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Case Study

Leading IC manufacturing and technology services provider increases CoW yield by 3.3% from 96.47% to 99.66% with Nordson.

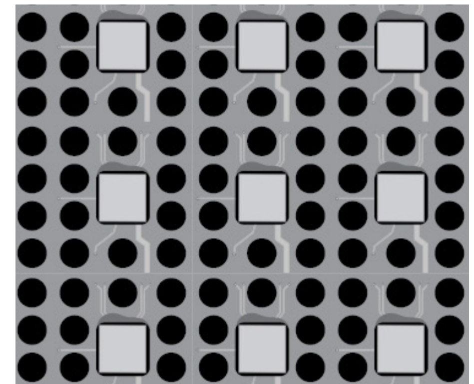
CHALLENGE

Chip-on-wafer (CoW) processes allow the stacking of similar and dissimilar dies, significantly improving inter-chip interconnect density and reducing a product's form factor.

Underfill material is used in CoW processes to bond chips directly to a wafer, minimizing stress on solder joints and offering thermal and mechanical stability that protects the package. Cost reduction and miniaturization demands challenge the CoW underfill process exponentially.

The manufacturing service provider processed 300 mm wafers in this application, each containing approximately 30,000 0.458 x 0.458 mm chips. As is typical in semiconductor applications, every wafer represents tens of thousands of dollars in revenue dependent on quality and yield outcomes.

When the manufacturer approached Nordson for optimization assistance, they were already achieving 96.47% yield running the advanced Forte Series® equipped with the IntelliJet® Jetting System and looking for additional ways to increase yield.



"...I would like to commend [the Nordson team] for their effort to enable us to meet our customer's [underfill process] demands. Their expertise led our team to be able to complete all the feasibility studies and to...complete a sample on time...to show our customer our capability."

All illustrations represent actual results, are used for illustrative purposes only, and are not an exact representation of the customer part.

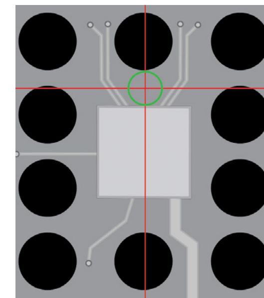
CHALLENGE CONTINUED

The opportunity centered on fine-tuning fluid placement to prevent the specified volume of underfill from flowing into an area with CMOS solder bumps and creating unintended electrical connections.

The manufacturer had also noted significant process-related warpage across wafers, causing the jet nozzle to make contact with chips in cases where height variance was substantial.

APPLICATION DETAILS AND SPECIFICATIONS

- A 300 µm dispense area (also known as a keep-out zone (KoZ)) with nearby solder bumps that underfill material could not flow into
- Significant warpage across wafers requiring varied dispense heights
- 300 mm wafers with 30,000 chips each
- A long 4-5 hour production run at 180,000 jetting cycles per wafer
- 12 µg of underfill material per chip
- 2-2.5 µg dot weight



300 µm keep-out zone (KoZ)

To understand the full magnitude of this challenge, imagine a pilot perfectly landing a multi-million dollar, high-speed jet on an aircraft carrier deck with 500 feet of runway on a rough sea 180,000 times daily without going over the edge.

Much like our hypothetical pilot, the engineers developing this dispensing process overcame several highly complex obstacles to achieve consistent and successful yield results with support from Nordson.

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SOLUTION

Nordson application engineers began their detailed analysis by evaluating two key areas: dispense locations and height-sensing capabilities.

Fine-Tuning Fluid Placement

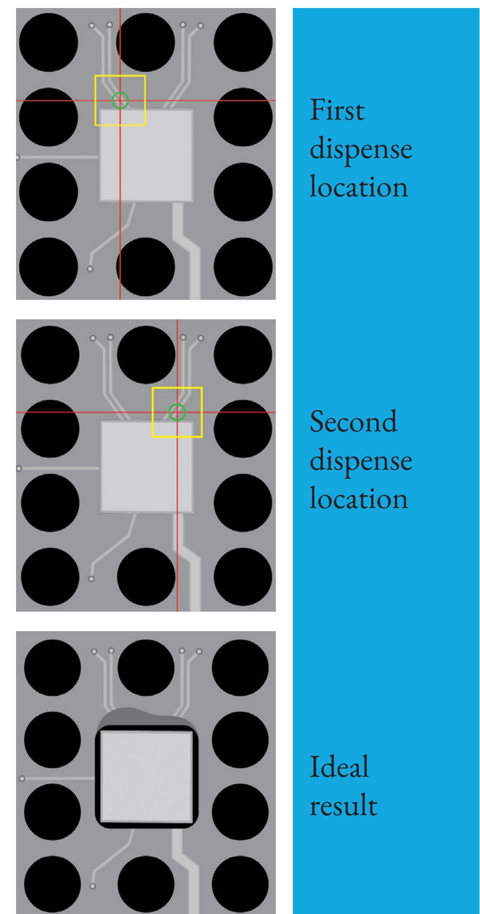
The first step involved determining the best method for dispensing the 12 µg of underfill material per chip into the 300 µm dispense area, allowing time for the capillary action to take effect and, therefore, prevent material from flowing into the neighboring keep-out zone around the solder bumps.

The Nordson application team assessed whether dispensing for each chip should occur at one or two locations. Because the dispensing area was extremely small at 300 µm, they decided to test dispensing five dots at two locations.

The shift from dispensing the entire volume of material in one location to two proved beneficial. It allowed enough time for the underfill material to flow under the die evenly. It also helped reduce the probability of the material flowing into the solder bump keep-out zone and creating an unintended electrical connection (bridge), a leading cause of poor yield in this application.

The Nordson applications team recommended the ASYMTEK Calibrated Process Jetting (CPJ) feature to further assist with the application adjustments. They developed a mid-cycle CPJ routine to monitor the dot weight, ensuring consistency over the extended production run.

To complete the fluid placement adjustments, the Nordson team implemented a periodic nozzle cleaning procedure to maintain cleanliness over the long production run, preventing fluid from collecting on the nozzle and potentially impacting yield.



First dispense location

Second dispense location

Ideal result

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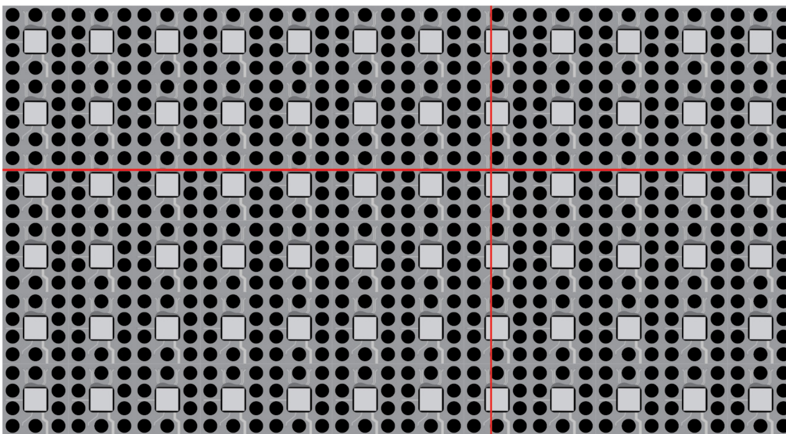
SOLUTION CONTINUED

Working Around Warpage

The next optimization step involved working with the manufacturer's operations team to implement Maximum Z Height Sensing. Height sensing ensures a consistent dispense height regardless of warpage, preventing contamination on the top of the die and the dispense valve from bumping into the chip surface due to height differences.

After identifying and applying Maximum Z Height Sensing, nozzle crash defects due to warpage were effectively eliminated, another cause of poor yield in this application.



Discover how Nordson can optimize your process. For more information, visit our website to find your local regional office or representative.

We have several global locations to serve you.

Acknowledgments

We thank our colleagues Ernel Avila, Application Manager, Jayaraj Kannan, Applications and Service Engineer, and Nick Tan, Technical Sales Manager, for their insight and technical expertise, which greatly assisted in creating this case study.

Process Optimization Results & Benefits

- The IntelliJet Jetting System's higher jetting frequency increased the wafer per hour (WPH) throughput by 84% and reduced production costs significantly with extended jet applicator lifetime.
- ±40 µm placement accuracy @ 3σ in the X and Y axis
- Consistent jetting performance at high frequencies over long production runs
- Elimination of defects related to warpage
- Increased CoW yield by 3.3% from 96.47% to 99.66%