Is Fully Automatic Bond Testing Possible? » What is Required for Automation?

What is Required for Automation?

Applications with only one type of bond that can be tested with one type of test sensor and tool can perform automation with a single head system. When more than one bond type is to be tested a multiple head system is required. Even applications for one test type can benefit from a multi-head system since spare tools can be fitted to a spare sensor enabling immediate recovery from a worn or damaged tool situation.

A fundamental requirement for bond testing automation is repeatable and accurate alignment of the test tool to the bond. To achieve this the tool must be positioned in three axes and a rotation relative to the samples bonds with the required accuracy. The accuracy depends on the sample but a bond tester should be designed for the most challenging of these.

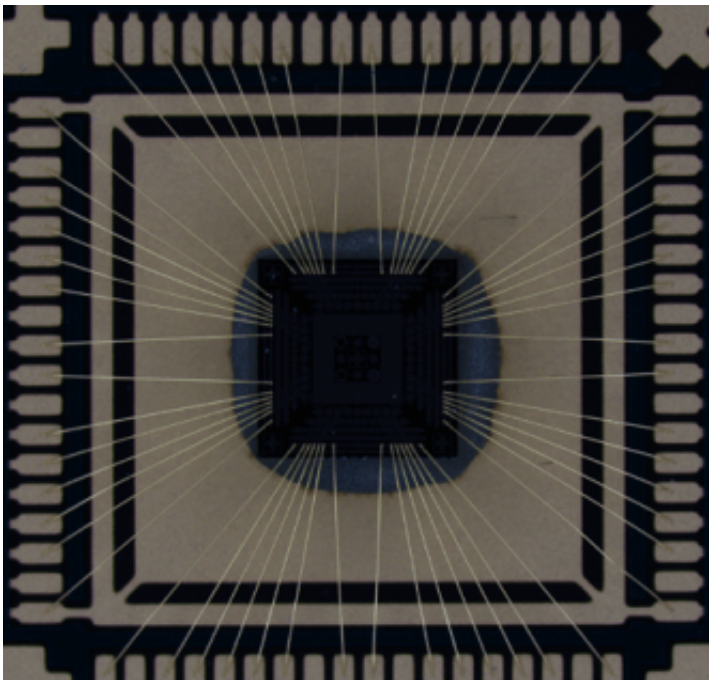

Fig 2. For wire pull the position of the wires can vary as illustrated by the marked wires

A bond tester's test method is actually a partial automation. It automatically applies the load to the sample with the selected sensor and tool in a prescribed manner. The details and design of test methods are explained in our "The Science of Bond Testing ©" modules. What is generally known as automation refers to the automatic alignment of the test tool to the sample before the application of a test method. This might seem simple but alignment is one of the 4 principle Test Parameters required for accurate and optimum bond testing (again explained in our Science of Bond Testing modules).

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Alignment of the test tool should therefore be applied to the bond with the required accuracy. In fine pitch applications high accuracy is required. In all bond testing the positional errors of the bonder must also be accounted for. Examples of this are the variation in wire position in wire pull (Fig 2) and die rotation in die shear; the bonder only has to account for things like variation in pad position, a bond tester has to account for the variations in the pad and the bond made on to the pad (Fig 3). In addition other features that might be an ideal reference (fiducial mark) for the bonder can be obscured once bonds are made and not available for the bond tester. An operator can easily make adjustments from a complex bonded image where machine vision may not.

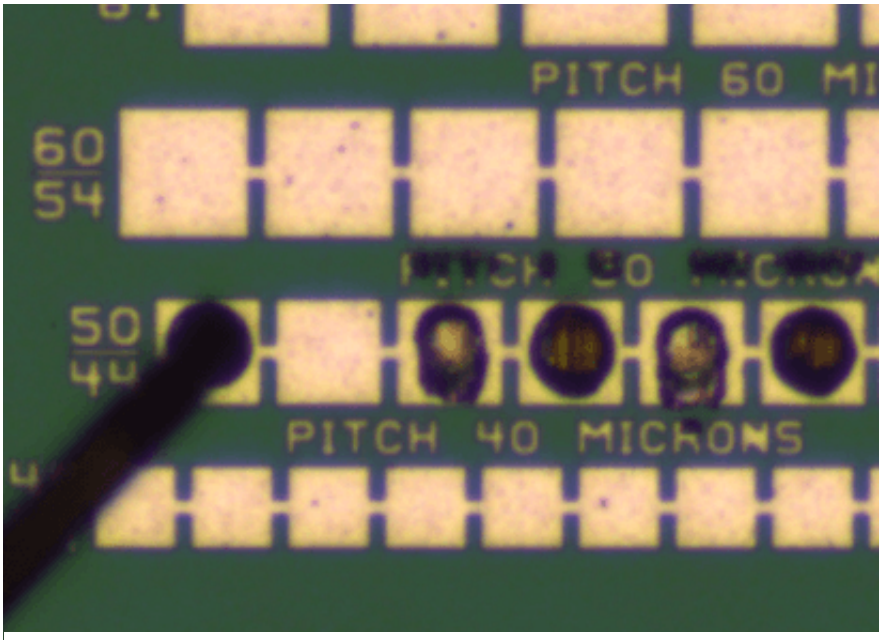

Fig 3. Variation of bonds on the pads. Bond pads are clearly defined for bonding but may be obscured for bond testing

For ball shear, the bond positions vary on the pads and wires at different angles can complicate image analysis (Fig 3).

A common perception is that a bond tester measures a bond's strength as a force. While this is mostly the case, it is only part of what it should provide. Also, it does not apply to INone Destruct Testing (NDT), something we refer to later. The bond "force" is typically the peak or maximum force recorded but the real force metric from a bond tester is the Force Vs Displacement data/graph which provides the peak force and much more including, energy and stiffness.

It should be understood thought that more important than anything, even force, a bond test produces a failure mode.

The Science of Bond Testing, Golden Rule Number 1 teaches us that we should "Choose the test type and settings that gives the most failure modes of interest". It follows on with, "If the bond test produces the same failure mode as the true load, the bond test measurement will be very

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meaningful. If the failure mode is different it will have less meaning or possible no meaning at all".

The message is that everything starts with the failure mode, there is less or no value in testing the "wrong thing". When we think about applying automation, the failure mode should be well understood but it always remains the most important measurement. In an appropriately set up bond test, there is normally a relatively small number of failure modes that will occur, selecting from these after each test is known as "Grading". A bond tester is extremely good at measuring Force Vs Displacement, it is typically much less capable at grading the failure mode. Again we traditionally rely on the operator to make a more accurate decision.

As an operator is traditionally required for accurate test tool to bond alignment and failure mode grading, they can also load and unload the sample. As in the case of wafer testing, manual load and unload of the sample can have unacceptable risk. The wafer may be contaminated or damaged in the process. This step is often automated but it is not always accomplished for the purpose of full automation.

As most bond tests produce some test debris this also has to be considered.

The additional requirements for full automation required from a conventional bond tester are then,

- Multiple test heads
- Accurate tool positioning
- Automatic load and unload
- Measurement of gross sample position (Fiducial camera alignment)
- Accurate automatic alignment for variations in bond position
- Automatic failure mode analysis
- Test debris management

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