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10X Thinking: The Deca Technologies Story

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In a report issued by KPMG, the Global Semiconductor Alliance and the Consumer Electronics Association, survey results revealed that two-thirds of integrated circuit (IC) manufacturers currently expect to derive 80% of their revenue from consumer electronics in the next five years. However, the report also showed that new consumer products themselves achieve a faster time-to-market than the IC devices required for them to function. As such, IC manufacturers must find new ways to design, fabricate and deliver products faster, and at a competitive price.

Deca Technologies introduced a breakthrough solution to these challenges in November 2011 with a new approach inspired by SunPower Corporation's unique solar wafer fabrication methods. Founded upon 10X thinking, Deca strives to deliver the industry an order-of-magnitude cycle time reduction for new products, unprecedented flexibility in design and manufacturing as well as leadership, and cost-of-ownership (CoO).

Oftentimes, inspiration for innovation comes within the very same market that the ultimate innovation is to serve. There are those rare occasions, however, where innovation is a result of a perceived opportunity to straddle two different markets, resulting in a capability that could be considered highly disruptive. Such is the case with Deca Technologies, whose wafer-level chip-scale packages (WLCSP) and associated product roadmap demonstrate a unique approach that offers customers a leap in capabilities as compared with the incumbent suppliers.

The Back Story

Deca Technologies foundations come from SunPower Corp. (NASDAQ:SPWR), a solar technology and energy services provider, and from Cypress Semiconductor, a provider of programmable system-on-chip solutions. Deca's founder, Tim Olson noted that the approach being developed by SunPower to manufacture highyielding, high-volume, cost-effective solar cells that met the market needs of the solar industry could be adapted to address many of the constraints and barriers the semiconductor wafer-level packaging industry was facing. There was not only an opportunity to resolve the fundamental challenges, but of doing so in a highly disruptive fashion. Deca's 10X mindset, coined from the Greek term for ten ("deca"), permeates the organization with an inherent dissatisfaction for the status quo.

The 10X Approach

Until now, Deca has fostered a conservative approach to sharing exactly how it achieves 10X thinking. However, as the processes reach maturity and volume production is now ramping, Deca is now divulging aspects that provide its unique capability.

As previously mentioned, Deca's approach to semiconductor manufacturing draws inspiration from SunPower's processes for solar cell fabrication, which operates at throughputs above 1 million wafers per day. While a staggering volume in semiconductor terms, the high throughput is a direct result of SunPower's success in combining a unique approach in solar cell design with a highly efficient wafer manufacturing operation. SunPower has been able meet the costreduction needs of the solar market, which has seen a

dramatic decline in average selling price over the past several years, the likes of which the semiconductor industry has never seen.

Several of SunPower's process steps, operational methodologies and supplier strategies have been replicated in Deca's approach. A key enabler of the 10X capability in cycle-time reduction has been the development of the world's first WLCSP autoline, inspired by the assembly autolines in Cypress Semiconductor's manufacturing operations.

Deca's autoline manufactures in wafer-level flow-line fashion through most steps, as opposed to the more traditional wafer fab batch-based processing, thereby eliminating a significant amount of wafer wait time. Rather than manage each of a multitude of process steps together as a batch, wafers move through the line continuously and sequentially. Automation between each step enables a traditional wafer lot to be running through multiple sequential manufacturing processes simultaneously, enabling a 10X cycle time improvement over typical industry competitors. While most companies experience a 12- to 15-day cycle time for processing wafers, Deca's autoline has the capability of ultimately achieving cycle times of less than 24 hours.

In line with its disruptive thinking, Deca strove to look outside of the traditional semiconductor capital equipment vendors to create this unique approach. Deca recognized that attempting to achieve 10X thinking by adapting processes using standard equipment would be counterproductive. The company has worked with equipment partners to develop differentiated tools that perform the required process steps at significantly lower cost of capital and CoO. A photo of Deca's unique autoline wafer-level electroplating process is shown in Figure 1.

Figure 1: Deca's Wafer-Level Autoline Plating System



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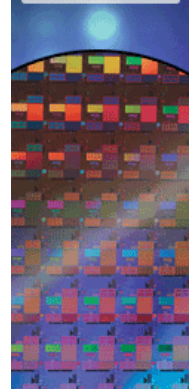
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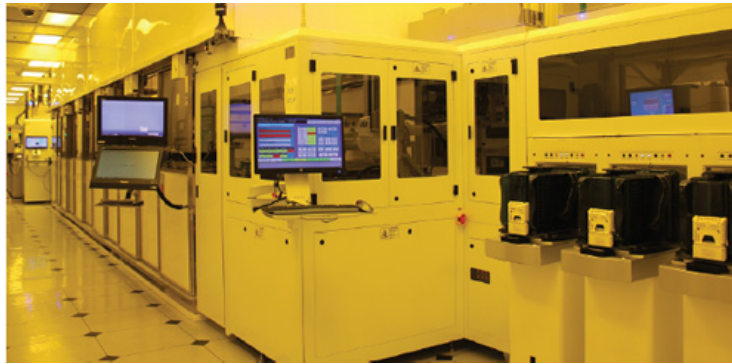
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Another key enabler of 10X thinking is Deca's radical approach to patterning. For many years, the industry has relied on traditional glass photo masks within the patterning process. While highly capable, photo masks take days to produce, are expensive, inflexible, and customers' semiconductor design changes demand that new masks be procured for each design. Deca broke through this barrier and created an approach that does not rely upon glass masks. Design completion to process-start is now measured in hours. These new capabilities are key in Deca's goal to deliver breakthrough cycle time, flexibility and CoO to the industry.

Deca's Roadmap

Deca's technology spans interconnect levels from chip to package to system. Its first product is a fan-in WLCSP available in a variety of configurations.

Extending beyond fan-in WLCSP, Deca saw an opportunity to further leverage its unique process capability in plating and patterning to resolve major challenges the industry faced with fanout wafer-level packaging (FOWLP). One of the acknowledged limitations of fan-in WLCSP is that the balls in the ball grid array (BGA) array must sit within the size of the IC. Consistently, the industry trend has been to reduce die size; meanwhile, I/O count is increasing, as added functionality is often integrated within the device. One approach to address this challenge is to reduce the ball pitch. Today the handset and tablet markets are comfortable using 0.4mm pitch BGA packages, and in some cases, slightly finer pitch. However, significant pitch reductions are not foreseen in the near future due to industry infrastructure limitations and cost concerns. FOWLP provides an approach whereby a plastic perimeter is created around the silicon, effectively increasing the available area for the IC, while not using valuable silicon to achieve the real estate increase. To accomplish this, the ICs are singulated and repopulated into a new wafer or panel format, with additional spacing between ICs prior to molding. With this approach, a "semi-plastic" wafer or panel is created that can then be processed through the wafer fab manufacturing process.

Deca has introduced our M-Series™ fan-out approach that brings several innovations to the field. M-Series is a fully molded CSP or BGA positioned to offer the electrical and thermal benefits of flipchip CSP with the smallest-possible form factor and at a cost that is competitive with entry-level BGAs (Figure 2). Interest for M-Series is high, from several leading semiconductor suppliers to the wireless handset industry.

Figure 2: M-Series Fan-out Approach



M-Series features Deca's revolutionary and proprietary Adaptive Patterning™, a process that was developed to overcome the die-shift problem, resulting in both higher interconnect yield and higher die-attach throughput. It works through optical inspection of die position combined with design and patterning processes that dynamically adjust a portion of the redistribution layer pattern or alignment to accurately interconnect each die on the panel. Future product introductions will see Deca's wafer-level processing capabilities applied to the industry's desire for cost-effective Si interposer technologies.

Conclusion

Deca Technologies has delivered a disruptive approach to the industry for WLP through its 10X thinking. Traditional barriers of long cycle times, inflexible manufacturing infrastructure and declining opportunities for cost reduction have given way to new capabilities that will enable new performance levels. Deca anticipates significant growth in 2014 and beyond as it continues to rapidly scale production capacity across a growing customer base.

About the Author

Garry Pycroft has been the Vice President of Sales & Marketing since April 2011. Prior to joining Deca Technologies Mr. Pycroft was Senior Vice President of Amkor Technology for Strategic Business Development, where he managed a team looking to penetrate new market segments for the company. Prior to this responsibility Mr. Pycroft was Vice President of Strategic accounts in Europe with a particular focus on the OEM development. Before joining Amkor in 1993 Mr. Pycroft was a regional sales manager within the UK for Kulicke & Soffa, a provider of capital equipment to the semiconductor assembly market.

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