



insights

Advanced Packaging

Ralph Zoberbier, Head of BU Advanced Packaging answers questions on the role of the industry going forward, the challenges it faces and how Evatec can contribute.

Q. You had already spent 20 years in Advanced Packaging when you joined Evatec at the end of 2019. It looks like you plan to stay in this industry for many more years. What makes you so excited about the industry and its technologies?

Advanced Packaging was introduced and established in the supply chain of electronics as a key enabler for next generation devices since its early days.

I started my career around 20 years ago when C4 bumping and Wafer Level Packaging were just being rolled out into high volume manufacturing for leading edge applications like the SONY PlayStation 2, both on ICs and Memory. Ever since then, Advanced Packaging technologies were supporting the never ending trends for smaller, lighter, thinner and more powerful devices. Mobile phones, and the transition into smartphones as we know them today, were only possible with the implementation of Advanced Packaging technologies on mission critical chips. However, Advanced Packaging always followed the front-end technology roadmap and Moore's Law. What really excites me however is that as front-end technology enhancements become more and more limited and extremely costly, Advanced Packaging really turned into a true enabling technology to shape our future.

Functionality and complexity is transferred from the chip into the package, which is no longer now a single chip package but rather a complete system in package, that delivers outstanding performance at reasonable costs. What could be more exciting than working with our passionate engineers, customers and industry partners on new technologies that support the mega trends of our century and help create new artificial intelligence, data storage concepts and greater computing power.

Q. What are the key market trends that drive innovation in Advanced Packaging technologies?

Mega trends are powerful, transformative forces that impact or even change the global economy, business and society. I believe the key trends that most impact Advanced Packaging are seen in areas like connectivity, health, safety, globalization and mobility. In all cases new improved electronic devices are needed to make the next step forward.

One of the key driving forces is certainly the implementation of 5G as a new communication standard. New infrastructure and the development of compatible next generation smartphones will be needed that support high volume data streams and higher communication speeds. Even in the challenging year of 2020 with its global pandemic, preparations of the supply chain continued full steam ahead and new manufacturing lines were established. Smartphone demand is expected to get back to pre pandemic levels in 2021 and beyond fueling the demand for Advanced Packaging.

New technologies in the automotive area will also drive semiconductor and its packaging applications. Smart automobiles are already a reality that support autonomous driving and other driver assisted features. The global push to electrical cars is another good example. One can easily see that the silicon content of cars is growing continuously with increasing demand for computing power and data storage, coupled with the most demanding requirements for electronics reliability and strong energy savings.

Last but not least, mega trends are fostering developments of new applications and products in areas like Artificial Intelligence, Internet of Things and Cloud Computing. Those applications have in common that they generate a great amount of data that needs to be computed and processed in real time and in parallel. This typically requires high speed data storage and transfer with the highest computing power. New chip designs and new system in package concepts support those requirements. Especially in those areas, new front-end nodes like 5nm and 3nm go hand in hand with new heterogenous integration technologies like Chiplets and SiP. Huge growth in demand in this Advanced Packaging segment is expected over the next 3-5 years.

Key market trends that drive innovation in Advanced Packaging technologies

Next Gen Smartphones Minutization & 5G



- Application processor SoC from 10nm to 7nm technology with first adoption of fan-out technology (InFo) vs. laminate substrate
- Drives continuous adoption of WLP, FOWLP & System in Package (SiP)
- 5G will require more complex & multifunctional RF modules

Automotive Electrification & AV



- Increasing SC content for Autonomy, Electrification & Connectivity
- Radar, Microcontrollers & Analog applications will require packaging developments for increased density, higher frequency, higher power & EMI shielding

High performance Computing High density interconnect & heterogenous integration



- 5G, AI-Big Data drive technology development and market introduction of Chiplets
- Robotics, transportation, healthcare
- Strong demand for HBM integration

Q. Where do you see the technology going and what is Evatec's vision in Advanced Packaging?

Let me focus on the three most important technology segments that we believe are driving developments and new products.

WLCSP & Fan-out (WLP & PLP)

- Wide adoption for PMIC and RF
- New potential for high-density Fan-out for APs and heterogeneous integration (CPU, memory)
- Push to FOPLP as supporter of cost reduction roadmap and heterogeneous integration
- Panel sizes up to 600mm x 600mm

Heterogeneous integration

- Si interposer adoption with TSVs
- Bump pitch reduction down to 10µm
- High-density substrate technology
- Fine line RDL
- High frequency, high signal integrity
- Separation of data and power lines
- Backside metal for advanced heat dissipation

Advanced IC substrates (including embedded die packaging)

- Fine line interconnects with roadmap to 2µm L/S in 2022
- Embedded die technologies
- FO on substrate / RDL interposer
- Panel sizes typically 510mm x 515mm
- PVD becomes crucial to support roadmap as chemical Cu alternative

Fan-out wafer level packaging (FOWLP) was introduced in the market around 10 years ago and was designed to provide better form factors, thermal and electrical performance and to increase the number of contacts without increasing die sizes. The adoption of FOWLP is still gaining momentum, and we currently see three trends that drive the technology at its core:

- New applications like Application Processors or Multi Die Packages require multi layer RDL, high density FO interconnects with features sizes down to 2µm L/S. New passivation materials and manufacturing technologies are required to support this trend.
- Secondly, the transition from wafer level to panel level processing is a fundamental change for Fan-out technology. Mounting pressure for cost reduction combined with increasing package dimensions are the key reasons that panel processing has been under investigation for some time by the packaging industry and its finally now coming to market. This requires panel capable process solutions and equipment which did not exist in the industry until now.
- Last but not least, Fan-out with its capability to combine multiple chips in one molded package is a key enabler to realize heterogeneous packages without costly TSV and interposer technologies. Thin film RDL are manufactured on substrates, either wafer or panel scale. Known good dies are attached on this layer and finally molded to create the final package.

Heterogeneous integration itself is another area that gains a lot of traction. It refers to the integration of separately manufactured components into a higher-level assembly. Under this theme, a wide range of different package designs and technology combinations are used to create high performance system solutions on a package level. This can include variations of Fan-out packaging, micro bumping, TSV, glass interposer and RDL interposer technologies. Many

different manufacturing technologies play a significant role, most importantly die to die, wafer to wafer bonding and hybrid bonding to build the system. Additional enhanced back side metal layers are needed as effective heat dissipation layers for the systems. Each of the packaging techniques bring its own requirements and challenges while the true complexity comes from their combination.

Finally, I see new requirements in substrate technology such as fine line features and the integration of embedded components as a key trend that impacts Advanced Packaging. New complexity and functionality are being embedded into the substrate like interconnect bridges between different chips, i.e. a GPU and memory chips. In this way the substrate itself becomes a true technology piece of the overall package and component. These new requirements drive the adoption of non PCB manufacturing technologies like PVD and enhanced lithography solutions on a panel scale. OSATs and substrate contract manufacturers have recognized this new business opportunity and are fighting for their position in the market.

Evatec aims to be one of the leading equipment and process solutions in thin film deposition and is supporting our customers and partners in these exciting segments with leading edge technology, both on wafer and panel level. We believe that new levels of performance in regard to Rc performance, particle count, handling capability and productivity will help to bring new products to the market quickly. Tailored solutions for each application are needed to fully meet our customers' needs and expectations. Besides technology, effective customer support with strong local service organizations including application and process support are key focus areas in which we continuously want to extend and improve our performance... and yes, we want to be a selected partner in each high-end packaging fab.

Q. What do you see as the biggest challenges faced by the Advanced Packaging industry in the next 5 years? How can Evatec play its part in solving them?

We clearly can see that Advanced Packaging is changing gears from a rather cost and formfactor driven technology to a real technology enabler. For decades, device manufacturers introduced higher performance products based on higher transistor density technology. However, this became more and more complex and costly, so packaging offers a solid alternative to bring complexity and functionality from the chip into the package. This pushes manufacturing technologies to a new level. Bump pitches will move to 20 or 10µm on leading edge products, package sizes will increase significantly, and different material compositions will have to match to name just a few. This means that the supply chain, and especially equipment manufacturers, have to bring up new models that are rather "front-end like" tools at reasonable cost levels. As recently presented by INTEL at one of the leading industry conferences, panel based packaging

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is becoming a real "must have" and it's only a matter of time. Evatec is focused on key developments to provide the industry with highly reliable tools that meet particle specs and uniformities and are compatible with different materials and substrates. With our newly developed panel platform, we are ready today to help customers get their new lines up and running quickly.

In addition, I strongly believe that the right support infrastructure and Business Unit setup is crucial to meet the industry's expectations for quick and efficient support. The magic word is "Globalization". We are building up very strong local teams in our sales and service organizations to serve our customers with quick responses and solid process know-how. We also established a strong global team that shares information and comes up with solutions as quick as possible. The headquarters and the dedicated Evatec Competence Lab (ECL) focus on core technology and product development and is equipped with latest equipment generations to support development, sample requests and small volume manufacturing. All in all, I believe that Evatec is well prepared, especially in the key areas like FOWLP, Heterogeneous Integration and Panel Level Packaging.

Q. What are the latest achievements that you want to share with us and what can we expect from Evatec Advanced Packaging Business Unit in 2021?

2020 was a very special year for all of us. The global pandemic was a clear low light in many regards. However, the Advanced Packaging Business Unit can look back to a very successful and positive year. Based on our flagship product, the HEXAGON, we could gain quite some market share in Flipchip and Fan-out applications at our key target customers. The first installations of the panel cluster tools in pilot production lines were a key milestone for the company but also the industry. I am excited to see this becoming a game changer in the packaging industry and I am happy that our company is an important part of this technology. In 2021 we have solid plans to launch new product generations to support our customers in the area of HD Fan-out, Heterogeneous Integration and Next Gen IC substrates. There has never been a more exciting time to be in the packaging industry.