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Defect detection and process control in DCB manufacturing

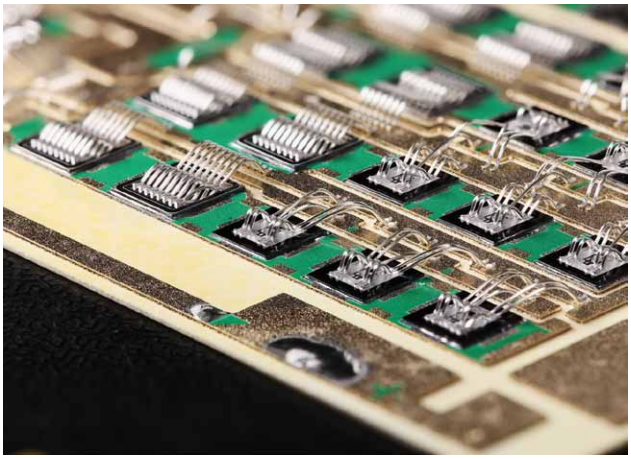
Case Study AOI

Defect detection and process control in DCB manufacturing

The company Semikron (SEMIKRON International GmbH) manufactures components and systems for power electronics and operates on a global basis. Their concentration is in the medium power segment from about 2 kW to 10 kW. The products are employed in, for example, RPM-controlled industrial drives, welding equipment or elevators. They also find their application in the sectors automation technology, uninterrupted power supply (UPS) and renewable energy as well as in electric and hybrid vehicles. For this use, the power modules must be constructed in a way that it is possible to supply current to the top and bottom sides and conduct the heat away with as little thermal resistance as possible. To accomplish this a carrier substrate, mostly with structured copper and an inner ceramic layer, is applied (Direct Copper Bonds, or DCBs). The electrical contacting of the chip top side is realized through wire bonds. In order to guarantee a consistent faultless connection to the electrical connections, the process technology division at Semikron in Nuremberg has decided for an automatic optical wire bond inspection from Viscom.

Semikron International GmbH: From component to the entire system

The family company was founded in 1951 and is headquartered in Nuremberg. Over 3,000 employees work in an international worldwide network of 37 companies with production sites in Brazil, China, Germany, France, India, Italy, Korea, Slovakia, South Africa and the USA. This guarantees fast, comprehensive customer support on site. The product range extends from chips, discrete semiconductors, IGBT diodes and thyristor modules, through customer-specific solutions and up to integrated power electronic systems. With a share of 30 %, Semikron is market leader in diode and thyristor semiconductor modules.



PCB with Wire Bond Connections

With the founding of the subsidiary SindoPower in 2009, Semikron extended its distribution channels. The eCommerce company SindoPower markets the power electronic products of the company online and also offers competent technical consultation for small and medium-sized companies.

F. l. t .r.: Dr. Andrea Weidner, SEMIKRON International GmbH and Wolf Rüdiger Pennuttis, Viscom AG

Advantages of automatic inspection

Consideration over securing the quality of the circuit boards with an automatic optical inspection has been going on at Semikron for some time. Since it was determined that in the case of increasingly complex products, delivery quality could be further increased by introducing a targeted, high quality AOI, these considerations were again revived.

"We have wholly different products", Dr. Weidner explains the initial situation, „simple circuit boards which can be checked very well with a human visual inspection, but also products which are clearly more complex and for which the many wire bond connections cannot be sufficiently checked with the human eye alone." Dr. Weidner is responsible for the AOI process at the Nuremberg location and sees even further advantages in the investment in the AOI system. "It is not just a matter of delivering products without defects, but of preventing defects right from the start. Therefore we have decided on an inspection system which not only finds the defects, but at the same time also saves information about them. This way we can rectify the cause by improving the upstream processes."

To find the right system, the company established a catalog of criteria and tested various inspection systems in an extensive test installation over several months. With its interplay between flexible illumina-

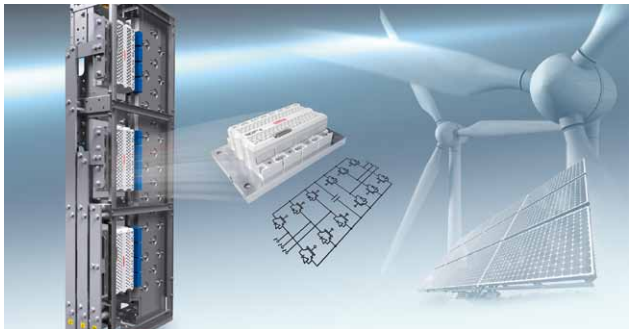
tion, comprehensive analysis options and many years of experience in development of bond-specific inspection algorithms, the sophisticated AOI technology from Viscom convinced the decision-makers at Semikron.

Inspection system S6056BO – 15 years' bond experience included

The automatic inline inspection of thin and thick wire bond connections has already preoccupied the experts at Viscom for over 15 years. Comprehensive expertise and multi-year experience in wire bond technology processes are the prerequisite for development of an appropriate inspection solution thereby. "The appearance of a "good bond" depends strongly on the purpose for which it is manufactured", explains Wolf Rüdiger Pennuttis, sales engineer at Viscom. "There are resounding differences between HF bonds in radar applications and bonds for power applications in energy supply, as reflected in their optical appearance. Based on experience with many hundreds of wire bond applications, Viscom has developed the essential elements of an AOI system: machine frame, axis system, camera heads, illumination and transport system to the point they can be individually customized to each bond application", continues Pennuttis. The Viscom product range extends from tabletop systems with manual loading to inline-capable systems with inspection object dimensions of more than 500 mm x 500 mm. A parallel inspection for especially high throughput requirements is also offered.

Wire defects reliably detected

At Semikron, the inspection system S6056BO is deployed. The system is equipped with two identical camera heads working in parallel. All camera heads command LED illumination units that can be controlled as groups, to generate the illumination specifically for wire bonds. They are well prepared to seek out defects on wires with complex reflective characteristics. For high throughput requirements, the system is laid out with two tracks. The inspection cradles of both tracks are loaded by internal shuttles.



SEMISTACK_RE: high power drive for wind and solar plants, synchronous generators and DFIG generators

Wire Bond Inspection with Viscom Inspection System S6056BO

Since the lots are manufactured per order on several bonders, afterwards they run through the wire bond inspection. The inspection gate is set up as follows: the circuit board is fed in by a handling system, inspected in the bond AOI system and then verified at a verification station. Which products run through the inspection system are determined with a criteria catalog. "For the products we have tested with the AOI, we have not yet received a single complaint", states Dr. Weidner. "Furthermore, during a measuring equipment test we determined that the automatic wire bond inspection is far more decisive than a visual inspection."

Defects detected by the automatic bond AOI include missing bonds, flatly drawn loops or damaged bond feet. The latter can occur when there is a solder splash under the bond foot. These defects cannot be detected with the naked eye. For inspection systems with the appropriate illumination and camera layout, this is no problem. Thanks to high performance image processing algorithms, a very high inspection depth is achieved.

SKiiP 4: most powerful Intelligent Power Module for wind and solar plants

In addition to the standard tasks for the system, customer-specific assignments can also be considered. At Semikron, for example, a customer-specific software for lot number management was implemented with the help of a solution for individual barcode reading. A multi-stitch analysis has also been developed. The advantages: the multi-stitch analysis enables robust separation of wires from inhomogeneous backgrounds. All wedges and loops can be reliably inspected with just one image, without multiple captures. Ultimately this means simplified inspection program generation and reduced cycle time.

In order to utilize the inspection system even more advantageously, Semikron is deliberating linking the inspection directly with the bond process, to use the inspection results for process control even more directly. In addition to further improvement of the inspection quality, this promises an additional cost reduction and shorter throughput times.

Are you interested in more details on this application or do you have any question regarding combined inspection? The Viscom NP Division will be glad to help you.

Please contact:

Viscom AG
Carl-Buderus-Str. 9 - 15
30455 Hanover · Germany
Tel.: +49 511 94996-0
Fax: +49 511 94996-900
www.viscom.com

Torsten Pelzer
Vice President Sales
Tel.: +49 511 94996-654
Email: Torsten.Pelzer@viscom.de

Presented by: