

Micromechanical testing of thin die

By Alan King [Nordson DAGE UK]

The need for micro testing thin die 100 microns and below is being driven by the increased demand for thinner mobile products with package-in-package (PiP) and system-in-package (SiP) devices for smartphones and tablets. This, combined with a need for ultra-thin die 50 microns and below for RFID tags, ID cards, and related products, is presenting an emerging challenge for micro testing at the die level and bond testing interconnect at the package level. This article takes a look at how micro materials testing and advanced bond testing has evolved to provide solutions.

The challenges

Inorganic semiconductors are brittle and their strength is greatly affected by the presence of surface flaws created by dicing and handling. These flaws manifest themselves as chips and scratches. Die can experience high levels of stress because of coefficient of thermal expansion (CTE) mismatch, or flexure of the substrate or board to which they are mounted. Flexural testing is ideal for assessing the impact of defects (cracks) and surface damage on the strength of brittle materials. The standard way of assessing the unfavorable effects of dicing and grinding is to perform a bend test on a statistically significant population typically greater than 25 samples, and this is normally done in accordance with industry standards such as: SEMI G86-0303 (Three-point bend test of die), or SEMI G96-1014 (Chip (die) strength by cantilever bending).

Different bend methods such as 3-point, 4-point, ring-on-ring and ball-on-ring (spherical bend) result in different stress distributions. The failure modes for 3- and 4-point bend testing are sensitive to both surface and edge cracks.

Micro testing of ultra-thin die

Three-point bend testing is not ideal for ultra-thin die 50 microns and below as their increased flexibility dictates that the supports should be close together, which causes

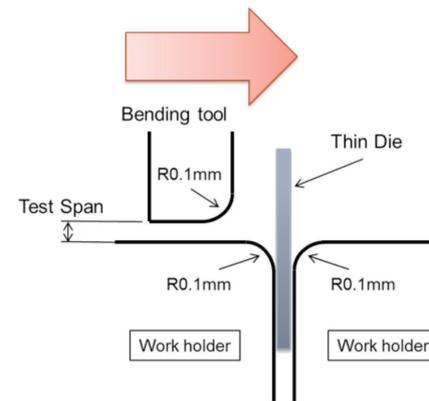


Figure 1: Illustration of a thin die held in a work holder ready for load to be applied during the cantilever bend method.

practical difficulties, making testing in accordance with SEMI G86-0303 inconvenient. Therefore, an alternative method (**Figure 1**) should be adopted: the SEMI-G96-1014 cantilever bend method. This particular method involves landing a shear tool (bending tool) on the surface of a work holder and then stepping back (up in Z) to a precise controlled test height before moving the Y stage towards the transducer in order to apply a load to the face of the die.

Young's modulus is reduced with die of 50 microns thickness and below, and therefore the traditional 3-point bend method becomes difficult to use. **Figure 2** shows the transition point between the 3-point bending region and the cantilever bending region.

Bond testing stacked die

Rapid advances in semiconductor packaging technology continue to drive bond testing capability. The testing of interconnects on stacked die, which are commonly used in SiPs presents a number of new and exciting challenges. One of these challenges is being able to land on a compliant thin-stacked die surface and accurately stepping back to a preset shear height before performing a shear test on a ball bond.

Overhanging die in particular can be difficult to bond test because of the complications, such as thickness of the die (flexing during load tool landing and step back) and the small spacing between the

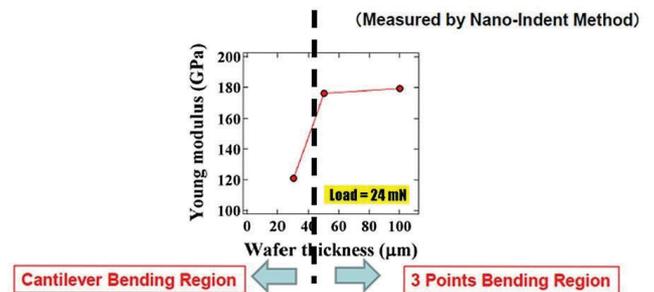


Figure 2: The graph shows that die below 50 microns in thickness should be tested using the cantilever bend method; and die above 50 microns-thick can be tested using the 3-point bend method.

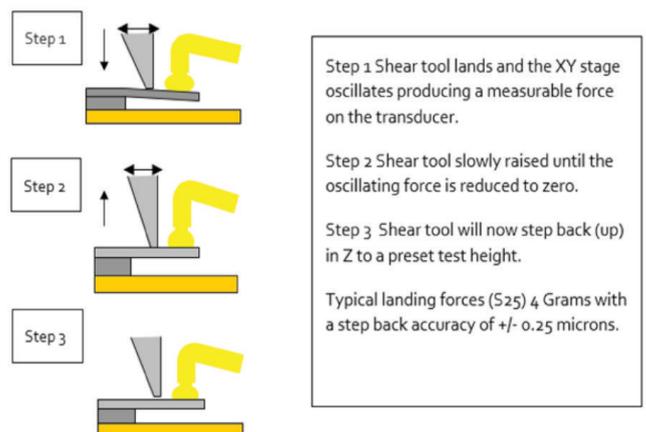


Figure 3: Soft landing procedure.

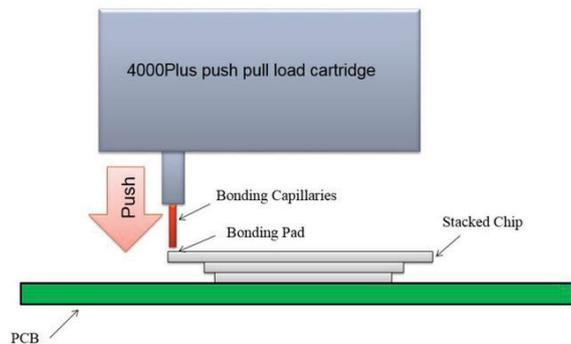


Figure 4: Showing the stacked thin-chip bend test method.

Die thickness	Typical destructive force
30 um	48 to 70 Grams
40 um	90 to 130 Grams

Table 1: Typical test results from a 4000Plus platform using a 500 gram push/pull load cartridge.

bonds. This has been addressed with the aid of specialized software and the problem of die surface deflection associated with the load tool landing has been solved. The Nordson DAGE Series 4000Plus (Figure 3) has a software option that enables the operator to set a soft land step distance (measured in millimeters). When landing the shear tool on a compliant surface, the small downward force applied by the shear tool is enough to move the surface. After the tool has clamped and lifted (step back) to the designated shear height, the surface of the die will deflect upwards towards its original position. The resulting shear height relative to the surface is now significantly less than the step back height selected.

Having landed and clamped the shear tool, the XY table makes small scrubbing movements back and forth. The cartridge load cell detects the movements of the table while in contact with the surface and is raised in steps until no contact is detected. At this point, the die has returned to its original position and the load cartridge will reset to zero and step back to the desired height before performing the ball shear test.

Measuring the deflective strength of thin stacked die

Stack die technology is also incorporated in memory products such as NAND flash memory, USB memory, SD and SRAM, and as such, it's not uncommon to encounter overhanging die in many of these package styles. As a result, there is an emerging need to be able to use bond testing to duplicate

the downward force that a wire bonding capillary would apply during the bonding cycle on the overhanging portion of the die. This is typically a destructive test with the peak force being known as the "deflective strength." This particular application would involve a 4000Plus mainframe with a 500 gram push/pull load cartridge with a bonding capillary fitted to the load cartridge (Figure 4). Typical test results obtained with this solution are shown in Table 1.

Summary

With the advent of new materials, technology, and advanced packaging trends, it's critical that traditional bond testing techniques are evolved to accommodate more of a micro materials testing environment. Many new and diverse testing techniques are needed to meet the challenge, and as a result, there is no longer a divide between bond testing and materials testing, it's all essentially micro testing.

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Biography

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