Over the years, permanent wafer bonding has been a game changer for several applications in the semiconductor world. In radio-frequency (RF) applications, MEMS, and even for CMOS image sensors (CIS), it has reduced the surface area occupied and improved performance hugely. But depending on the application or the goal of the Original Equipment Manufacturers (OEMs), the technology can differ. For example, wafer bonding processes is used to reduce system footprints and signal losses by coupling the MEMS area with the application-specific integrated circuit (ASIC) controller. In this report, we will go through the main permanent wafer bonding technologies to see the pros and the cons of each.

Among these technologies, we have identified two main groups. One, bonding wafers without intermediate layers, includes fusion, copper-copper hybrid and anodic bonding approaches. The second group involves bonding wafers with intermediate layers using an insulator like a glass frit, or a metal in eutectic and thermocompression approaches. In this report, we show examples of each wafer bonding approach in different applications. We analyze and compare each wafer bonding process type to show the benefit in terms of cost and space used.

By switching from glass frit bonding to metal bonding thermo-compression, a manufacturer could reduce component area by up to 30%, reclaiming lost space around the active surface and cutting cost. However, some bonding technologies are currently used only in some market segments. For example, hybrid copper-copper bonding is only used in CIS and glass frit technology is found only in products in automotive and some consumer MEMS applications.

In the comparison, we have analyzed each component’s wafer bonding process, including component dimensions, cost and manufacturing approach. We provide an overview of technology costs and manufacturer choices by application and range. We offer buyers and device manufacturers a unique possibility of understanding permanent wafer bonding technology, evolution, and comparing process costs.
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