

PACKAGE SINGULATION PROCESSES

By Dr Ramon J. Albalak

THE GROWING VARIETY AND COMPLEXITY OF MATRIX ARRAY PACKAGES PRESENT A TRUE CHALLENGE TO MANY BACK-END PROCESSES. THE SINGULATION OF THESE ARRAYS INTO INDIVIDUAL PACKAGES IS AN IMPORTANT STEP IN THE MANUFACTURING PROCESS, AND AS IN MANY CASES, NEEDS TO BE OPTIMISED TO MINIMISE THE OVERALL COST OF THE PACKAGE.

The continuous reduction in package size, along with the uncompromising demand for increased throughput without sacrificing cut quality, has resulted in a shift from shearing/punching techniques to dicing processes for many matrix array packages. The decrease in package size also affects downstream pick-and-place integration - an issue beyond the scope of this article. The trends in package singulation are expected to have a significant impact on the Chinese industry, with assembly lines, including many independent packaging foundries (IPFs) relocating from around the world to China.

Leaning on three decades of experience in dicing, Advanced Dicing Technologies (ADT) has developed specific processes for its customers who are faced with the task of dicing such diverse packages as low temperature co-fired ceramic (LTCC) packaging of surface acoustic wave (SAW) devices, wafer level chip scale package (CSP) for image sensor packaging, and a multitude of different ball grid array (BGA) and quad frame no-lead (QFN) packages.

QFN presents an excellent example of a complex substrate composed of both ductile (copper) and brittle (plastic moulding) materials, showing clear trends of reduction in package size and continuous tightening of cut quality specifications. The worldwide demand for QFN is in the order of one billion units a year, with a predicted annual increase of 20-30 percent. Part of this increase will be at the expense of other packages such as small outline integrated circuits (SOICs).

Advanced Dicing Technologies has identified QFN as a package with enormous potential, and has dedicated significant resources over the past three years to providing its customers with a total dicing process solution to satisfy their needs. The following section presents some of the main findings and developments to date of this ongoing programme.

DICING QFN

As stated above, QFN is a composite material, and the dicing process needs to address a combination of brittle and ductile materials that interact very differently with the dicing blade. The main quality issue associated with the brittle moulding is chipping along the edges of the diced kerf, whereas the quality issues related to the copper components stem from smearing of the ductile copper and the formation of burrs. The current customer specification for chipping of the moulding is in the order of 50 microns, although this number is expected to decrease in the future. 50 microns is also the upper limit for the formation of copper burrs that may protrude from the leads in the dicing direction ('x-burrs') or in either of the two perpendicular directions ('y-burrs' and 'z-burrs'). A generally acceptable measure of smearing between leads is 25 percent of the lead-to-lead distance. Our expectation is to see tightening of both the burr and smearing specifications in the future. Figure 1 shows two micrographs that demonstrate variations in cut quality on two diced samples of QFN.



Figure 1: Micrographs of the cross sections of diced QFN samples demonstrating variations in cut quality. Left - cut quality within specifications; Right - large burrs and extensive smearing of leads



Most blades used to dice QFN throughout the industry today are based upon a resinoid binder, although both nickel and metal sintered blades may be successfully used in specific cases.



Two major factors having a direct impact on the process-related expenses are units per hour (UPH) and blade consumption, which need to be balanced carefully to minimise the cost of the product. The direct implementation of UPH in the dicing process is the feed rate at which the dicing blade progresses through the substrate. Typical feed rates in the industry today range from 20 to 70 mm/s. On one hand, high feed rates tend to reduce cut quality and increase blade wear, thus leading to an undesired growth in blade consumption. On the other hand, low feed rates may reduce blade consumption and preserve cut quality, but result in unacceptable throughputs. Most blades used to dice QFN throughout the industry today are based upon a resinoid binder, although both nickel and metal sintered blades may be successfully used in specific cases. Typical wear rates for resinoid blades may reach several tens of microns of blade radius per meter of diced substrate, depending on the process parameters and substrate being diced. Using a single flange, the obtainable blade life may reach a few hundred meters of diced substrate.

Our research and development over the past three years has resulted in precise and calculated modification of the resinoid binder, enabling us to significantly extend blade life while maintaining cut quality within specifications. These improved blades, offered exclusively by ADT specifically for dicing QFN, are known as the E-Series. The increase in blade life obtained over the years through our research program is demonstrated in Figure 2.

Further improvement in cut quality, mainly in the extent of lead-smearing, and reduction of blade wear may be achieved by use of a chilled coolant additive as an alternative to water. The dicing process developed by ADT uses a 5-10% solution of additive that is chilled to 8°C and circulated through the dicing saw by means of a separate closed loop filtration system. The dramatic effect that use of the chilled coolant additive has on both cut quality and blade-wear can be seen in Figure 3.

The QFN Dicing Program is starting its fourth year at Advanced Dicing Technologies (ADT), and along with our customers, we are increasing our demands from the dicing process. As part of our ongoing task of supplying our customers with a total dicing solution, our current goal is to dice all types of QFN at a feed rate of up to 100 mm/s and to achieve blade life of 1,500 meters using a single flange. ■

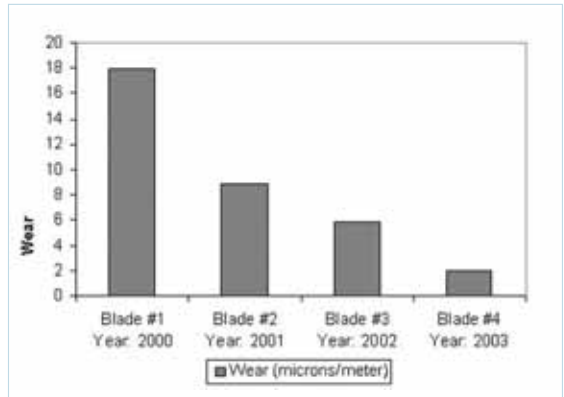


Figure 3: Comparison between lead-smearing and blade-wear for dicing with tap water at room temperature and for dicing using a chilled coolant additive at 8°C

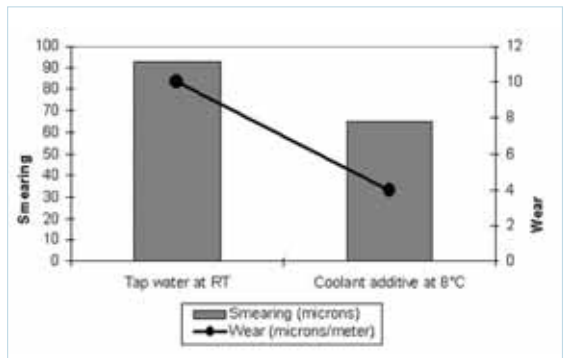


Figure 2: The increase in blade life obtained over the years in the ADT QFN research program

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