CASE STUDY

Powertech Technology Inc. (PTI) Advances Underfill for Panel-Level Packaging (PLP), Achieving Over 99% Yield

With Industry-Leading Nordson Application Support and Fluid Dispensing Technology in Large Panel Format

Powertech Technology Inc. (PTI), a leading Outsourced Semiconductor Assembly and Test (OSAT) company headquartered in Taiwan is enabling panel-level packaging (PLP) applications—an emerging and promising solution designed to meet the semiconductor industry's growing demands. PLP offers a path to managing the increasing complexity of larger die sizes and higher-density designs while maintaining manufacturability and cost efficiency. Our collaboration helped accelerate the adoption of this advanced packaging technology, positioning them at the forefront of next-generation semiconductor manufacturing to capitalize on surging artificial intelligence (AI) and high-performance computing (HPC) demand.

Introduction

Underfill has been pivotal in semiconductor packaging since the adoption of flip-chips in the 1990s. As applications have become more demanding—particularly in high-performance CPUs, GPUs, and advanced architectures like flip-chip and 2.5D/3D ICs—the importance of underfill in enhancing mechanical reliability and thermal performance has only grown.

Since the beginning, Nordson has been at the forefront, continually driving innovation across every stage of underfill evolution—from board-level and substrate-level processes to wafer-level and now panel-level applications.

PLP is rapidly gaining momentum in response to the growing need for efficient, scalable packaging solutions that support emerging technologies such as AI.

While traditional semiconductor packaging has been confined to silicon wafers up to 300 mm in diameter, panel-level processing opens new opportunities that enable heterogeneous integration (HI), chiplet architectures, and 3D packaging strategies and offers significant throughput and cost-efficiencies for manufacturing.

The Challenge

Although PLP offers many advantages, it does introduce some unique challenges for the underfill process that mainly stem from the complexity of processing larger packages on large panels.

Panel Warpage: Warpage, which is common with large panels, can significantly hinder uniform underfill dispensing and impact yield.

Multiple Dispense Passes and Flow-Out Time: A standard approach to recipe development is often insufficient to mitigate the impact of long cycle times in PLP applications. Multiple dispensing passes are required to deliver sufficient underfill material, ensuring complete encapsulation of solder bumps. When multiple passes are combined with extended wait times for capillary flow-out, total cycle times can stretch over several hours per panel. The prolonged process also increases the risk of in-process curing of material, negatively impacting yield and throughput.

Solution Overview

The Nordson team has solved several common panel-related challenges, from handling and transport to warpage, cycle time, and ensuring heat uniformity across the panel to achieve void-free underfill results. Our PLP solution combines the ASYMTEK Vantage® Series dispensing system, IntelliJet® jetting system, and Canvas® fluid dispensing software operations, controls, and traceability to support panel-level applications.

In this demonstration, Nordson applications engineers leveraged our Vantage Series PLP equipment solution and application development knowledge to achieve a significant milestone by successfully addressing the main challenges to processing a 515 x 510 mm panel containing ~70 50 x 50 mm packages.

Each package required several dispense passes to complete the underfill process. Idle time was necessary between each dispense pass to allow the underfill material to flow under the packages, completely encapsulating the solder bumps and creating the desired fillet width, height, and shape. This success is a testament to our team's expertise and the effectiveness of our equipment and methods.

Challenges At-A-Glance

- Handling and transporting warped panels between the factory and dispensing system, ensuring contact with the panels and keeping them flat during handling.
- Applying heat uniformly to eliminate warpage and facilitate fluid flow during dispensing.
- Balancing all process parameters, including capillary flow-out and material cure time, to achieve complete encapsulation and optimal cycle time.
- Automatically adjusting for skewed parts in the x and y-axis.

Application Details and Process Targets

- Fluid type: Underfill
- Panel size: 515 x 510 mm
- Approximately 70 packages per panel
- Package size: 50 x 50 mm
- Bump gap: 15-20 µm
- Die to substrate gap: 40 µm

Solution Details

Optimizing the Configuration: The Vantage Series system was configured with dual IntelliJet valves mounted on independent heads to maximize maneuverability and provide real-time correction. If needed, the independent valves automatically adjusted for skewed parts and component height variation in the x and y-axes, allowing for the maintenance of high-speed, precise dispense accuracy over a large-area panel.

Managing Warpage and Optimizing Flow: The Nordson applications team applied vacuum suction, heat, and an additional clamping tool to accommodate a panel warpage of ±6 mm. Panels were pre-heated using a method that minimizes cycle time, eliminates warpage, and keeps them within a set temperature range throughout the process to optimize fluid flow.

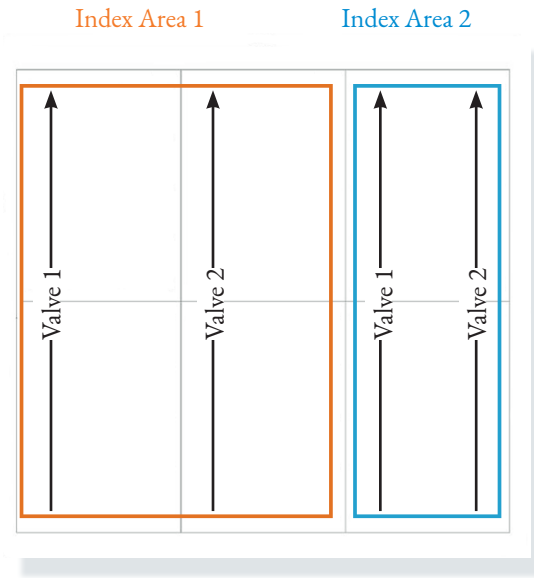
Optimizing Cycle Time: The team identified that each package needed multiple dispensing passes and determined that the dispensing cycle time should not exceed one hour to prevent the material from curing during the process. To tackle this issue, they concentrated on optimizing the dispensing recipe. This effort preserved yield while reducing the dispensing cycle time for an entire panel by approximately 30%, a notable improvement.

The panel was divided into two index areas to aid recipe development for this application. This setup allowed for consistent positioning of the dispensing heads and ensured accurate fluid deposition at specific locations and intervals. Index Area 1 accounted for 65% of the packages, while Index Area 2 accounted for 35%. The process involved nine passes to dispense the necessary fluid volume, completing the underfill process for all packages. **Important note:** While the team utilized indexing for this application, Nordson will offer a next-generation equipment solution that eliminates the need for indexing, further decreasing cycle time and enhancing overall efficiency.

Demonstration Results and Impact

- Transitioning from a 300 mm wafer to a 515 x 510 mm panel increased throughput from approximately 25 to 70 packages per process
- Void-free dispensing performance with yield > 99%
- Processing cycle time was reduced by approximately 30% for the 515 x 510 mm panel, keeping it under the critical one-hour mark to prevent in-process underfill curing
- Panel warpage of ±6 mm was effectively mitigated

For this demonstration, the Vantage Series with Canvas fluid dispensing software was equipped with dual IntelliJet valves, RS-58F valve cartridges, high-flow vacuum tooling, a Nano1450 camera, a confocal laser height sensor, panel-level indexing capabilities, and a precision scale.



The 515 x 510 mm panel layout required nine dispense passes per package with idle time between passes, allowing the underfill material to flow under the packages and achieve void-free results.

Contact Us

If you're navigating the complexities of high-density, next-generation semiconductor packaging, now is the time to partner with a proven leader. Our innovative dispensing solutions and expert application support are helping manufacturers overcome critical PLP challenges.

Connect with our team today to learn how we can support your PLP journey and enhance your competitive advantage.

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