What Can We Expect in 2011?

by **Dr. Jennie S. Hwang,** *CEO,*
H-TECHNOLOGIES GROUP

IN SUMMARY

Dr. Hwang highlights 2011's technological trends in 10 critical areas of the EMS industry.

Once again, the time has arrived to ponder the outlook for the New Year. I will take a long view on market thrusts and technological trends in 10 selected areas deemed to be critical and relevant to the industry. Each of these 10 areas will be briefed in highlights. Further discussions will be addressed in subsequent publications and speeches. While the impact of the global economic debacle in 2008/2009 still lingers, let's first look at the anticipated global economy for 2011. As the saying goes: "A rising tide lifts all boats," and vice-versa.

Global Economic Outlook

Not being an economist by any stretch, I am always intrigued to "forecast" a GDP number for the sake of self-challenge. In retrospect, the good news is that my number has been reasonably close to what had actually happened; the not-so-good news is that my number does not come from a trained economist.

What will be the business and economic environment for 2011? Companies have worked through cost-cutting and down-sizing during the last couple of years. Because of this streamlining process, most of these companies should emerge as leaner and more fit organizations. Meanwhile, any excess inventory throughout an industry's supply chain has essentially depleted and the re-stocking is commencing. Governments, U.S. or other countries, have initiated incentive

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programs and tax breaks to prop the business growth. But one should not to ignore the power of human psychology on the economy. As experienced in the late 1990s, human optimism created the "bubble" propelled by the swift deployment of the Internet. By the same token, after having gone through excruciating and painful cost cutting and depth of a global financial crisis, the human factor would again steer a more prudent and resourceful mindset, thus allowing execution. For the past four quarters, company balance sheets have gotten stronger and earnings are expected to hit record highs in the fourth quarter of 2010. Presently, corporations collectively hold more than $1 trillion in cash.

The confluence of those upward forces is expected to build up the momentum to reap growth and profits regardless of the industry sector. What's the downside? The national unemployment rate stays high in the 8 to 9% range and the housing market remains sluggish. Nonetheless, I would anticipate a strong U.S. economy with a GDP to hover around 2.7 to 3.5%, most likely at 3.2 +/- 0.2%.

As the only super power in the world, the U.S. economy is pivotal to the world economy. However, in this globally-connected world, other countries are also respectable parts of the global economic equation. Asia continues to be a high-growth region as the world's economic engine. Latin America is another growth region. Although some European countries, such as Spain, Portugal, Ireland, may stay in financial doldrums, Germany, the largest European economy, fares well. China, sitting on $2.7 trillion foreign exchange reserve with both export and import prowess, is well-positioned on the world stage drawing from its national recourses, human capital and economic growth. The evolving balance in the country's export and domestic consumption, manageable inflation, coupled with the stable GDP growth in the range of 8 and 9% and inflation rate of less than 5% (hopefully), will catapult its role on the stage of the world economy.

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All in all, 2011 is expected to deliver a rising economy with healthy market demand, thus a great year for all. Yes, a rising tide lifts all boats, but it would be an entirely different story if there is a leak in the boat. A stronger economy should lift all companies. The effort is to make sure a company does not have a "leak."

Electronics Industry: Hardware

Brisk demand in 2011 is expected and electronics will exert a larger impact on all industries.

If you feel that in the last few years the new product introduction of consumer electronics has been dazzling, and the selection from the myriad gadgets is mind-boggling, you haven't seen anything yet. Going forward, I predict more new product introductions at an even faster speed. The prevalent platforms will co-exist and new platforms will be born. As a result, consumers will benefit, enjoying better products at a lower costs. Overall, one glaring feature will be the augmentation of connectivity. The 2011 theme of consumer electronics will be mobility and connectivity with proliferating tablets and smart phones, as well as gaming gadgets.

To the designers and manufacturers of these new gadgets, inevitable challenges will arise in every link of the supply chain, ranging from electronics packaging to solder material.

Overall, transformative products may not materialize in 2011, yet a plethora of innovations will be reflected in products across industries.

Moving toward the "smart" world, I expect to see the marriage of electronics and automotive industries become stronger and the global demands of electronics by solar photovoltaics continue to rise.

Solar Photovoltaic (PV) Performance

Perceptions have been that solar PV is only viable when the oil price is high. Oil prices may rise and fall (likely rise in 2011?), but should not dictate the viability of solar photovoltaics. The rationale was outlined in my recent article: "Solar Energy: 10 Reasons Why Oil Prices Should Not Deter Solar Energy Deployment."

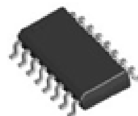
With or without cap and trade, renewable energy will be on the national agenda of both developed and developing countries. Solar is here to stay as a viable renewable energy source. 2011 may be too soon to see a breakthrough technology to revolutionize the PV industry, but this does not mean potentially breakthrough activities are not in the works. I expect to see the growth of solar cells through current mainstream technologies (crystalline silicon/thick film system, thin film system, modified crystalline/thick film system) at an impressive rate of 35 to 45%. The number is not a certainty, but the upward trend is clear.

Electronics Industry in China

Back in 1997, I wrote a sketch of the electronics industry in China. Excerpts: "… China is poised for the speedy development of the electronics industry… With all the challenges and developments, one thing that could not be ignored is the market power of the world's most populous country. … For electronics industry, opportunities in this burgeoning market are abundant." From 1999, excerpts from my "Evolution of SMT Manufacturing in Southern China" article: "… Today's Chinese engineers and technicians are well positioned for working with SMT manufacturing"… China market will continue to grow throughout the electronic hierarchy and become the global manufacturing center. With its internal market size, export capacity, low-cost labor and entrepreneurial zeal, China will be the bright spot…" Today, China is recognized and functioning as the manufacturing center of electronics hardware.

In the Chinese Zodiac, the year 2011 is the year of rabbit: Auspicious, calm, prudent, doing things slowly, deliberately and cautiously. I see China making an effort to shift toward a more consumption-oriented economy, albeit gradually and very slowly. This shift should further expand the demands of electronic products for all industry sectors, be it automotive, smartphone or industrial equipment, which should benefit all multinational companies doing business in China.

Semiconductor IC Packaging



In 2011, the semiconductor integrated circuit (IC) in unit shipment is expected to rise amid the up-swing cycle.

As ICs move into 22 nm or below, one natural question is: What are the viable approaches to make the next level of connections to reach the outside world? High-density packages, including 3-D packages and system-in-package (SIP), become necessary alternatives. Comparing SIP with 3-D, SIP offers density and functionality advantages, yet poses higher cost, longer time to market, testability challenges and lower yield. In the near term, 3-D is expected to be a practical choice. In 3-D packages, through-silicon-via (TSV) is advancing at a full speed. Stacking packages, known as package-on-package (PoP), deliver an assured alternative by avoiding the known-good-die problem and test challenges. PoP can also offer design versatility and accommodate different device types.

Continued market demand in the miniaturization of hand-held electronics further drives the lighter, smaller and lower-profile components. A family of bottom-termination components (BTC), such as QFNs, SONs, LGAs, MLFs and MLPs, serves the purpose.

This year will be fruitful for PoP and

"small" BTC packages. On the semiconductor IC level, sub-threshold IC technology, with 300mV (to operate), will lead to new classes of portable devices designed to take advantage of greater battery life, which, in turn, will drive popularity. New developments of packaging substrate to deliver heat stability and high pin count capability are in the works.

In selecting the IC packages, the ultimate practice is the tradeoffs of functionality, reliability and cost, leading to the increased use of these 3-D and BTC packages. This will push challenges to the board-level manufacturing in process, equipment and materials of the SMT industry.

SMT Manufacturing

What challenges lie ahead for the SMT manufacturing sector? The broad answer is to produce, at a competitive and acceptable cost, the quality, reliable products regardless of industry sectors—automotive, consumer, industrial, telecommunication, computer, medical and military, alike.

Specifically, attention goes to the following demands:

- Process, materials to accommodate 3-D packages and small components;
- Component compatibility with process conditions, especially reflow temperature;
- PCB compatibility with reflow temperature;
- Lead-free solder joint reliability;
- Solder paste performance; and
- "Accessories" (stencils, squeegees, printing techniques, printers, etc.) in applying solder paste to boost performance.

Such demands lead to the following topics are covered by my workshops on PoP and BTC Assembly: Material, Process and Reliability and Preventing Production defects and Failures at IPC APEX Expo, April 10-11, 2011.

One important point: To achieve high-yield/low-defect manufacturing, a low-cost, proper process window is mandatory, a narrow process window is bound for high defects at best.

PCB Characteristics and Performance

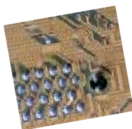
The most critical property of PCBs is heat tolerance under the higher manufacturing temperature imposed by a reflow process using an SAC solder paste. Although a PCB possessing a higher glass transition temperature (Tg) is readily available, Tg, per se, does not represent the PCB's heat tolerance ability. Other properties, such as thermal decomposition temperature, thermal expansion over a temperature range, out of plane and in-plane thermal expansion and moisture absorption all contribute to the overall performance, i.e. internal structure integrity.

In reality, there is no single characteristic that is sufficient to attest to the performance. The fabrication techniques and process control also affect the properties and performance.

A PCB's vulnerability to the higher reflow temperature cannot be underestimated, increasing with the level of its complexity (thickness, number of layers, number of ground planes, Cu weight). It should be noted that almost all potential problematic areas (delamination, blistering, thru-hole barrel crack, Cu-pad lifting, Cu dissolution, electroless Cu separates from the post, electrolytic Cu separates from electroless Cu, pad cratering) are associated with the assembly process temperature, either induced or aggravated by a higher temperature.

In 2011, keeping the PCB's structural integrity in check is essential; and newer surface finishes are expected to provide a safeguard to the mitigation of common surface finish-induced or interface-related problems.

Solder Paste Performance



To properly assemble a PCB designed with conventional packages (QFPs, SOICs BGAs, CSPs, etc.) as well as the newer packages (BTCs, PoPs) and smaller passives (201, 01005), a higher level of performance in solder paste is needed. Namely:

- Ability to accommodate finer solder powder particles in terms of fluxing and stability;
- Printability (Note: Using coarse powder particles is feasible as a safe practice.);
- Dipping ability;
- Solderability without solder balls; and
- Consistency.

The above topics are discussed in my SMT Online article Role of Solder Paste in the New Decade of Packaging and Assembly and subsequent publications.

Lead-Free and Solder Joint Reliability

Three missions have yet to be accomplished.

In 1998, the very first lead-free electronic gadget was introduced to market, which complied with the anticipated RoHS legislation. By now, consumer lead-free electronics has a 12-year service record. How is its track record? Actually, it's not bad, considering that the dynamics of the industry propelled relentless changes in design and components and that millions of products have been put into use. However, the high-reliability product, particularly to serve under extreme and harsh environments, is yet to come.

Overall, the industry has been long in generating reliability test results, but short on "what it takes to have a high-performing lead-free alloy." A solder joint cannot outperform the maximum intrinsic performance of a solder alloy, thus reliability comes from a "robust" solder alloy.

Within the SAC system, the current performance is as good as you can get. Having high reliability in mind, the true reliability improvements will have to go outside the SAC ternary system. The "core values" and "deep" metallurgy, including dislocation theory, microstructure, and strengthening and failure modes, must come into play. And we have to resort to that old cliché: Innovate and work "out of the box" for sweepingly better performance. Simply put, quaternary or higher alloy system is necessary. The substantive guiding principles, which are not reiterated herein, were covered in one of my books: Environment-Friendly Electronics—Lead Free Technology.

Secondly, high-temperature solder alloys that are equivalent to the SnPb system containing more than 89% Pb with balanced Sn are needed. This is a technically challenging task,in the sense that the alloy must possess the combined performance features: high melting temperature (specifically, liquidus above 290°C and solidus not below 260°C), adequate strength, proper ductility and the absence of multiple phase transitions. The modifications of the SnAgCu system and similar approaches will not accomplish the goal.

Thirdly, a lead-free counterpart in low temperature applications, meaning a process temperature below 180°C, is required for temperature-sensitive or thermal-shock vulnerable applications, such as soldering on the metalized glass or ceramic substrates. This will be discussed separately.

Further, the medium-temp, but lower reflow process temperature than what is currently being adopted using SnAgCu solder paste in SMT reflow is desirable or required in some applications. To accomplish this, solder alloy's melting temperature should be lower than 210°C, rendering the process temperature close to that of SnPb eutectic process (the high end of peak temperature range ~ 230°C). These alloys are available at a higher cost in $/kg.

Will all three systems be accomplished in 2011? Here is my anticipation: Yes for the low-temp applications; not quite ready for the high-temp applications.

Environmentally-Friendly Manufacturing

Environmentally-friendly production from cradle-to-grave will continue to gain momentum in 2011. Within the electronics industry, the share of lead-free products will increase at the expense of leaded counterpart, and the halogen-free PCBs will advance in technology.

There will be more products to comply with RoHS or to get closer to it. However, is 2011 the year to bring all electronics to be in RoHS compliance? The answer is not yet.

The environmental stewardship for global sustainability, an important corporate business policy, will take the center stage. SMT

About the Author: Dr. Hwang, a pioneer and long-standing contributor to SMT manufacturing since its inception as well as to the lead-free development, has helped improve production yield and solved challenging reliability issues. Among her many awards and honors, she has been inducted into the WIT International Hall of Fame, elected to the National Academy of Engineering and named an R&D-Stars-to-Watch. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, IEM Corp., she is currently CEO of H-Technologies Group providing business, technology and manufacturing solutions. She is a member of the U.S. Commerce Department's Export Council, and serves on the board of Fortune 500 NYSE companies and civic and university boards. She is the author of 300+ publications and several textbooks, and an international speaker and author on trade, business, education and social issues. Contact her at (216) 577-3284; e-mail JennieHwang@aol.com.

ZESTRON Enjoys Record Revenue in 2010

At a recent company event, Dr. Harald Wack, President of ZESTRON, a global leader in high-precision cleaning products and services for the electronics manufacturing industry, announced that 2010 proved to be the most successful year in the company's history.

"Even though the economy has been slow to recover, we have had an excellent year," said Wack. "The careful investments we have made in building a globally linked corporate infrastructure as well as our innovative product technologies are obviously meeting our customers' demands. Looking ahead, we are extremely optimistic and excited about the further expansion of our superior product line, exceptional services, world class technical support and global technical centers."

ZESTRON embraced the beginning of 2010 by announcing a comprehensive "Global Link" initiative. With a global key account management program; fully functional state-of-the-art Technical Centers in the U.S., Europe, China and Malaysia; an upgraded, secure and worldwide linked database system; and a high-definition video teleconferencing system, ZESTRON's goal was to create a borderless environment, enabling customers to receive faster and more effective assistance with their precision cleaning challenges as well as access to the company's global engineering knowledge base.

"These investments have paid large dividends as ZESTRON was able to substantially expand its current customer base and add a number of new applications in 2010," says Sal Sparacino, Technical Marketing Manager, ZESTRON.

For additional information, visit http://www.zestron.com.