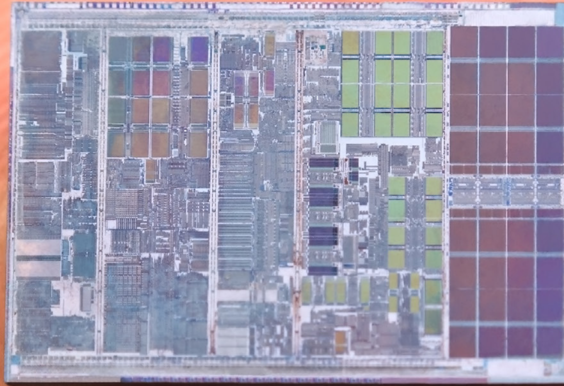


Die Strength Testing

Application Note

Introduction

Nordson DAGE bond testers are known as industry leaders in testing bonds in microelectronics, but did you know that the same machine can be used to test the die itself as well? The reliability of electronics depends on all of the components working as intended and silicon dies are vulnerable to damage, just as solder bonds are. There are many ways to characterize die such as three-point bend, cantilever bend, four-point bend and spherical bend. In addition to these requirements, Nordson DAGE bond testers can accommodate a wide range of shapes and sizes of dies for testing.

Standards for Dies & Passive Components

Standard	Description
SEMI G86-0303, SEMI G96-1014	Three point bend test of die and cantilever bend of die
IEC 60068-2-77	SMT resistors and capacitors
ASTM C1161	Four point bend
ASTM C1499	Equibiaxial ball on Ring
AEC-Q200	Qualification of Passive Components
ASTM C1239	Standard Practice for Reporting Uniaxial Strength Data for Advanced Ceramics

Nordson DAGE

Die Strength Testing

Application Note

The challenge

The present trend for thin substrates and large area devices has made dies susceptible to fracture from small cracks induced during dicing and thinning. Whether or not a die will fail depends on the applied stress and the size of any defects present. There are several factors which require strength testing to be performed on individual die.

- Inorganic semiconductors are brittle and their strength is greatly affected by the presence of surface flaws such as chips and scratches
- Die can experience high levels of stress due to CTE mismatch or flexure of the board they are mounted to.
- Handling, back thinning and dicing processes all introduce scratches into a die, so the question is not 'are there defects on the die', but 'what effects do the defects have on die strength?'

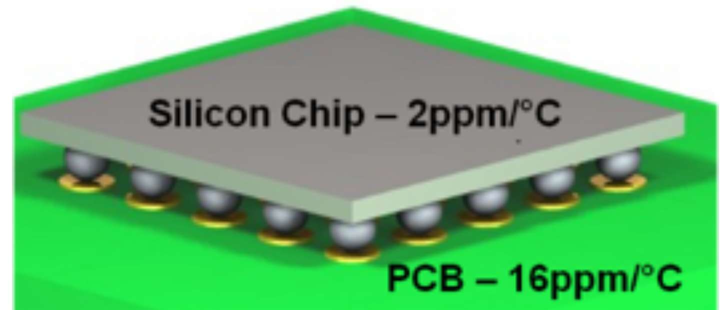


Figure 2 Bending loads can be caused by thermal expansion

Flexural testing is ideal for assessing the impact of defects (cracks) and surface treatments on the strength of brittle materials. As silicon dies are brittle, consistent set-up of the testing process is key to producing repeatable results. A good test set-up for die strength testing needs to be:

1. Quick and repeatable test set-up
2. Repeatable and accurate micro tool positioning (both X and Y)
3. Easy to interpret results

It is important to correctly choose which test you should perform and this is generally done based on the thickness of the die. For thicker die bend testing is recommended, while thin die the cantilever test can be used:

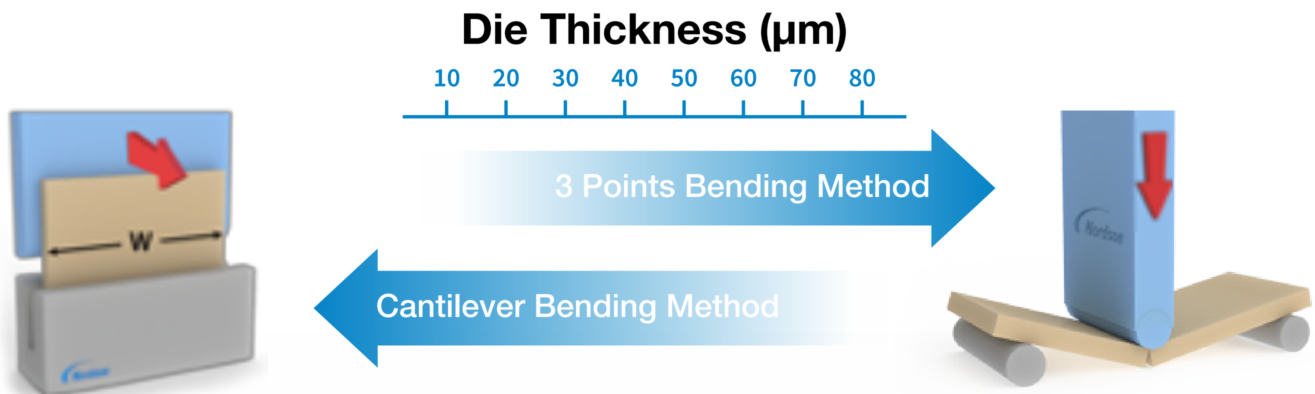


Figure 1: Choosing the right test method

Three-point Bending

The conventional way of testing silicon die strength is the three-point bend test; The die is pushed down by a roller (or indenter) in the centre and supported at the sides. For large samples, a PP50KG cartridge is available for accurately measuring large bend loads. The three-point bend apparatus can easily be converted to performing four-point bend by replacing the single roller with a dual roller assembly. Four-point bending generates a constant bending stress between the two upper rollers, unlike three-point bending, where the stress increases to a peak under the centre roller. Four-point bending provides more consistent results, but can only be carried out on relatively long, thin components.

Nordson DAGE makes a range of support anvils to provide a support span for a variety of die sizes, as the ideal test has a large proportion of the die unsupported. Small dies can be tested using the PP500G cartridge, which is accurate down to 0.5 g force. The three-point bend set-up meets SEMI G86-0303 and other applicable international standards.

Support anvils can be custom made so that the die can be simply slotted into place against a hard stop to ensure quick and easy positioning every time. Where a variety of die sizes needs to be tested, the die can be positioned accurately using the nudge function of the bond tester and then independently checked using the image capture camera, to very high precision

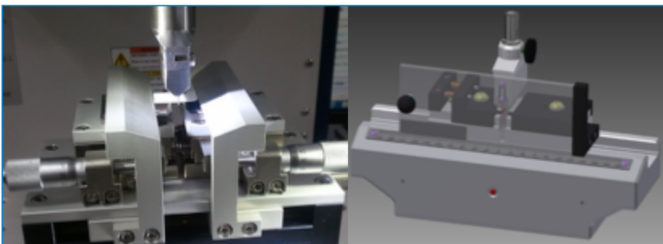


Figure 4 Micro three-point bend set-up with self-aligning tool

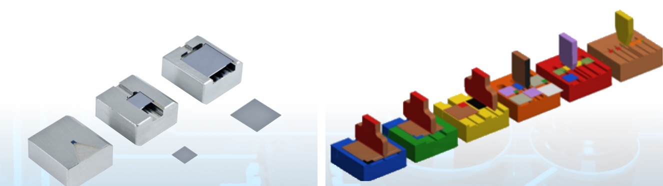
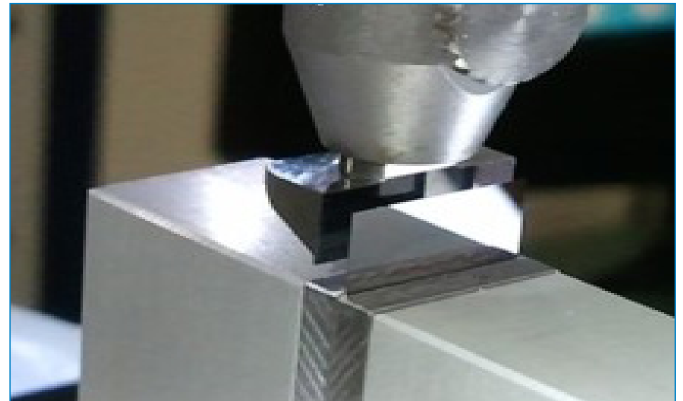


Figure 5 Standard and customer options anvils for micro three-point bend

Cantilever Bend

When the die is very long and thin, the deflection during a three-point bend can cause the die to slip during the test, invalidating the results. For these components, Nordson DAGE bond testers can carry out cantilever bend tests. The die is clamped into a support and the top is pushed to bend the die. The bend test equipment is designed to be compatible with common international standards, including SEMI G96-1015. Cantilever bend allows the bending span to be very short, eliminating the need to go to very large deflections. On Nordson DAGE bondtesters, this small bending span is accurately controlled by using the shear height function- consistent bending span is vital to producing consistent test results.



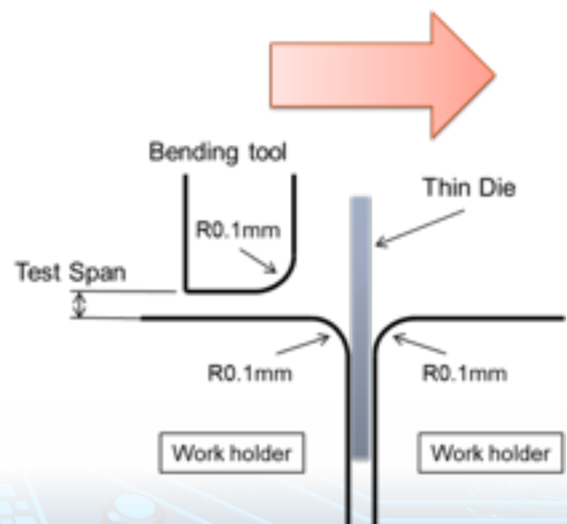


Figure 7 A cantilever bend test

Spherical bend

As the strength of silicon materials is dominated by edge and surface flaws, it is sometimes necessary to test a die without loading the edge. The solution is to use a ball as the indenter and support the die with a ring, so that the edges are outside the loaded area.

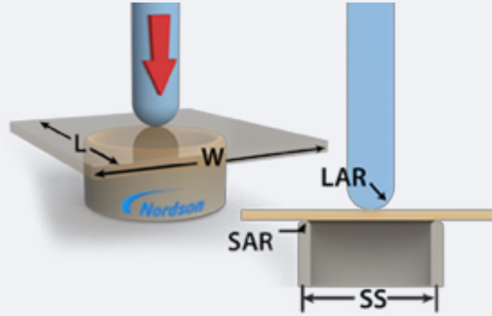


Figure 8 Ball-on-ring bend testing

Analysis

A powerful way of understanding the data from testing brittle materials is through Weibull analysis. Paragon™ software provides a Weibull plot as standard, eliminating the need to carry out post-processing on the results. In addition, Paragon™ uses the sample dimensions to allow the results to be plotted in terms of stress and strain, instead of simply load and displacement, so that results can be compared with samples of different sizes.

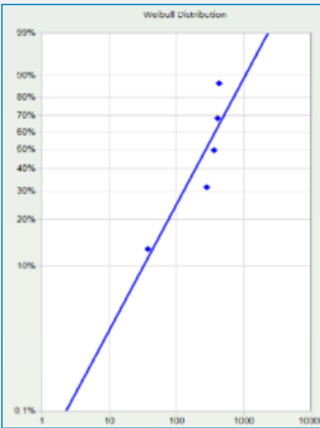


Figure 9 Weibull distribtuion analysis

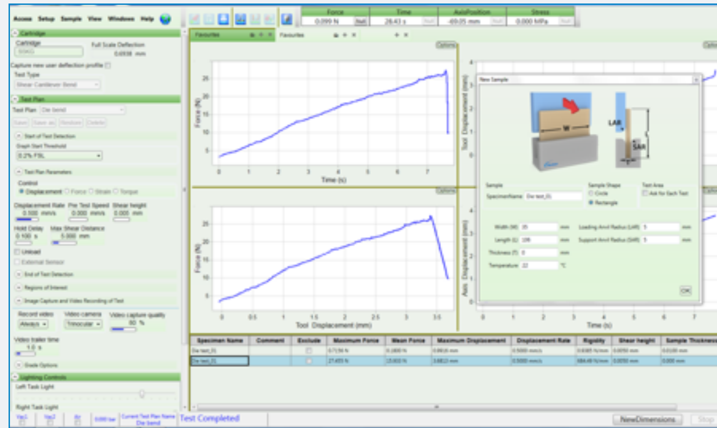


Figure 10 Paragon Materials™ die bend testing screen

Chose the right method for your die testing

Nordson DAGE supports all of the relevant test methods for die bend testing, no matter what size of your die.

For more information, speak with your Nordson representative or contact your Nordson regional office

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