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Dr. Ken Gilleo

What Quiet Packaging Revolution?

The drive for low-cost packages is pushing thermoplastics into the mainstream.

Electronic packaging is a hot technology topic that is evolving and unfolding ever faster as we follow our roadmap to three-dimensional (3-D) stacked designs and wafer-level package (WLP) processes. Quiet might not seem appropriate to describe the fanfare accompanying the latest multichip package (MCP) and WLP technologies. But what about the new materials for these breakthrough packages?

Building on the Basics

While many new materials exist, epoxies—used for nearly 50 years as encapsulants and later in chip carriers—are still found in most new packages. And polyimide (PI) film is still the preferred material for flex-based packaging, including 3-D fold-over designs.

Thermoset polymers, typified by epoxy molding compound (EMC), were the obvious choice way back when plastic packaging was being developed. Once processed, it did not melt and was strong, but it was non-hermetic. Nevertheless, chip passivation permitted most devices to work well enough for plastic encapsulated microelectronics (PEM) to succeed.

The Emergence of Thermoplastics

Today's thermoplastics, the other major class of polymers, are now superior to EMCs in critical categories. They can take the abuse of lead-free soldering, have better moisture resistance, are rapidly shaped into precise 3-D structures and are halogen free.

The thermoplastic shaping processes have also kept pace. Injection molding (IM) can produce tens of thousands of packages in an hour. IM also readily produces complex 3-D cavity-style package structures. It can form a strip or array of cavity ball grid array (BGA) packages at high volume and low cost using economical engineering plastics like liquid crystal polymer (LCP), the popular new flexible circuitry substrate.

The ABCs of Injection Molding

The IM process first liquefies plastic resin, injects it into a metal mold that may have 100 or more package-shaped cavities and then ejects finished parts. The cycle is repeated. A complete IM cycle for BGAs takes less than 10 seconds. The hot molten plastic is quickly

cooled by the mold to form a tough, solid part that will not melt during soldering. IM, one of the most pervasive manufacturing processes, is used around the world to produce large and small parts for every industry, including automotive and electronics.

The perfect storm of change has moved across the packaging landscape to thrust thermoplastics into the mainstream. Thermoplastics are cheap, environmentally friendly and boast near-hermetic properties far superior to non-hermetic epoxies. But the critical need for lower cost cavity packages is the catalyst.

Microelectromechanical systems (MEMS), micro-optoelectromechanical systems (MOEMS), radio frequency (RF) and optoelectronics (OE) have created an ever-increasing demand for low-cost, free-space enclosures best satisfied by modern thermoplastics. This quiet packaging revolution is being carried out by startups and other small companies, which is why it has been whispering along.

A Sample Package

One simple design, called *low ball*, insert-molds non-fusible metal balls into the plastic BGA package while it is being formed. The metal balls, captured in the plastic, protrude through the package floor for chip connection. The bottom of each ball extends through the plastic to the outside of the package base to enable assembly to a printed wiring board (PWB). Each tiny ball thus serves as both the first- and second-level interconnect. Nothing can be simpler. Low ball could be the world's lowest cost cavity BGA. The complete package can be produced automatically in a single machine—a modified injection molding press.

Low ball is just one of many thermoplastic packages under development. Another design, Flip2Stack, is intended for multiple die configured in planar and stacked configurations. The packages can be made stackable with interconnects on the bottom and top.

Thermoplastics and the injection molding process offer simplification, precision and sophistication. So keep listening for the quiet revolution and the inevitable drum roll. ■

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