MEPTEC Report

SPRING 2015

A Quarterly Publication of The Microelectronics Packaging & Test Engineering Council

Volume 19, Number 1

13th ANNUAL MEPTEC

MEMS TECHNOLOGY SYMPOSIUM

Enabling the Internet of Things:

Foundations of MEMS Process, Design, Packaging & Test

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FIRST ANNUAL

IoT Online

MEPTEC THE NEXT GENERATION

Internet of Things

Technology Symposium

Analytics. Applications. Hardware. Software.

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MEPTEC MEMBER COMPANY PROFILE

Founded in 1982, Delphon is a leading provider of advanced materials used with high-value semiconductor, optoelectronic, data stotage and medical components.

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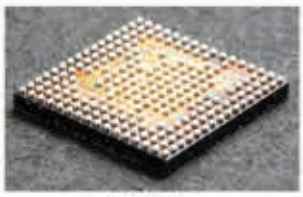
ASE GROUP

IC Packaging & Test for the next big thing in electronics.


Copper Pillar


MEMS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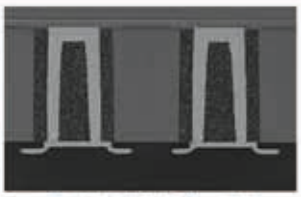
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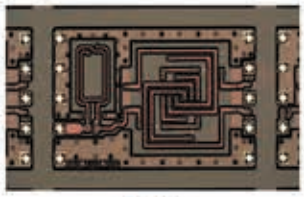
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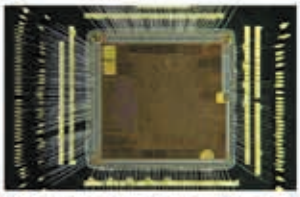
Copper Wire Bond

With a proven track record spanning three decades, ASE continues its tradition of dedication and commitment through close collaboration with customers, suppliers and partners, alike. Alongside a broad portfolio of established technologies, ASE is delivering advanced packaging and SiP solutions to meet growth momentum across a broad range of emerging applications and end markets.

For more: www.aseglobal.com

Internet of Things and Wearables are Transforming Semiconductor Industry

Nikhil Kelkar
Exar Corporation

AFTER THE LAST KILLER APP, THE 'mobile phone', the semiconductor industry is closely monitoring the 3rd digital revolution brought in by the out-burst of product opportunities in the area of "Internet of Things (IoT)" and "Wearables" devices. IoT and Wearables are physical devices consisting of sensors and analytical ability that can receive and share data through a network. Examples are fitness bands, smart home sensors, and networked factory automation equipment. The innovation and proliferation of IoT/Wearable solutions are essential to realize smart-energy, smart-homes, smart-infrastructure, smart-factories, smart-mobility, and smart-health – a smart-society. The IoT/Wearables industry is approaching an inflection point to accomplish the world of hyper-connected devices a reality; >30B devices by 2020 (per IDC). The trend has captured attention of semiconductor supply chain and started to leverage technology advances. Gartner expects that the projection of 30B devices will need >35 new 200mm wafer fabs to produce required MEMS and logic devices. Customers and installers of IoT/Wearables are observing demand growth and addressing emerging standards of communication and security.

The first digital revolution that started in the Seventies brought in computing. It improved not only industrial productivity but also personal productivity with introduction of the personal computer. Over the last fifteen years, the second digital revolution has altered landscape of communication, made internet pervasive and with mobile phones connected the world as never before. IoT/Wearables are at the convergence of communication, computing, sensor and energy technologies and will drive the 3rd digital revolution.

The semiconductor industry is adapting and responding to IoT/Wearables requirements and opportunities. Lithography, lateral transistor fabrication and chip packaging made possible the Computing era microelectronics. Packaging evolved from a protective function to an essential part of the product. Subsequently, developments in communication and hand-held consumer devices, e.g. mobile phones, have incorporated wafer level and 3D packaging (stacking of devices) innovations to deliver faster, cheaper and smaller pieces of equipment. Innovative foundry, packaging and test solutions for sensors, actuators and energy will be crucial for IoT/Wearables growth over the next 5-10 years. In other words, the long term evolution will continue from discrete devices to integrated circuits to systems integrating efficient sensors/actuators, optimized connectivity and embedded processing as well as efficient power generation and/or management for the specific cases of Wearables. These systems will incorporate a variety of existing assembly and packaging technologies, e.g. embedded wafer level packages, package-on-package, die/wafer-on-wafer, flip-chip, SiP, modules, TSV and yes, wire bonding. Existing and newer 2.5/3D packaging technics will be key to integrate sensors and actuators without compromising performance requirements e.g. integration of LEDs and optical sensors, inclusion of biocompatible materials, 3D printing, etc. Cost effective advanced packaging techniques are a must for IoT/Wearables to succeed.

While the devices underlying IoT/Wearables may not immediately have a significant economic impact on the semiconductor industry, the objectives will be to define "standard" products for the IoT/Wearables applications to maximize R&D effectiveness. According to ST Microelectronics, semiconductor manufacturers should approach IoT/Wearable products as solutions to exploit omnipresent internet connectivity; an approach analogous to smartphone "apps" development. Additionally, there will be opportunities to develop new solutions where IoT/Wearables intersect the established Communications and Computing markets, for example, cloud computing which is at the foundation of IoT/Wearables technology where all the data will stored and analyzed. Therefore, on one hand, IoT/Wearables will need low power, limited computing capability at the node but on the other hand, higher speed, high capacity server solutions will be needed for computing and storage of big-data.

IoT/Wearables is a transformational change that has started and will become mainstream over the next 7-10 years. Our ability to adapt to and succeed with this change will be a deciding factor. IoT/Wearables will revolutionize not only industrial/consumer economics but also how humans and machines interact in the new smart-society. ◆

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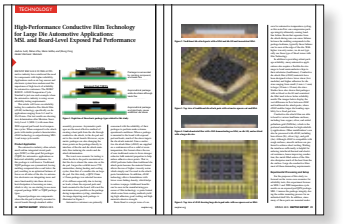
ON THE COVER

MEPTEC presents its Thirteenth Annual MEMS Technology Symposium, titled "Enabling the Internet of Things", on Wednesday, May 20, 2015 at the Holiday Inn-San Jose Airport in San Jose, CA. In addition, MEPTEC and IoT Online are pleased to announce our First Annual Internet of Things Technology Symposium, being co-located with the MEMS Technology Symposium and will be held the following day, Thursday, May 21st. Discounts are available for attending or exhibiting at both events.



MEPTEC

THE NEXT GENERATION

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Advanced Semiconductor Engineering (ASE) Joins the Electronic Industry Citizenship Coalition (EICC)

ASE HAS ANNOUNCED that it has joined the Electronic Industry Citizenship Coalition (EICC), the world's largest industry coalition committed to creating shared value for the businesses, people, and communities who collectively contribute to the manufacture of electronic devices around the world. ASE's membership further represents the Company's resolve to align and work with suppliers and partners that share similar values regarding sustainability.

As the world's leading provider of semiconductor assembly and test services, ASE re-cognizes the need to consistently demonstrate a higher standard of corporate social responsibility. Membership in the EICC underscores the significant strides ASE has taken in enhancing its commitment to environmental and social governance, both within ASE operations as well as throughout its broader supply chain. Through this membership, ASE has joined a dedicated community of leading electronics companies, and will benefit from the opportunity to learn and collaborate with customers, partners, peers, and suppliers, alike.

ASE has also adopted the EICC Code of Conduct to improve efficiency and social, ethical and environmental responsibility throughout its global supply chain, with the expectation that suppliers likewise act in accordance with the code too. In addition, ASE suppliers and partners are encouraged to commit to 'The ASE Group sustainability supply chain management' policies and procedures when conducting business with ASE, as these have been developed to align closely with the EICC Code.

For more about EICC visit www.eiccoalition.org/.

The ASE Group is the world's largest provider of independent semiconductor manufacturing services in assembly, test, materials and design manufacturing. The Group generated sales revenues of US$8.5 billion in 2014 and employs over 68,000 people worldwide.

For more information about the ASE Group visit www.aseglobal.com. ◆

Sonoscan Automates Inspection of IGBT Modules

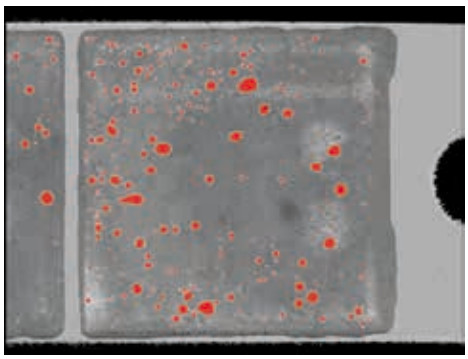
POWER IGBT MODULES HAVING VOIDS and other internal structural defects are a problem for makers and users of the modules. These defects can block heat dissipation and cause electrical failure.

Sonoscan has now developed and is shipping a fully automated Acoustic Micro Imaging system that images and analyzes these module defects.

The C-SAM® model DF2400Z incorporates Sonoscan's inverted transducer, placed beneath the module to prevent water from reaching module circuitry. There is no need for human attention. Once your recipe for scanning has been defined, the factory automation interface controls the operation step by step:

- a conveyor loads two IGBT modules onto the two (for high throughput) system stages.
- the two ultrasonic transducers, one for each stage, raster-scan each module. Ultrasound is pulsed into the module and echo signals are received from gap-type defects at the depths of interest.
- at the conclusion of scanning, accepts and rejects are stacked in separate locations.

The accept/reject criteria are written by the user of the system. Early users of the system are chiefly searching for voids, delaminations and non-bonds in the solder layer, because these defects are frequent causes of failure. But all depths within the module can be imaged separately in a single scan, if desired, with no change in throughput speed.



Acoustic image gated on IGBT module's solder layer reveals numerous heat-blocking voids (red).

Because imaging is typically carried out before encapsulation of the modules, the acoustic images reveal what type of rework is needed on rejects. In addition to finding gap-type defects at any level, the system can also image tilting and warping of module elements such as rafts.

For more information visit the Sonoscan website at www.sonoscan.com. ◆

FINETECH & MARTIN APPOINT TORENKO FOR REWORK SYSTEM SALES

Finetech and subsidiary Martin, are pleased to announce the addition of Torenko and Associates as sales representatives in Texas, Oklahoma, Arkansas and Louisiana for Finetech and Martin rework products. Torenko will be responsible for supporting new and existing accounts for Martin rework systems, reballing units, and underheaters, as well as Finetech's ultra-precise rework solutions. Torenko is headquartered in the Dallas/Fort Worth metroplex area, with additional offices throughout the region. They specialize in providing proven solutions to address cutting-edge SMT, semiconductor, test and repair challenges, including sub-millimeter rework applications.
www.finetechusa.com

AMKOR ANNOUNCES SENIOR MANAGEMENT CHANGE

Amkor Technology, Inc. has announced that Dr. Choon Heung Lee has been appointed Executive Vice President for Worldwide Manufacturing Operations and President of Amkor Technology Korea, reporting to Steve Kelley, Amkor's President and CEO. Dr. Lee succeeds JooHo Kim who is retiring at the end of this month after a long and distinguished career with the company.

Choon Heung Lee, 56, joined Amkor in 1996. In 2004, he was promoted to Head of R&D, and in 2010, he became Amkor's Head

▸▸

of Corporate Technology. In 2013, Mr. Lee became Amkor's Executive Vice President and Chief Technology Officer and he will remain in this position.
www.amkor.com

MICRO SYSTEMS ENGINEERING COMPLETES EXPANSION

Micro Systems Engineering, Inc. (MSEI), an MST company and a leading specialist in the development and manufacture of electronic modules for active medical implants, has expanded its existing cleanroom capacity with a state of the art cleanroom, bringing total cleanroom area to 20,000 square feet. The Class 10,000 rated cleanroom is qualified for medical implantable electronic manufacturing with the tightest environmental and cleanliness controls. The space will house automated assembly and test equipment to support new business growth.
www.mst.com/msei

ANALOG DEVICES WELCOMES JOSÉ ALMEIDA TO BOARD OF DIRECTORS

Analog Devices, Inc. has announced that José (Joe) Almeida has been elected as a Director of the Company. Mr. Almeida is currently Chairman of the Board, President and Chief Executive Officer of Covidien, a company that develops, manufactures, and sells healthcare products. Before assuming his current position, Mr. Almeida served as the President of Covidien's Medical Devices business segment and also as President of Covidien's International business.
www.analog.com

Infineon Introduces Embedded Secure Elements for Advanced Mobile Communications

INFINEON TECHNOLOGIES AG has announced its new embedded security controllers for premium handsets and smart wearables at Mobile World Congress 2015. The new members of the SOLID FLASH™-based SLE 97 product family provide industry's highest memory capacity of up to 1.5MByte and are available with ultra-small packages. New functionalities require memory capacity to securely store biometric data or encryption keys on the security controller: these include e.g. fingerprint authentication enabling FIDO (Fast IDentity Online), secured cloud services, NFC-based applications or advanced online payment.

Furthermore, Infineon has extended its Chip Scale Package (CSP) technology to high-end security controllers, providing a package solution which is considerably smaller than the standard SMD (Surface mounted device) packages. As an industry first, Infineon is already shipping embedded Secure Elements with ultra-small packages in volume quantities to several leading handset manufacturers for their new smart devices.

The combination of both – smallest PCB footprints and the flexibility of high-end security controllers – enables system designers as well as equipment manufacturers to address new markets such as smart wearables.

The SLE 97 security controller family has explicitly been developed for the maximum performance and for high security to address the high-end UICC (Universal Integrated Circuit Card) and the embedded Secure Element markets. The product family has now been extended by adding security controllers with 1.5MByte and 1.3MByte memory density. Both products are based on an Infineon security chip architecture utilizing an ARM® SecurCore™ SC300™ enhanced by Infineon's cache and SOLID FLASH™ technology.

Visit the Infineon website at: www.infineon.com/nfc for more information. ◆

Altera Ships 20 nm SoCs

ALTERA CORPORATION has strengthened its leadership position in SoC FPGA products by shipping its second-generation SoC family. Arria® 10 SoCs are the industry's only programmable devices that combine ARM® processors with a 20 nm FPGA fabric. Arria 10 SoCs bring across-the-board improvements to enable higher performing, lower power, and more feature rich embedded systems compared to previous generation SoC FPGAs. Altera showcased its SoC-based solutions, including the industry's only 20 nm SoC FPGA, to attendees of Embedded World 2015 in Nurnberg, Germany.

Embedded developers who have already realized the value of SoC FPGAs have a clear migration path with Altera for enhancing their next-generation systems. Arria 10 SoCs are fully software compatible with Altera's previous 28 nm SoC product family for seamless software migration between generations. Arria 10 SoCs provide up to 50 percent higher performance and up to 40 percent lower power than the previous generation. Altera's SoC portfolio also includes a 3rd-generation 14 nm Stratix® 10 SoC with a 64-bit quad-core ARM Cortex-A53 processor for embedded developers that demand the highest performance and power efficiency.

Altera SoC FPGAs enable smarter embedded systems by enabling single-chip product differentiation in both hardware and software. Combining ARM processors with FPGA fabric provides greater system value through reductions in power, costs and board space. Arria 10 SoCs are optimized to deliver the performance, power, security and cost requirements for next-generation embedded applications within wireless infrastructure, wireline communications, computer and storage, and broadcast equipment.

Visit www.altera.com for more information. ◆

Micron Technology Breaks Ground on Expansion of Singapore NAND Flash Memory Fabrication Facility

MICRON TECHNOLOGY HOSTED A GROUNDBREAKING ceremony March 3, 2015 with company and Singapore government officials to begin the expansion of its Singapore NAND flash memory fabrication facility.

Previously announced by the company in December, the approximate 255,000 square foot expansion will facilitate efficient implementation of 3D NAND production at the Singapore facility and give Micron the flexibility to gradually add incremental capacity in response to market requirements. In addition, the space will enable production of storage class and other memory technologies.

With expansion construction under way, Micron expects initial manufacturing output to occur in fiscal 2017. To learn more about Micron Technology, Inc., visit www.micron.com. ◆

SEMICON Russia 2015 Presents Microelectronics Market Conference and New TechARENA Sessions

Event develops dialogue between Russian and foreign players, attracts investment, and promotes new joint projects

SEMICON RUSSIA, THE PREMIER meeting place of the entire micro- and nanoelectronics industry in Russia, will take place from 16 to 18 June in Moscow. SEMICON Russia Exhibition is scheduled for 17-18 June with traditional location at Expocentre fairgrounds. With programs that include the Microelectronics Market Conference, an Exhibition, TechARENA sessions and presentations, SEMICON Russia offers advanced opportunities for networking and cooperation with local and foreign professionals. The event features the latest developments and emerging new markets, in addition to an opportunity to connect with customers, partners and investors. In 2015, SEMICON Russia features a new program TechARENA, consisting of sessions on Intelligent Systems and Semiconductor Optoelectronics. Over 130 exhibitors from 15 countries – including international and regional leading suppliers of equipment, materials and services – are expected to be on the show floor and more than 1500 attendees.

The Microelectronics Market Conference takes place on 16 June the day before the exhibition opening in Expocentre. It is devoted to the creation of large-scale manufacture of electronics in the Russian regions. The event is a unique opportunity to get a comprehensive perspective of the market situation, with panel discussions which include open debates. The Conference is attended by the representatives of federal and regional organizations and agencies, top and middle managers of major Russian and foreign companies, development institutions, Research Studies Institutes, industrial clusters, Russian and foreign experts.

For more information on SEMICON Russia visit www.semiconrussia.org ◆

INDUSTRY INSIGHTS

By Ron Jones

The Answer Is "It Depends!"

WHEN YOU ASK A CONSULTANT how much a project will cost or how long it will take . . . the almost universal answer is, "It depends." It's not that consultants (myself included) are being evasive, but we typically don't know the scope and parameters of what you have in mind.

As many of you know, N-Able Group has been spending a lot of effort over the last 18 months on conflict minerals compliance with a focus on the semiconductor industry.

As time passes, there is more and more public dialogue about conflict minerals and the wide variety of violence that takes place in the Democratic Republic of Congo by groups trying to make money controlling the process.

I often get asked the question, "Are things getting better or worse?" to which my answer is "It depends." The reason for this answer is "It depends" to whom you ask the question.

The question itself is far too ambiguous as there are many facets to Conflict Minerals and the Democratic Republic of the Congo (DRC).

Let me present a few facts that may explain some of the clouding factors:

- The DRC conflict region is half the size of California and entirely covered by dense jungle
- There are few significant size mines
- Most mining is artisanal, carried out by individuals or small groups spread out over the region
- There is no significant automation; mining is done with rudimentary picks and shovels
- Most mining takes place in remote locations, far from cities and smelters
- There are few roads that connect the myriad mine sites with the limited number of smelters
- The minerals typically change hands multiple times between extraction and smelting
- The supply chain between extraction and smelter is porous and open to violent intervention
- Current tracking systems (bag and tag) are often ineffective
- Minerals excavated in the DRC are often "laundered" by smuggling to adjacent countries
- Minerals mined in the DRC are processed in smelters around the world

There are a lot of smart, concerned people looking at this situation. There are multiple organizations involved including EICC, GeSI, CFSI, OECD, Enough!, The United Nations, US Department of Commerce and companies like Intel, Apple and HP. Most have good intentions, but there are many private agendas that color opinions and make consensus elusive.

The answer depends on whom you ask.

- If you ask the miners if things are getting better, some will say yes and some will say that they have lost their jobs and can't feed their families because of the regulations and controls.
- If you ask major corporations who are spending lots of money to "improve" the situation, they will generally say yes as evidenced by an increasing number of compliant smelter operations.
- If you ask the DRC government, you will get mixed answers depending on the responsibility of the particular government entity.
- If you ask human rights groups like Enough!, Responsible Sourcing Network and others, you will get a list of pros and cons, not a unified answer.
- A recent United Nations report includes scores of observations: many documenting positive results and others recording, in detail, many armed groups and activities.

At the end of the day, to some degree, everybody is right and everybody is wrong.

My thoughts and views on conflict minerals:

- Done with good intentions . . . but hastily implemented without adequate planning and support.
- Companies had the requirement dropped on them, totally out of the blue for most.
- Companies reacted by cutting off sourcing from DRC almost overnight, thus eradicating jobs.
- No plans made for replacement jobs for displaced miners and affiliated workers.
- Many legitimate mines were shut down along with conflict affected operations.
- Short term impact was mostly negative from the perspective of the workers and their families
- I believe the situation will continue to get better after the initial negative shock
- Better procedures and technology is needed to seal the porosity in the supply chain
- More programs are needed to provide additional jobs to affected workers.

The US State Department can add minerals or regions to Conflict Minerals Compliance by simply declaring they are conflict affected. I hope that if additions are made, there will be more time allotted for people and companies to get prepared and more support put in place to minimize impact on the affected countries and people.

Starting with a wrecking ball and building back from there should not be our plan for future undertakings. ◆

RON JONES is CEO of N-Able Group International; a semiconductor focused consulting and recruiting company. N-Able Group utilizes deep semi supply chain knowledge and a powerful cloud based software application to provide Conflict Mineral Compliance support services to companies throughout the semiconductor supply chain including fabless, foundry, OSAT and materials suppliers. Visit www.n-ablegroup.com or email ron.jones@n-ablegroup.com for more information.

COUPLING & CROSSTALK

By Ira Feldman

Electronic coupling is the transfer of energy from one circuit or medium to another. Sometimes it is intentional and sometimes not (crosstalk). I hope that this column, by mixing technology and general observations, is thought provoking and "couples" with your thinking. Most of the time I will stick to technology but occasional crosstalk diversions may deliver a message closer to home.

Products *or* Services?

"Paper or Plastic?" A simple grocery store inquiry? Think again: this decision has many layers of complexity as does the examination of products versus services. There have been endless discussions as to the benefits and downsides of paper, versus plastic, bags. Everything from environmental concerns, to reusability, to biodegradability, and much more has been deliberated. Just when we thought that the paper bag had triumphed with California outlawing plastic bags, a ballot initiative has intensified this debate. To some people this is a crusade, others are happy as long as they have a free garbage bag.

Is a "phone" company a product company or a service provider? In the days of "Ma Bell", AT&T was a telephone service and today the mobile operators still consider themselves "service providers". But it gets fuzzy fast, since customers see them as a company that sells a smartphone (a tangible product) along with the service that makes it work. Even though companies are looking for supporters of their "holy wars" - Apple vs. Android, AT&T vs. T-Mobile, etc. - most users simply don't care as long as their phone works and talk is cheap.

Passions often run high when discussing the difference between products and services. Companies often describe themselves as a "product company" or a "services company." Have you listened to a sales presentation and couldn't quite tell what is being sold? A product? A service?

Ten years ago there was substantial hardware specification differentiation on the order of 20 to 30% between different makes and models of personal computers. Today this difference has shrunk to the high single digits. Why? It is true that Moore's Law has exponentially increased the computing power available in a computer. And for PCs there are standard architectures typically based on Intel microprocessors along with the still-prevalent Windows operating system. The vast majority of microprocessors in smartphones and tablets are based on ARM intellectual property (IP) cores. This is just a fancy way of saying ARM licenses the design to multiple companies for use as the foundation of their processor design.

So the supply chain for mobile devices and PCs has consolidated? That certainly levels the playing field but that does not fully explain the underlying hardware uniformity between vendors. What really has happened is that **the customer has changed from a specification-based buyer to an experience-based buyer.** The user no longer cares about the processor clock speed; they care about how easy it is to use and to get their work done. This has happened as the market has transitioned from enthusiast based (a euphemism for "geek") to mainstream user.

Computer purchasers – both consumers and corporate information technology (IT) departments - give greater weight to the user experience assuming that basic functionality is met. Once again, **most users do not understand how the underlying technology really works. They simply care about what it can do for them.** They also focus on the rest of the user experience including how easy it is to do productive work and how to get support when things go wrong. Don't forget aesthetics too! Apple's Jonathan Ive has created many generations of lust-inducing designs. As long as the customers coveted the designs, it does not matter if Apple drives the engineers, the new product introduction (NPI) teams, and the supply chain crazy with "bleeding edge" requirements.

I used to shudder when I heard the United States (US) economy being described as transitioning from manufacturing- to services- centric. With my many years of experience in designing, building, and managing "hardware" products, **I bemoan the loss of "hardcore" manufacturing activity in the US.** This was when I understood a "service economy" to mean an economy of only restaurants, nail salons, doctors, accountants, and law firms. Do we really need more lawyers or more complex tax codes? Are these really value-added activities? A good discussion for another time, perhaps when I am under the professional care of a mixologist…

A more enlightened version of a services economy is illustrated in the change of customer desires. Consumers have moved from purchasing basic groceries and staples (materials) to convenience foods and pre-made meals (value plus products). And there appears to be a strong correlation in increased dining out and a strong economy especially at least here in Silicon Valley. These consumers have moved from products (food) to services ("feed me"). And who doesn't want to be waited on let alone skip the shopping, preparing, cooking, and cleaning usually required?

Perhaps product or service is a false dichotomy? The dictionary defines a product as the "result of labor or effort". Therefore **a service is a product.** And when people hear "product" many immediately think of manufactured items or physical goods. We need to expand our interpretation of product to include services especially with those that are wrapped around tangible items.

We may need to stretch our paradigm for products further on the basis of value and differentiation. With cellular (mobile telephone) service in the US, a consumer may spend 5x to 6x or more on their service plan over their two-year service contract than they did on the purchase of an expensive smartphone. Due to clever marketing, the consumer is more focused on the smartphone than on the smaller monthly payments. However, these payments add up significantly over the two years. Using the classical marketing analogy, **these consumers are more focused on the handle than the razor blades!** And sometimes the carriers (mobile service providers) even give away the handles for free, just like razor companies, to lock in their customer base.

Differentiation, especially in commodity products, comes from the user experience throughout the entire product life. Apple was a late entrant to the smartphone market with the original iPhone in 2007. Many were skeptical especially when performance specifications were compared to existing smartphones. Not only did Apple have a different user interface based upon a

touchscreen (usage model), they built out services in terms of excellent support (in-store "Genius Bars" and online) and a comprehensive application-content ecosystem (iTunes). In addition, they dramatically up-scaled the "retail experience" by building their own stores.

Those who point out the iPhone is losing market share in terms of units (~ 20%) or sales, especially to low-cost Android-based smartphones, are still looking at the world from a tangible goods instead of from a service based "products" perspective. Strategy Analytics recently reported that **Apple captured 89% of the smartphone profit** in Q4 2014. Apple did this by **focusing on services to differentiate their products.** Market share and overall volumes can be important but, with commodity products, wouldn't it be better to walk away with substantial profits from significantly higher margin products? **Not only are services the new economy but we need better metrics for evaluating performance.**

Having a comprehensive product strategy that looks at the services that drive the user experience is essential. ***Especially if you think you just make hardware!***

For more of my thoughts, please see my blog http://hightechbizdev.com.

As always, I look forward to hearing your comments directly. Please contact me to discuss your thoughts or if I can be of any assistance. ◆

IRA FELDMAN (ira@feldmanengineering.com) is the Principal Consultant of Feldman Engineering Corp. which guides high technology products and services from concept to high volume manufacturing. He engages on a wide range of projects including technical marketing, product-generation processes, supply-chain management, and business development.

Ira follows many "small technologies" from semiconductors to MEMS to nanotechnology. He volunteers for numerous industry committees and events including the organizing committee of the MEPTEC MEMS Technology Symposium, organizing committee and editor of the "Environmental Sensing" chapter of the TSensors Roadmap & Summits, general chair of the Burn-in & Test Strategy (BiTS) Workshop, and the Test Working Group of the International Technology Roadmap for Semiconductors (ITRS).

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MEMS TECHNOLOGY SYMPOSIUM

Enabling the Internet of Things:

Foundations of MEMS Process, Design, Packaging & Test

MEMS based products are key enablers in the Internet of Things (IoT) revolution. The availability of large numbers of reliable and cost-effective MEMS sensors and actuators has driven an explosion in the number of IoT applications to reach the market. The Internet of Things is pushing MEMS technology to new levels of performance and bringing forth new requirements.

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INTRODUCTION

The Internet of Things (IoT) will connect everything with everyone to form a global integrated network, and is anticipated to create the next technological revolution. With 10 billion devices connected today and 50 billion projected by 2020 according to Cisco Systems, the global IoT market will see an explosive growth. IDC predicts that the global IoT market would grow at a rate of 17.5% from $1.9 trillion in 2013 to $7.1 trillion in 2020.

This symposium will bring together experts to discuss the state-of-the-art hardware, software, cloud platforms, connectivity, security, standards and data analytics that will fuel the growth of IoT applications, and will focus on the core technologies, emerging applications and new market opportunities.

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Maciej Kranz, Vice President, Corporate Technology Group
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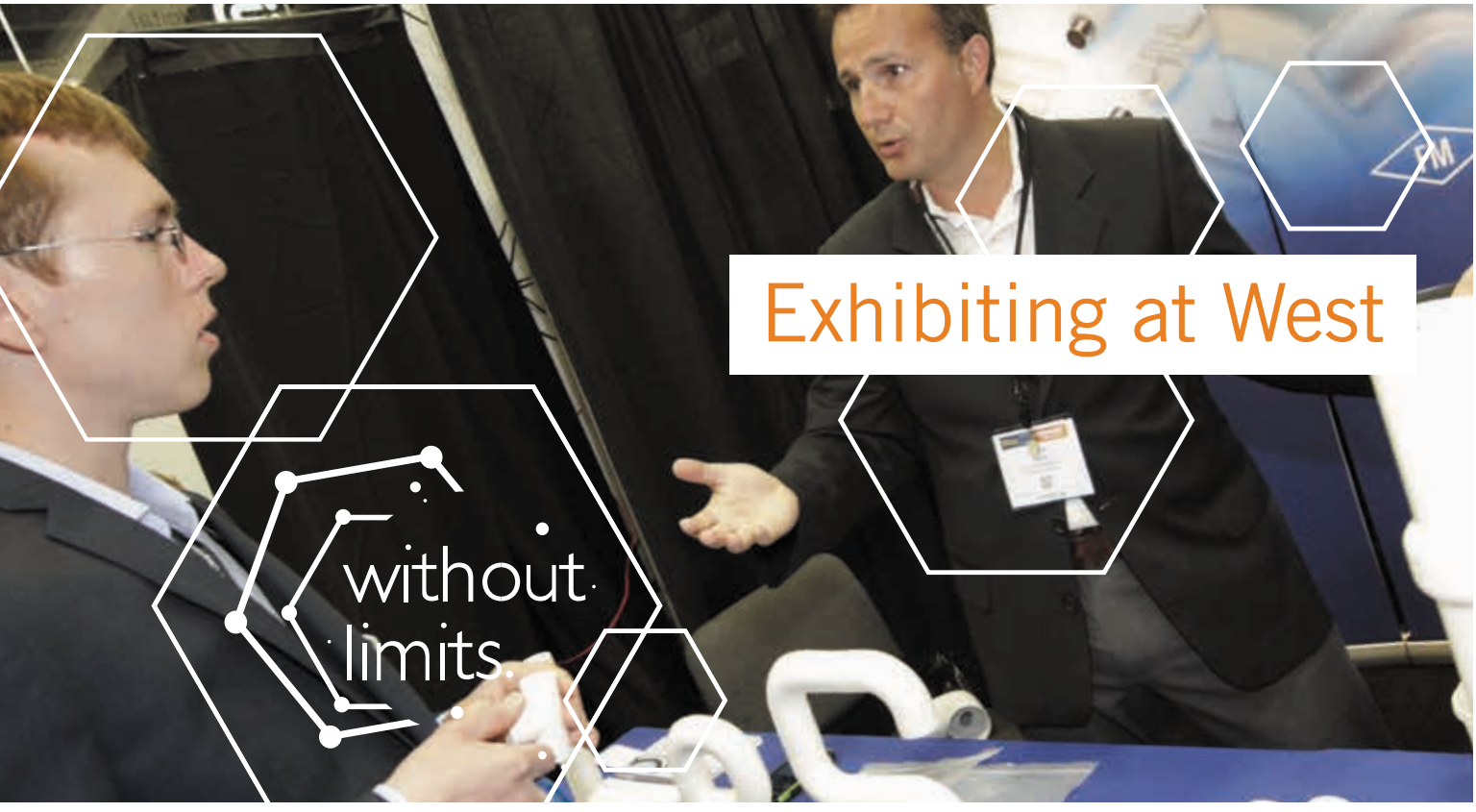

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Processing, Sensing and Communications Semiconductor Device Portion of the IoT is Set for Rapid Growth

Automotive, LED Lighting and Home Consumer Segments to Drive a Huge Portion of Overall Semiconductor Growth Through 2020

Gartner, Inc.

THE PROCESSING, SENSING AND communications semiconductor device portion of the Internet of Things (IoT) will be a rapidly growing segment of the total semiconductor market, growing 36.2 percent in 2015, compared with the overall semiconductor market growth of 5.7 percent, according to Gartner, Inc. Processing will be the largest revenue contributor to the IoT "things" semiconductor device forecast, at $7.58 billion in 2015, while sensors will see the strongest growth, with 47.5 percent growth in 2015.

The processing semiconductor device segment consists of microcontrollers and embedded processors, while the sensing semiconductor segment includes optical and nonoptical sensors.

"The demand for billions of things will ripple throughout the entire value chain, from software and services to semiconductor devices," said Alfonso Velosa, research director at Gartner. "These 'things' will drive huge demand for individual chips. IoT semiconductor growth will come from industries spanning consumer, industrial, medical, automotive and others." (see Figure 1) Gartner's forecast for the top 15 things, based on semiconductor revenue, highlights some very interesting trends:

The automotive industry plays a huge role in the semiconductor demand from things through the end of the decade, with six segments in the top 15. Regulations for safety and a need for convenience and more autonomous vehicles are driving tremendous demand for new semiconductor devices silicon in the car. One example of how the IoT will transform an automobile is the use of predictive maintenance. Using small sensors throughout the engine, predictive maintenance allows for a better experience for the consumer while enabling tremendous cost savings for both the consumer and the automotive dealer.

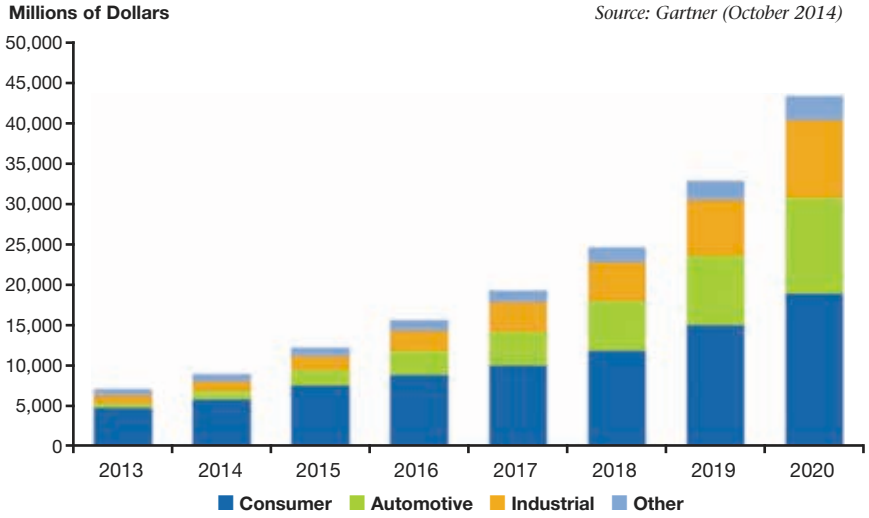

Figure 1. IoT Semiconductor Revenue by Electronic Equipment (Millions of Dollars).

LED lighting will be a huge volume play, both in lowering costs and enabling new services through its capability to connect, network and sense the environment.

Consumers looking to enhance their lifestyles will also play a central role in growing IoT demand, which in turn will create more demand for semiconductors. The smart TV and set-top box (STB) revenue will continue to grow, due to the increased need for processing and relatively expensive bill of materials (BOM) compared with a traditional embedded "thing".

Smart glasses and smartwatches also benefit from a larger BOM cost and will be in more demand as wearables become a bigger part of every consumer's life. Energy savings has always been a real value-add for the IoT.

"Gartner forecasts almost 30 percent growth through 2020 for IoT semiconductor revenue," said Dean Freeman, research vice president at Gartner. "This revenue spans every conceivable industry and is driven by the immense scale of low-cost devices. Some in the industry believe this growth will transform the semiconductor industry. However, further investigation shows that the majority of IoT devices are commodity offerings. The truth is that inexpensive devices are one of the biggest enablers of IoT."

More detailed analysis is available in the report "Forecast Analysis: IoT Endpoints – Sensing, Processing and Communications Semiconductors, Worldwide, 2014 Update." The report is available on Gartner's website at http://www.gartner.com/document/2884217. ◆

DELPHON

Founded in 1982, Delphon is a leading provider of advanced materials used with high-value semiconductor, optoelectronic, data storage, and medical components. The company is led by Jeanne Beacham, an experienced veteran of the semiconductor industry. In February of 2014, Delphon embarked on a new partnership with Fulham & Co. as part of an ongoing expansion strategy. Fulham is an investment firm that focuses on manufacturing companies that sell highly engineered products with strong brands in niche markets. Delphon is leveraging this partnership to help drive advancement in product and service offerings through material development and acquisitions in the electronics and medical markets.

BY COMBINING UNIQUE MATERIALS and proprietary technologies, Delphon has established itself as a go-to innovator of solutions that protect its customer's fragile devices, minimize contamination in critical environments, provide precision product markings, and reduce time-to-market for new chip designs. Delphon's state-of-the-art R&D lab and engineering team work closely with customers to develop new products and services that meet the requirements of their specific applications. The company's cleanroom manufacturing facilities are ISO 9001:2008 certified and its Quik-Pak facility is ITAR qualified for US Defense programs.

Delphon is headquartered in Hayward, CA with operations in San Diego, CA and Wilsonville, OR. The company's **Gel-Pak, Quik-Pak, TouchMark and UltraTape Divisions**, along with a worldwide sales and distribution network, serve a wide range of markets including the semiconductor, optoelectronics, data storage, sensors, medical, aerospace, defense, and telecom.

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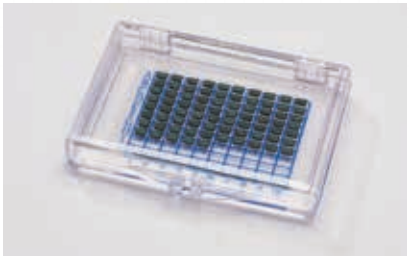

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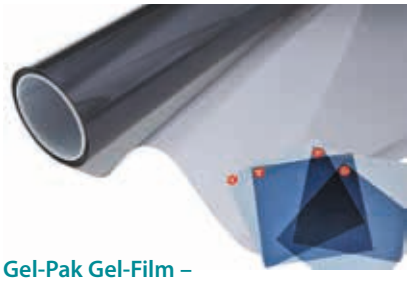

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Gel-Pak manufactures a line of versatile Gel-coated films that are ideal for a number of processes including lapping, surface protection, polishing optics, fixturing, graphene exfoliation, kitting, high temperature operations, and more. When a process or application requires a unique material, or film configuration, Gel-Pak's engineering staff is capable of developing a customized solution using its existing polymer coating technology or its new extrusion coating line. This new line provides extrusion coating of thermoplastic elastomers (TPE's), olefins, and hot melt adhesives.

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The company also has its own analytical lab that is capable of analyzing materials and surfaces in order to create an optimal printing process. If a substrate's surface energy needs to be increased for improved ink adhesion, TouchMark's in-house surface pretreatment services can modify the surface to ensure permanent ink adhesion. As an expert in specialty inks, TouchMark has developed processes for medical grade, radiopaque, and conductive inks.

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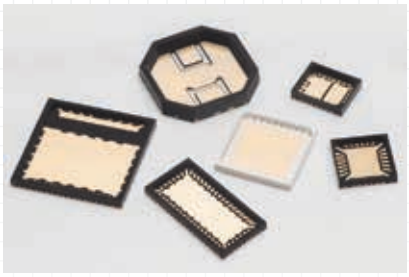

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Delphon's Quik-Pak division specializes in IC packaging that takes customer designs from prototype to volume production. The company provides prototype and on-shore volume IC packaging and assembly services. Quik-Pak specializes in providing a full turn-key solution that gets new microelectronic designs to market quickly.

Quik-Pak offers a broad range of package types including Open-molded Plastic Packages (OmPP®) and Open Cavity Plastic Packages (OCPP). The company also manufactures custom molded QFN's in high volume. Quik-Pak's full range of assembly services includes precision die attach, encapsulation, and marking/branding. Advanced assembly capabilities are available for flip chip, ceramic packages, chip-on-board, stacked die, and MEMS. The company recently expanded its wafer preparation facility to accommodate new equipment capable of supporting wafer backgrinding and dicing operations. ◆

Delphon is committed to working hand-and-hand with its customers and leveraging its expertise in material development to create unique, high-quality solutions. To learn more about Delphon and its divisions, visit www.delphon.com, or call Delphon at 1-510-576-2220.

DELPHON

High-Performance Conductive Film Technology for Large Die Automotive Applications: MSL and Board-Level Exposed Pad Performance

Andrew Laib, Pukun Zhu, Mario Saliba, and Jihong Deng
Henkel Electronic Materials

RECENT RECALLS IN THE AUTOmotive industry have reinforced the need for components with higher reliability. Applications such as air bag sensors and electronic system have underscored the importance of high levels of reliability for automotive customers. The JEDEC JESD22- A104D Temperature Cycle Standard is just one such example where the automotive industry is using severe reliability testing requirements.

This article will focus on reliability testing for conductive Die Attach Film (cDAF) technology, specifically on die applications ranging from 1x1 mm^2 to 10x10 mm^2. Our test results are showing zero delamination after Moisture Sensitivity Level 1 (MSL 1) with more than 2000 exposed pad board-level temperature cycles. When compared to die attach paste with similar product characteristics, cDAF technology is outperforming MSL 1 and temp cycle results.

Product Application

The automotive industry often selects small outline integrated circuit packages (SOIC) or thin quad flat packages (TQFP) for automotive applications as historical reliability performance for this package is well known. Traditional TQFP packages are symmetrical, having molding compound above and below the pad, resulting in an optimized balance of forces on all sides of the die. As automotive electronics are integrating more and more functionality into these devices, heat dissipation is becoming an issue, which is why we are starting to see more exposed package SOIC or TQFP package types.

Exposed packages are components where the die pad is directly mounted to circuit boards through standard solder assembly processes. Asymmetric packages are the most effective method of creating a heat path from the die through conductive die attach, to the die pad and out to the circuit boards. However, asymmetric packages are also changing the stress points on the package directly to interface of the die and die attach materials, thus inducing die cracks and die attach delamination.

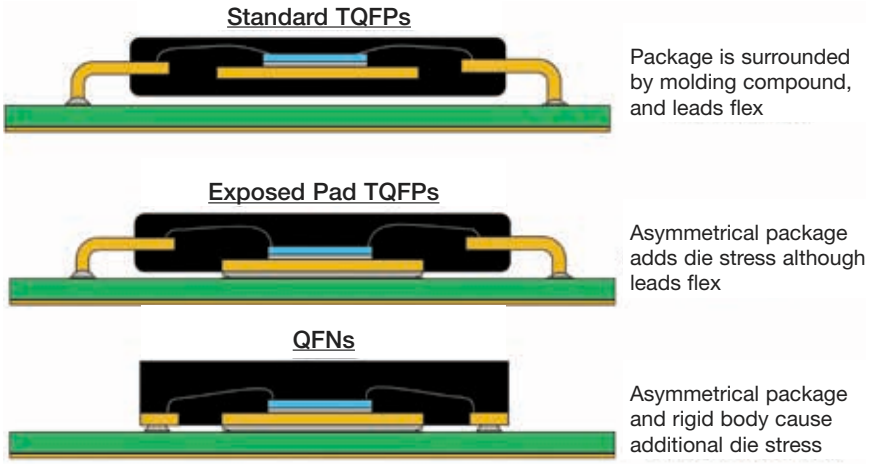

Figure 1. Depiction of three basic package types related to this study.

The worst case scenario for testing is when the die to die pad is maximized so that the die is almost the same size as the die pad. Larger dies exhibit more CTE mismatches, during heating and cooling cycles, than that of a smaller die on large die pad. For this study, a QFN 12mm x 12mm package was selected because of its stiffness especially due to having no leads, where the exposed pads and leads mounted to the board will exert the maximum stress possible on the package during temperature cycling, simulation. An image depicting each package is illustrated in Figure 1.

Automotive customers are primarily concerned with the reliability of their packages to perform under extreme operational conditions. When a package is mounted to the board with exposed pad and leads, much of the stress targets the die attach material. Since conductive die attach films (cDAF) are supplied on a continuous roll as a solid at room temperature, this format allows the use of non-traditional resins to form stronger cohesive bulk material properties to help reduce adhesive stress points. That is, cDAF performs better than traditional die attach paste because the material format allows the use of higher viscosity resins which simply can't be used in die attach paste formulations. In addition, cDAF technology allows formulations with lower cross-linking density, which helps to reduce warpage. Additional benefits can be seen in the manufacturing processes of film technology vs paste format which come from coating methods yielding high adhesion, good wetting and high material cohesive strength.

Resin bleed is a major issue of con-

Figure 2. Traditional die attach paste with a fillet and die tilt and inconsistent fillet.

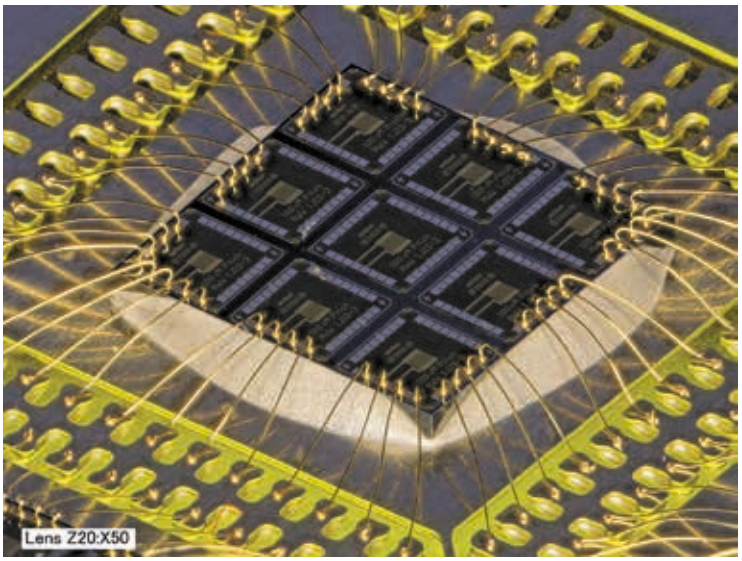

Figure 3. Top view of traditional die attach paste with extensive squeeze out and fillet.

Figure 4. Limited material flow with cDAF demonstrating no fillet, no die tilt, and no bleed with a larger die size.

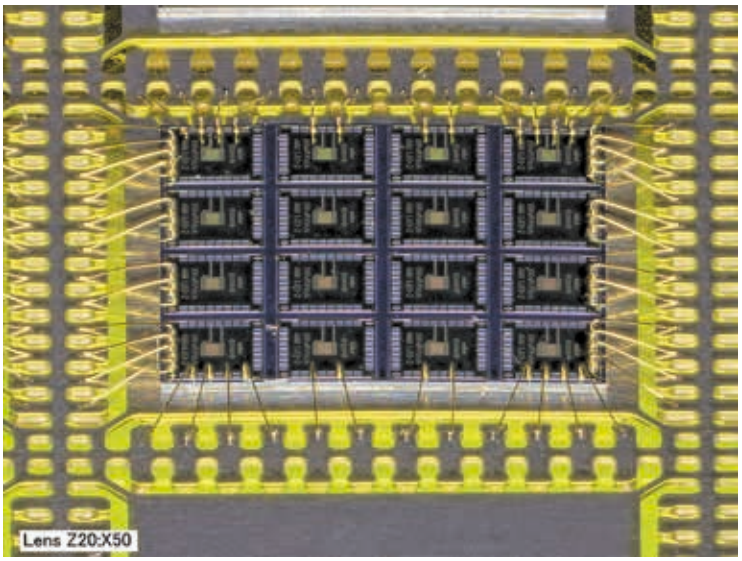

Figure 5. Top view of cDAF showing large die-to-pad ratio with no squeeze out or fillet.

cern for automotive temperature cycling, as this resin flow can compromise package integrity ultimately causing bondline failure. Resin that separates from die attach during cure can cause failures between the molding compounds to the package leaframe, typically these failures can be seen at the edge of the die. With higher viscosity resins, we do not typically see these type of bleed issues with film Technology.

In addition to providing robust package reliability, many automotive applications also require a flexible die size range to bond semiconductor chips to their substrates (leadframes). Conductive die attach film (cDAF) materials have been designed to have lower stress (low modulus) and higher adhesion for die sizes ranging from small (1 mm x 1 mm) to large (10 mm x 10 mm) die sizes. Studies have also shown that packages with no bleed or die tilt and consistent die fillet tend to have better reliability results. The images below display the vast difference in flow between cDAF and traditional die attach paste, where cDAF enables larger die bonding capability for a fixed pad size.

Conductive die attach films are able to bond to various leadframe surfaces, including bare copper, silver, and nickel palladium gold (NiPdAu), which is the preferred metallization for high reliability applications. Other metallization's can also be processed with cDAF, including bare silicon (Si), silver (Ag), and gold (Au). Although cDAF is compatible with rough surfaces, smooth surfaces are preferred to achieve ideal wetting. Wetting the interfaces sufficiently is helpful for reducing interfacial thermal and electrical resistance, hence improving conduction; the metal-filled nature of the film also dissipates much of the heat from the die surface. Large die conductive films meet all these demanding requirements.

Experimental Processing and Setup

For the purposes of this study we focused on the worse-case scenarios for reliability tests, this experiment focuses on MSL 1 and 2000 temperature cycle results on an exposed pad QFN package. MSL 1 insures the package integrity during the solder mounting process for an unlimited shelf life. In addition, since many of these parts are mounted under-

Test	Temperature Requirements	Reason for the Test	Assessment Method
MSL 1	260°C reflow three times	Determines the shelf life of the package before mounting on the board	Scan the acoustic image before and after testing. Measure delamination when needed.
Board-level Temperature Cycling 2000 cycles	-55° to 125°C a cycle	Simulates a lifetime of automotive operation with accelerated reliability testing	Scan the acoustic image before and after testing. Measure delamination when needed.

Table 1. MSL 1 and board-level temperature cycling reliability testing.

the-hood or on critical applications with brake systems, temperature cycling guarantees a lifetime of material performance simulating the stress exerted on the material during the heating and cooling cycles of normal automobile use.

Our reliability tests, required an MSL 1 (260°C reflow three times) rated package with 2000 cycles of board-level JEDEC JESD22- A104D Standard "B" Temperature Cycling (20 minute cycles of -55° to 125°C). The thermal cycling causes stress build up from the CTE mismatch, where the die attach material is under tension during the coldest portion of the cycle and in compression during the hottest portion.

In addition to the above stringent requirements, a zero-level delamination specification is a key component of testing criteria for critical automotive applications. This reliability process relies heavily on acoustic imaging to verify no delamination of the bond-line and general package integrity. Inspection was performed with reflective acoustic imaging, as the woven pattern of the laminated board prevented acoustic through-scan imaging. Once the package is mounted on the board, the test results are referred to as pertaining to a "board-level" test (see Table 1).

The purpose of this experiment is to compare the MSL 1 and 2000 temperature cycling reliability performance of the following three materials: traditional paste (Material 1), an older generation of large die cDAF (Material 2), and a newer generation of cDAF (Material 3), where the newer generation has a lower modulus with less crack initiation points than the latest generation.

Regarding the processing to build this package for both MSL and temperature cycling testing, the cDAF product is laminated onto a metallized (gold for added thermal conductivity) backside wafer and dicing ring with a standard 2-in-1 laminator. This wafer is then diced to an 8.0 x 8.0 x 0.3 mm^3 die size and bonded onto a NiPdAu leadframe using traditional die attach equipment with a heater block. After curing, wirebonding, molding and singulation, the packaging process is complete; see Figure 6 for the process flow of the packages used for this study.

The package is then mounted onto a printed circuit board (PCB) using a screen or stencil printing technique, pick-and-place technology, and a solder reflow process. The board used for this experiment was found to be extremely rigid, made of several layers of copper and laminated substrate. Once the parts are mounted onto the PCB and start temperature cycling, the expansion and contraction from the CTE mismatches (the different packaging materials' coefficients of thermal expansion) cause stress, which is primarily exerted on the die attach material itself due to the rigid nature of the board: the more rigid the board, the more the die attach material will be stressed.

Additionally, QFN packages are generally quite rigid, approximately 12 x 12 mm^2 in size, without extended leads and a large die-to-pad ratio. After stencil printing and reflow, the board will appear as in Figure 7 with some of the locations occupied by packages. The package will be mounted onto the center of the board location with solder under the exposed pad and also on the leads fixing the package edges and center pad firmly in place.

Reliability Results

Initial results for large die Material 2 cDAF results show good wetting and adhesion to the die and leadframe compared to traditional die attach paste and Material 1 cDAF; the warpage is as low as the leading paste products. In addition, the package exhibits good thermal and electrical performance after the packaging process.

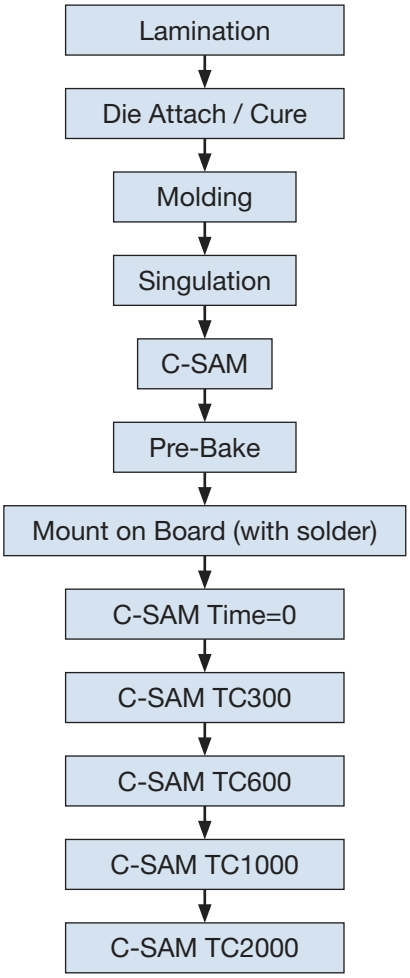

Figure 6. Package Process Flow Chart.

Regarding reliability results, Material 3 passed MSL 1 on the QFN12x12 package with an 8x8mm^2 die due to its high adhesion to the die and substrate and high moisture resistance, while Materials 1 and 2 failed due to their low adhesion.

In regards to board-level temperature cycling, Material 3 also passed the required 2000 cycles with zero delamination, with the bond-line integrity also verified by cross-sectioning. However, Material 1, the paste product, would fail after 1000 cycles with predictable delamination on the edge of the die, the

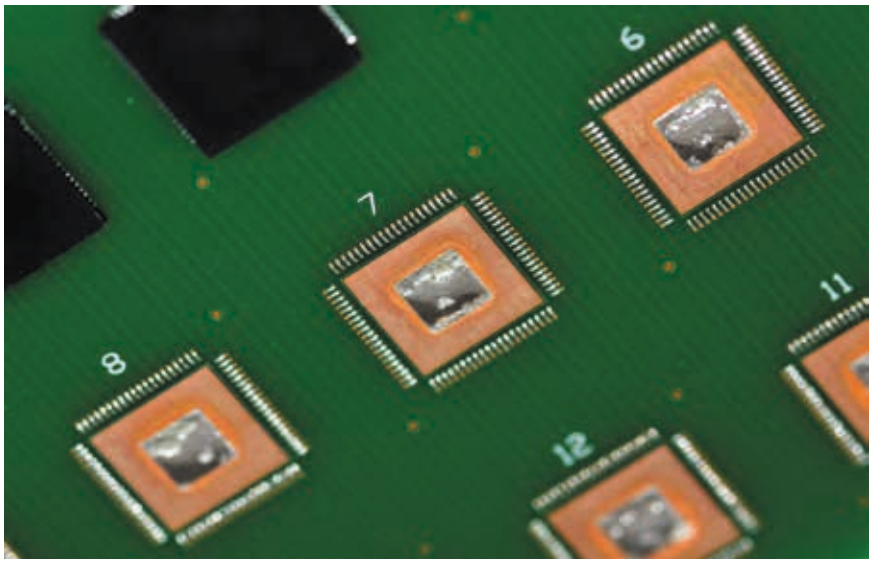

Figure 7. Board after reflow showing solder on both the leads and the exposed pad (bottom right) are also soldered to the QFN component, demonstrating the strenuous nature of board-level temperature cycling. QFN12x12 parts are also mounted on the board (top left).

Number	Material	MSL Result	Board-level Temperature Cycling Result
1	Traditional Paste	Failed MSL 1	Predictable delamination on the edge of the dies after 1000 cycles
2	First generation of cDAF	Failed MSL 1	Unpredictable delamination under the dies after 1000 cycles
3	Second generation of cDAF	Passed MSL 1	Zero delamination after 2000 cycles

Table 2. Reliability test results.

area of highest stress. Material 2, on the other hand, showed poor temperature cycling performance as the modulus is high resulting in brittle material breakage around crack initiation points during temperature cycling, resulting in unpredictable delamination anywhere under the die. The adhesion of Material 2 to the die was also low causing further separation between both the die attach material and the die and leadframe interfaces. Table 2 further summarizes the results of the tests.

The modulus was found to be a major contributing factor to the passing of this rigorous temperature cycling testing, where lower modulus materials will experience less stress during the cycling. In addition, the size of the particles in the bond-line and the resulting reduction in crack initiation points and good wetting of the material were also contributing factors to the success of Material 3's positive temperature cycling testing. Due to these reasons, the new generation of cDAF outperforms paste in temperature cycling. Further investigation is on-going into the effects of fillet and die tilt on the failure of die attach paste temperature performance.

Summary

With regards to the severe reliability testing required by the automotive industry, Henkel's new generation of large die cDAF is the only product that meets and exceeds these rigorous MSL and exposed pad board-level temperature cycling testing expectations with no delamination, while maintaining the necessary thermal conductivity. This unique combination of low modulus, high adhesion, and high moisture resistance produces a material platform with high reliability performance, outperforming traditional die attach paste. Film technology also bonds to the leadframe in a clean, easy process that eliminates squeeze-out, fillet, bleed, and die tilt, enabling larger die sizes in a fixed package size further enhancing reliability. ◆

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A Novel Solution to Handling Thin Wafers During Device Fabrication and Packaging

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WITH THE ADVANCES IN PACKAGING technology, the middle-end - as it is being defined - is becoming more complex and aggressive in terms of design rules. One main challenge in this middle-end space is thin substrate handling. Handling thin wafers is not new to the industry. However, with the shrinking nodes and advances in technology, combined with the need for managing costs, thin wafer handling applications have increased tremendously in the emerging middle-end, as well as the front-end lithography space. The traditional handling of thin wafers on carrier substrates, such as glass wafers or other, is not the optimum solution at this time.

Device packaging for a thin wafer is becoming the norm for the high-end Semiconductor Assembly & Test Services (SATS). There is a strong push for improvements in the present methods of handling thin wafers with bonded wafers (glass carrier wafer or tape frame) due to its limitations in process capabilities, added process steps, yield impact and contamination risk. Present methods of thin wafer handling have substantial added process steps that impacts yield in each step. Yield is impacted due to physical aspect of bonding and de-bonding and also negatively impacted due to the inherent contamination issues of bond material during bonding and de-bonding steps.

Often the wafer thickness can be below 50 microns causing substantial challenges in handling. At present, a carrier wafer is used to bond the thin wafer. Each of these bonding methods, though functional, adds substantial process steps and yield risk as stated. The risk of yield on these very expensive wafers are substantial and even a fractional improvement in yield can save big and help in cost reduction steps.

To address all the yield impact and minimize added process steps an innovative portable ESC technology is offered by ProTec Carrier Systems. This technology has been tested and implemented at major research institutions and industry segments in Europe and the US, and is in use at multiple facilities in the photovoltaic, optical, semiconductor, and flexible display industry segment. This product has undergone rigorous testing and development for several years to make this technology a success.

This elegant solution eliminates much of these risks in handling thin wafers though a portable Electrostatic Carrier (ESC) enabling thin wafer handling as a standard wafer. The application of portable ESC can be in multiple process areas including lithography, spin cleaning, plasma etch, deposition, high temperatures process, and in other applications such as a stencil mask or thinned wafers with TSV prior to electroplating. And it has the ability to handle diced wafers, flexible displays, and even regular wafers, with the potential to carry smaller wafers on larger wafer-capable tools to leverage the advances offered on newer tools.

The basic principle of the technology is a conductive material such as silicon substrate (same form factor as a standard wafer of relevant size) or copper covered by a dielectric. The dielectric material does not generate contamination and thus critical semiconductor fabrication levels are met. The whole system of conductor covered by dielectric is able to be charged to behave like an electrostatic chuck. A thin wafer when placed on this carrier can be chucked effectively with excellent flatness and the combination behaves like a rigid wafer, eliminating the challenges of handling a thin wafer. The advantage of this ESC is that the carrier, even when disengaged from the charging station, is able to retain the electrostatic charge. For a thin wafer this offers a similar mechanical advantage as that of a bonded glass carrier wafer. However at the end of the process, unlike the bonded carrier process, there are no chemicals and cleaning required to de-bond the wafer, which typically adds risk of yield loss. For the portable ESC to de-bond simply reverse the charge and the thin wafer is separated. The charge retention time is long enough to endure even the toughest DRIE etch process in plasma environments. A broad array of samples can be chucked. The portable ESC can be customized for different shapes and sizes with a minimum suggested carrier thickness of 500 microns.

The distinct advantage of this type of carrier, when compared to a bonded carrier wafer or on tape frame, is that the portable ESC can withstand substantially higher temperature ranges while in process and does not leave any residue. It also does not require any chemicals for bonding, de-bonding and cleaning. In addition, the carrier is reusable several hundred/thousand times, depending on applications. Any incremental cost is easily offset by savings on minimized process steps, improved yield, cost of chemicals and waste handling. This is a dual benefit where cost is reduced while environmentally friendly to save manufacturing costs. Cost is a critical component in any manufacturing process, and is especially so in this semiconductor segment, where cost per transistor had continued to drop until recently, where it has begun to go up due to complexities. So any effort to cut cost is welcome, at the same time making the thin wafer handling easier.

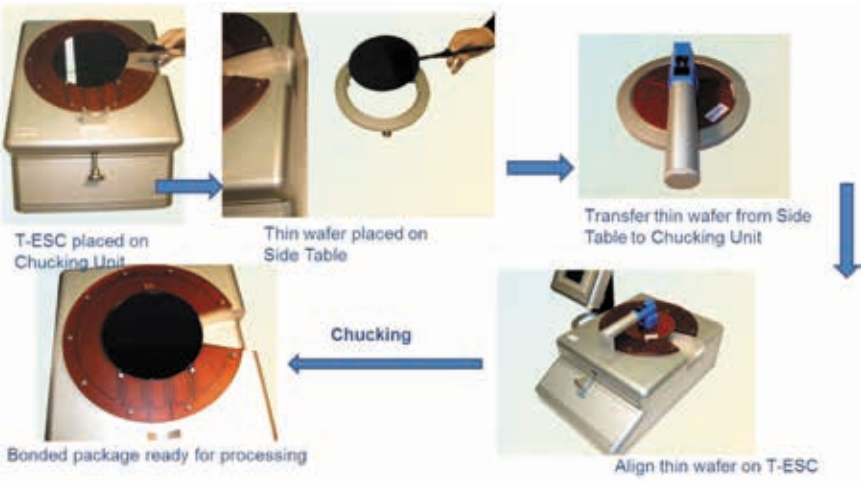

Figure 1. Manual Chucking Unit MCU 3000.

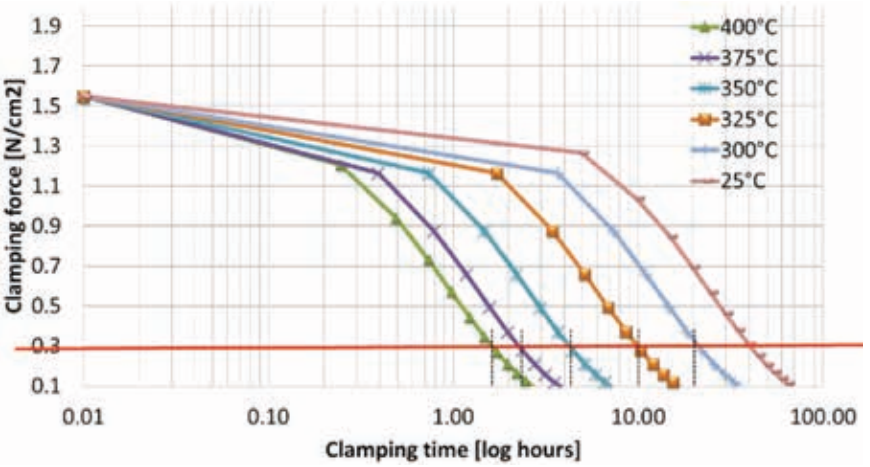

Figure 2. Clamping Force Versus Time.

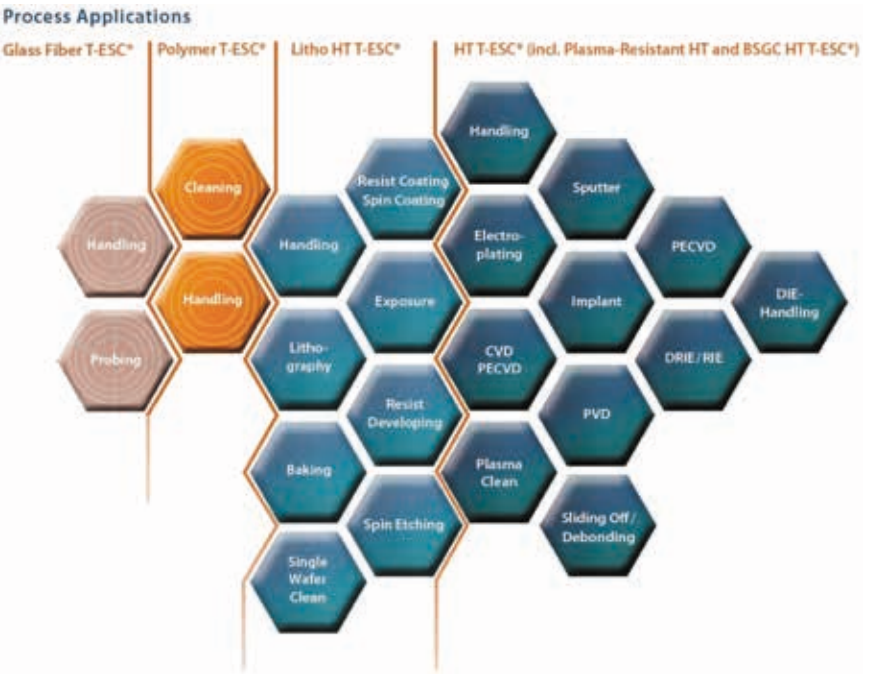

Figure 3. Process Applications.

Figure 1 shows a fundamental process of chucking on a portable ESC.

Figure 2 shows the duration of the portable ESC at different temperature settings.

Figure 3 shows the application space for this portable ESC.

In summary, we believe the solution offered by this thin wafer carrier is a novel solution that eliminates unwanted chemistry, reduces process steps, making thin wafer handling substantially easier while improving productivity in turn reducing cost. ◆

Acknowledgements: For technical data by Sebastian Wagner, ProTec Carrier Systems.

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New Materials Solutions Deliver Miniaturization-Friendly, In-Package EMI Shielding Options

Simon Turvey
The Electronics Group of Henkel

THE ISSUE OF ELECTRO-MAGNETIC interference (EMI) has been well understood by electronics specialists for decades. If not controlled, EMI – which is a disturbance to an electrical circuit due to electromagnetic coupling from external sources – can compromise or inhibit the function of a circuit and can lead to data degradation or loss. Traditionally, the most common way to protect against EMI is through EMI shielding caps – metal lids attached to grounding pads – to prevent outside interference, minimize interference between components within a design and to prevent crosstalk of components on printed circuit boards (PCBs). This solution is effective, but market dynamics are forcing non-conventional approaches to EMI shielding.

The drive toward highly miniaturized designs, increased integration and greater functionality is driving package designers and materials specialists to innovate new approaches to EMI package shielding. Not only are device dimensions dictating smaller package profiles, which limit the use of traditional cans, but multiple parts that have higher and lower operating frequencies are now within the same package and can experience EMI. So now, not only is there package interference concern with other adjacent packages on the same board, but with parts within the same package. This is the case with today's System-in-Package (SiP) designs and, in the longer-term, EMI will also have to be addressed for system-on-chip (SoC) devices.

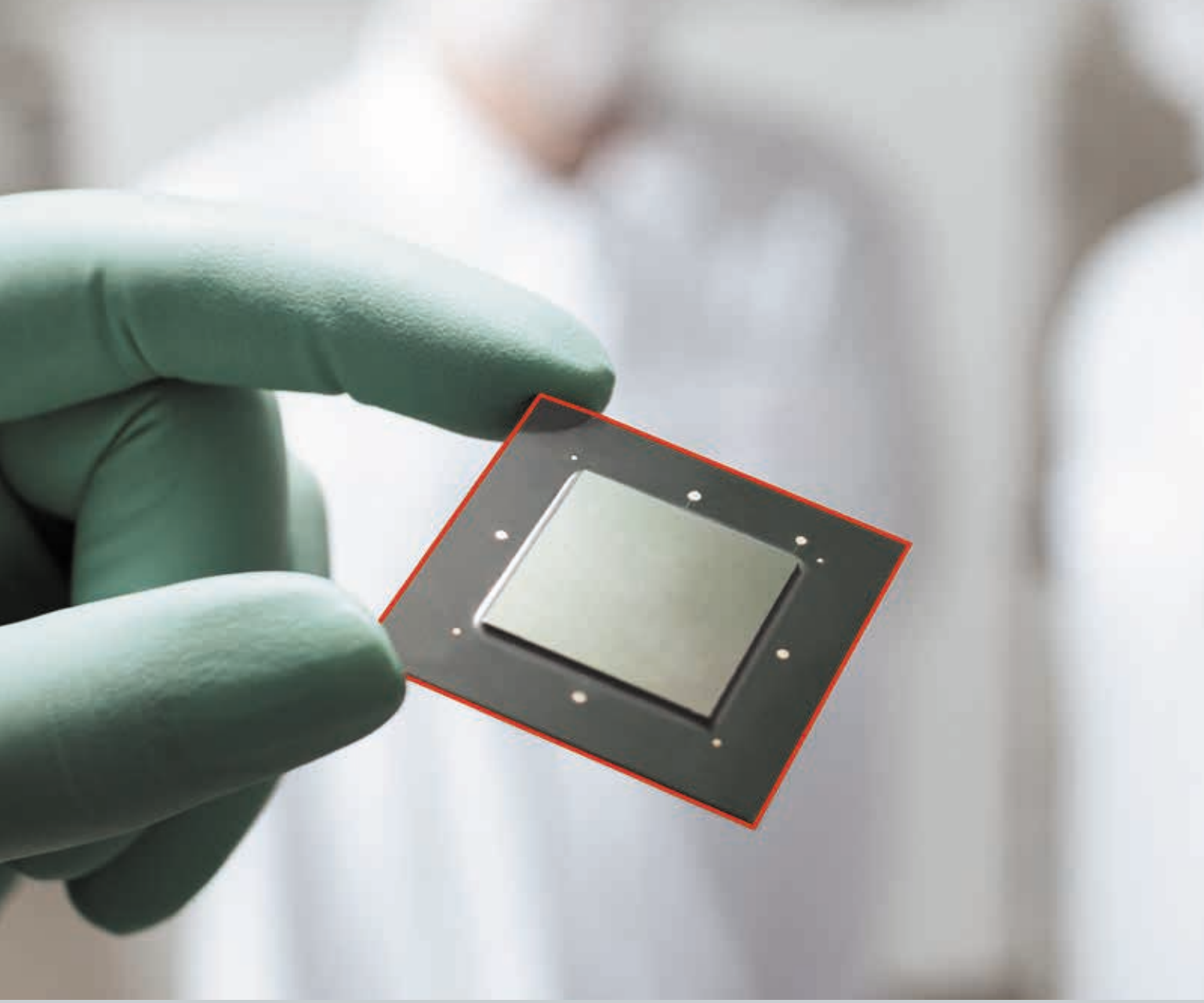
Understanding material formulation complexities and in-field performance requirements, the materials specialists at Henkel have begun developing some novel solutions for EMI shielding. The three Henkel approaches address solutions for traditional package shielding, SiP compartment shielding and shielding in package and are promising strategies to manage current and future challenges.

First, Henkel is actively working on two different methods for cap shielding. While conventional metal cans provide good board level package shielding at comparatively low cost, the cans are not practical as designs become thinner and smaller. Some industry alternatives have already emerged and include plating and sputtering shielding material directly onto the package so as to lower the profile and deliver a thinner conformal shielding solution. While both of these methods are being used in production, they do have some drawbacks. Primarily, the challenge with plating and sputtering is the ability to cover the sides of the package at the strip level prior to singulation. Sputtering requires the individual parts to be singulated first, placed on a dicing tape, marked before coating and then coated: it's a time-intensive and expensive process. The two alternatives Henkel is investing resource in are techniques that enable coating and part marking prior to singulation. The first method leverages the speed of stencil printing and has been successfully carried out at a well-known package subcontractor. The second approach is a unique spraying deposition method that can apply a very thin coating on the top of the package and in the narrow pre-singulated molding lanes, delivering a streamlined and high UPH solution. Both conformal shielding methods are being developed in tandem, with early results very promising.

For SiP devices, where targeted die need to be separated from each other to avoid signal interference, Henkel has commercialized two gap filling materials that create two Faraday cages to separate the die from each other within the package. Once the part is molded, a groove is laser cut through the mold compound down to the package substrate and runs in conjunction with a series of ground pads that are in the printed circuit board (PCB). That gap then has to be filled, which is challenging. Filling the gap aspect ratio, which can be anywhere from 5:1 up to 10:1, involves not just depositing the material, but also displacing the air so that the gap is completely filled. Henkel's LOCTITE® ABLESTIK® ABP 2820 and LOCTITE® ABLESTIK® ABP 2821 are currently the market's only viable materials for this application. Both materials are high solids loading conductive epoxy/acrylate systems that are jetted into the gap to effectively fill them while providing low shrinkage, good adhesion and low voiding. The materials create the fourth wall of the Faraday cage and deliver robust compartment shielding in a high UPH process. Following this process, the package is then coated with a conformal shield as described above.

Finally, Henkel's innovative technologists have moved from the package to the chip and have applied for a patent for materials that provide shielding directly on the die in the package. Put simply, instead of the Faraday cage being formed on the outside of the package as in the SiP process, this takes the idea to the chip level. Using novel encapsulants, shielding materials and then final molding compound, a package within a package that already contains shielding functionality is formed. Indeed, it is a novel concept and one for which Henkel has already applied for patents on the enabling materials. Beta testing will soon be underway, moving the industry closer to a viable, user-friendly in-package shielding solution.

Package- and chip-level functionality will only continue to increase, driving the need for creative solutions for EMI shielding to protect device and product performance. With a forward-looking approach, Henkel has already developed innovative materials and processes for on-package and in-package shielding, offering manufacturers high UPH, cost-effective ways to achieve design and performance objectives. For more information on any of Henkel's package shielding solutions, visit www.henkel.com/electronics or call +1-888-943-6535 in the Americas, +32 1457 5611 in Europe or +86 21 3898 4800 in Asia. ◆



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Engineering Education - Where Art Thou Headed?

Guna Selvaduray, Ph.D.,
Professor, College of Engineering, San Jose State University

IF WE TURN THE CLOCK BACK TO 1965 (50 years ago) could most of us have predicted what today we take for granted, things such as the internet and the mobile communication devices? International phone calls that were extremely expensive are now practically free and those of us who migrated to the US make international phone calls with far more ease than we used to when we made domestic phone calls back in the 1960s. (Some of us are old enough to remember this.)

Back in the 1960s the engineering field was compartmentalized with relatively clear boundaries. As a student, if you were interested in automobiles, then you majored in either mechanical engineering or automobile engineering. If you wanted to work in a petroleum refinery, then you majored in chemical engineering. Thought processes, especially those linking education to future professional activity, was relatively linear.

To say the world has changed is an understatement, and the linear thinking that was prevalent is no longer relevant. Electronic components (including the packaging of electronic components) are ubiquitous. They are everywhere and in practically every product. Today it is practically impossible to buy a toaster oven that does not have some electronic components built into their control systems. Those of us who used to work on our automobiles know that while the drive mechanism is still mechanical, just about everything is controlled electronically and most of the safety and creature comforts we have come to take for granted are electronic as well - with the appropriate packaging, of course.

The point here is that while a discipline such as electrical engineering has a direct relevance to the design and manufacture of electrical/electronic components, when it comes to designing and manufacturing actual products expertise from a variety of fields is required, and electrical engineering today is one of key disciplines. The same statement can be made about some other disciplines such as software engineering and materials engineering.

High school students applying for colleges, and their parents, tend to want to enter what they think are "growth areas". These typically tend to be those that receive wide media attention. These days the field receiving such attention tends to be IT and Health Care. Cyber Security is also gaining more name recognition and notoriety. One consequence is the lack of student interest in some of the other fields that are not publicized in a similar manner, leading to enrollment declining in these fields, and therefore a "graying" of the workforce in those fields. Steel and concrete manufacturing, and power generation, are perhaps good examples of fields that receive very little attention, but without the production of steel and concrete our society as we know it now will most probably collapse.

What this leads us to is a very important question that will affect all of us: What can we do to enlighten students, and their parents, about the numerous opportunities that exist in the various industrial sectors. More importantly, how do we overcome the tendency towards "linear thinking" so that new talent will continue to be channeled to all industrial sectors in a more uniform manner?

This is where industry can play an important role. University-industry collaborations have tended to focus more on problems that industry needs to be solved, i.e., research problems. Very few efforts are aimed at broader curriculum changes and improvements that are sorely needed in order to enlighten students about the broader needs of an industrialized society.

An excellent example is the Medical Electronics Symposium series organized by MEPTEC. The fact that more and more medical devices, especially implantable medical devices, are controlled and operated by electronics, is clearly evident. Yet, the symposia that I have attended has hardly any students attending. And, according to my subjective estimate, the average age of the attendees is around 40+, with very few participants in their early 20s, i.e., fresh graduates. Industry, and industry associations, can play a role here by providing scholarships for students to attend interdisciplinary symposia, conferences and meetings such as these to make them aware of applications outside the traditional areas.

It is also high time that industry engaged universities in active dialogs to plan and develop changes to existing engineering curricula so that students can become aware of the multiple opportunities that exist in all sectors of society. While there are growth sectors, I do not think there are any "dying sectors" because the growth sectors are built upon existing industries. If existing sectors are not robust and improving the foundation for the growth sectors will be shaky at best. A good example is the demise of machining in the US. Manufacturers in all sectors are now having to rely more and more on off shore sources for their machining needs. Granted, the availability of the required IT tools does make this possible, but I do not think it is a complete substitute for being able to sit down face to face with manufacturing engineers to work out problems.

If we are to sustain the USA's technological leadership and robust economy, we need to make changes, not just in the university curricula. Of importance here is the extent to which industry is willing to commit resources, both personnel and financial, to guide and enable these changes. ◆

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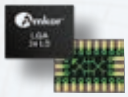

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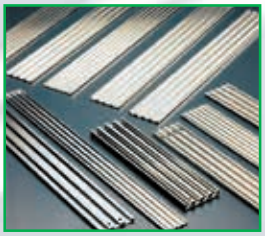
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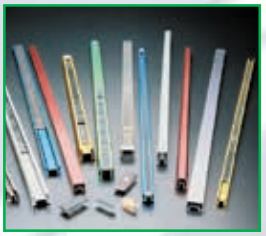
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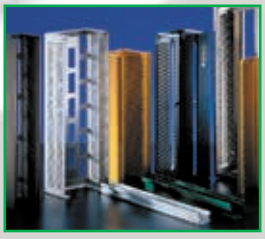
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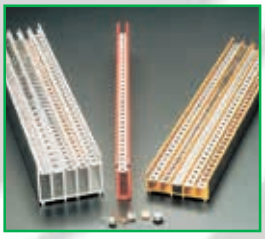
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