Innovations in Wire Bond Inspection

A technological shift is coming in wire bond inspection. Viscom is developing a 3D wire bond inspection system which is specifically designed to meet the challenges of wire bonding. The new system features substantially improved sensors, a high image resolution and fast image data processing, and is capable of performing 3D measurements to detect bond wires as thin as 20 µm.

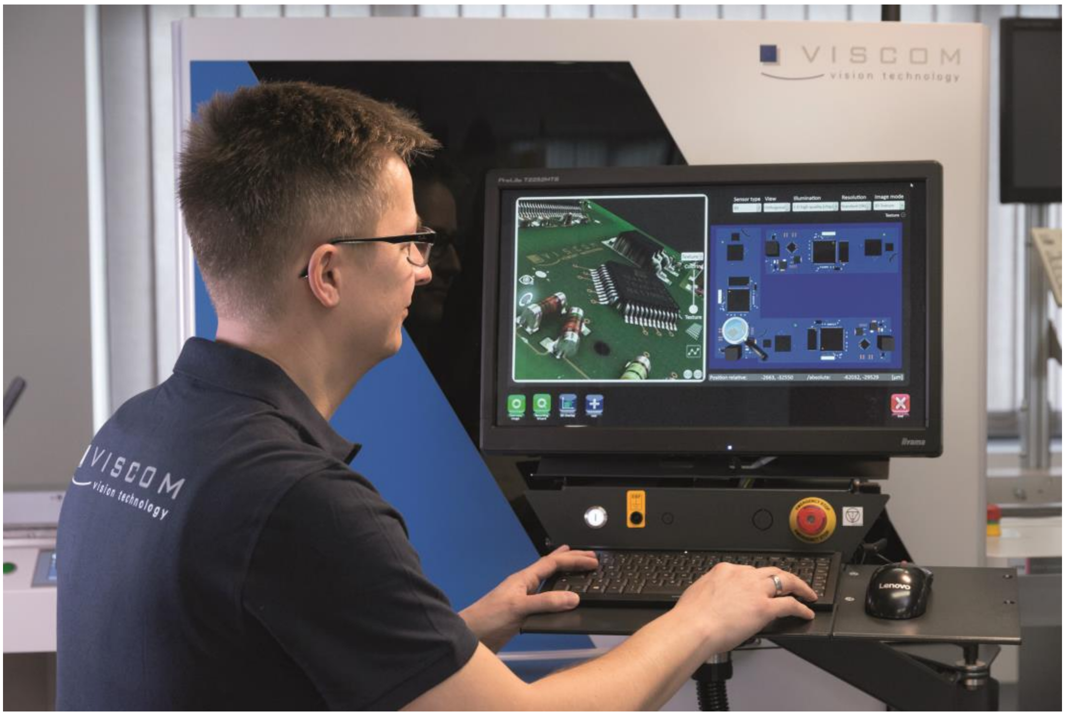
Rolf Demitz, Vice President of Development XP/NP at Viscom AG, reports on the particular challenges of wire bond inspection and the advantages offered by the new 3D technology.

Increasingly thin wires, finer pitches and more applications of thick wire for higher capacities are among the current trends in wire bonding. At the same time, the requirements for robust and defect-free bonds are increasing, for example in assistance systems in the automotive sector and in RF modules in 5G mobile communications. Complex and safety-related applications such as these demand extremely reliable inspection methods.

Electrical tests alone are insufficient for inspecting the adhesive integrity of bonds or for detecting missing wires on multiple bonds. Moreover, current 2D wire bond inspection systems have the disadvantage of lacking height information. This means that specifications regarding minimum distances, wire lengths and the actual height of loops and wedges cannot be inspected quantitatively.

A new approach for 3D wire bond inspection systems

3D measurement technologies from the area of SMT are only of limited suitability for wire bond inspection. Unlike SMD components, the highly reflective and round bond wires cannot be detected reliably. Thin wires in particular do not provide any suitable 3D information when inspected using this technology. As a result, measurement is often limited to thick bond wires with a diameter of 300 µm or more.



Traditional 3D AOI systems from the area of SMT are not capable of sufficiently inspecting the highly reflective and round bond wires.

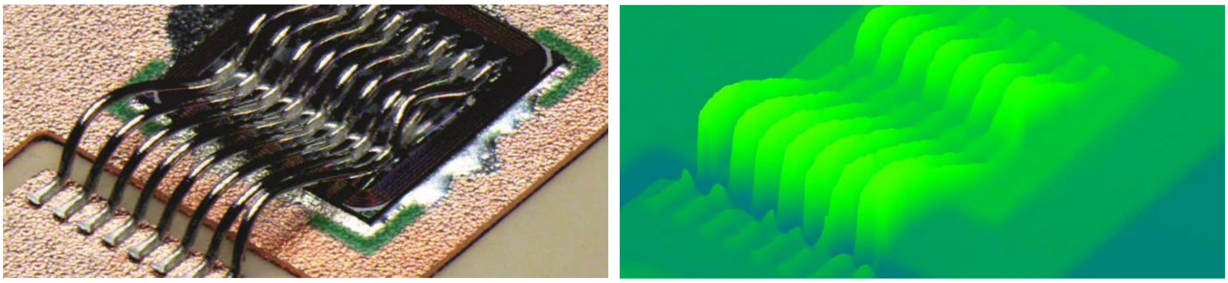
Viscom is developing a 3D wire bond inspection method which is specifically designed to meet the challenges of wire bonding. There are three main aspects which set the new procedure apart from the 3D AOI technology used in the area of SMT:

A special illumination system: The dome illuminator features a number of different reflected-light and dark-field illuminators. By combining these different illuminators, the new method facilitates the measurement of individual characteristics of the bond wire's highly reflective surface, and thus the reliable detection of bond wires as thin as approximately 15 µm.

A unique camera system: Another impressive feature of the new 3D wire bond inspection system is the use of a camera system developed by Viscom. The camera system is distinguished by its significantly higher data transfer rate and an image resolution of 25 megapixels. The enhanced image quality lowers the false call rate and facilitates the verification of defects.

A unique 3D procedure: For the 3D measurement, a large number of different high-resolution 2D images are generated in a very short time. 3D height information is extracted from this image stack. Graphics processors (GPUs) as well as the main processor (CPU) are used to execute calculations in parallel to ensure high-speed image processing. This makes in-line inspection in the production line possible even when performing 3D inspections.

The new 3D wire bond inspection system is suitable for all standard bond procedures, including ball wedge, wedge wedge and security bonds; different materials and alloys of aluminum, copper, silver, gold and other metals whether as ribbons, thick wire or thin wire. The procedure includes inspection of bond positions, wire paths, dies and component positions. The wire bond inspection system includes an offline programming station which is located outside of the production line. The programming station can be used to create and optimize inspection programs offline without obstructing the in-line inspection.



The results of Viscom innovation: 3D wire bond inspection of thick wire on DCB substrate, as a real image and a height image

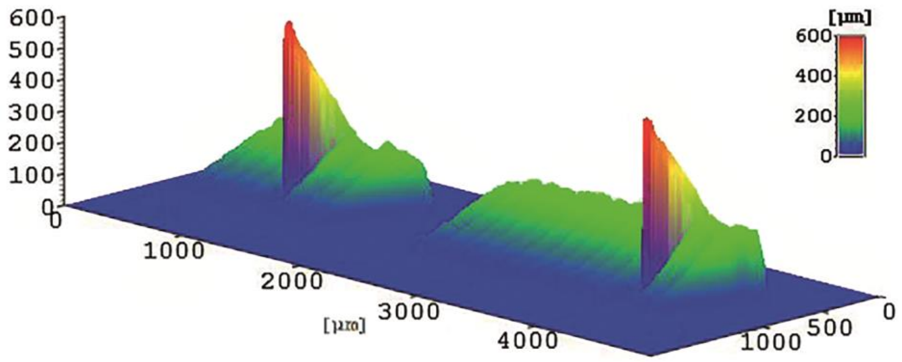
3D technology detects process deviations

Viscom is outfitting the new 3D wire bond inspection system with a classification station (verification station) which can be used to assess defect candidates. Using statistical process control (SPC), defects undergo a systematic defect analysis which can be combined with filter functions to perform your own statistical evaluations, for example to define process control limits. The classification station features an in-line trend analysis and is also used to document process results.

The automated defect analysis provides systematic process monitoring which detects when and where defects occur most frequently, including:

Structural element defects: such as damage and positional deviations in the case of dies; excessive or missing conductive adhesive
Ball and wedge defects: such as excessively large, excessively small or missing balls, incorrect ball position or wedge shape, as well as lift-off
Wire defects: such as wire courses; missing, ruptured, bent or pinched wires; or incorrect wire distances

The defect analysis can be used to identify systematic process deviations. For example, the area directly surrounding a bond can be inspected for contamination. If abnormalities are found, this can lead to the conclusion that there is also contamination underneath the bond. Other process deviations which can be detected include variations in bond position following the changing of a bond tool, optical changes in wedges caused by bond tool wear, and variations in loop form caused by different bonder settings.



3D information aids not only the inspection of heights and distances. Through the precise determination of the course of the wire, it also enables the inspection of specified wire lengths.

3D measurement lowers the false call rate even further

3D measurement also makes it possible for the first time ever to measure the actual height of wire loops, for example to inspect the minimum distance of the wire to the case cover. Wedge heights are also measured, and wire lengths can be inspected reliably. The measured height information is determined and compared with the nominal values. These advantages become particularly evident in the case of circuits installed in narrow spaces. Another positive aspect is that the wafer indentation depth can now be incorporated fully into the inspection of the bond quality of ribbons.

All of the 3D inspections mentioned above can also be used as a complement to 2D inspection, allowing the high lateral resolution to be retained for each inspection layer. The skillful combination of 2D and 3D inspection makes it possible to reliably inspect even complex assemblies with fewer false calls and faster inspection times.

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