



LMI TECHNOLOGIES

FactorySmart® Inspection



SEMICONDUCTOR QUALITY INSPECTION

WITH GOCATOR® 3D LINE CONFOCAL
AND COAXIAL LINE CONFOCAL SENSORS

Gocator®

CONTENTS

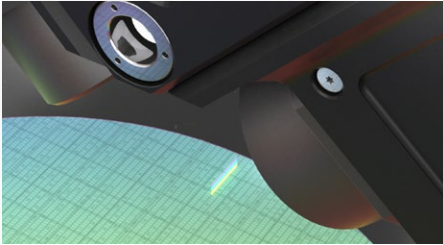
- 4 BGA Inspection
- 5 Wire Bonding Inspection
- 6 Bump Inspection
- 7 Wafer flatness and warpage inspection
- 8 Underfill Inspection
- 9 Dimple Inspection

OVERVIEW

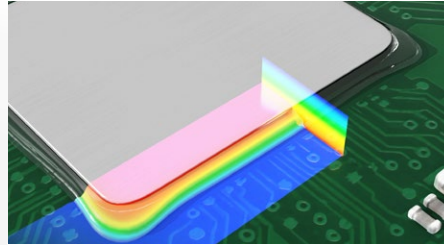
Unlike traditional methods, wafer-level packaging performs part or all of the packaging process directly on the wafer before dicing. While this enables higher throughput and miniaturization, it also introduces new challenges for inspection, as defects can be harder to detect at this stage.

To address these challenges, machine vision has become essential in semiconductor manufacturing. Manufacturers rely on 3D machine vision to precisely inspect wafer-level packaging, ensuring quality control, improving product performance, and maintaining high production efficiency.

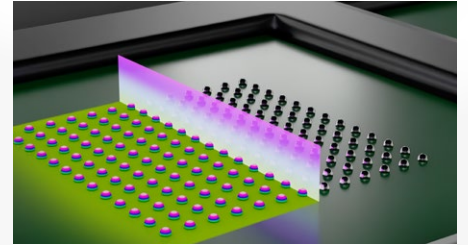
Advanced solutions such as Gocator 3D coaxial and dual-axis confocal sensors are widely used in the following applications:



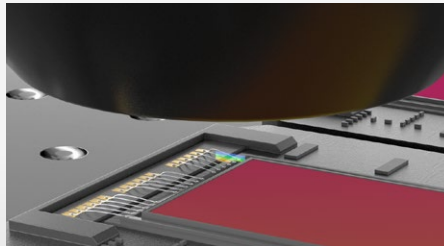
Wafer Flatness and Warpage Measurement



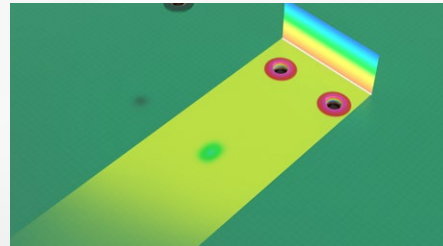
Underfill Inspection



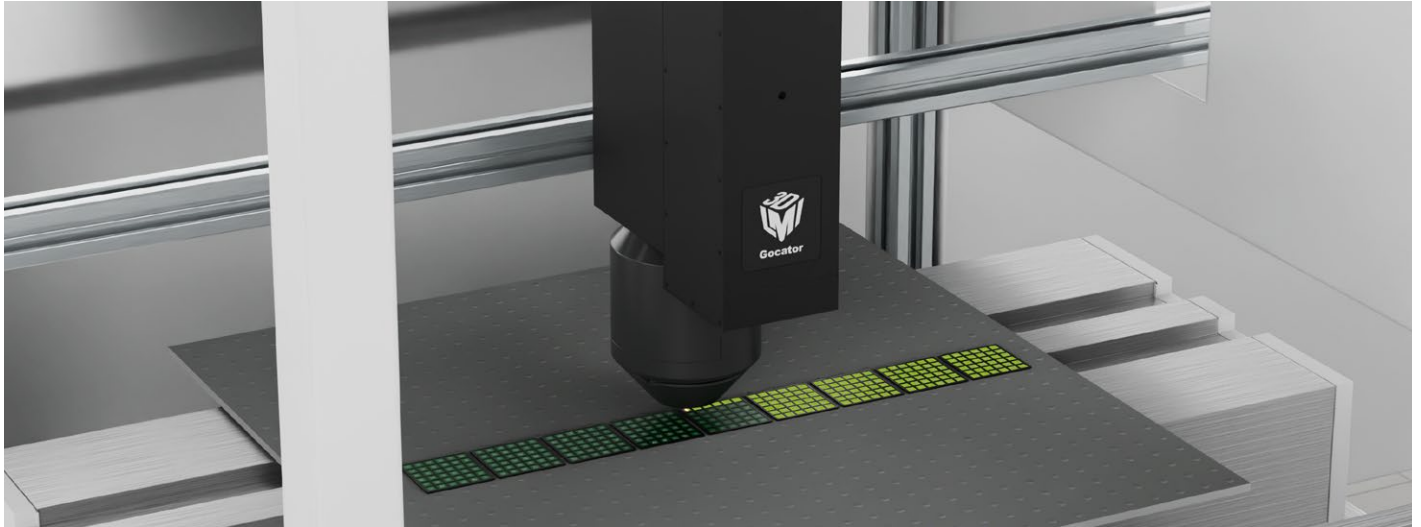
BGA Inspection



Wire Bonding Inspection



PCB Blind Via Inspection



BGA INSPECTION

Application Background

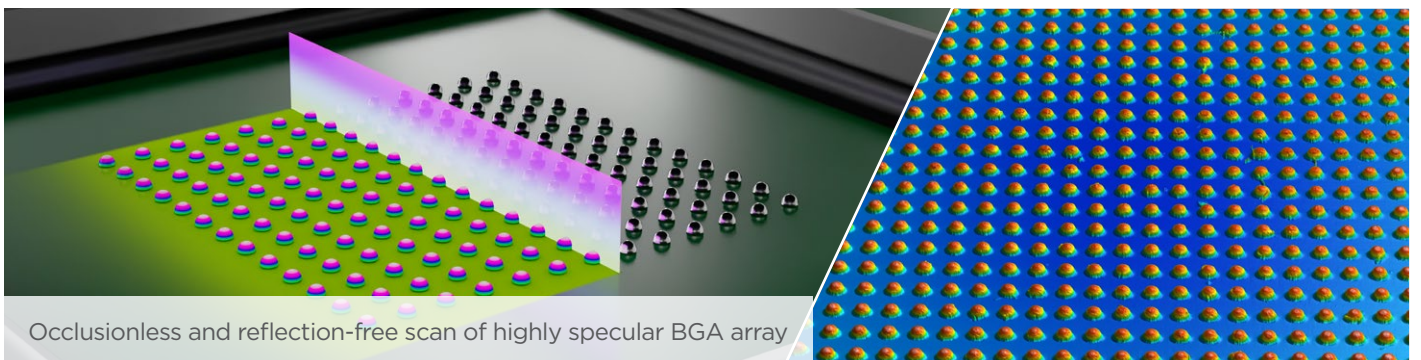
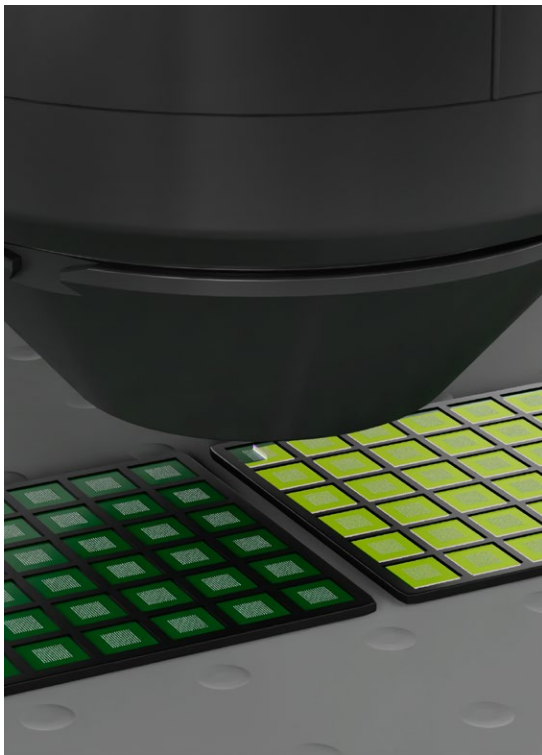
BGA (Ball Grid Array) is a common IC packaging technology that uses SMT (Surface Mount Technology) to achieve high-density connectivity. Solder balls are distributed on the underside of the chip, allowing more connections without increasing package size.

As BGA becomes more prevalent in semiconductor production, precise inspection of ball height, diameter, offset, and missing solder is essential. Undetected defects can significantly compromise device performance.

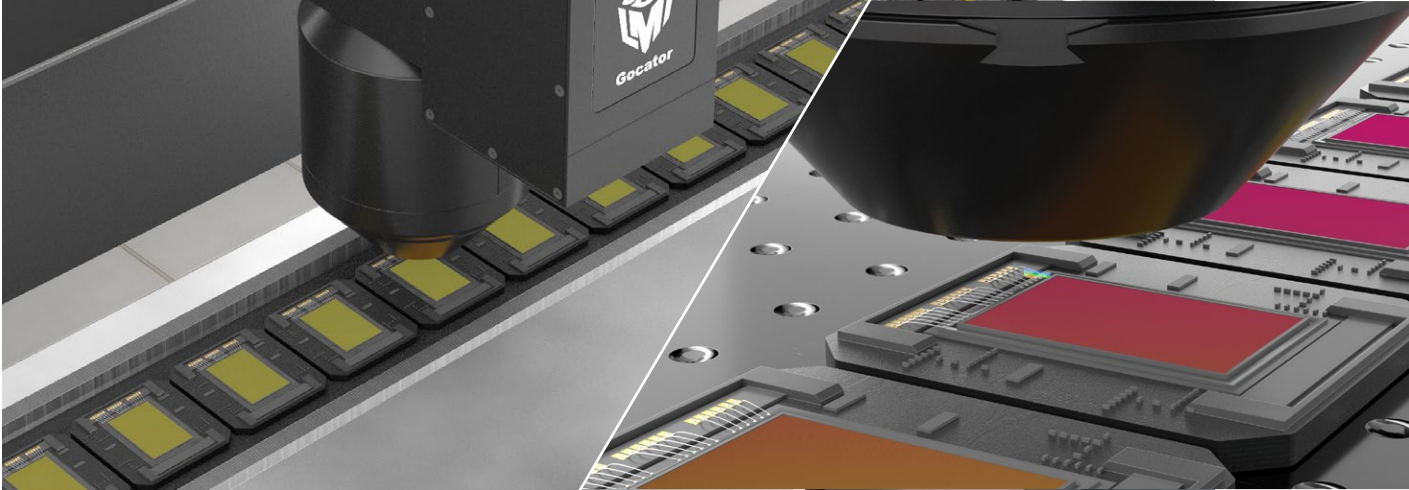
Solution

Gocator® 3D coaxial confocal sensors (4000 series) and 3D dual-axis confocal sensors (5500 series) provide accurate measurement of ball height, diameter, and coplanarity. Depending on customer requirements and BGA materials, the appropriate smart line confocal sensor is selected to rapidly capture precise BGA data.

The Gocator 4000 series delivers shadow-free 3D inline inspection at up to 36 kHz scanning speed, faithfully representing ball geometry and height characteristics in high-detail.



Occlusionless and reflection-free scan of highly specular BGA array



WIRE BONDING INSPECTION

Application Background

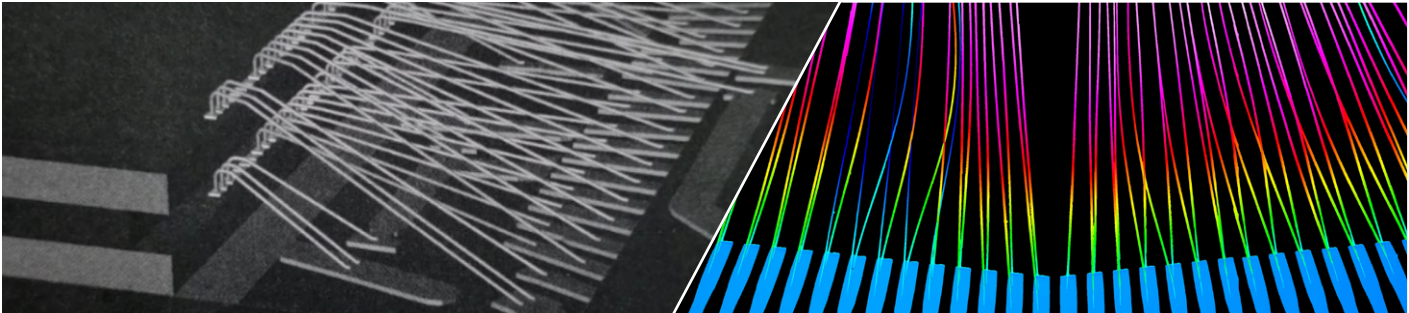
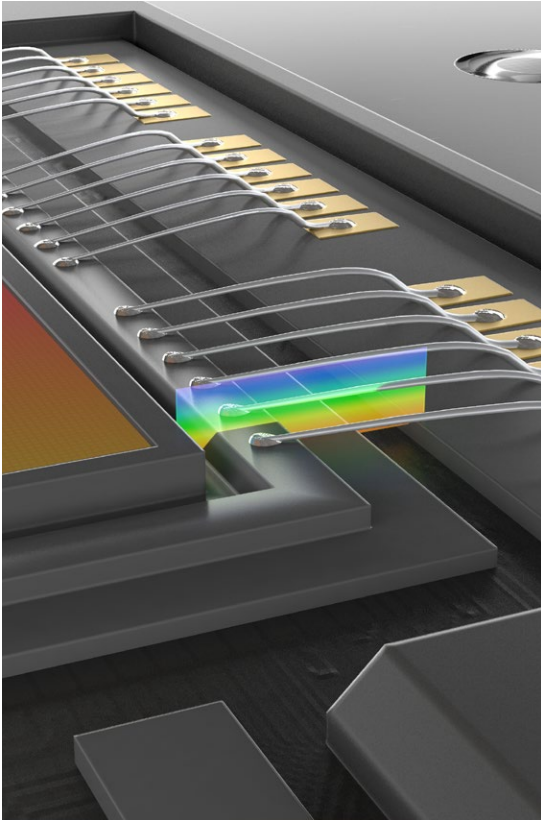
Wire bonding is a critical step in chip packaging, connecting the chip to external circuitry. Its quality directly affects device performance and reliability. As packaging layers increase, inspecting deeply buried wire bonds becomes more difficult.

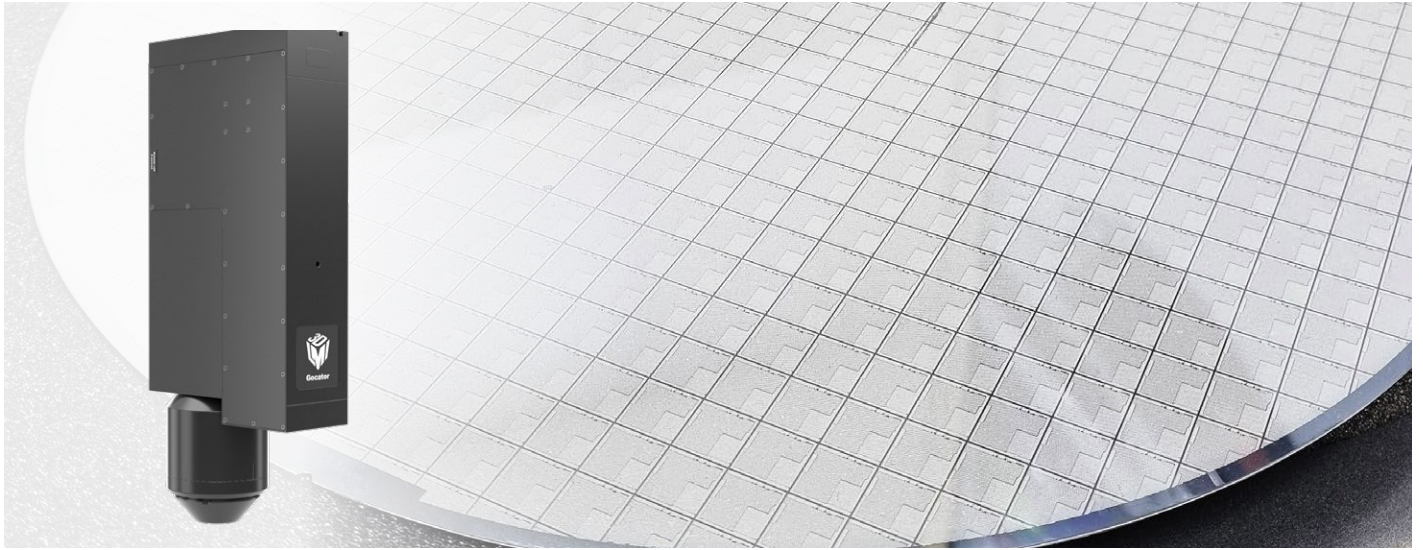
Traditional methods—including contact inspection, 2D imaging, and manual inspection—are increasingly inadequate. To meet soldering process requirements and ensure chip quality, accurate, non-contact measurement of pin defects is essential.

Solution

The Gocator® 4010 3D coaxial line confocal sensor provides precise measurement of pin width, height differences, and defects such as skew, shortages, or improper contact. It captures complete surface data and enables rapid detection of misaligned pins.

Its coaxial lighting design ensures measurements remain unaffected by surface material or light intensity, delivering shadow-free 3D inline inspection over a wide angular range. Unlike traditional gold-wire height measurement methods, the Gocator 4010 avoids stray signals and surface damage, reliably identifying defects and improving yield.





BUMP INSPECTION

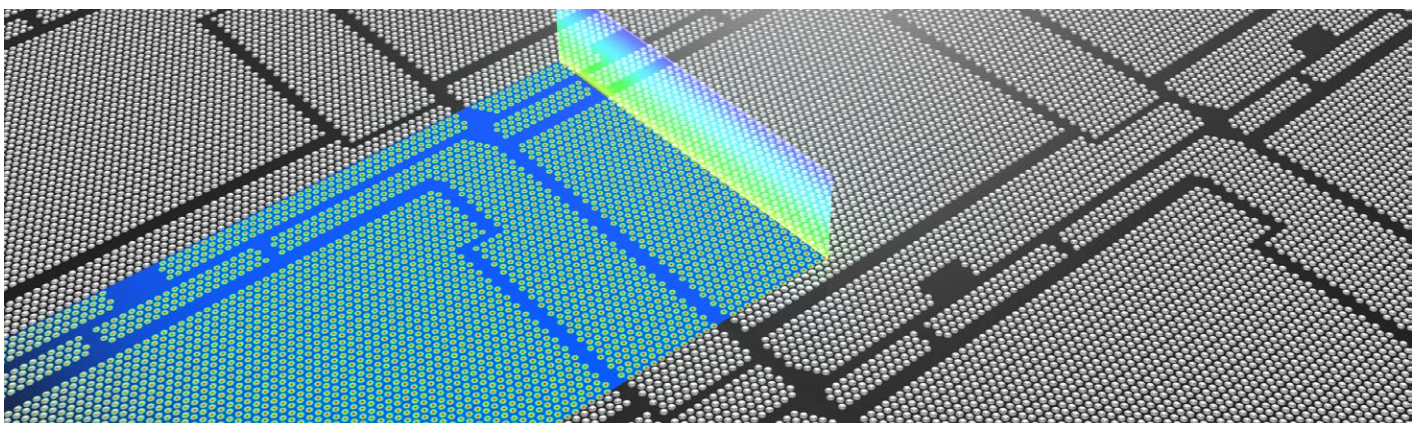
Application Background

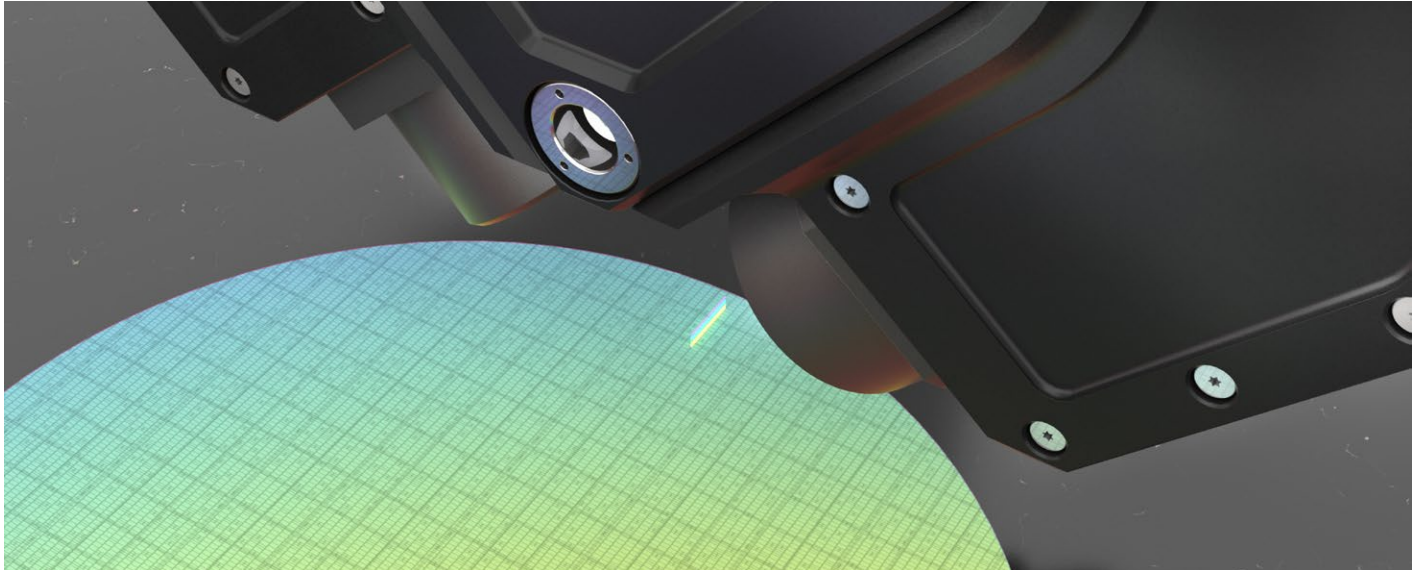
In semiconductor manufacturing, the bump process creates tiny conductive connections—typically gold, copper, or other metals—on the chip. These bumps link the chip to the packaging substrate or to other chips, enabling electrical signal and power transmission.

Bump technology helps reduce PCB size, improve signal stability, and enhance overall product performance and reliability. To maintain strict packaging quality standards, precise measurement of bump height, count, and placement is essential.

Solution

The Gocator® 4011 provides accurate inspection of wafer bump height, with dynamic repeatability as tight as 0.3 μm , ensuring reliable and consistent quality control.





WAFER FLATNESS AND WARPAGE INSPECTION

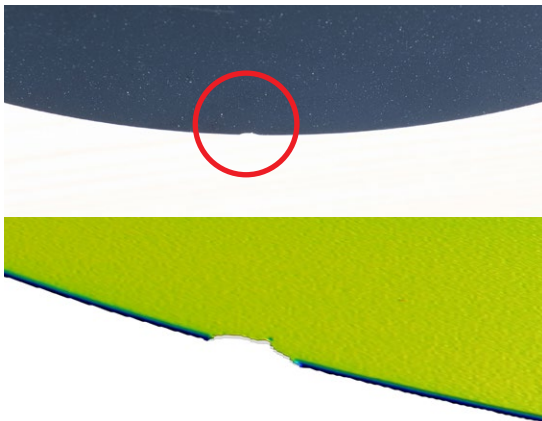
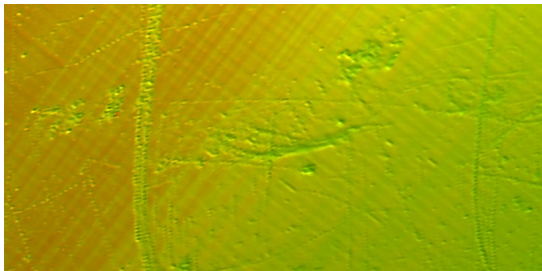
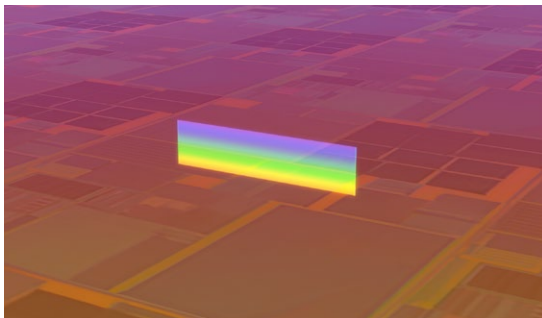
Application Background

Warpage is a critical indicator of semiconductor packaging quality, directly affecting device reliability and performance. During production, differences in material thermal expansion and temperature fluctuations can easily cause warpage.

Warped wafers can result in poor soldering, reduced reliability, compromised thermal management, and other downstream failures. Strict control of warpage during packaging is essential to minimize these risks.

Solution

The Gocator® 5512 smart 3D line confocal sensor offers a non-contact inspection solution featuring a 11.6 mm field of view (FOV). It accurately measures wafer flatness and dimensions while simultaneously detecting surface defects, such as edge collapse, ensuring superior product quality and maximizing productivity.



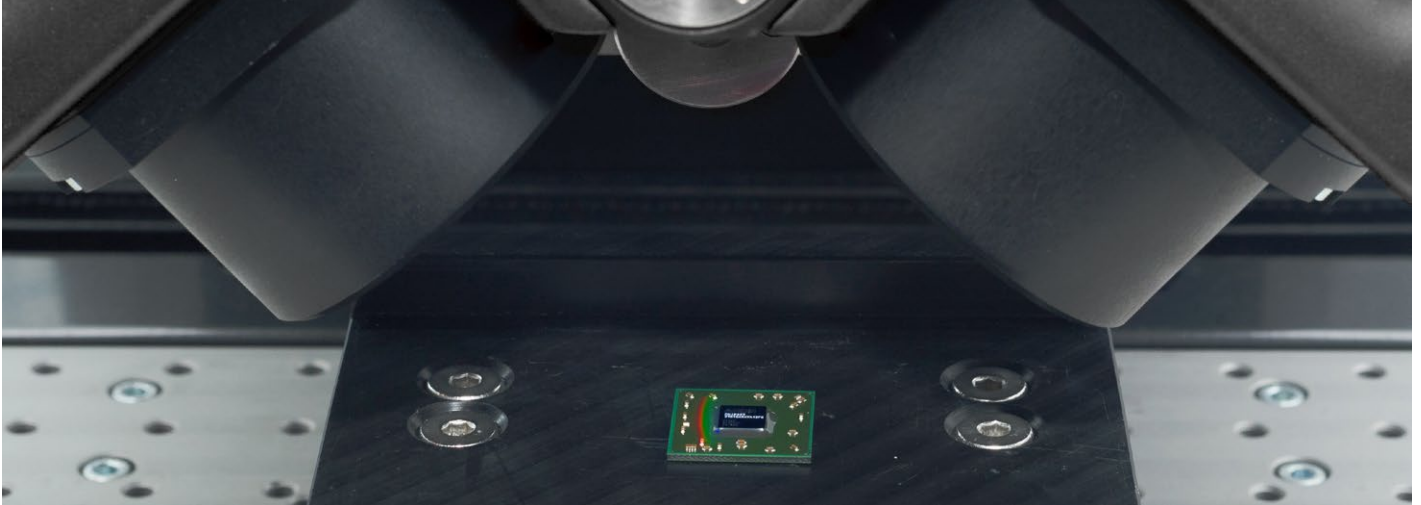
Wafer edge collapse



Good wafer

Wafer warpage

Dome warpage



UNDERFILL INSPECTION

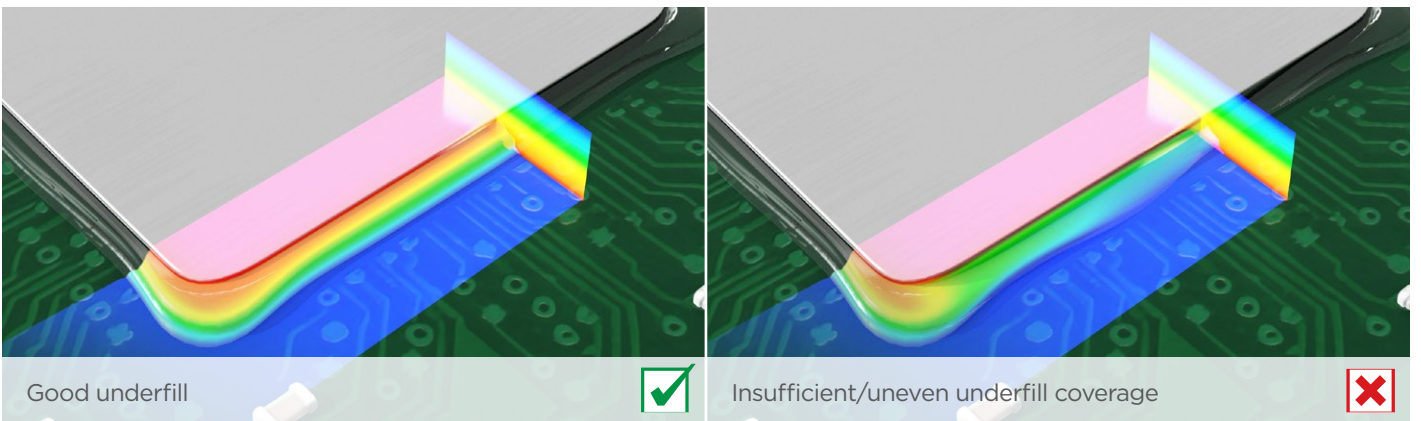
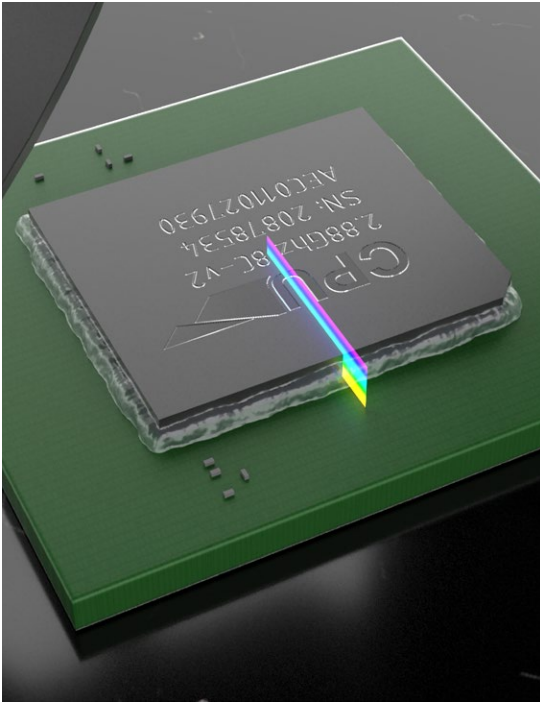
Application Background

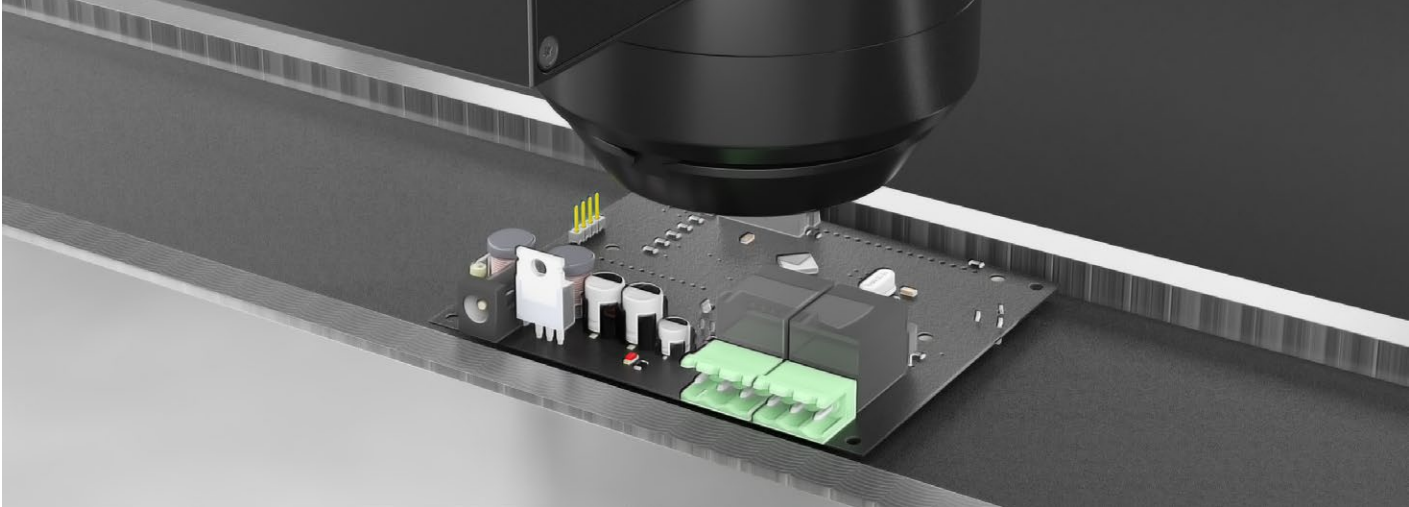
In semiconductor packaging, underfill provides mechanical support to solder joints, fills voids and bubbles, and protects electrical performance. Poor dispensing can compromise impact resistance, thermal cycling durability, curing, and electrical reliability, resulting in higher repair rates.

For no-flow underfill, accurate dispensing control is essential to ensure even distribution during curing. After curing, the underfill must be inspected around chip edges for excess or insufficient coverage.

Solution

The Gocator® 4020 accurately inspects reflective and transparent materials, including no-flow and capillary underfill. The sensor ensures proper underfill placement and volume both before and after the curing process, maximizing product yield.





DIMPLE INSPECTION

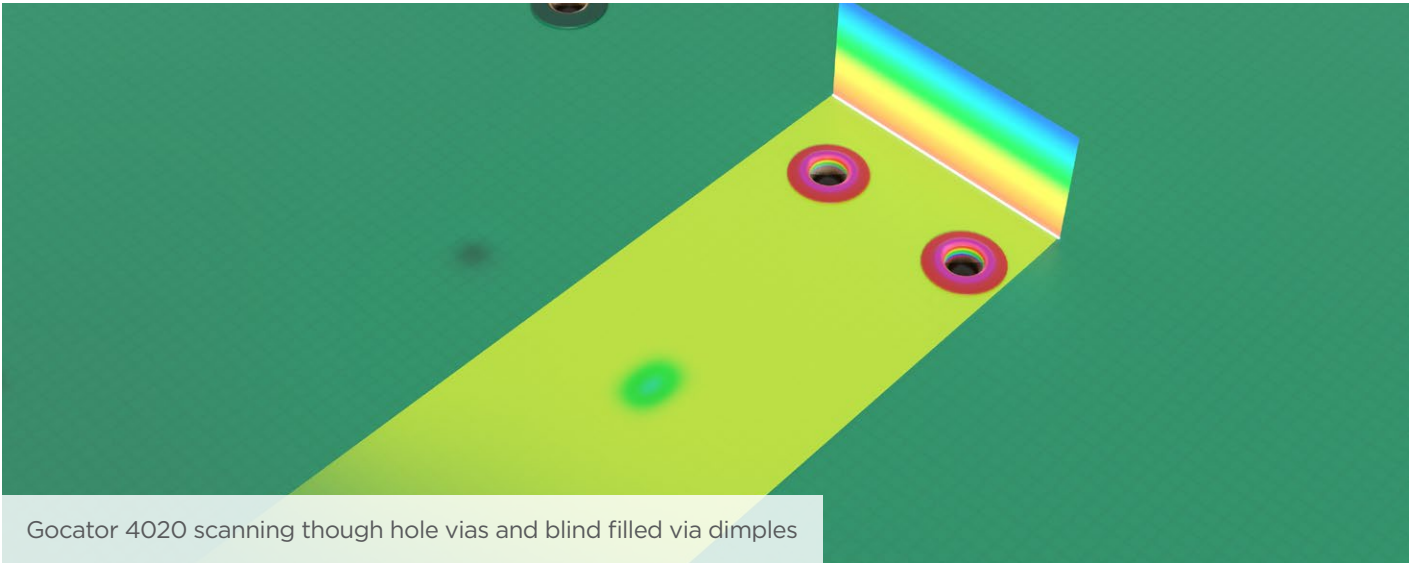
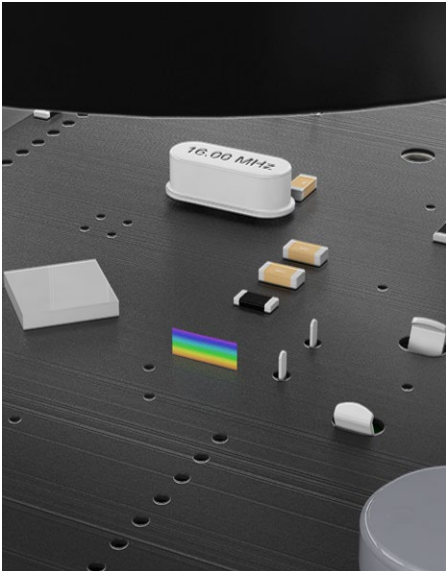
Application Background

PCB blind vias typically range from 50 to 300 μm in diameter. Multiple vias of varying sizes on the same surface must be inspected simultaneously to ensure they meet dimensional tolerances.

Solution

The Gocator[®] 4020 3D coaxial line confocal sensor accurately scans and inspects blind vias, measuring both size and depth. It provides a maximum field of view of 5 mm and an X-direction resolution of 2.6 μm .

The sensor can detect dimple depths from 0–100 μm , with a depth measurement accuracy of $\pm 2 \mu\text{m}$, ensuring reliable quality control.



Gocator®



Additional applications solved

- ✓ Patterned wafer broad range inspection
- ✓ Multi-substrate defect inspection and metrology
- ✓ Advanced surface inspection of compound semiconductor materials
- ✓ Defect inspection on SiC and GaN substrates
- ✓ Hard disk drive media and substrates defect inspection, topography measurement, and classification
- ✓ High throughput defect inspection for large and irregular shaped substrates
- ✓ Inline flat panel temperature monitoring
- ✓ Unpatterned wafer flatness measurement
- ✓ Wafer warp/bow inspection
- ✓ Wafer edge roll-off inspection
- ✓ Wafer edge geometry measurement and defect detection
- ✓ Sub-micron (i.e. deep) surface defect detection
- ✓ Global and local wafer topography measurement

Application Summary

Semiconductor manufacturing is a complex multi-step process that requires 100% quality inspection. Contact methods of inspection, such as manual quality control or the use of CMMs, are prone to error and or damaging of the semiconductor materials.

Conclusion

Non contact 3D line confocal technologies provide manufacturers with a non-contact, high performance, and scalable solution for precision 3D inspection of challenging semiconductor materials, components, and assemblies.

LMI OFFICE LOCATIONS



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60+ Distributors | 40+ Countries

LMI Technologies has offices worldwide. All contact information is listed at lmi3d.com/contact



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