

Future of Embedding and Fanout Packaging Technologies

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All the packaging technologies can be classified into four types: 1) Wafer-level Packaging, 2) Embedded Packaging, 3) Fan-out Packaging, and 4) Embedded and Fan-out Packaging. Wafer-level Packaging (WLP) is an approach that starts with ICs and builds package wiring in the wafer fab by simply redistributing the BEOL I/Os and placing bumps. This WLP is a single unit with a continuum of interconnections from transistors to BEOL to RDL to bumps. It is a chip-scale package with chip and package sizes nearly the same. This is the best package electrically. But it is limited to small ICs and to small packages, typically below 5mm. As such, it is limited in external I/Os to connect to the board, typically at 400 microns and above in pitch.

To eliminate this I/O limitation issue, fan-out technology was initially developed in 1980s by GE followed by many others including Intel, Freescale and more recently further developed into production by Infineon. But this technology is not a wafer-level packaging, as the above. It is not a continuum of transistors to bumps. While it addresses the I/O limitation, it is also an embedded packaging technology to reduce package thickness and improve interconnect performance. It is an embedded fan-out technology with many great packaging attributes such as not requiring assembly, since the wiring is deposited directly on the face of the ICs with shortest interconnections between ICs and the RDL wiring layers. Many IC companies refer to it as wafer fan-out, since it is made of reconstituted ICs to form the wafer and since it is processed as round wafers. There are many variations of this by IC companies such as TSMC using wafer BEOL tools and by OSATs using packaging tools and processes. This technology, however, has three strategic limitations: 1) high cost for larger packages, 2) molding compound-driven limitations in lithography, and 3) board-level reliability. Many of these are being addressed and improved by emerging Panel Fan-out and Embedding Technologies, currently in organic or laminate technologies and in future in inorganic technologies

This presentation will describe the historical evolution and future of embedding and fan-out technologies.