential. A poorly executed job will not only fail to adequately remove the solder but also can result in any number of defects.

The soldering iron must be of the correct wattage to be capable of transferring enough heat to melt solder and cause wick-
NEXT GENERATION
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High reliability with superior dispensing stability that ensures no missed joints. Excellent reflow.

eCore
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SN100C (044)

Excellent wetting and spread characteristics of the flux-cored solder wire. Fast soldering. Reduced cracking of the flux residue.

Completely halogen-free means that it does not contain F, Cl, Br or I
The scavenging tool is height adjustable to suit boards of different thickness, resulting in a truly non-contact operation that avoids damaging the board.

This approach ensures users that the critical parameters are carefully controlled and potential damage is avoided with the possible exception of accidental contact.

**Automatic Scavenging.** This follows much the same procedure as used in manual vacuum scavenging; however, this automates it so that, apart from the loading and unloading of the assembly to be scavenged, all the elements of the operational sequence and associated processes are preprogrammed, and further operator involvement is unnecessary.

An automated surface mount rework system with motorized X-Y motion is taught to scan a component site so that once the assembly is correctly located on the system, the complete sequence of operations is performed automatically. Identification of the board/site combination automatically selects the correct set of times, temperatures, motion directions, speeds and any other relevant parameters for the procedure (Figure 1).

Essential to the success of this operation is the incorporation of a feature such as VJ Electronix’s Dynamic Height Sensing (DHS). This is invaluable because it automatically maintains a consistent gap between the scavenging tool and the surface of the board (Figure 2). This not only guarantees repeatable, optimum process conditions but also ensures that there will be no contact between the tool and board, thus avoiding any damage.

**Conclusion**

Hand Scavenging with Soldering Iron—QUESTIONABLE! This method is prone to high defect rates and depends on the operator’s skill level of operator. The only advantage is low upfront cost.

Manual, Non-Contact Vacuum Scavenging—BETTER! This method provides much lower defect rates but still is operator dependent.

Automatic Scavenging—BEST! Automatic scavenging is software-driven, requires minimum operator involvement, and provides consistent results as well as very low defect rates.
for electronic manufacturing

productronica 2011
19th International Trade Fair for Innovative Electronics Production

november 15–18, 2011
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electronica India 2011 and productronica India 2011 open their gates

The electronics industry in India has been very optimistic and consumption of electronic components is on a new high. Messe München International (MMI) has sought this opportunity and has organized electronica India 2011 and productronica India 2011 which is set to start on September 13, 2011, at Pragati Maidan, New Delhi. This is the best place to gather information to build the technology roadmap and identify ways to make business more agile and efficient. The four day exhibition provides comprehensive thought leadership in electronic and product technology driving the business technology market in India.

After a successful show in 2010 in Bangalore, electronica India 2011 and productronica India 2011 will play host to over 900 exhibitors with country pavilions from China, Germany, Hong Kong Korea, Singapore and Taiwan. The events will also have participation from Japan, Switzerland, USA, Italy, Spain, and Malaysia, all together from 25 countries.

Major players exhibiting this year include Agilent Technologies, element14, Infineon Technologies, Juki India, Kaynes Technology, Leaptech Corporation, National Instruments, NMTronics, NXP Semiconductors, Panasonic Corporation, RS Components & Controls, Rohde & Schwarz India, STMicroelectronics, Sony, TATA Power.

The events will be accompanied by two concurrent technical conferences where industry experts from India and overseas will share their knowledge and expertise, and work towards creating a roadmap for sustainable growth and enable global competitiveness.

electronica India 2011 and productronica India 2011 co-operate with ministries and official organizations and are supported by all important industry associations. One important partner in this respect is the Ministry of Communications and Information Technology, department of Information Technology. More than 15 industry associations which are working around for the development of the industry support these events.

India has already emerged as a hot spot for Contract Manufacturing (Electronics Manufacturing Services—EMS and Original Developer Manufacturing—ODM). The growing Indian economy is fuelling a massive consumer boom. Demand for electronic gadgets, appliances and equipment is growing briskly, companies are increasingly turning to EMS firms to fill the gap, as said by Darryl Dasilva, CEO - MMI India.

Dasilva further adds: “Despite difficult global economic conditions, the Indian economy is on a steady growth plan. If we look for impulses behind this growth, the electronics industry is definitely an important part. India, as a market, is still growing and is one of the most important future markets for the electronics industry, due to its innovation, strength and growth potential. The long term for India as an outsourcing location is also very promising.”

Play KIC’s man vs. machine reflow profiling game for a chance to win an Apple iPad2 at Electronica/Productronica India 2011

KIC, manufacturer of thermal process development and control products, is offering Electronica/Productronica India visitors an opportunity to win an Apple iPad2 by beating the company’s award-winning Auto-Prediction Navigator Profiling Software. In addition to the chance to win an iPad2, all participants will come away with a certificate for a free KIC Navigator or Auto-Focus Power upgrade, a $975 value*!

The competition consists of three real-life challenges, each of which represents an actual PCB. In each challenge, the KIC Navigator finds an in-spec solution in less than 15 seconds. Can you do that?

Visit distributor Mectronics Marketing Services’ Booth #1230 at the Electronica International Trade Fair, or visit http://kithermal.com/man-versus-machine.html.

* Navigator or Auto-Focus is required to run the Navigator Power. The certificate is valid until October 31, 2011.

India is a growing market and the events prove to be good platforms for companies to showcase their products and get a feel of what is happening in the industry in terms of new technology and offerings. electronica India and productronica India are established platforms for electronic components and electronics production and a good experience to see many international participants providing access to the emerging Indian market. The strong presence of companies with the product spectrum of semiconductors, passive components, material processing, soldering technology and many more make the event one of the hot spots for electronics.

electronica India 2011 is India’s and South Asia’s leading fair for electronic components, systems and applications. As the most important communication platform for the electronics industry, electronica India displays all a specialized fair can offer with products ranging from semiconductors, sensors, relays, switched and interconnection technology to passive components, motors/drives, cables, ED/EDA, assemblies and subsystems to test and measurement technology, Displays and power supplies. With electronica India, the entire value-added chain of the electronics industry is presented.

productronica India 2011 is an innovative platform for production technologies covering as wide as packaging, material processing, component manufacturing, manufacturing equipment and logistics for PCBs and other circuit carriers, technologies in cable processing, soldering technology, manufacturing equipment and logistics for assemblies, modules and hybrids, general operation aids, production subsystems, production related services, laser and laser systems for electronics production.
**New products**

**Data I/O Corporation introduces new RoadRunner3 inline programming system**
Data I/O Corporation announced the new RoadRunner3 inline programming system. With its Factory Integration Software, RoadRunner3 streamlines the production process and eliminates operator errors through its connection to a firm’s manufacturing execution system or other shop-floor control software. RoadRunner3 easily integrates into existing SMT processes. By removing unprogrammed Flash memory devices from tape, the RoadRunner3 programs four devices in parallel and then delivers the programmed parts to the pickup point of the placement machine. www.dataio.com

**JBC Tools Inc. introduces C245 Super Cartridges for high thermal efficiency**
JBC Tools, Inc. introduces its new C245 Super Cartridges for high thermal efficiency. JBC’s R&D team developed a new range of high thermal efficiency cartridges that allow the T245 hand piece station to supply the most power possible to the solder joint. This is achieved through redesigning tip geometries for optimal thermal transfer. www.jbctools.com

**Essemtec doubles dispensing speed and accuracy**
Essemtec introduces the new Scorpion automatic dispensing system. The machine is built on the Paraquda machine base, which enables highly accurate dispensing and performance of up to 100,000 dots per hour. The machine can be equipped with up to four different dispensing valves and is designed for flexible and productive dispensing in electronics manufacturing, LED assembly and other industries. www.essemtec.com

**SIPLACE Alternative Components for component bottlenecks**
With SIPLACE Alternative Components, ASM Assembly Systems GmbH & Co. KG presents a software add-on that allows electronics manufacturers to define alternative components for each placement position. This makes it possible to seamlessly switch to functionally identical components (for example, alternative/second-source components from other manufacturers) when bottlenecks occur, even if these components have a slightly different packaging or shape. Electronics manufacturers also save the expense of having to change and administer different placement program versions to accommodate different component manufacturers. www.siplace.com

**Miyachi Unitek introduces single mode Fiber Laser Marker**
Miyachi Unitek Corporation announces the release of its new 20 W single mode fiber laser marker, which yields a finer beam with a variety of advantages for marking, scribing and cutting applications. The new LMF 2000-SM laser marker can produce finer lines and increases the mark working area. It also has an increased depth of focus for marking on curved surfaces. The new model is ideal for the scribing and cutting a wide variety of materials, including alumina, silicon, copper and aluminum foils. www.miyachiunitek.com

**Medical grade epoxy adhesive withstands high temperatures and repeated sterilization**
Capable of tolerating the harsh environments of the medical industry, Master Bond EP42HT-2ND2MED fully complies with the testing requirements of USP Class VI plastics. This two component epoxy resists recurrent autoclaving and sterilizations including radiation, steam, ethylene oxide, and chemical sterilants. EP42HT-2ND2MED is an electrical insulator with a volume resistivity over 10^12 ohm-cm, a thermal expansion coefficient of 35 to 40 in/in x 10^{-6}/°C, a dielectric constant of 3.8, and a tensile strength exceeding 12,000 psi at ambient temperatures. www.masterbond.com
Breakthrough pressureless silver sintering technology delivers high UPH, high reliability solution
Henkel Electronic Materials announces its success with a silver (Ag) sintering technology that enables production of modern power packages in a process that does not require pressure. Henkel’s Ag sintering capability has been designed into Ablestik SSP2000. With Ablestik SSP2000, because the silver particles are joined via a unique surface tension mechanism, the pressure requirement is eliminated and the material can be cured in a standard batch oven at a temperature as low as 200˚C.

www.henkel.com/electronics

Techcon Systems enhances the TS6500CIM Techkit mixer
Techcon Systems introduces the updated TS6500CIM Techkit mixer. The TS6500CIM Series cartridge mixer incorporates many high-quality safety features including a two-hand start, a strengthened metal door with acrylic windows that is fitted with a safety interlock, preventing accidental start up, and an emergency stop button. With the introduction of a pressure relief valve, the plunger assembly depressurizes when the safety door is opened.

www.techconsystems.com

Electrolube adds to its green credentials
Electrolube has added to its green credentials by introducing two new products with improved environmental properties. Electrolube’s FREH Freezer, a powerful refrigerant, and the EADH Air Duster have been developed without the use of harmful gases. Both products contain a novel hydrofluorocarbon propellant with improved environmental properties. The propellant used in alternative products is usually HFC-134a or a blend thereof; switching to the propellant used in FREH and EADH can reduce the equivalent CO2 emissions by >99.5%.

www.electrolube.com

High Precision Dispenser Ultimus™ V—a new way to handle changing fluid viscosity
Silver epoxies, die-attach epoxies and underfill materials are used in many electronics and other assembling applications in production. Because these fluids change viscosity over time, they pose a unique challenge. To solve these problems, Nordson EFD developed the Ultimus™ V High Precision Dispenser, which eliminates viscosity-related issues by automatically adjusting dispensing parameters over the course of the fluid’s working life to maintain uniform shot size.

www.nordsonefd.com

Multitest introduces new MEMS test and calibration equipment
Multitest has successfully added a new application to its MEMS test and calibration product line. With the new application, 3-D earth magnetic field sensors can be used for innovative mobile applications and state-of-the-art navigation applications without the use of a GPS. In addition to being an alternative to using the earth’s magnetic field, the application can be configured with external magnetic coils. This configuration provides high magnetic force at the highest accuracy.

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